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Version 3, 29 June 2007

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data structure

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## 1.2 libintl 0.22.5-r0

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(For example, a function in a library to compute square roots has



a purpose that is entirely well-defined independent of the application. Therefore, Subsection 2d requires that any application-supplied function or table used by this function must be optional: if the application does not supply it, the square root function must still compute square roots.)  
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@var{signature of Ty Coon}, 1 April 1989

Ty Coon, President of Vice

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## 1.4 libdw 0.191-r0

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## 1.5 py3-setuptools-pyc 70.3.0-r0

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## 1.6 apacheutils 2.4.62-r0

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```
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 */
```

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*/

```

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For the server\util\_md5.c component:

```

/*****
* NCSA HTTPd Server
* Software Development Group
* National Center for Supercomputing Applications
* University of Illinois at Urbana-Champaign

```

```

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*
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*
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*/
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For the test\zb.c component:

```
/*          ZeusBench V1.01
=====
```

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Written by Adam Twiss (adam@zeus.co.uk). March 1996

Thanks to the following people for their input:

Mike Belshe (mbelshe@netscape.com)

Michael Campanella (campanella@stevms.enet.dec.com)

\*/

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<script type="text/javascript"><!--<!--><![CDATA[//<!--

var comments\_shortcode = 'httpd';

var comments\_identifier = 'http://httpd.apache.org/docs/2.4/license.html';

(function(w, d) {

if (w.location.hostname.toLowerCase() == "httpd.apache.org") {

d.write('<div id="comments\_thread"></div>');

var s = d.createElement('script');

```

s.type = 'text/javascript';
s.async = true;
s.src = 'https://comments.apache.org/show_comments.lua?site=' + comments_shortcode + '&page=' +
comments_identifier;
(d.getElementsByTagName('head')[0] || d.getElementsByTagName('body')[0]).appendChild(s);
}
else {
d.write('<div id="comments_thread">Comments are disabled for this page at the moment.</div>');
}
})(window, document);
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href="/sitemap.html">Sitemap</a></p></div><script type="text/javascript"><!--<![CDATA[<!--<!--
if (typeof(prettyPrint) !== 'undefined') {
prettyPrint();
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## 1.9 utmps-libs 0.1.2.3-r2

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# 1.10 py3-packaging-pyc 24.2-r0

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## 1.11 libpanelw 6.5\_p20241006-r3

### 1.11.1 Available under license :

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```
# ncurses 6.5 - patch 20241006 - Thomas E. Dickey
#
# -----
#
# Ncurses 6.5 is at
#  https://invisible-island.net/archives/ncurses/
#  https://invisible-mirror.net/archives/ncurses/
#  https://ftp.gnu.org/gnu/ncurses/
#
# Patches for ncurses 6.5 can be found at
#  https://invisible-island.net/archives/ncurses/6.5
#  https://invisible-mirror.net/archives/ncurses/6.5
#
# -----
# https://invisible-island.net/archives/ncurses/6.5/ncurses-6.5-20241006.patch.gz
# patch by Thomas E. Dickey <dickey@invisible-island.net>
```

# created Sun Oct 6 23:44:01 UTC 2024

```
# -----
# NEWS | 6 +++
# VERSION | 2 -
# c++/cursesf.cc | 6 +--
# c++/cursesf.h
| 6 +--
# c++/cursesm.cc | 6 +--
# c++/cursesm.h | 6 +--
# c++/cursespc.cc | 6 +--
# c++/cursespad.cc | 6 +--
# c++/cursslk.cc | 12 +++----
# c++/cursslk.h | 6 +--
# dist.mk | 4 +-
# misc/terminfo.src | 23 ++++++++--
# ncurses/base/lib_screen.c | 4 +-
# ncurses/base/new_pair.c | 4 +-
# ncurses/curses.priv.h | 4 +-
# ncurses/new_pair.h | 4 +-
# ncurses/tinfo/trim_sgr0.c | 7 ++--
# ncurses/tty/lib_twait.c | 6 +--
# package/debian-mingw/changelog | 4 +-
# package/debian-mingw64/changelog | 4 +-
# package/debian/changelog | 4 +-
# package/mingw-ncurses.nsi | 4 +-
# package/mingw-ncurses.spec | 2 -
# package/ncurses.spec | 2 -
# package/ncurset.spec |
2 -
# test/blue.c | 10 +++--
# test/bs.c | 8 ++--
# test/cardfile.c | 12 +++----
# test/chgat.c | 6 +--
# test/clip_printw.c | 8 ++--
# test/color_name.h | 6 +--
# test/demo_defkey.c | 4 +-
# test/demo_forms.c | 22 +++++-----
# test/demo_menus.c | 32 ++++++++-----
# test/demo_new_pair.c | 4 +-
# test/demo_panels.c | 16 ++++----
# test/demo_termcap.c | 18 +++++-----
# test/demo_terminfo.c | 18 +++++-----
# test/dots.c | 6 +--
# test/dots_mvcur.c | 6 +--
# test/dots_termcap.c | 8 ++--
# test/dup_field.c | 14 ++++----
# test/filter.c | 6 +--
# test/form_driver_w.c | 6 +--
```

```

# test/gdc.c          | 10 +++---
# test/inch_wide.c
    | 6 +--
# test/inchs.c        | 6 +--
# test/ins_wide.c     | 6 +--
# test/insdelln.c     | 8 ++--
# test/inserts.c      | 6 +--
# test/knight.c       | 7 ++--
# test/list_keys.c    | 8 ++--
# test/move_field.c   | 18 +++++-----
# test/movewindow.c   | 16 +++++-----
# test/ncurses.c      | 61 ++++++-----
# test/padview.c      | 12 +++---
# test/parse_rgb.h    | 6 +--
# test/picsmap.c      | 14 +++++---
# test/popup_msg.c    | 8 ++--
# test/popup_msg.h    | 6 +--
# test/railroad.c     | 6 +--
# test/rain.c         | 20 ++++++-----
# test/redraw.c       | 6 +--
# test/savescreen.c   | 14 +++++---
# test/tclock.c       | 4 +-
# test/test.priv.h
    | 10 +++---
# test/test_add_wchstr.c | 6 +--
# test/test_addchstr.c  | 6 +--
# test/test_addstr.c    | 6 +--
# test/test_addwstr.c   | 6 +--
# test/test_endwin.c    | 6 +--
# test/test_get_wstr.c  | 8 ++--
# test/test_getstr.c    | 8 ++--
# test/test_instr.c     | 8 ++--
# test/test_inwstr.c    | 8 ++--
# test/test_mouse.c     | 4 +-
# test/test_opaque.c    | 8 ++--
# test/test_sgr.c       | 26 ++++++-----
# test/test_tparm.c     | 12 +++---
# test/test_vidputs.c   | 6 +--
# test/testcurs.c       | 8 ++--
# test/testscanw.c      | 6 +--
# test/view.c          | 21 ++++++-----
# 83 files changed, 392 insertions(+), 369 deletions(-)
# -----
Index: NEWS
Prereq:
1.4185
--- ncurses-6.5-20240928+/NEWS 2024-09-28 20:27:44.000000000 +0000
+++ ncurses-6.5-20241006/NEWS 2024-10-06 08:53:45.000000000 +0000

```



@@ -26,7 +26,7 @@

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-----  
--- \$Id: NEWS,v 1.4185 2024/09/28 20:27:44 tom Exp \$

+-- \$Id: NEWS,v 1.4188 2024/10/06 08:53:45 tom Exp \$  
-----

This is a log of changes that ncurses has gone through since Zeyd started

@@ -46,6 +46,10 @@

Changes through 1.9.9e did not credit all contributions;

it is not possible to add this information.

+20241006

+ + fixes for compiler warnings/cppcheck.

+ + use xterm+alt+title in wezterm -TD

+

20240928

+ improve error-message from infocmp when a terminal entry cannot be  
opened (patch by Branden Robinson).

Index:

VERSION

--- ncurses-6.5-20240928+/VERSION 2024-09-28 09:53:21.000000000 +0000

+++ ncurses-6.5-20241006/VERSION 2024-10-06 08:53:45.000000000 +0000

@@ -1 +1 @@

-5:0:10 6.5 20240928

+5:0:10 6.5 20241006

Index: c++/cursesf.cc

Prereq: 1.26

--- ncurses-6.5-20240928+/c++/cursesf.cc 2021-04-17 18:11:08.000000000 +0000

+++ ncurses-6.5-20241006/c++/cursesf.cc 2024-10-05 22:47:12.000000000 +0000

@@ -1,6 +1,6 @@

// \* this is for making emacs happy: -\*-Mode: C++;-\*-

/\*\*\*\*\*

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@@ -36,7 +36,7 @@

#include "cursesf.h"

#include "cursesapp.h"

-MODULE\_ID("\$Id: cursesf.cc,v 1.26 2021/04/17 18:11:08 tom Exp \$")

+MODULE\_ID("\$Id: cursesf.cc,v 1.27 2024/10/05 22:47:12 tom Exp \$")

NCursesFormField::~NCursesFormField () THROWS(NCursesException)

{

@@ -76,7 +76,7 @@

```
void NCursesForm::setDefaultAttributes()
```

```
{
- NCursesApplication* S = NCursesApplication::getApplication();
+ const NCursesApplication* S = NCursesApplication::getApplication();
```

```
    int n = count();
```

```
    if (n > 0) {
```

Index: c++/cursesf.h

Prereq: 1.39

--- ncurses-6.5-20240928+/c++/cursesf.h 2022-08-20 20:52:15.000000000 +0000

+++ ncurses-6.5-20241006/c++/cursesf.h 2024-10-05 22:47:12.000000000 +0000

@@ -1,7 +1,7 @@

```
// * This makes emacs happy -*-Mode: C++;-*-
```

```
// vile:cppmode
```

```
/*****
```

```
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```

@@ -33,7 +33,7 @@

```
 * Author: Juergen Pfeifer, 1997 *
```

```
*****/
```

```
-// $Id: cursesf.h,v 1.39 2022/08/20 20:52:15 tom Exp $
```

```
+// $Id: cursesf.h,v 1.40 2024/10/05 22:47:12 tom Exp $
```

```
#ifndef NCURSES_CURSESF_H_incl
```

```
#define NCURSES_CURSESF_H_incl 1
```

@@ -384,7 +384,7 @@

```
}
```

```
inline void *get_user() {
```

```
- UserHook* uptr = reinterpret_cast<UserHook*> (::form_userptr (form));
```

```
+ const UserHook* uptr = reinterpret_cast<UserHook*> (::form_userptr (form));
```

```
    assert (uptr != 0 && uptr->m_back==this && uptr->m_owner==form);
```

```
    return uptr->m_user;
```

```
}
```

Index: c++/cursesm.cc

Prereq: 1.27

--- ncurses-6.5-20240928+/c++/cursesm.cc 2021-04-17 18:11:08.000000000 +0000

+++ ncurses-6.5-20241006/c++/cursesm.cc 2024-10-05

22:47:12.000000000 +0000

@@ -1,6 +1,6 @@

```
// * this is for making emacs happy: -*-Mode: C++;-*-
```

```

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@@ -36,7 +36,7 @@
#include "cursesm.h"
#include "cursesapp.h"

-MODULE_ID("$Id: cursesm.cc,v 1.27 2021/04/17 18:11:08 tom Exp $")
+MODULE_ID("$Id: cursesm.cc,v 1.28 2024/10/05 22:47:12 tom Exp $")

NCursesMenuItem::~NCursesMenuItem() THROWS(NCursesException)
{
@@ -168,7 +168,7 @@
void
NCursesMenu::setDefaultAttributes()
{
- NCursesApplication* S = NCursesApplication::getApplication();
+
const NCursesApplication* S = NCursesApplication::getApplication();
if (S) {
    ::set_menu_fore(menu, S->foregrounds());
    ::set_menu_back(menu, S->backgrounds());
Index: c++/cursesm.h
Prereq: 1.35
--- ncurses-6.5-20240928+/c++/cursesm.h 2022-08-20 20:52:15.000000000 +0000
+++ ncurses-6.5-20241006/c++/cursesm.h 2024-10-05 22:47:12.000000000 +0000
@@@ -1,6 +1,6 @@@
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@@@ -32,7 +32,7 @@@
* Author: Juergen Pfeifer, 1997
*****/

-// $Id: cursesm.h,v 1.35 2022/08/20 20:52:15 tom Exp $
+// $Id: cursesm.h,v 1.36 2024/10/05 22:47:12 tom Exp $

#ifndef NCURSES_CURSESM_H_incl
#define NCURSES_CURSESM_H_incl 1
@@@ -245,7 +245,7 @@@
}

```

```

inline void *get_user() {
-   UserHook* uptr = STATIC_CAST(UserHook*)(::menu_userptr (menu));
+   const UserHook* uptr = STATIC_CAST(UserHook*)(::menu_userptr (menu));
    assert (uptr != 0 && uptr->m_back==this && uptr->m_owner==menu);
    return uptr->m_user;
}
Index: c++/cursespc.cc
Prereq: 1.27
--- ncurses-6.5-20240928+/c++/cursespc.cc 2020-02-02 23:34:34.000000000 +0000
+++ ncurses-6.5-20241006/c++/cursespc.cc 2024-10-05 22:47:12.000000000 +0000
@@ -1,6 +1,6 @@
// * this is for making emacs happy: -*-Mode: C++;-*-
/*****
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@@ -35,7 +35,7 @@
#include "internal.h"
#include "cursespc.h"

-MODULE_ID("$Id: cursespc.cc,v 1.27 2020/02/02 23:34:34 tom Exp $")
+MODULE_ID("$Id: cursespc.cc,v 1.28 2024/10/05 22:47:12 tom Exp $")

NCursesPanel* NCursesPanel::dummy = static_cast<NCursesPanel*>(0);

@@ -64,7 +64,7 @@
void
NCursesPanel::redraw()
{
-   PANEL *pan;
+   const PANEL *pan;

    pan = ::panel_above(NULL);
    while (pan) {
Index: c++/cursespad.cc
Prereq: 1.18
--- ncurses-6.5-20240928+/c++/cursespad.cc 2020-02-02 23:34:34.000000000 +0000
+++ ncurses-6.5-20241006/c++/cursespad.cc 2024-10-05 22:47:12.000000000 +0000
@@ -1,6 +1,6 @@
// * this is for making emacs happy: -*-Mode: C++;-*-
/*****
-
+ * Copyright 2020 Thomas E. Dickey                      *
+ * Copyright 2020,2024 Thomas E. Dickey                  *

```

```

* Copyright 1999-2012,2013 Free Software Foundation, Inc. *
*
* Permission is hereby granted, free of charge, to any person obtaining a *
@@ -36,7 +36,7 @@

#include <cursesw.h>

-MODULE_ID("$Id: cursespad.cc,v 1.18 2020/02/02 23:34:34 tom Exp $")
+MODULE_ID("$Id: cursespad.cc,v 1.19 2024/10/05 22:47:12 tom Exp $")

NCursesPad::NCursesPad(int nlines, int ncols)
: NCursesWindow(),
@@ -221,7 +221,7 @@
void NCursesFramedPad::OnOperation(int pad_req)
{
(void) pad_req;
- NCursesWindow* W = Win();
+ const NCursesWindow* W = Win();
NCursesWindow* W2 = getWindow();

if ((static_cast<NCursesWindow*>(0) != W) && (static_cast<NCursesWindow*>(0) != W2)) {
Index: c++/cursslk.cc
Prereq:
1.22
--- ncurses-6.5-20240928+/c++/cursslk.cc 2024-06-15 21:07:30.000000000 +0000
+++ ncurses-6.5-20241006+/c++/cursslk.cc 2024-10-05 19:36:22.000000000 +0000
@@ -35,10 +35,10 @@
#include "internal.h"
#include "cursesapp.h"

-MODULE_ID("$Id: cursslk.cc,v 1.22 2024/06/15 21:07:30 tom Exp $")
+MODULE_ID("$Id: cursslk.cc,v 1.23 2024/10/05 19:36:22 tom Exp $")

Soft_Label_Key_Set::Soft_Label_Key&
- Soft_Label_Key_Set::Soft_Label_Key::operator=(char *text)
+ Soft_Label_Key_Set::Soft_Label_Key::operator=(const char *text)
{
delete[] label;
size_t need = 1 + ::strlen(text);
@@ -111,11 +111,11 @@

void Soft_Label_Key_Set::activate_label(int i, bool bf) {
if (!b_attrInit) {
- NCursesApplication* A = NCursesApplication::getApplication();
+ const NCursesApplication* A = NCursesApplication::getApplication();
if (A) attrset(A->labels());
b_attrInit = TRUE;
}

```

```

- Soft_Label_Key& K = (*this)[i];
+ const Soft_Label_Key& K = (*this)[i];
  if (ERR==::slk_set(K.num,bf?K.label:"",K.format))
    Error("slk_set");
  noutrefresh();
@@ -124,12 +124,12 @@
void Soft_Label_Key_Set::activate_labels(bool bf)
{
  if (!b_attrInit) {
-   NCursesApplication* A = NCursesApplication::getApplication();
+   const NCursesApplication* A = NCursesApplication::getApplication();
    if (A) attrset(A->labels());
    b_attrInit = TRUE;
  }
  for(int i=1; i <= num_labels; i++) {
-   Soft_Label_Key& K = (*this)[i];
+   const Soft_Label_Key& K = (*this)[i];
    if (ERR==::slk_set(K.num,bf?K.label:"",K.format))
      Error("slk_set");
  }
}
Index: c++/cursslk.h
Prereq: 1.19
--- ncurses-6.5-20240928/c++/cursslk.h 2021-04-17 18:11:08.000000000 +0000
+++ ncurses-6.5-20241006/c++/cursslk.h 2024-10-05 22:47:12.000000000 +0000
@@ -1,7 +1,7 @@
// * this is for making emacs happy: -*-Mode: C++;-*-
// vile:cppmode
/*****
- * Copyright 2019-2020,2021 Thomas E. Dickey
*
+ * Copyright 2019-2021,2024 Thomas E. Dickey *
* Copyright 1998-2003,2005 Free Software Foundation, Inc. *
*
* Permission is hereby granted, free of charge, to any person obtaining a *
@@ -33,7 +33,7 @@
* Author: Juergen Pfeifer, 1997 *
*****/

-// $Id: cursslk.h,v 1.19 2021/04/17 18:11:08 tom Exp $
+// $Id: cursslk.h,v 1.20 2024/10/05 22:47:12 tom Exp $

#ifndef NCURSES_CURSSLK_H_incl
#define NCURSES_CURSSLK_H_incl
@@ -62,7 +62,7 @@

public:
  // Set the text of the Label
-   Soft_Label_Key& operator=(char *text);

```

```

+ Soft_Label_Key& operator=(const char *text);

// Set the Justification of the Label
Soft_Label_Key& operator=(Justification just) {
Index: dist.mk
Prereq: 1.1634
--- ncurses-6.5-20240928+/dist.mk 2024-09-28
09:53:21.000000000 +0000
+++ ncurses-6.5-20241006/dist.mk 2024-10-06 08:53:45.000000000 +0000
@@ -26,7 +26,7 @@
# use or other dealings in this Software without prior written      #
# authorization.                                                    #
#####
-# $Id: dist.mk,v 1.1634 2024/09/28 09:53:21 tom Exp $
+# $Id: dist.mk,v 1.1636 2024/10/06 08:53:45 tom Exp $
# Makefile for creating ncurses distributions.
#
# This only needs to be used directly as a makefile by developers, but
@@ -38,7 +38,7 @@
# These define the major/minor/patch versions of ncurses.
NCURSES_MAJOR = 6
NCURSES_MINOR = 5
-NCURSES_PATCH = 20240928
+NCURSES_PATCH = 20241006

# We don't append the patch to the version, since this only applies to releases
VERSION = $(NCURSES_MAJOR).$(NCURSES_MINOR)
Index: misc/terminfo.src
--- ncurses-6.5-20240928+/misc/terminfo.src 2024-09-07 16:23:31.000000000
+0000
+++ ncurses-6.5-20241006/misc/terminfo.src 2024-10-05 16:04:17.000000000 +0000
@@ -6,8 +6,8 @@
# Report bugs and new terminal descriptions to
# bug-ncurses@gnu.org
#
-# $Revision: 1.1150 $
-# $Date: 2024/09/07 16:23:31 $
+# $Revision: 1.1153 $
+# $Date: 2024/10/05 16:04:17 $
#
# The original header is preserved below for reference. It is noted that there
# is a "newer" version which differs in some cosmetic details (but actually
@@ -8060,6 +8060,17 @@
# "wezterm is a terminal emulator with support for modern features
# such as fonts with ligatures, hyperlinks, tabs and multiple windows."
#
+# The documentation bears mention. It refers to the "ANSI" standard and
+# https://wezfurlong.org/wezterm/what-is-a-terminal.html#ansi-and-ecma-48

```

```

+# X3.64 (withdrawn long ago). A related website
+# https://github.com/wez/ecma48
+# states that ECMA-48 was issued in 1979 and not revised since. Actually that
+# was the second revision; the fifth revision in 1991 is current. The source
+#
code refers to the second revision in a half-dozen places. Further, there
+# are three times as many references to Wikipedia as to xterm's documentation.
+# The git commit comments in several instances hint at an incomplete reading
+# of the relevant standards.
+#
# wezterm-20240203-110809-5046fc22 tested with MacOS
# General:
# + initial screensize is now 80x24
@@ -8094,7 +8105,7 @@
# + poor (doesn't copy anyone, most of the results are wrong)
# vttest:
# + DA is VT5xx with sixel, selective erase, user windows, color
-# + DA2 is VT220 version 277
+# + DA2 is VT220 version 277, perhaps a reference to xterm #277
# + only the VT100 character set works, contrary to DA/DA2.
# + no NRCS, either
# + double-sized character work, with some debris
@@ -8136,7 +8147,7 @@
use=ansi+rep, use=ansi+sgrdim, use=bracketed+paste,
use=ecma+index, use=ecma+italics, use=ecma+strikeout,
use=report+version, use=vt220+cvis,
- use=xterm+256color2, use=xterm+alt1049,
+ use=xterm+256color2,
use=xterm+alt+title,
use=xterm+focus, use=xterm+pcc2, use=xterm+pce2,
use=xterm+pcf2, use=xterm+sl-alt, use=xterm+sm+1006,
use=xterm+tmux,
@@ -27644,4 +27655,8 @@
# 2024-09-07
# + update comments -TD
#
+# 2024-10-05
+# + use xterm+alt+title in wezterm -TD
+# + update comments -TD
+#
##### SHANTIH! SHANTIH! SHANTIH!
Index: ncurses/base/lib_screen.c
Prereq: 1.108
--- ncurses-6.5-20240928+/ncurses/base/lib_screen.c 2024-09-22 20:20:36.000000000 +0000
+++ ncurses-6.5-20241006/ncurses/base/lib_screen.c 2024-10-05 20:47:44.000000000 +0000
@@ -42,7 +42,7 @@
#define CUR SP_TERMTYPE
#endif

```



```

-MODULE_ID("$Id: lib_screen.c,v 1.108 2024/09/22 20:20:36 tom Exp $")
+MODULE_ID("$Id: lib_screen.c,v 1.109 2024/10/05 20:47:44 tom Exp $")

#define MAX_SIZE 0x3fff /* 16k is big enough for a window or pad */

@@ -943,7 +943,7 @@
* Replace a window covering the whole screen, i.e., newscr or curscr.
*/

static WINDOW *
-replace_window(WINDOW *target, FILE *source)
+replace_window(const
WINDOW *target, FILE *source)
{
WINDOW *result = getwin(source);
#if NCURSES_EXT_FUNCS
Index: ncurses/base/new_pair.c
Prereq: 1.24
--- ncurses-6.5-20240928+/ncurses/base/new_pair.c 2024-07-27 19:22:23.000000000 +0000
+++ ncurses-6.5-20241006/ncurses/base/new_pair.c 2024-10-05 20:51:29.000000000 +0000
@@ -61,7 +61,7 @@

#endif

-MODULE_ID("$Id: new_pair.c,v 1.24 2024/07/27 19:22:23 tom Exp $")
+MODULE_ID("$Id: new_pair.c,v 1.25 2024/10/05 20:51:29 tom Exp $")

#if NCURSES_EXT_COLORS

@@ -193,7 +193,7 @@
* pair table.
*/

NCURSES_EXPORT(void)
-_nc_reset_color_pair(SCREEN *sp, int pair, colorpair_t * next)
+_nc_reset_color_pair(SCREEN *sp, int pair, const colorpair_t * next)
{
colorpair_t *last;

Index: ncurses/curses.priv.h
Prereq: 1.691
--- ncurses-6.5-20240928+/ncurses/curses.priv.h 2024-09-28 15:35:01.000000000 +0000
+++ ncurses-6.5-20241006/ncurses/curses.priv.h 2024-10-05 21:01:50.000000000 +0000
@@ -35,7 +35,7 @@
*****/

/*
- * $Id: curses.priv.h,v 1.691 2024/09/28 15:35:01 tom Exp $
+ * $Id: curses.priv.h,v 1.692 2024/10/05 21:01:50 tom Exp $

```

```

*
* curses.priv.h
*
@@ -2170,7 +2170,7 @@
extern NCURSES_EXPORT(int) _nc_read_termcap_entry (const char *const, TERMTYPE2 *const);
extern NCURSES_EXPORT(int) _nc_setup_tinfo(const char *, TERMTYPE2 *);
extern NCURSES_EXPORT(int) _nc_setupscreen (int, int, FILE *, int, int);
-extern NCURSES_EXPORT(int) _nc_timed_wait (SCREEN *, int, int, int * EVENTLIST_2nd(_nc_eventlist *));
+extern NCURSES_EXPORT(int) _nc_timed_wait (const SCREEN *, int, int, int *
EVENTLIST_2nd(_nc_eventlist *));
extern NCURSES_EXPORT(int) _nc_trans_string (char *, const char *);
extern NCURSES_EXPORT(void) _nc_init_termtype (TERMTYPE2 *const);
extern NCURSES_EXPORT(void) _nc_do_color (int, int, int, NCURSES_OUTC);
Index: ncurses/new_pair.h
Prereq: 1.14
--- ncurses-6.5-20240928+/ncurses/new_pair.h 2024-05-25 23:10:33.000000000 +0000
+++
ncurses-6.5-20241006/ncurses/new_pair.h 2024-10-05 20:57:47.000000000 +0000
@@ -34,7 +34,7 @@
/*
* Common type definitions and macros for new_pair.c, lib_color.c
*
- * $Id: new_pair.h,v 1.14 2024/05/25 23:10:33 tom Exp $
+ * $Id: new_pair.h,v 1.15 2024/10/05 20:57:47 tom Exp $
*/

#ifndef NEW_PAIR_H
@@ -116,7 +116,7 @@
#if NCURSES_EXT_FUNCS && NCURSES_EXT_COLORS
extern NCURSES_EXPORT(void) _nc_copy_pairs(SCREEN*, colorpair_t*, colorpair_t*, int);
extern NCURSES_EXPORT(void) _nc_free_ordered_pairs(SCREEN*);
-extern NCURSES_EXPORT(void) _nc_reset_color_pair(SCREEN*, int, colorpair_t*);
+extern NCURSES_EXPORT(void) _nc_reset_color_pair(SCREEN*, int, const colorpair_t*);
extern NCURSES_EXPORT(void) _nc_set_color_pair(SCREEN*, int, int);
#else
#define _nc_free_ordered_pairs(sp) /* nothing */
Index: ncurses/tinfo/trim_sgr0.c
Prereq: 1.23
--- ncurses-6.5-20240928+/ncurses/tinfo/trim_sgr0.c 2024-07-27 19:22:23.000000000 +0000
+++ ncurses-6.5-20241006/ncurses/tinfo/trim_sgr0.c 2024-10-05
20:53:48.000000000 +0000
@@ -37,7 +37,7 @@

#include <tic.h>

-MODULE_ID("$Id: trim_sgr0.c,v 1.23 2024/07/27 19:22:23 tom Exp $")
+MODULE_ID("$Id: trim_sgr0.c,v 1.24 2024/10/05 20:53:48 tom Exp $")

```

```

#undef CUR
#define CUR tp->
@@ -237,12 +237,10 @@

    if (PRESENT(exit_attribute_mode)
    && PRESENT(set_attributes)) {
- bool found = FALSE;
    char *on = set_attribute_9(tp, 1);
    char *off = set_attribute_9(tp, 0);
    char *end = strdup(exit_attribute_mode);
    char *tmp;
- size_t i, j, k;

    TR(TRACE_DATABASE, ("checking if we can trim sgr0 based on sgr"));
    TR(TRACE_DATABASE, ("sgr0    %s", _nc_visbuf(end)));
@@ -255,6 +253,9 @@
    FreeIfNeeded(off);
} else if (similar_sgr(off, end)
    && !similar_sgr(off, on)) {
+ bool found = FALSE;
+ size_t i, j, k;
+
    TR(TRACE_DATABASE, ("adjusting sgr(9:off) : %s", _nc_visbuf(off)));
    result = off;
    /*
Index: ncurses/tty/lib_twait.c
Prereq: 1.81
--- ncurses-6.5-20240928+/ncurses/tty/lib_twait.c 2023-09-16
16:30:40.000000000 +0000
+++ ncurses-6.5-20241006/ncurses/tty/lib_twait.c 2024-10-05 22:47:12.000000000 +0000
@@ -1,5 +1,5 @@
/*****
- * Copyright 2018-2020,2023 Thomas E. Dickey                *
+ * Copyright 2018-2023,2024 Thomas E. Dickey                *
* Copyright 1998-2015,2016 Free Software Foundation, Inc.    *
*                                                              *
* Permission is hereby granted, free of charge, to any person obtaining a *
@@ -76,7 +76,7 @@
#endif
#undef CUR

-MODULE_ID("$Id: lib_twait.c,v 1.81 2023/09/16 16:30:40 tom Exp $")
+MODULE_ID("$Id: lib_twait.c,v 1.82 2024/10/05 22:47:12 tom Exp $")

/*
* Returns an elapsed time, in milliseconds (if possible).
@@ -168,7 +168,7 @@
* descriptors.

```

```

*/
NCURSES_EXPORT(int)
-_nc_timed_wait(SCREEN *sp MAYBE_UNUSED,
+_nc_timed_wait(const
SCREEN *sp MAYBE_UNUSED,
    int mode MAYBE_UNUSED,
    int milliseconds,
    int *timeleft
Index: package/debian-mingw/changelog
--- ncurses-6.5-20240928+/package/debian-mingw/changelog 2024-09-28 09:53:21.000000000 +0000
+++ ncurses-6.5-20241006/package/debian-mingw/changelog 2024-10-06 08:53:45.000000000 +0000
@@ -1,8 +1,8 @@
-ncurses6td (6.5+20240928) unstable; urgency=low
+ncurses6td (6.5+20241006) unstable; urgency=low

* latest weekly patch

- -- Thomas E. Dickey <dickey@invisible-island.net> Sat, 28 Sep 2024 05:53:21 -0400
+ -- Thomas E. Dickey <dickey@invisible-island.net> Sun, 06 Oct 2024 04:53:45 -0400

ncurses6 (5.9+20131005) unstable; urgency=low

Index: package/debian-mingw64/changelog
--- ncurses-6.5-20240928+/package/debian-mingw64/changelog 2024-09-28 09:53:21.000000000 +0000
+++ ncurses-6.5-20241006/package/debian-mingw64/changelog 2024-10-06 08:53:45.000000000 +0000
@@ -1,8 +1,8 @@
-ncurses6td (6.5+20240928) unstable; urgency=low
+ncurses6td
(6.5+20241006) unstable; urgency=low

* latest weekly patch

- -- Thomas E. Dickey <dickey@invisible-island.net> Sat, 28 Sep 2024 05:53:21 -0400
+ -- Thomas E. Dickey <dickey@invisible-island.net> Sun, 06 Oct 2024 04:53:45 -0400

ncurses6 (5.9+20131005) unstable; urgency=low

Index: package/debian/changelog
--- ncurses-6.5-20240928+/package/debian/changelog 2024-09-28 09:53:21.000000000 +0000
+++ ncurses-6.5-20241006/package/debian/changelog 2024-10-06 08:53:45.000000000 +0000
@@ -1,8 +1,8 @@
-ncurses6td (6.5+20240928) unstable; urgency=low
+ncurses6td (6.5+20241006) unstable; urgency=low

* latest weekly patch

- -- Thomas E. Dickey <dickey@invisible-island.net> Sat, 28 Sep 2024 05:53:21 -0400
+ -- Thomas E. Dickey <dickey@invisible-island.net> Sun, 06 Oct 2024 04:53:45 -0400

```

ncurses6 (5.9+20120608) unstable; urgency=low

Index: package/mingw-ncurses.nsi

Prereq: 1.669

--- ncurses-6.5-20240928+/package/mingw-ncurses.nsi 2024-09-28 09:53:21.000000000 +0000

+++

ncurses-6.5-20241006/package/mingw-ncurses.nsi 2024-10-06 08:53:45.000000000 +0000

@@ -1,4 +1,4 @@

-\$Id: mingw-ncurses.nsi,v 1.669 2024/09/28 09:53:21 tom Exp \$

+\$Id: mingw-ncurses.nsi,v 1.671 2024/10/06 08:53:45 tom Exp \$

; TODO add examples

; TODO bump ABI to 6

@@ -10,7 +10,7 @@

!define VERSION\_MAJOR "6"

!define VERSION\_MINOR "5"

!define VERSION\_YYYY "2024"

!define VERSION\_MMDD "0928"

!define VERSION\_MMDD "1006"

!define VERSION\_PATCH \${VERSION\_YYYY}\${VERSION\_MMDD}

!define MY\_ABI "5"

Index: package/mingw-ncurses.spec

--- ncurses-6.5-20240928+/package/mingw-ncurses.spec 2024-09-28 09:53:21.000000000 +0000

+++ ncurses-6.5-20241006/package/mingw-ncurses.spec 2024-10-06 08:53:45.000000000 +0000

@@ -3,7 +3,7 @@

Summary: shared libraries for terminal handling

Name: mingw32-ncurses6

Version: 6.5

-Release: 20240928

+Release: 20241006

License: X11

Group: Development/Libraries

URL: <https://invisible-island.net/ncurses/>

Index: package/ncurses.spec

--- ncurses-6.5-20240928+/package/ncurses.spec 2024-09-28

09:53:21.000000000 +0000

+++ ncurses-6.5-20241006/package/ncurses.spec 2024-10-06 08:53:45.000000000 +0000

@@ -1,7 +1,7 @@

Summary: shared libraries for terminal handling

Name: ncurses6

Version: 6.5

-Release: 20240928

+Release: 20241006

License: X11

Group: Development/Libraries

URL: <https://invisible-island.net/ncurses/>

```

Index: package/ncurset.spec
--- ncurses-6.5-20240928+/package/ncurset.spec 2024-09-28 09:53:21.000000000 +0000
+++ ncurses-6.5-20241006/package/ncurset.spec 2024-10-06 08:53:45.000000000 +0000
@@ -1,7 +1,7 @@
Summary: Curses library with POSIX thread support.
Name: ncurses6
Version: 6.5
-Release: 20240928
+Release: 20241006
License: X11
Group: Development/Libraries
Source: ncurses-%{version}-%{release}.tgz
Index: test/blue.c
Prereq: 1.55
--- ncurses-6.5-20240928+/test/blue.c 2022-12-10 23:31:31.000000000 +0000
+++ ncurses-6.5-20241006/test/blue.c 2024-10-05 19:26:24.000000000 +0000
@@ -1,5 +1,5 @@
/*****
-
* Copyright 2019-2021,2022 Thomas E. Dickey                *
+ * Copyright 2019-2022,2024 Thomas E. Dickey                *
* Copyright 1998-2016,2017 Free Software Foundation, Inc.    *
*                                                              *
* Permission is hereby granted, free of charge, to any person obtaining a *
@@ -37,7 +37,7 @@
*****/

/*
- * $Id: blue.c,v 1.55 2022/12/10 23:31:31 tom Exp $
+ * $Id: blue.c,v 1.56 2024/10/05 19:26:24 tom Exp $
*/

#include <test.priv.h>
@@ -437,7 +437,7 @@
static void
use_pc_display(void)
{
- char *check = nl_langinfo(CODESET);
+ const char *check = nl_langinfo(CODESET);
    if (!strcmp(check, "UTF-8")) {
#if USE_WIDEC_SUPPORT
suits = uglyphs;
@@ -448,8 +448,8 @@
        !strcmp(check, "CP437") ||
        !strcmp(check,
"IBM850") ||
        !strcmp(check, "CP850")) {
- char *smacs = tigetstr("smacs");

```

```

- char *smpch = tigetstr("smpch");
+ const char *smacs = tigetstr("smacs");
+ const char *smpch = tigetstr("smpch");
/*
    * The ncurses library makes this check to decide whether to allow
    * the alternate character set for the (normally) nonprinting codes.
Index: test/bs.c
Prereq: 1.79
--- ncurses-6.5-20240928+/test/bs.c 2023-05-27 20:13:10.000000000 +0000
+++ ncurses-6.5-20241006/test/bs.c 2024-10-05 19:26:24.000000000 +0000
@@ -1,5 +1,5 @@
/*****
- * Copyright 2018-2022,2023 Thomas E. Dickey                *
+ * Copyright 2018-2023,2024 Thomas E. Dickey                *
* Copyright 1998-2016,2017 Free Software Foundation, Inc.    *
*                                                              *
* Permission is hereby granted, free of charge,
to any person obtaining a *
@@ -35,7 +35,7 @@
* v2.0 featuring strict ANSI/POSIX conformance, November 1993.
* v2.1 with ncurses mouse support, September 1995
*
- * $Id: bs.c,v 1.79 2023/05/27 20:13:10 tom Exp $
+ * $Id: bs.c,v 1.80 2024/10/05 19:26:24 tom Exp $
*/

#include <test.priv.h>
@@ -147,7 +147,7 @@
    bool placed; /* has it been placed on the board? */
} ship_t;

-static bool checkplace(int b, ship_t * ss, int vis);
+static bool checkplace(int b, const ship_t * ss, int vis);

#define SHIPIT(name, symbol, length) { name, 0, symbol, length, 0,0, 0, FALSE }

@@ -686,7 +686,7 @@
}

static bool
-checkplace(int b, ship_t * ss, int vis)
+checkplace(int b, const ship_t * ss, int vis)
{
    int l, xend, yend;
Index: test/cardfile.c
Prereq: 1.51
--- ncurses-6.5-20240928+/test/cardfile.c 2022-12-04 00:40:11.000000000 +0000

```

```

+++ ncurses-6.5-20241006/test/cardfile.c 2024-10-05 19:26:24.000000000 +0000
@@@ -1,5 +1,5 @@@
/*****
-
* Copyright 1919-2021,2022 Thomas E. Dickey
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@@@ -30,7 +30,7 @@@
/*
* Author: Thomas E. Dickey
*
- * $Id: cardfile.c,v 1.51 2022/12/04 00:40:11 tom Exp $
+ * $Id: cardfile.c,v 1.52 2024/10/05 19:26:24 tom Exp $
*
* File format: text beginning in column 1 is a title; other text is content.
*/
@@@ -161,7 +161,7 @@@
}

static CARD *
-find_card(char *title)
+find_card(const char *title)
{
    CARD *card;

@@@ -173,7 +173,7 @@@
}

static void
-read_data(char *fname)
+read_data(const char *fname)
{
    FILE *fp;

@@@ -341,7 +341,7 @@@
}

static FIELD **
-make_fields(CARD * p, int form_high,
    int form_wide)
+make_fields(const CARD * p, int form_high, int form_wide)
{
    FIELD **f = typeCalloc(FIELD *, (size_t) 3);

@@@ -385,7 +385,7 @@@
/*****

```



```

static void
-cardfile(char *fname)
+cardfile(const char *fname)
{
    WINDOW *win;
    CARD *p;
Index: test/chgat.c
Prereq: 1.21
--- ncurses-6.5-20240928+/test/chgat.c 2024-06-29 17:45:32.000000000 +0000
+++ ncurses-6.5-20241006/test/chgat.c 2024-10-06 22:35:55.000000000 +0000
@@ -27,7 +27,7 @@
* authorization.
*
*****/
/*
- * $Id: chgat.c,v 1.21 2024/06/29 17:45:32 tom Exp $
+ * $Id: chgat.c,v 1.23 2024/10/06 22:35:55 tom Exp $
*
* test-driver for chgat/wchgat/mvchgat/mvwchgat
*/
@@ -160,7 +160,7 @@
}

static void
-do_subwindow(WINDOW *win, STATUS * sp, void func(WINDOW *))
+do_subwindow(WINDOW *win, const STATUS
* sp, void func(WINDOW *))
{
    WINDOW *win1 = newwin(sp->y_max - 2, sp->x_max - 2,
    sp->y_beg + 1, sp->x_beg + 1);
@@ -204,7 +204,7 @@
static void
show_help(WINDOW *win)
{
- static const char *msgs[] =
+ static NCURSES_CONST char *msgs[] =
{
    "Basic commands:"
    ,"Use h/j/k/l or arrow keys to move the cursor."
Index: test/clip_printw.c
Prereq: 1.23
--- ncurses-6.5-20240928+/test/clip_printw.c 2023-09-30 19:57:44.000000000 +0000
+++ ncurses-6.5-20241006/test/clip_printw.c 2024-10-06 22:36:25.000000000 +0000
@@ -1,5 +1,5 @@
/*****
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*

```

```

*
*
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@@ -27,7 +27,7 @@
* authorization.
*****/
/*
- * $Id: clip_printw.c,v 1.23 2023/09/30 19:57:44 tom Exp $
+ * $Id: clip_printw.c,v 1.25 2024/10/06 22:36:25 tom Exp $
*
* demonstrate how to use printw with/without wrapping.
*/
@@ -212,7 +212,7 @@
}

static void
-do_subwindow(WINDOW *win, STATUS *sp, void func(WINDOW *))
+do_subwindow(WINDOW *win, const STATUS *sp, void func(WINDOW *))
{
    WINDOW *win1 = newwin(sp->y_max - (2 * MARGIN),
        sp->x_max - (2 * MARGIN),
@@ -268,7 +268,7 @@
static void
show_help(WINDOW *win)
{
- static const char *msgs[] =
+ static NCURSES_CONST char *msgs[] =
{
    "Basic commands:"
    ,"Use h/j/k/l or arrow keys to move the cursor."
Index: test/color_name.h
Prereq: 1.9
--- ncurses-6.5-20240928+/test/color_name.h 2021-04-24 23:25:29.000000000 +0000
+++ ncurses-6.5-20241006/test/color_name.h 2024-10-05
19:26:24.000000000 +0000
@@ -1,5 +1,5 @@
/*****
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*
*
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@@ -27,7 +27,7 @@
* authorization.
*****/
/*
- * $Id: color_name.h,v 1.9 2021/04/24 23:25:29 tom Exp $
+ * $Id: color_name.h,v 1.10 2024/10/05 19:26:24 tom Exp $

```

```

*/

#ifndef __COLORNAME_H
@@ -63,7 +63,6 @@
{
    int result = 0;
    char *endp = 0;
-   size_t n;

    if ((result = (int) strtol(color,
&endp, 0)) >= 0
&& (endp == 0 || *endp == 0)) {
@@ -71,6 +70,7 @@
    } else if (!strcmp(color, "default")) {
result = -1;
    } else {
+   size_t n;
    for (n = 0; n < SIZEOF(the_color_names); ++n) {
        if (!strcmp(the_color_names[n], color)) {
            result = (int) n;
Index: test/demo_defkey.c
Prereq: 1.35
--- ncurses-6.5-20240928+/test/demo_defkey.c 2024-01-20 20:46:12.000000000 +0000
+++ ncurses-6.5-20241006/test/demo_defkey.c 2024-10-05 18:20:04.000000000 +0000
@@ -27,7 +27,7 @@
* authorization.
*
*****/
/*
- * $Id: demo_defkey.c,v 1.35 2024/01/20 20:46:12 tom Exp $
+ * $Id: demo_defkey.c,v 1.36 2024/10/05 18:20:04 tom Exp $
*
* Demonstrate the define_key() function.
* Thomas Dickey - 2002/11/23
@@ -199,7 +199,7 @@
}

static void
-redefine(WINDOW *win, char *string, int code)
+redefine(WINDOW *win, const char *string, int code)
{

    really_define_key(win, string, code);
}
Index: test/demo_forms.c
Prereq: 1.63
--- ncurses-6.5-20240928+/test/demo_forms.c 2023-11-11 00:29:53.000000000 +0000
+++ ncurses-6.5-20241006/test/demo_forms.c 2024-10-06 21:15:12.000000000 +0000
@@ -1,5 +1,5 @@

```

```

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@@ -27,7 +27,7 @@
* authorization.
*****/

/*
- * $Id: demo_forms.c,v 1.63 2023/11/11 00:29:53 tom Exp $
+ * $Id: demo_forms.c,v 1.67
2024/10/06 21:15:12 tom Exp $
*
* Demonstrate a variety of functions from the form library.
* Thomas Dickey - 2003/4/26
@@ -148,7 +148,7 @@
}

static FIELD *
-make_label(const char *label, int frow, int fcol)
+make_label(NCURSES_CONST char *label, int frow, int fcol)
{
    FIELD *f = new_field(1, (int) strlen(label), frow, fcol, 0, 0);

@@ -242,7 +242,7 @@
#define O_SELECTABLE (O_ACTIVE | O_VISIBLE)

static FIELD *
-another_field(FORM *form, const FIELD *const field)
+another_field(NCURSES_CONST FORM *form, NCURSES_CONST FIELD *const field)
{
    FIELD **f = form_fields(form);
    FIELD *result = 0;
@@ -306,9 +306,9 @@
}

static void
-show_current_field(WINDOW *win, FORM *form)
+show_current_field(WINDOW *win, NCURSES_CONST FORM *form)
{
-    FIELD *field;
+    NCURSES_CONST FIELD *field;
    int field_rows, field_cols, field_max;
    int currow, curcol;

@@ -325,7 +325,7 @@
waddch(win, '\n');

```

```

    if ((field = current_field(form)) != 0) {
- FIELDTYPE *type;
+ NCURSES_CONST
  FIELDTYPE *type;
  int nbuf;

  wprintw(win, "Page %d%s, Field %d/%d%s:",
@@ -383,7 +383,7 @@

  waddstr(win, "\n");
  for (nbuf = 0; nbuf <= 2; ++nbuf) {
-   char *buffer;
+   NCURSES_CONST char *buffer;
    if ((buffer = field_buffer(field, nbuf)) != 0) {
      wprintw(win, "buffer %d:", nbuf);
      (void) wattrset(win, A_REVERSE);
@@ -408,8 +408,8 @@
      int c;
      unsigned n = 0;
      int pg;
-   const char *fname;
-   static const char *my_enum[] =
+   NCURSES_CONST char *fname;
+   static NCURSES_CONST char *my_enum[] =
      {"first", "second", "third", 0};

#ifdef NCURSES_MOUSE_VERSION
@@ -515,7 +515,7 @@
    f[n] = (FIELD *) 0;

    if ((form = new_form(f)) != 0) {
- WINDOW *w;
+ NCURSES_CONST WINDOW *w;
    WINDOW *also;
    int finished = 0;

Index: test/demo_menus.c
Prereq: 1.80
--- ncurses-6.5-20240928+/test/demo_menus.c 2023-05-27 20:13:10.000000000 +0000
+++ ncurses-6.5-20241006/test/demo_menus.c 2024-10-06 19:58:28.000000000 +0000
@@ -1,5
+1,5 @@
/*****
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*                                                              *

```

```

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@@ -27,7 +27,7 @@
* authorization.
*****/
/*
- * $Id: demo_menus.c,v 1.80 2023/05/27 20:13:10 tom Exp $
+ * $Id: demo_menus.c,v 1.82 2024/10/06 19:58:28 tom Exp $
*
* Demonstrate a variety of functions from the menu library.
* Thomas Dickey - 2005/4/9
@@ -185,7 +185,7 @@
}

```

```

static int
-menu_getc(MENU * m)
+menu_getc(NCURSES_CONST MENU * m)
{
    return wGetchar(menu_win(m));
}
@@ -214,7 +214,7 @@
my_menu_init(MENU * menu)
{
    Trace(("called MenuHook my_menu_init"));
-   mvwprintw(status, 2, 0, "menu_init %p", (void *) menu);
+   mvwprintw(status, 2, 0, "menu_init %p", (const void *) menu);
    wclrtoeol(status);
    wrefresh(status);
}
@@ -223,7 +223,7 @@
my_menu_term(MENU * menu)
{
    Trace(("called MenuHook my_menu_term"));
-   mvwprintw(status, 2, 0, "menu_term %p", (void *) menu);
+   mvwprintw(status, 2, 0, "menu_term %p", (const void *) menu);
    wclrtoeol(status);
    wrefresh(status);
}
@@ -231,7 +231,7 @@
static void
my_item_init(MENU * menu)
{
-   ITEM *item = current_item(menu);
+   NCURSES_CONST ITEM *item = current_item(menu);
    const char *name = item_name(item);

    Trace(("called MenuHook my_item_init (%s)", name));
@@ -243,7 +243,7 @@
static void

```

```

my_item_term(MENU * menu)
{
-   ITEM *item = current_item(menu);
+   NCURSES_CONST ITEM *item = current_item(menu);
    const char *name = item_name(item);

    Trace(("called MenuHook my_item_term (%s)", name));
@@ -348,7 +348,7 @@

/* force the given menu to appear */
static void
-menu_display(MENU * m)
+menu_display(NCURSES_CONST MENU * m)
{
    touchwin(menu_win(m));
    wrefresh(menu_win(m));
@@ -584,10 +584,10 @@
    * the others
    */

static bool
-update_trace_menu(MENU * m)
+update_trace_menu(NCURSES_CONST MENU * m)
{
    ITEM **items;
-   ITEM *i;
+   NCURSES_CONST ITEM *i;
    bool changed = FALSE;

    items = menu_items(m);
@@ -613,7 +613,7 @@
    int result;

    for (ip = menu_items(mpTrace); *ip; ip++) {
-   MENU_DATA *td = (MENU_DATA *) item_userptr(*ip);
+   NCURSES_CONST MENU_DATA *td = (MENU_DATA *) item_userptr(*ip);
    unsigned mask = td->mask;
    if (mask == 0)
        set_item_value(*ip, _nc_tracing == 0);
@@ -628,7 +628,7 @@
    unsigned newtrace = 0;
    for (ip = menu_items(mpTrace); *ip; ip++) {
    if (item_value(*ip)) {
-   MENU_DATA *td = (MENU_DATA *) item_userptr(*ip);
+   NCURSES_CONST
MENU_DATA *td = (MENU_DATA *) item_userptr(*ip);
        newtrace |= td->mask;
    }
    }
}

```

```
@@ -718,7 +718,9 @@
```

```
}
```

```
static int
```

```
-move_menu(MENU * menu, MENU * current, int by_y, int by_x)
```

```
+move_menu(NCURSES_CONST MENU * menu,
```

```
+ NCURSES_CONST MENU * current,
```

```
+ int by_y, int by_x)
```

```
{
```

```
    WINDOW *top_win = menu_win(menu);
```

```
    WINDOW *sub_win = menu_sub(menu);
```

```
@@ -798,7 +800,7 @@
```

```
#endif /* defined(KEY_RESIZE) && NCURSES_EXT_FUNCS */
```

```
static void
```

```
-show_status(int ch, MENU * menu)
```

```
+show_status(int ch, NCURSES_CONST MENU * menu)
```

```
{
```

```
    wmove(status, 0, 0);
```

```
    wprintw(status, "key %s, menu %d, mark %s, match %s",
```

```
@@ -919,7 +921,7 @@
```

```
    wrefresh(menu_win(last_menu));
```

```
    if (code == E_UNKNOWN_COMMAND
```

```
        || code == E_NOT_POSTED) {
```

```
-    ITEM *item = current_item(last_menu);
```

```
+    NCURSES_CONST ITEM *item = current_item(last_menu);
```

```
    MENU_DATA *td = (MENU_DATA *) item_userptr(item);
```

```
    td->func((int) td->mask);
```

```
}
```

```
Index: test/demo_new_pair.c
```

```
Prereq: 1.28
```

```
--- ncurses-6.5-20240928+/test/demo_new_pair.c 2024-06-29
```

```
19:30:26.000000000 +0000
```

```
+++ ncurses-6.5-20241006/test/demo_new_pair.c 2024-10-05 18:21:44.000000000 +0000
```

```
@@ -27,7 +27,7 @@
```

```
* authorization.
```

```
*
```

```
*****/
```

```
/*
```

```
- * $Id: demo_new_pair.c,v 1.28 2024/06/29 19:30:26 tom Exp $
```

```
+ * $Id: demo_new_pair.c,v 1.29 2024/10/05 18:21:44 tom Exp $
```

```
*
```

```
* Demonstrate the alloc_pair() function.
```

```
*/
```

```
@@ -49,7 +49,7 @@
```

```
static bool
```

```
valid_cap(NCURSES_CONST char *name)
```

```
{
```

```
-    char *value = tigetstr(name);
```



```

+   const char *value = tigetstr(name);
   return (value != 0 && value != (char *) -1) ? TRUE : FALSE;
}

```

Index: test/demo\_panels.c

Prereq: 1.48

--- ncurses-6.5-20240928+/test/demo\_panels.c 2022-12-04 00:40:11.000000000 +0000

+++ ncurses-6.5-20241006/test/demo\_panels.c 2024-10-06 20:01:21.000000000 +0000

@@ -1,5 +1,5 @@

/\*\*\*\*\*\*

-

```

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*

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@@ -27,7 +27,7 @@

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\*\*\*\*\*/

/\*

- \* \$Id: demo\_panels.c,v 1.48 2022/12/04 00:40:11 tom Exp \$

+ \* \$Id: demo\_panels.c,v 1.50 2024/10/06 20:01:21 tom Exp \$

\*

\* Demonstrate a variety of functions from the panel library.

\*/

@@ -42,7 +42,7 @@

#define TEMP\_POS '>'

```

typedef void (*InitPanel) (void);

```

```

-typedef void (*FillPanel) (PANEL *);

```

```

+typedef void (*FillPanel) (NCURSES_CONST PANEL *);

```

```

static bool use_colors = FALSE;

```

```

static bool

```

```

unboxed = FALSE;

```

@@ -301,7 +301,7 @@

```

int code;

```

```

int y0, x0;

```

```

int y1, x1;

```

```

- WINDOW *win = panel_window(pans[which]);

```

```

+ NCURSES_CONST WINDOW *win = panel_window(pans[which]);

```

```

char also[80];

```

```

getbegyx(win, y0, x0);

```

@@ -368,7 +368,7 @@

```

}

```

```

static void

```

```

-fill_panel(PANEL *pan)
+fill_panel(NCURSES_CONST PANEL *pan)
{
    WINDOW *win = panel_window(pan);
    const char *userptr = (const char *) panel_userptr(pan);
@@ -388,7 +388,7 @@
}

static void
-fill_unboxed(PANEL *pan)
+fill_unboxed(NCURSES_CONST PANEL *pan)
{
    WINDOW *win = panel_window(pan);
    const char *userptr = (const char *) panel_userptr(pan);
@@ -431,7 +431,7 @@
}

static void
-fill_wide_panel(PANEL *pan)
+fill_wide_panel(NCURSES_CONST PANEL *pan)
{
    WINDOW *win = panel_window(pan);
    int num = ((const char *) panel_userptr(pan))[1];
@@ -453,7 +453,7 @@
#define MAX_PANELS 5

static int
-which_panel(PANEL *px[MAX_PANELS + 1], PANEL *pan)
+which_panel(PANEL *px[MAX_PANELS + 1], NCURSES_CONST
PANEL *pan)
{
    int result = 0;
    int j;
Index: test/demo_termcap.c
Prereq: 1.65
--- ncurses-6.5-20240928+/test/demo_termcap.c 2023-05-27 20:13:10.000000000 +0000
+++ ncurses-6.5-20241006/test/demo_termcap.c 2024-10-06 20:05:09.000000000 +0000
@@ -1,5 +1,5 @@
/*****
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 *
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@@ -30,7 +30,7 @@
/*
 * Author: Thomas E. Dickey
 *

```

```

- * $Id: demo_termcap.c,v 1.65 2023/05/27 20:13:10 tom Exp $
+ * $Id: demo_termcap.c,v 1.70 2024/10/06 20:05:09 tom Exp $
*
* A simple demo of the termcap interface.
*/
@@ -256,7 +256,7 @@

    * to hold all of the strings extracted from the terminal entry.
    */
    char area[1024], *ap = area;
-   char *str;
+   NCURSES_CONST char *str;
    int num;

    if ((str = tgetstr(cap, &ap)) != 0) {
@@ -289,7 +289,7 @@
    }

static void
-brute_force(const char *name)
+brute_force(NCURSES_CONST char *name)
{
    char buffer[1024];

@@ -369,7 +369,7 @@
#ifdef NCURSES_VERSION
    if (x_opt && (my_blob == 0) && y_opt) {
#ifdef NCURSES_XNAMES
-   TERMTYPE *term = (TERMTYPE *) cur_term;
+   NCURSES_CONST TERMTYPE *term = (TERMTYPE *) cur_term;
    if (term != 0
        && (NUM_BOOLEANs(term) != BOOLCOUNT)
        || (NUM_NUMBERS(term) != NUMCOUNT)
@@ -781,12 +781,12 @@
    {
        int ch;
        int n;
-   char *name;
+   NCURSES_CONST char *name;
        bool a_opt = FALSE;
#ifdef defined(NCURSES_VERSION) || defined(HAVE_CURSES_DATA_OSPEED)
        bool v_opt = FALSE;
#endif
-   char *input_name = 0;
+   NCURSES_CONST char *input_name = 0;

        int repeat;
        int r_opt = 1;

```

```

@@ -867,7
+867,7 @@
    } else if ((name = getenv("TERM")) != 0) {
    brute_force(name);
    } else {
- static char dumb[] = "dumb";
+ static NCURSES_CONST char dumb[] = "dumb";
    brute_force(dumb);
    }
}
@@ -894,7 +894,7 @@
    } else if ((name = getenv("TERM")) != 0) {
    demo_termcap(name);
    } else {
- static char dumb[] = "dumb";
+ static NCURSES_CONST char dumb[] = "dumb";
    demo_termcap(dumb);
    }
}
Index: test/demo_terminfo.c
Prereq: 1.57
--- ncurses-6.5-20240928+/test/demo_terminfo.c 2023-05-27 20:13:10.000000000 +0000
+++ ncurses-6.5-20241006/test/demo_terminfo.c 2024-10-06 21:16:43.000000000 +0000
@@ -1,5 +1,5 @@
/*****
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 * Copyright 2009-2016,2017 Free Software Foundation, Inc.    *
 *
*
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@@ -30,7 +30,7 @@
/*
 * Author: Thomas E. Dickey
 *
- * $Id: demo_terminfo.c,v 1.57 2023/05/27 20:13:10 tom Exp $
+ * $Id: demo_terminfo.c,v 1.59 2024/10/06 21:16:43 tom Exp $
 *
 * A simple demo of the terminfo interface.
 */
@@ -253,7 +253,7 @@
#define LegalItem(c,n) (n)

static void
-brute_force(const char *name)
+brute_force(NCURSES_CONST char *name)
{
#define MAX_FORCE 5 /* omit "colors", since CPU-time is a problem */

```

```

static const char legal[] = "\
@@ -324,7 +324,7 @@
#endif

static void
-demo_terminfo(char *name)
+demo_terminfo(NCURSES_CONST char *name)
{
    unsigned n;
    NCURSES_CONST char *cap;
@@ -366,7 +366,7 @@
    if (x_opt && (my_blob == 0)) {
    if (y_opt) {
#if NCURSES_XNAMES
-    TERMTYPE *term = (TERMTYPE *) cur_term;
+    const TERMTYPE *term = (TERMTYPE *) cur_term;
    if (term != 0
        && ((NUM_BOOLEANS(term)
            != BOOLCOUNT)
            || (NUM_NUMBERS(term) != NUMCOUNT)
@@ -813,9 +813,9 @@
    int ch;
    int n;
    int repeat;
-    char *name;
+    NCURSES_CONST char *name;
    int r_opt = 1;
-    char *input_name = 0;
+    const char *input_name = 0;

    while ((ch = getopt(argc, argv, OPTS_COMMON "abd:e:fi:nqr:sxy")) != -1) {
    switch (ch) {
@@ -891,7 +891,7 @@
        } else if ((name = getenv("TERM")) != 0) {
        brute_force(name);
        } else {
-    static char dumb[] = "dumb";
+    static NCURSES_CONST char dumb[] = "dumb";
        brute_force(dumb);
        }
    }
@@ -918,7 +918,7 @@
        } else if ((name = getenv("TERM")) != 0) {
        demo_terminfo(name);
        } else {
-    static char dumb[] = "dumb";
+    static NCURSES_CONST char dumb[] = "dumb";
        demo_terminfo(dumb);

```

```

    }
}
Index: test/dots.c
Prereq: 1.45
--- ncurses-6.5-20240928+/test/dots.c 2023-01-07 17:21:48.000000000 +0000
+++ ncurses-6.5-20241006/test/dots.c 2024-10-06 21:17:54.000000000 +0000
@@ -1,5 +1,5 @@
/*****
-
- * Copyright 1919-2022,2023 Thomas E. Dickey                *
+ * Copyright 1919-2023,2024 Thomas E. Dickey                *
* Copyright 1999-2013,2017 Free Software Foundation, Inc.    *
*                                                              *
* Permission is hereby granted, free of charge, to any person obtaining a *
@@ -30,7 +30,7 @@
/*
* Author: Thomas E. Dickey <dickey@clark.net> 1999
*
- * $Id: dots.c,v 1.45 2023/01/07 17:21:48 tom Exp $
+ * $Id: dots.c,v 1.46 2024/10/06 21:17:54 tom Exp $
*
* A simple demo of the terminfo interface.
*/
@@ -61,7 +61,7 @@
}

```

```

static bool
-outs(const char *s)
+outs(NCURSES_CONST char *s)
{
    if (VALID_STRING(s)) {
        tputs(s, 1, outc);

```

Index: test/dots\_mvcur.c

Prereq: 1.31

```

--- ncurses-6.5-20240928+/test/dots_mvcur.c 2023-01-07 17:21:48.000000000 +0000
+++ ncurses-6.5-20241006/test/dots_mvcur.c 2024-10-06
21:17:54.000000000 +0000
@@ -1,5 +1,5 @@

```

```

/*****
- * Copyright 1919-2022,2023 Thomas E. Dickey                *
+ * Copyright 1919-2023,2024 Thomas E. Dickey                *
* Copyright 2007-2013,2017 Free Software Foundation, Inc.    *
*                                                              *
* Permission is hereby granted, free of charge, to any person obtaining a *
@@ -30,7 +30,7 @@
/*
* Author: Thomas E. Dickey - 2007
*

```

```

- * $Id: dots_mvcur.c,v 1.31 2023/01/07 17:21:48 tom Exp $
+ * $Id: dots_mvcur.c,v 1.32 2024/10/06 21:17:54 tom Exp $
*

* A simple demo of the terminfo interface, and mvcur.
*/
@@ -62,7 +62,7 @@
}

static bool
-outs(const char *s)
+outs(NCURSES_CONST char *s)
{
    if (VALID_STRING(s)) {
        tputs(s, 1, outc);
Index: test/dots_termcap.c
Prereq: 1.33
--- ncurses-6.5-20240928+/test/dots_termcap.c 2024-08-31
15:55:46.000000000 +0000
+++ ncurses-6.5-20241006/test/dots_termcap.c 2024-10-06 21:18:35.000000000 +0000
@@ -30,7 +30,7 @@
/*
* Author: Thomas E. Dickey
*
- * $Id: dots_termcap.c,v 1.33 2024/08/31 15:55:46 tom Exp $
+ * $Id: dots_termcap.c,v 1.35 2024/10/06 21:18:35 tom Exp $
*

* A simple demo of the termcap interface.
*/
@@ -113,7 +113,7 @@
}

static bool
-outs(char *s)
+outs(NCURSES_CONST char *s)
{
    if (VALID_STRING(s)) {
        tputs(s, 1, outc);
@@ -178,7 +178,7 @@
get_number(NCURSES_CONST char *cap, const char *env)
{
    int result = tgetnum(cap);
-   char *value = env ? getenv(env) : 0;
+   const char *value = env ? getenv(env) : 0;
    if (value != 0 && *value != 0) {
        char *next = 0;
        long check = strtol(value, &next, 10);
@@ -229,7 +229,7 @@
        double c;

```

```

    char buffer[1024];
    char area[1024];
-   char *name;
+   NCURSES_CONST char *name;
    size_t need;
    char *my_env;

```

Index: test/dup\_field.c

Prereq: 1.9

--- ncurses-6.5-20240928+/test/dup\_field.c 2024-06-29

17:45:32.000000000 +0000

+++ ncurses-6.5-20241006/test/dup\_field.c 2024-10-06 20:07:19.000000000 +0000

@@ -26,7 +26,7 @@

\* authorization.

\*

\*\*\*\*\*/

/\*

- \* \$Id: dup\_field.c,v 1.9 2024/06/29 17:45:32 tom Exp \$

+ \* \$Id: dup\_field.c,v 1.11 2024/10/06 20:07:19 tom Exp \$

\*

\* Demonstrate dup\_field().

\*/

@@@ -146,27 +146,27 @@@

}

static FieldAttrs \*

-my\_field\_attrs(FIELD \*f)

+my\_field\_attrs(NCURSES\_CONST FIELD \*f)

{

return (FieldAttrs \*) field\_userptr(f);

}

static int

-buffer\_length(FIELD \*f)

+buffer\_length(NCURSES\_CONST FIELD \*f)

{

return my\_field\_attrs(f)->row\_lengths[0];

}

static void

-set\_buffer\_length(FIELD \*f, int length)

+set\_buffer\_length(NCURSES\_CONST FIELD \*f, int length)

{

my\_field\_attrs(f)->row\_lengths[0] = length;

}

static int

-offset\_in\_field(FORM \*form)

+offset\_in\_field(NCURSES\_CONST



```

FORM *form)
{
-   FIELD *field = current_field(form);
+   NCURSES_CONST FIELD *field = current_field(form);
    int currow, curcol;

```

```

    form_getyx(form, currow, curcol);
@@ -245,7 +245,7 @@

```

```

default:
    modified = (ch < MIN_FORM_COMMAND
-   && isprint(ch));
+   && isprint(UChar(ch)));
    break;
}

```

Index: test/filter.c

Prereq: 1.38

--- ncurses-6.5-20240928+/test/filter.c 2022-12-04 00:40:11.000000000 +0000

+++ ncurses-6.5-20241006/test/filter.c 2024-10-05 19:26:24.000000000 +0000

@@ -1,5 +1,5 @@

/\*\*\*\*\*

```

- * Copyright 2019-2020,2022 Thomas E. Dickey          *
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*                                                         *

```

```

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```

@@

-30,7 +30,7 @@

/\*

```

* Author: Thomas E. Dickey 1998

```

\*

```

- * $Id: filter.c,v 1.38 2022/12/04 00:40:11 tom Exp $

```

```

+ * $Id: filter.c,v 1.39 2024/10/05 19:26:24 tom Exp $

```

\*

```

* An example of the 'filter()' function in ncurses, this program prompts
* for commands and executes them (like a command shell). It illustrates

```

@@ -65,7 +65,7 @@

```

    if (clocked) {
if (limit >= 3) {
    time_t now = time((time_t *) 0);
-   struct tm *my = localtime(&now);
+   const struct tm *my = localtime(&now);
    char buffer[80];
    int skip, y, x;
    int margin;

```

Index: test/form\_driver\_w.c

Prereq: 1.17

```

--- ncurses-6.5-20240928+/test/form_driver_w.c 2022-12-10 23:31:31.000000000 +0000
+++ ncurses-6.5-20241006/test/form_driver_w.c 2024-10-06 23:13:40.000000000 +0000
@@ -1,5 +1,5 @@
/*****
- * Copyright 2020,2022 Thomas E. Dickey                      *
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*
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*
* Permission is hereby granted, free of charge, to any person obtaining a *
@@ -32,7 +32,7 @@
*****/

/*
- * $Id: form_driver_w.c,v 1.17 2022/12/10 23:31:31 tom Exp $
+ * $Id: form_driver_w.c,v 1.18 2024/10/06 23:13:40 tom Exp $
*
* Test form_driver_w (int, int, wchar_t), a wide char aware
* replacement of form_driver.
@@ -68,7 +68,7 @@
int
main(int argc, char *argv[])
{
- static const char *help[] =
+ static NCURSES_CONST char *help[] =
{
"Commands:",
" ^D,^Q,ESC      - quit program",
Index: test/gdc.c
Prereq: 1.60
--- ncurses-6.5-20240928+/test/gdc.c 2024-06-29 19:59:06.000000000 +0000
+++ ncurses-6.5-20241006/test/gdc.c 2024-10-06 20:08:59.000000000 +0000
@@ -34,7 +34,7 @@
* modified 10-18-89
for curses (jrl)
* 10-18-89 added signal handling
*
- * $Id: gdc.c,v 1.60 2024/06/29 19:59:06 tom Exp $
+ * $Id: gdc.c,v 1.62 2024/10/06 20:08:59 tom Exp $
*/

#include <test.priv.h>
@@ -181,7 +181,7 @@
int check;
time_t result;
char c = 0;
- struct tm *tm;
+ NCURSES_CONST struct tm *tm;

```

```

switch (sscanf(value, "%d:%d:%d%c", &hh, &mm, &ss, &c)) {
default:
@@ -243,7 +243,7 @@
main(int argc, char *argv[])
{
time_t now;
- struct tm *tm;
+ NCURSES_CONST struct tm *tm;
long t, a;
int i, j, s, k, ch;
int count = 0;
@@ -293,7 +293,7 @@

InitAndCatch({
if (redirected) {
- char *name = getenv("TERM");
+ NCURSES_CONST char *name = getenv("TERM");
if (name == 0
|| newterm(name, ofp, ifp) == 0) {
fprintf(stderr, "cannot open terminal\n");
@@ -431,7 +431,7 @@
_nc_STRNCPY(buf, ctime(&now), (size_t) 30);
{
char *d2 = buf + 10;
- char *s2 = buf + 19;
+ NCURSES_CONST char *s2 = buf + 19;
while ((*d2++ = *s2++) != '\0') ;
}
MvAddStr(16, 30, buf);
Index: test/inch_wide.c
Prereq: 1.13
--- ncurses-6.5-20240928+/test/inch_wide.c 2022-12-10 23:55:34.000000000 +0000
+++ ncurses-6.5-20241006/test/inch_wide.c 2024-10-06 23:14:31.000000000 +0000
@@ -1,5 +1,5 @@
/*****
- * Copyright 2019-2020,2022 Thomas E. Dickey *
+ * Copyright 2019-2022,2024 Thomas E. Dickey *
* Copyright 2007-2010,2017 Free Software Foundation, Inc. *
*
* Permission is hereby granted, free of charge, to any person obtaining a *
@@ -27,7 +27,7 @@
* authorization. *
*****/
/*
- * $Id: inch_wide.c,v 1.13 2022/12/10 23:55:34 tom Exp $
+

```

```

* $Id: inch_wide.c,v 1.14 2024/10/06 23:14:31 tom Exp $
*/
/*
    int in_wch(cchar_t *wcval);
@@ -61,7 +61,7 @@
static int
test_inchs(int level, char **argv, WINDOW *chrwin, WINDOW *strwin)
{
- static const char *help[] =
+ static NCURSES_CONST char *help[] =
    {
        "Test input from screen using inch(), etc., in a moveable viewport.",
        "",
Index: test/inchs.c
Prereq: 1.19
--- ncurses-6.5-20240928+/test/inchs.c 2022-12-11 00:01:39.000000000 +0000
+++ ncurses-6.5-20241006/test/inchs.c 2024-10-06 21:17:54.000000000 +0000
@@ -1,5 +1,5 @@
/*****
- * Copyright 2019-2020,2022 Thomas E. Dickey                *
+ * Copyright 2019-2022,2024 Thomas E. Dickey                *
* Copyright 2007-2012,2017 Free Software Foundation, Inc.    *
*                                                              *
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charge, to any person obtaining a *
@@ -27,7 +27,7 @@
* authorization.                                           *
*****/
/*
- * $Id: inchs.c,v 1.19 2022/12/11 00:01:39 tom Exp $
+ * $Id: inchs.c,v 1.20 2024/10/06 21:17:54 tom Exp $
*
* Author: Thomas E Dickey
*/
@@ -71,7 +71,7 @@
static int
test_inchs(int level, char **argv, WINDOW *chrwin, WINDOW *strwin)
{
- static const char *help[] =
+ static NCURSES_CONST char *help[] =
    {
        "Test input from screen using inch(), etc., in a moveable viewport.",
        "",
Index: test/ins_wide.c
Prereq: 1.30
--- ncurses-6.5-20240928+/test/ins_wide.c 2022-12-10 22:28:50.000000000 +0000
+++ ncurses-6.5-20241006/test/ins_wide.c 2024-10-05 19:26:24.000000000 +0000
@@ -1,5 +1,5 @@

```

```

/*****
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+ * Copyright
2020-2022,2024 Thomas E. Dickey                      *
* Copyright 2002-2016,2017 Free Software Foundation, Inc.    *
*
* Permission is hereby granted, free of charge, to any person obtaining a *
@@ -27,7 +27,7 @@
* authorization.
*****/

/*
- * $Id: ins_wide.c,v 1.30 2022/12/10 22:28:50 tom Exp $
+ * $Id: ins_wide.c,v 1.31 2024/10/05 19:26:24 tom Exp $
*
* Demonstrate the wins_wstr() and wins_wch functions.
* Thomas Dickey - 2002/11/23
@@ -73,7 +73,7 @@
static int n_opt = -1;

static void
-legend(WINDOW *win, int level, Options state, wchar_t *buffer, int length)
+legend(WINDOW *win, int level, Options state, const wchar_t *buffer, int length)
{
    const char *showstate;

Index: test/insdelln.c
Prereq: 1.15
--- ncurses-6.5-20240928+/test/insdelln.c 2022-12-10
23:31:31.000000000 +0000
+++ ncurses-6.5-20241006/test/insdelln.c 2024-10-06 21:08:52.000000000 +0000
@@ -1,5 +1,5 @@
/*****
- * Copyright 2019-2020,2022 Thomas E. Dickey                      *
+ * Copyright 2019-2022,2024 Thomas E. Dickey                      *
* Copyright 2008-2014,2017 Free Software Foundation, Inc.    *
*
* Permission is hereby granted, free of charge, to any person obtaining a *
@@ -27,7 +27,7 @@
* authorization.
*****/

/*
- * $Id: insdelln.c,v 1.15 2022/12/10 23:31:31 tom Exp $
+ * $Id: insdelln.c,v 1.17 2024/10/06 21:08:52 tom Exp $
*
* test-driver for deleteln, wdeleteln, insdelln, winsdelln, insertln, winsertln
*/
@@ -160,7 +160,7 @@
}

```

```

static void
-do_subwindow(WINDOW *win, STATUS *sp, void func(WINDOW *))
+do_subwindow(WINDOW *win, const STATUS *sp, void func(WINDOW *))
{
    WINDOW *win1 = newwin(sp->y_max - 2, sp->x_max - 2,
        sp->y_beg + 1, sp->x_beg + 1);
@@ -204,7 +204,7 @@
static void
show_help(WINDOW *win)
{
- static const char *table[] =
+ static NCURSES_CONST char *table[] =
    {
        "Basic commands:"
        , "Use h/j/k/l or arrow keys to move the cursor."
Index: test/inserts.c
Prereq: 1.34
--- ncurses-6.5-20240928+/test/inserts.c 2022-12-10 22:28:50.000000000 +0000
+++ ncurses-6.5-20241006/test/inserts.c 2024-10-05 19:26:24.000000000 +0000
@@ -1,5 +1,5 @@
/*****
- * Copyright 2020,2022 Thomas E. Dickey
+ * Copyright 2020-2022,2024 Thomas E. Dickey
* Copyright 2002-2016,2017 Free Software Foundation, Inc.
*
*
* Permission is hereby granted, free of charge, to any person obtaining a
@@ -27,7 +27,7 @@
* authorization.
*****/
/*
- * $Id: inserts.c,v 1.34 2022/12/10 22:28:50 tom Exp $
+ * $Id: inserts.c,v 1.35 2024/10/05 19:26:24 tom Exp $
*
* Demonstrate the winsstr() and winsch functions.
* Thomas Dickey - 2002/10/19
@@ -98,7 +98,7 @@
}

static int
-ColOf(char *buffer, int length, int margin)
+ColOf(const char *buffer, int length, int margin)
{
    int n;
    int result;
Index: test/knight.c
Prereq: 1.52

```

```

--- ncurses-6.5-20240928+/test/knight.c 2022-12-04 00:40:11.000000000 +0000
+++ ncurses-6.5-20241006/test/knight.c 2024-10-05 19:38:58.000000000 +0000
@@ -1,5 +1,5 @@
/*****

- * Copyright
2018-2021,2022 Thomas E. Dickey          *
+ * Copyright 2018-2022,2024 Thomas E. Dickey          *
* Copyright 1998-2013,2017 Free Software Foundation, Inc.      *
*
* Permission is hereby granted, free of charge, to any person obtaining a *
@@ -34,7 +34,7 @@
* Eric S. Raymond <esr@snark.thyrsus.com> July 22 1995.  Mouse support
* added September 20th 1995.
*
- * $Id: knight.c,v 1.52 2022/12/04 00:40:11 tom Exp $
+ * $Id: knight.c,v 1.53 2024/10/05 19:38:58 tom Exp $
*/

#include <test.priv.h>
@@ -450,7 +450,8 @@
}

static bool
-evaluate_move(SQUARES squares, HISTORY * doneData, int doneSize, int row, int column)
+evaluate_move(SQUARES squares, const HISTORY * doneData, int doneSize,
+  int row, int column)
{
    if (doneSize <= 1)
        return (TRUE);
Index: test/list_keys.c
Prereq: 1.33
--- ncurses-6.5-20240928+/test/list_keys.c 2023-11-11
00:35:05.000000000 +0000
+++ ncurses-6.5-20241006/test/list_keys.c 2024-10-05 19:26:24.000000000 +0000
@@ -1,5 +1,5 @@
/*****

- * Copyright 2018-2022,2023 Thomas E. Dickey          *
+ * Copyright 2018-2023,2024 Thomas E. Dickey          *
* Copyright 2016,2017 Free Software Foundation, Inc.      *
*
* Permission is hereby granted, free of charge, to any person obtaining a *
@@ -27,7 +27,7 @@
* authorization.          *
*****/
/*
- * $Id: list_keys.c,v 1.33 2023/11/11 00:35:05 tom Exp $
+ * $Id: list_keys.c,v 1.34 2024/10/05 19:26:24 tom Exp $
*

```

```

* Author: Thomas E Dickey
*
@@ -297,7 +297,7 @@
#if NCURSES_XNAMES
    if (x_opt) {
        for (k = 0; k < count; ++k) {
-   TERMTYPE *term;
+   const TERMTYPE *term;
            set_curterm(terms[k]);
            term = (TERMTYPE *) cur_term;
            total += (size_t) (NUM_STRINGS(term) - STRCOUNT);
@@ -348,7 +348,7 @@
widths1 = (int) strlen(modifier);

    for (k = 0; k < count; ++k) {
- char *value;
+ const char *value;
        set_curterm(terms[k]);
        if ((value = termname()) == NULL)
            failed("termname");
Index: test/move_field.c
Prereq: 1.16
--- ncurses-6.5-20240928+/test/move_field.c 2024-06-29 17:45:02.000000000 +0000
+++ ncurses-6.5-20241006/test/move_field.c 2024-10-06 21:12:35.000000000 +0000
@@ -26,7 +26,7 @@
* authorization.
*
*****/
/*
- * $Id: move_field.c,v 1.16 2024/06/29 17:45:02 tom Exp $
+ * $Id: move_field.c,v 1.19 2024/10/06 21:12:35 tom Exp $
*
* Demonstrate move_field().
*/
@@ -146,27 +146,27 @@
}

static FieldAttrs
*
my_field_attrs(FIELD *f)
+my_field_attrs(NCURSES_CONST FIELD *f)
{
    return (FieldAttrs *) field_userptr(f);
}

static int
-buffer_length(FIELD *f)
+buffer_length(NCURSES_CONST FIELD *f)
{

```



```

    return my_field_attrs(f)->row_lengths[0];
}

static void
-set_buffer_length(FIELD *f, int length)
+set_buffer_length(NCURSES_CONST FIELD *f, int length)
{
    my_field_attrs(f)->row_lengths[0] = length;
}

static int
-offset_in_field(FORM *form)
+offset_in_field(NCURSES_CONST FORM *form)
{
-   FIELD *field = current_field(form);
+   NCURSES_CONST FIELD *field = current_field(form);
    int currow, curcol;

    form_getyx(form, currow, curcol);
@@ -245,7 +245,7 @@

default:
    modified = (ch < MIN_FORM_COMMAND
-   && isprint(ch));
+   && isprint(UChar(ch)));
    break;
}

@@ -275,9 +275,9 @@

/* display a status message to show what's happening */
static void
-show_status(FORM *form, FIELD *field)
+show_status(NCURSES_CONST FORM *form, NCURSES_CONST FIELD
*field)
{
-   WINDOW *sub = form_sub(form);
+   NCURSES_CONST WINDOW *sub = form_sub(form);
    int currow, curcol;

    getyx(stdscr, currow, curcol);
Index: test/movewindow.c
Prereq: 1.54
--- ncurses-6.5-20240928+/test/movewindow.c 2023-05-27 20:13:10.000000000 +0000
+++ ncurses-6.5-20241006/test/movewindow.c 2024-10-06 18:44:26.000000000 +0000
@@@ -1,5 +1,5 @@@
/*****
- * Copyright 2018-2022,2023 Thomas E. Dickey
*

```

```

+ * Copyright 2018-2023,2024 Thomas E. Dickey *
* Copyright 2006-2013,2017 Free Software Foundation, Inc. *
*
* Permission is hereby granted, free of charge, to any person obtaining a *
@@ -27,7 +27,7 @@
* authorization. *
*****/
/*
- * $Id: movewindow.c,v 1.54 2023/05/27 20:13:10 tom Exp $
+ * $Id: movewindow.c,v 1.56 2024/10/06 18:44:26 tom Exp $
*
* Demonstrate move functions for windows and derived windows from the curses
* library.
@@ -135,7 +135,7 @@
*/
static PAIR *
selectcell(WINDOW *parent,
- WINDOW *child,
+ NCURSES_CONST WINDOW *child,
int uli, int ulj,
int lri, int lrj,
bool relative,
@@ -252,7 +252,7 @@
int max_col = (parent == stdscr) ? COL_MAX : getmaxx(parent);
int min_line = (parent == stdscr) ? LINE_MIN : 0;
int max_line = (parent == stdscr) ? LINE_MAX : getmaxy(parent);
- PAIR *tmp;
+ NCURSES_CONST PAIR *tmp;
bool result = FALSE;

head_line("Use arrows to move cursor, anything else to mark corner 1");
@@ -346,7 +346,7 @@
}

static WINDOW *
-parent_of(WINDOW *win)
+parent_of(NCURSES_CONST WINDOW *win)
{
WINDOW *result = 0;
int n = window2num(win);
@@ -435,7 +435,7 @@
int max_col = top ? COL_MAX
: getmaxx(parent);
int min_line = top ? LINE_MIN : 0;
int max_line = top ? LINE_MAX : getmaxy(parent);
- PAIR *tmp;
+ NCURSES_CONST PAIR *tmp;
bool more;

```

```

head_line("Select new position for %swindow", top ? "" : "sub");
@@ -474,7 +474,7 @@
}

static void
-show_derwin(WINDOW *win)
+show_derwin(NCURSES_CONST WINDOW *win)
{
    int pary, parx, maxy, maxx;

@@ -500,7 +500,7 @@
int max_col = top ? COL_MAX : getmaxx(parent);
int min_line = top ? LINE_MIN : 0;
int max_line = top ? LINE_MAX : getmaxy(parent);
- PAIR *tmp;
+ NCURSES_CONST PAIR *tmp;
bool more;

show_derwin(win);
Index: test/ncurses.c
Prereq: 1.538
--- ncurses-6.5-20240928+/test/ncurses.c 2023-11-11 01:23:59.000000000 +0000
+++ ncurses-6.5-20241006/test/ncurses.c 2024-10-06 20:18:59.000000000 +0000
@@ -1,5 +1,5 @@
/*****
- * Copyright 2018-2022,2023 Thomas E. Dickey
+ * Copyright 2018-2023,2024
Thomas E. Dickey
* Copyright 1998-2016,2017 Free Software Foundation, Inc.
*
* Permission is hereby granted, free of charge, to any person obtaining a
@@ -41,7 +41,7 @@
Author: Eric S. Raymond <esr@snark.thyrsus.com> 1993
Thomas E. Dickey (beginning revision 1.27 in 1996).

-$Id: ncurses.c,v 1.538 2023/11/11 01:23:59 tom Exp $
+$Id: ncurses.c,v 1.541 2024/10/06 20:18:59 tom Exp $

*****/

@@ -273,7 +273,7 @@
++x;
break;
default:
- if (!isprint(ch) || ch >= KEY_MIN) {
+ if (!isprint(UChar(ch)) || ch >= KEY_MIN) {
beep();

```

```

    } else if ((int) strlen(buffer) < limit) {
    int j;
@@ -928,7 +928,7 @@
    /* at least Solaris SVR4 curses breaks unctrl(128), etc. */
    c2 &= 0x7f;
#endif
- if (isprint(c))
+ if (isprint(UChar(c)))
    (void)
wprintw(win, "%c", UChar(c));
    else if (c2 != UChar(c))
        (void) wprintw(win, "M-%s", unctrl(c2));
@@ -1693,7 +1693,7 @@
    chtype extras = (chtype) ac;

    if (UseColors) {
- NCURSES_PAIRS_T pair = 0;
+ NCURSES_PAIRS_T pair;
    if ((fg != COLOR_BLACK) || (bg != COLOR_BLACK)) {
        pair = 1;
        if (init_pair(pair, fg, bg) == ERR) {
@@ -2345,7 +2345,6 @@
    for (i = (NCURSES_PAIRS_T) (base_row * per_row); i < pairs_max; i++) {
        int row = grid_top + (i / per_row) - base_row;
        int col = (i % per_row + 1) * width;
- NCURSES_PAIRS_T pair = i;

        if ((i / per_row) > row_limit)
            break;
@@ -2355,6 +2354,7 @@
        if (row >= 0 && move(row, col) != ERR) {
            NCURSES_COLOR_T fg = (NCURSES_COLOR_T) InxToFG(i);
            NCURSES_COLOR_T bg = (NCURSES_COLOR_T) InxToBG(i);
+ NCURSES_PAIRS_T pair = i;

            init_pair(pair, fg, bg);
            attron(COLOR_PAIR(pair));
@@ -2517,7 +2517,7 @@
static int
x_color_test(bool recur GCC_UNUSED)
{
- long i;
+ int i;

    int top = 0, width;
    int base_row = 0;
    int grid_top = top + 3;
@@ -2613,17 +2613,17 @@

```

```

/* show color names/numbers across the top */
for (i = 0; i < per_row; i++) {
    show_color_name(top + 2,
-   ((int) i + 1) * width,
-   (int) i * zoom_size + MinColors,
+   (i + 1) * width,
+   i * zoom_size + MinColors,
    opt_wide,
    opt_zoom);
}

/* show a grid of colors, with color names/ numbers on the left */
for (i = (base_row * per_row); i < pairs_max; i++) {
-   int row = grid_top + ((int) i / per_row) - base_row;
-   int col = ((int) i % per_row + 1) * width;
-   int pair = (int) i;
+   int row = grid_top + (i / per_row) - base_row;
+   int col = (i % per_row + 1) * width;
+   int pair = i;

    if ((i / per_row) > row_limit)
        break;
@@ -2828,7 +2828,7 @@
#define DecodeRGB(n) (NCURSES_COLOR_T) ((n * 1000) / 0xffff)

static void
-init_all_colors(bool xterm_colors, char *palette_file)
+init_all_colors(bool xterm_colors, NCURSES_CONST
char *palette_file)
{
    NCURSES_PAIRS_T cp;
    all_colors = typeMalloc(RGB_DATA, (unsigned) MaxColors);
@@ -3317,7 +3317,7 @@
{
    int c, fmt = 1;
    char buf[9];
-   char *s;
+   NCURSES_CONST char *s;
    attr_t attr = A_NORMAL;
    unsigned at_code = 0;
#if HAVE_SLK_COLOR
@@ -3938,8 +3938,7 @@

    *dst = *src;
    do {
-   int count;
-   TEST_CCHAR(src, count, {
+   TEST_CCHAR(src, {

```

```

    attr |= (test_attrs & A_ALTCHARSET);
    setcchar(dst, test_wch, attr, pair, NULL);
}, {
@@ -4810,7 +4809,8 @@
/* Ask user for a window definition */
{
    WINDOW *rwindow;
-   pair ul, lr, *tmp;
+   pair ul, lr;
+   NCURSES_CONST pair *tmp;

    move(0, 0);
    clrtoeol();
@@ -5014,7 +5014,8 @@
#if HAVE_WRESIZE
case CTRL('X'): /* resize window */
    if (current) {
-   pair *tmp, ul, lr;
+   NCURSES_CONST pair *tmp;
+   pair ul, lr;
    int mx, my;

    move(0, 0);
@@ -5249,7 +5250,7 @@
}

static void
-fill_panel(PANEL *pan)
+fill_panel(NCURSES_CONST PANEL
*pan)
{
    WINDOW *win = panel_window(pan);
    const char *userptr = (const char *) panel_userptr(pan);
@@ -5286,7 +5287,7 @@
}

static void
-fill_wide_panel(PANEL *pan)
+fill_wide_panel(NCURSES_CONST PANEL *pan)
{
    WINDOW *win = panel_window(pan);
    const char *userptr = (const char *) panel_userptr(pan);
@@ -5336,7 +5337,7 @@
}

static int
-demo_panels(void (*InitPanel) (WINDOW *), void (*FillPanel) (PANEL *))
+demo_panels(void (*InitPanel) (WINDOW *), void (*FillPanel) (NCURSES_CONST PANEL *))

```

```

{
    int count;
    int itmp;
@@ -6246,7 +6247,8 @@
run_trace_menu(MENU * m)
{
    ITEM **items;
-   ITEM *i, **p;
+   NCURSES_CONST ITEM *i;
+   ITEM **p;

    for (;;) {
        bool changed = FALSE;
@@ -6424,7 +6426,7 @@

        if (field_info(me, &rows, &cols, &frow, &fcol, &nrow, &nbuf) == E_OK
&& nbuf > 0) {
-   char *source = field_buffer(me, 1);
+   NCURSES_CONST char *source = field_buffer(me, 1);
    size_t have = (source ? strlen(source) : 0) + 1;
    size_t need
        = 80 + have;
    char *temp = malloc(need);
@@ -6434,7 +6436,7 @@
    _nc_STRNCPY(temp, source ? source : "", have + 1);
    len = (size_t) (char *) field_userptr(me);
    if (c <= KEY_MAX) {
-   if (isgraph(c) && (len + 1) < sizeof(temp)) {
+   if (isgraph(UChar(c)) && (len + 1) < sizeof(temp)) {
        temp[len++] = (char) c;
        temp[len] = 0;
        set_field_buffer(me, 1, temp);
@@ -6484,7 +6486,7 @@
    }

static int
-form_virtualize(FORM *f, WINDOW *w)
+form_virtualize(NCURSES_CONST FORM *f, WINDOW *w)
{
    /* *INDENT-OFF* */
    static const struct {
@@ -6658,7 +6660,7 @@
static
FIELDCHECK_CB(pw_field_check)
{
-   char *s = field_buffer(fld, 0);
+   NCURSES_CONST char *s = field_buffer(fld, 0);
    int n;

```

```

    for (n = 0; s[n] != '\0'; ++n) {
@@ -6680,7 +6682,8 @@
form_test(bool recur GCC_UNUSED)
{
    FORM *form;
-   FIELD *f[12], *secure;
+   FIELD *f[12];
+   NCURSES_CONST FIELD *secure;
    FIELDTYPE *fty_middle = new_fieldtype(mi_field_check, mi_char_check);
    FIELDTYPE *fty_passwd = new_fieldtype(pw_field_check, pw_char_check);
    int c;
@@ -7176,7 +7179,7 @@
}

static void
-overlap_test_4(int flavor, WINDOW *a, WINDOW *b)
+overlap_test_4(int flavor, NCURSES_CONST WINDOW *a, WINDOW *b)
{
    switch ((otCOPY) flavor) {
        case otCOPY_overwrite:
@@ -7899,7 +7902,7 @@
        bool monochrome = FALSE;
#ifdef HAVE_COLOR_CONTENT
        bool xterm_colors = FALSE;
-       char *palette_file = 0;
+       NCURSES_CONST char *palette_file = 0;
#endif

    setlocale(LC_ALL, "");
Index: test/padview.c
Prereq: 1.22
--- ncurses-6.5-20240928+/test/padview.c 2022-12-04 00:40:11.000000000 +0000
+++ ncurses-6.5-20241006/test/padview.c 2024-10-06 21:08:25.000000000 +0000
@@ -1,5 +1,5 @@
/*****
- * Copyright 2019-2021,2022 Thomas E. Dickey
+ * Copyright 2019-2022,2024 Thomas E. Dickey
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Software Foundation, Inc.
*
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@@ -29,7 +29,7 @@
/*
* clone of view.c, using pads
*
- * $Id: padview.c,v 1.22 2022/12/04 00:40:11 tom Exp $
+ * $Id: padview.c,v 1.24 2024/10/06 21:08:25 tom Exp $

```



```

*/

#include <test.priv.h>
@@ -182,7 +182,7 @@

#if USE_WIDEC_SUPPORT
    if (!memcmp("\357\273\277", my_blob, 3)) {
- char *s = my_blob + 3;
+ const char *s = my_blob + 3;
    char *d = my_blob;
    Trace(("trim BOM"));
    do {
@@ -213,7 +213,7 @@
        for (k = 0; my_vec[k]; ++k) {
            char *s;
#if USE_WIDEC_SUPPORT
- char *last = my_vec[k] + (int) strlen(my_vec[k]);
+ const char *last = my_vec[k] + (int) strlen(my_vec[k]);
            wchar_t wch[2];
            size_t rc;
#ifdef state_unused
@@ -279,7 +279,7 @@
int
main(int argc, char *argv[])
{
- static const char *help[] =
+ static NCURSES_CONST char *help[] =

    {
        "Commands:",
        " q,^Q,ESC      - quit this program",
@@ -532,7 +532,7 @@
        beep();
        break;
    }
- if (c >= KEY_MIN || (c > 0 && !isdigit(c))) {
+ if (c >= KEY_MIN || (c > 0 && !isdigit(UChar(c)))) {
    got_number = FALSE;
    value = 0;
}
Index: test/parse_rgb.h
Prereq: 1.5
--- ncurses-6.5-20240928+/test/parse_rgb.h 2020-02-02 23:34:34.000000000 +0000
+++ ncurses-6.5-20241006/test/parse_rgb.h 2024-10-05 19:26:24.000000000 +0000
@@ -1,5 +1,5 @@
/*****
- * Copyright 2018,2020 Thomas E. Dickey
+ * Copyright 2018-2020,2024 Thomas E. Dickey

```

```

*
*
* Permission is hereby granted, free of charge, to any person obtaining a *
* copy of this software and associated documentation files (the
@@ -26,7 +26,7 @@
* authorization.
*
*****/
/*
- * $Id: parse_rgb.h,v 1.5 2020/02/02 23:34:34 tom Exp $
+ * $Id: parse_rgb.h,v 1.6 2024/10/05 19:26:24 tom Exp $
*
* Sample implementation of ncurses RGB extension from user_caps(5).
*/
@@ -49,7 +49,7 @@
int bits;
int pwr2;
int r = 0, g = 0, b = 0;
- char *data;
+ const char *data;
char ch;

for (max_bits = 0, pwr2 = 1;
Index: test/picsmap.c
Prereq: 1.149
--- ncurses-6.5-20240928+/test/picsmap.c 2023-04-23 23:20:37.000000000 +0000
+++ ncurses-6.5-20241006/test/picsmap.c 2024-10-05 19:26:24.000000000 +0000
@@ -1,5 +1,5 @@
/*****
- * Copyright 2018-2022,2023 Thomas E. Dickey
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* Copyright 2017,2018 Free Software Foundation, Inc.
*
*
*
* Permission is hereby granted, free of charge, to any person obtaining a *
@@ -27,7 +27,7 @@
* authorization.
*
*****/
/*
- * $Id: picsmap.c,v 1.149 2023/04/23 23:20:37 tom Exp $
+ * $Id: picsmap.c,v 1.150 2024/10/05 19:26:24 tom Exp $
*
* Author: Thomas E. Dickey
*
@@ -574,7 +574,7 @@
_nc_STRCAT(full_name, filename, need);
if (tries & 4) {
char *t = s;
- char *tc;

```

```

+ const char *tc;
int num;
char chr;
int found = 0;
@@ -1374,8 +1374,8 @@
int r, g, b, nocolor;
float rf, gf, bf;
unsigned check;
- char *t;
- char *s = t = strchr(buffer, '#');
+ char *s = strchr(buffer, '#');
+ const char *t = s;
bool matched = FALSE;

if (s != 0) {
@@ -1492,7 +1492,7 @@
#define fg_color(pics,n) (pics->fgcol[n].fgcol)

static void
-dump_picture(PICS_HEAD
* pics)
+dump_picture(const PICS_HEAD * pics)
{
    int y, x;

@@ -1767,7 +1767,7 @@
#if USE_EXTENDED_COLORS
case 'x':
{
- char *s = optarg;
+ const char *s = optarg;
while (*s) {
    switch (*s++) {
        case 'p':
Index: test/popup_msg.c
Prereq: 1.12
--- ncurses-6.5-20240928+/test/popup_msg.c 2024-06-29 18:34:58.000000000 +0000
+++ ncurses-6.5-20241006/test/popup_msg.c 2024-10-06 21:07:01.000000000 +0000
@@ -27,7 +27,7 @@
* authorization.
*
*****/
/*
- * $Id: popup_msg.c,v 1.12 2024/06/29 18:34:58 tom Exp $
+ * $Id: popup_msg.c,v 1.13 2024/10/06 21:07:01 tom Exp $
*
* Show a multi-line message in a window which may extend beyond the screen.
*
@@ -62,7 +62,7 @@

```

```

* Display a temporary window, e.g., to display a help-message.
*/
void
-popup_msg(WINDOW *parent, const char *const *msg)
+popup_msg(WINDOW *parent, NCURSES_CONST
char *const *msg)
{
    int x0 = 4;
    int y0 = 2;
@@ -171,12 +171,12 @@
void
popup_msg2(WINDOW *parent, char **msg)
{
-    popup_msg(parent, (const char *const *) msg);
+    popup_msg(parent, (NCURSES_CONST char *const *) msg);
}

#else
void
-popup_msg(WINDOW *parent, const char *const *msg)
+popup_msg(WINDOW *parent, NCURSES_CONST char *const *msg)
{
    (void) parent;
    (void) msg;
Index: test/popup_msg.h
Prereq: 1.5
--- ncurses-6.5-20240928+/test/popup_msg.h 2020-02-02 23:34:34.000000000 +0000
+++ ncurses-6.5-20241006/test/popup_msg.h 2024-10-06 21:17:54.000000000 +0000
@@ -1,5 +1,5 @@
/*****
- * Copyright 2018,2020 Thomas E. Dickey                      *
+ * Copyright 2018-2020,2024 Thomas E. Dickey                *
 * Copyright 2017 Free Software Foundation, Inc.              *
 *
*
* Permission is hereby granted, free of charge, to any person obtaining a *
@@ -27,7 +27,7 @@
* authorization.                                             *
*****/
/*
- * $Id: popup_msg.h,v 1.5 2020/02/02 23:34:34 tom Exp $
+ * $Id: popup_msg.h,v 1.6 2024/10/06 21:17:54 tom Exp $
*
* Utility functions for a popup-message or help-screen.
*/
@@ -37,7 +37,7 @@

#include <test.priv.h>

```

```
-extern void popup_msg(WINDOW *parent, const char *const *msg);
+extern void popup_msg(WINDOW *parent, NCURSES_CONST char *const *msg);
extern void popup_msg2(WINDOW *parent, char **msg);
```

```
#endif /* POPUP_MSG_H_incl */
```

```
Index: test/railroad.c
```

```
Prereq: 1.26
```

```
--- ncurses-6.5-20240928+/test/railroad.c 2022-12-11 00:12:13.000000000 +0000
```

```
+++ ncurses-6.5-20241006/test/railroad.c 2024-10-05 19:26:24.000000000 +0000
```

```
@@ -1,5 +1,5 @@
```

```
/******
```

```
-
```

```
* Copyright 1919-2020,2022 Thomas E. Dickey *
```

```
+ * Copyright 1919-2022,2024 Thomas E. Dickey *
```

```
* Copyright 2000-2013,2017 Free Software Foundation, Inc. *
```

```
* *
```

```
* Permission is hereby granted, free of charge, to any person obtaining a *
```

```
@@ -30,7 +30,7 @@
```

```
/*
```

```
* Author: Thomas E. Dickey - 2000
```

```
*
```

```
- * $Id: railroad.c,v 1.26 2022/12/11 00:12:13 tom Exp $
```

```
+ * $Id: railroad.c,v 1.27 2024/10/05 19:26:24 tom Exp $
```

```
*
```

```
* A simple demo of the termcap interface.
```

```
*/
```

```
@@ -113,7 +113,7 @@
```

```
static void
```

```
ShowSign(char *string)
```

```
{
```

```
- char *base = string;
```

```
+ const char *base = string;
```

```
int first, last;
```

```
if (moveit != 0) {
```

```
Index: test/rain.c
```

```
Prereq: 1.58
```

```
--- ncurses-6.5-20240928+/test/rain.c 2024-08-31 15:56:10.000000000 +0000
```

```
+++ ncurses-6.5-20241006/test/rain.c 2024-10-06 21:09:00.000000000 +0000
```

```
@@ -27,7 +27,7
```

```
@@
```

```
* authorization. *
```

```
*****/
```

```
/*
```

```
- * $Id: rain.c,v 1.58 2024/08/31 15:56:10 tom Exp $
```

```
+ * $Id: rain.c,v 1.62 2024/10/06 21:09:00 tom Exp $
```

```
*/
```

```

#include <test.priv.h>
#include <popup_msg.h>
@@ -45,7 +45,7 @@

struct DATA;

-typedef void (*DrawPart) (struct DATA *);
+typedef void (*DrawPart) (const struct DATA *);

typedef struct DATA {
    int y, x;
@@ -118,25 +118,25 @@
}

static void
-part1(DATA * drop)
+part1(const DATA * drop)
{
    MvAddCh(drop->y, drop->x, '.');
}

static void
-part2(DATA * drop)
+part2(const DATA * drop)
{
    MvAddCh(drop->y, drop->x, 'o');
}

static void
-part3(DATA * drop)
+part3(const DATA * drop)
{
    MvAddCh(drop->y, drop->x, 'O');
}

static void
-part4(DATA * drop)
+part4(const DATA * drop)
{
    MvAddCh(drop->y - 1, drop->x, '-');
    MvAddStr(drop->y, drop->x - 1, "|.|");
@@ -144,7 +144,7 @@
}

static void
-part5(DATA * drop)
+part5(const DATA * drop)
{

```

```

    MvAddCh(drop->y - 2, drop->x, '-');
    MvAddStr(drop->y - 1, drop->x - 1, "\\");
@@ -154,7 +154,7 @@
}

static void
-part6(DATA * drop)
+part6(const DATA * drop)
{
    MvAddCh(drop->y - 2, drop->x, ' ');
    MvAddStr(drop->y - 1, drop->x - 1, " ");
@@ -186,7 +186,7 @@
}

static void
-draw_part(void (*func) (DATA *), int state, DATA * data)
+draw_part(void (*func) (const DATA *), int state, DATA * data)
{
    data->func = func;
    data->state = state;
@@ -328,7 +328,7 @@
int
main(int argc, char *argv[])
{
-   static const char *help[] =
+   static NCURSES_CONST char *help[] =
    {
        "Commands:",
        " q/Q      exit the program",
Index: test/redraw.c
Prereq: 1.17
--- ncurses-6.5-20240928+/test/redraw.c 2022-12-10 22:28:50.000000000 +0000
+++ ncurses-6.5-20241006/test/redraw.c 2024-10-06 21:17:54.000000000 +0000
@@@ -1,5 +1,5 @@@
/*****
-
* Copyright 2020-2021,2022 Thomas E. Dickey                *
+ * Copyright 2020-2022,2024 Thomas E. Dickey                *
* Copyright 2006-2012,2017 Free Software Foundation, Inc.    *
*                                                              *
* Permission is hereby granted, free of charge, to any person obtaining a *
@@@ -27,7 +27,7 @@@
* authorization.                                           *
*****/
/*
- * $Id: redraw.c,v 1.17 2022/12/10 22:28:50 tom Exp $
+ * $Id: redraw.c,v 1.18 2024/10/06 21:17:54 tom Exp $
*

```

```

* Demonstrate the redrawwin() and wredrawln() functions.
* Thomas Dickey - 2006/11/4
@@ -61,7 +61,7 @@
static void
test_redraw(WINDOW *win)
{
- static const char *help[] =
+ static NCURSES_CONST char *help[] =
    {
    "Commands:",
    " ^Q/ESC/q - quit",
Index: test/savescreen.c
Prereq:
1.62
--- ncurses-6.5-20240928+/test/savescreen.c 2022-12-10 23:23:27.000000000 +0000
+++ ncurses-6.5-20241006/test/savescreen.c 2024-10-06 21:10:09.000000000 +0000
@@ -1,5 +1,5 @@
/*****
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* Copyright 2006-2017,2018 Free Software Foundation, Inc.    *
*                                                              *
* Permission is hereby granted, free of charge, to any person obtaining a *
@@ -27,7 +27,7 @@
* authorization.                                           *
*****/
/*
- * $Id: savescreen.c,v 1.62 2022/12/10 23:23:27 tom Exp $
+ * $Id: savescreen.c,v 1.65 2024/10/06 21:10:09 tom Exp $
*
* Demonstrate save/restore functions
from the curses library.
* Thomas Dickey - 2007/7/14
@@ -96,7 +96,7 @@
}

static int
-load_screen(char *filename)
+load_screen(NCURSES_CONST char *filename)
{
    int result;

@@ -170,7 +170,7 @@
#if USE_WIDEC_SUPPORT
    cchar_t mycc;
#endif
- char *filename = files[which];
+ NCURSES_CONST char *filename = files[which];

```



```

bool dumped = FALSE;

if (filename != 0) {
@@ -216,7 +216,7 @@
static void
editor_help(void)
{
- static const char *msgs[] =
+ static NCURSES_CONST char *msgs[] =
{
    "You are now in the screen-editor, which allows you to make some",
    "lines on the screen, as well as save copies of the screen to a",
@@ -238,7 +238,7 @@
static void
replay_help(void)
{
- static const char *msgs[] =
+ static NCURSES_CONST char *msgs[] =
{
    "You are now in the screen-loader, which allows you to view",
    "the dumped/restored screens.",
@@ -286,7 +286,7 @@
    bool replaying = FALSE;
    bool done = FALSE;
    char **files;
-
    char *fill_by = 0;
+ NCURSES_CONST char *fill_by = 0;
#if USE_WIDEC_SUPPORT
    cchar_t mycc;
    static const wchar_t mywc[2] =
Index: test/tclock.c
Prereq: 1.48
--- ncurses-6.5-20240928+/test/tclock.c 2023-02-25 16:42:22.000000000 +0000
+++ ncurses-6.5-20241006/test/tclock.c 2024-10-05 18:47:56.000000000 +0000
@@@ -1,4 +1,4 @@@
-/* $Id: tclock.c,v 1.48 2023/02/25 16:42:22 tom Exp $ */
+/* $Id: tclock.c,v 1.49 2024/10/05 18:47:56 tom Exp $ */

#define NEED_TIME_H
#include <test.priv.h>
@@@ -145,7 +145,7 @@@
    int lastbeep = -1;
    bool odd = FALSE;
    time_t tim;
- struct tm *t;
+ const struct tm *t;
    char szChar[20];

```

```

    char *text;
    short my_bg = COLOR_BLACK;
Index: test/test.priv.h
Prereq: 1.219
--- ncurses-6.5-20240928+/test/test.priv.h 2024-08-31 10:46:01.000000000 +0000
+++ ncurses-6.5-20241006/test/test.priv.h 2024-10-05 19:01:00.000000000 +0000
@@ -30,7 +30,7 @@
/*****
 * Author: Thomas E. Dickey          1996-on          *
 *****/
-/* $Id: test.priv.h,v 1.219 2024/08/31 10:46:01 Rafael.Kitover Exp $ */
+/* $Id: test.priv.h,v 1.220 2024/10/05 19:01:00 tom Exp $ */

#ifndef __TEST_PRIV_H
#define __TEST_PRIV_H 1
@@ -765,8 +765,8 @@

#define VERSION_COMMON() \
static char *version_common(char **argv) { \
- char *base = argv[0]; \
- char *part = strrchr(base, '/'); \
+ const char *base = argv[0]; \
+ const char *part = strrchr(base, '/'); \
size_t need = strlen(base) + 80; \
char *result = malloc(need); \
if (result != NULL) { \
@@ -916,8 +916,8 @@
 * Workaround in case getcchar() returns a positive value when the source
 * string produces only a L'\0'.
 */
-#define TEST_CCHAR(s, count, then_stmt, else_stmt) \
- if ((count = getcchar(s, NULL, NULL, NULL, NULL)) > 0) { \
+#define TEST_CCHAR(s, then_stmt, else_stmt) \
+ if (getcchar(s, NULL, NULL,
NULL, NULL) > 0) { \
    wchar_t test_wch[CCHARW_MAX + 2]; \
    attr_t test_attr; \
    NCURSES_PAIRS_T test_pair; \
Index: test/test_add_wchstr.c
Prereq: 1.34
--- ncurses-6.5-20240928+/test/test_add_wchstr.c 2022-12-10 22:28:50.000000000 +0000
+++ ncurses-6.5-20241006/test/test_add_wchstr.c 2024-10-05 19:26:24.000000000 +0000
@@ -1,5 +1,5 @@
/*****
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 *

```

```

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@@ -27,7 +27,7 @@
* authorization.
*****/
/*
- * $Id: test_add_wchstr.c,v 1.34 2022/12/10 22:28:50 tom Exp $
+ * $Id: test_add_wchstr.c,v 1.35 2024/10/05 19:26:24 tom Exp $
*
* Demonstrate the waddwchstr() and wadd_wch functions.
* Thomas Dickey - 2009/9/12
@@ -158,7 +158,7 @@
}

```

```

static void
-legend(WINDOW *win, int level, Options state, wchar_t *buffer, int length)
+legend(WINDOW *win, int level, Options state, const wchar_t *buffer, int length)
{
    const char *showstate;

```

Index: test/test\_addchstr.c

Prereq: 1.29

--- ncurses-6.5-20240928+/test/test\_addchstr.c 2022-12-10 22:28:50.000000000 +0000

+++ ncurses-6.5-20241006/test/test\_addchstr.c 2024-10-05 19:26:24.000000000 +0000

```

@@@ -1,5 +1,5 @@@
/*****
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*
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@@ -27,7 +27,7 @@
* authorization.
*****/
/*
- * $Id: test_addchstr.c,v 1.29 2022/12/10 22:28:50 tom Exp $
+ * $Id: test_addchstr.c,v 1.30 2024/10/05 19:26:24 tom Exp $
*
* Demonstrate the waddchstr() and waddch functions.
* Thomas Dickey - 2009/9/12
@@ -169,7 +169,7 @@
}

```

```

static int
-ColOf(char *buffer, int length, int margin)
+ColOf(const char *buffer, int length, int margin)
{
    int n;
    int result;

```

Index: test/test\_addstr.c

Prereq: 1.20

--- ncurses-6.5-20240928+/test/test\_addstr.c 2022-12-10 22:28:50.000000000 +0000

+++ ncurses-6.5-20241006/test/test\_addstr.c 2024-10-05 19:27:33.000000000 +0000

@@ -1,5 +1,5 @@

/\*\*\*\*\*

-

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@@ -27,7 +27,7 @@

\* authorization. \*

\*\*\*\*\*/

/\*

- \* \$Id: test\_addstr.c,v 1.20 2022/12/10 22:28:50 tom Exp \$

+ \* \$Id: test\_addstr.c,v 1.21 2024/10/05 19:27:33 tom Exp \$

\*

\* Demonstrate the waddstr() and waddch functions.

\* Thomas Dickey - 2009/9/12

@@ -91,7 +91,7 @@

}

static int

-ColOf(char \*buffer, int length, int margin)

+ColOf(const char \*buffer, int length, int margin)

{

int n;

int result;

Index: test/test\_addwstr.c

Prereq: 1.22

---

ncurses-6.5-20240928+/test/test\_addwstr.c 2023-05-27 20:13:10.000000000 +0000

+++ ncurses-6.5-20241006/test/test\_addwstr.c 2024-10-05 19:27:33.000000000 +0000

@@ -1,5 +1,5 @@

/\*\*\*\*\*

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@@ -27,7 +27,7 @@

\* authorization. \*

\*\*\*\*\*/

/\*

- \* \$Id: test\_addwstr.c,v 1.22 2023/05/27 20:13:10 tom Exp \$

+ \* \$Id: test\_addwstr.c,v 1.23 2024/10/05 19:27:33 tom Exp \$

```

*
* Demonstrate the waddwstr() and wadd_wch
functions.
* Thomas Dickey - 2009/9/12
@@ -82,7 +82,7 @@
static int n_opt = -1;

static void
-legend(WINDOW *win, int level, Options state, wchar_t *buffer, int length)
+legend(WINDOW *win, int level, Options state, const wchar_t *buffer, int length)
{
    const char *showstate;

Index: test/test_endwin.c
Prereq: 1.2
--- ncurses-6.5-20240928+/test/test_endwin.c 2023-11-10 15:17:19.000000000 +0000
+++ ncurses-6.5-20241006/test/test_endwin.c 2024-10-05 19:27:33.000000000 +0000
@@ -1,5 +1,5 @@
/*****
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*
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* copy of this software and associated documentation files (the
@@ -26,7 +26,7 @@
* authorization.
*****/
/*
- * $Id: test_endwin.c,v 1.2 2023/11/10 15:17:19 tom Exp $
+ * $Id: test_endwin.c,v 1.3 2024/10/05 19:27:33 tom Exp $
*/
#include <test.priv.h>

@@ -67,7 +67,7 @@
    int rc_e1 = OK;
    int rc_e2 = OK;
    int rc_e3 = OK;
-   SCREEN *sp = NULL;
+   const SCREEN *sp = NULL;
    bool opt_e = FALSE;
    bool opt_i = FALSE;
    bool opt_n = FALSE;
Index: test/test_get_wstr.c
Prereq: 1.14
--- ncurses-6.5-20240928+/test/test_get_wstr.c 2022-12-10 23:59:13.000000000 +0000
+++ ncurses-6.5-20241006/test/test_get_wstr.c 2024-10-06 23:15:10.000000000 +0000
@@ -1,5 +1,5 @@
/*****

```

```

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*
*
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@@ -27,7 +27,7 @@
* authorization.
*****/

/*
- * $Id: test_get_wstr.c,v 1.14 2022/12/10 23:59:13 tom Exp $
+ * $Id: test_get_wstr.c,v 1.16 2024/10/06 23:15:10 tom Exp $
*
* Author: Thomas E Dickey
*
@@ -69,7 +69,7 @@
}

static int
-Remainder(WINDOW *txtwin)
+Remainder(const WINDOW *txtwin)
{
    int result = getmaxx(txtwin) - getcurx(txtwin);
    return (result > 0) ? result : 0;
@@ -138,7 +138,7 @@
static int
recursive_test(int level, char **argv, WINDOW *strwin)
{
-    static const char *help[] =
+    static NCURSES_CONST char *help[] =
    {
        "Commands:",
        " q,^Q,ESC - quit this program",
Index: test/test_getstr.c
Prereq:
1.16
--- ncurses-6.5-20240928+/test/test_getstr.c 2022-12-10 23:58:37.000000000 +0000
+++ ncurses-6.5-20241006/test/test_getstr.c 2024-10-06 22:36:46.000000000 +0000
@@ -1,5 +1,5 @@
*****/

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*
*
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@@ -27,7 +27,7 @@
* authorization.
*****/

```

```

/*
- * $Id: test_getstr.c,v 1.16 2022/12/10 23:58:37 tom Exp $
+ * $Id: test_getstr.c,v 1.19 2024/10/06 22:36:46 tom Exp $
*
* Author: Thomas E Dickey
*
@@ -76,7 +76,7 @@
}

static int
-Remainder(WINDOW *txtwin)
+Remainder(NCURSES_CONST WINDOW *txtwin)
{
    int result = getmaxx(txtwin) - getcurx(txtwin);
    return (result > 0) ? result : 0;
@@ -145,7 +145,7 @@
static int
recursive_test(int level, char **argv, WINDOW *strwin)
{
-    static const char *help[] =
+    static NCURSES_CONST char *help[] =
    {
        "Commands:",
        " q,^Q,ESC    - quit this program",
Index: test/test_instr.c
Prereq: 1.13
--- ncurses-6.5-20240928+/test/test_instr.c 2024-06-29 18:42:53.000000000 +0000
+++ ncurses-6.5-20241006/test/test_instr.c 2024-10-06 21:11:54.000000000 +0000
@@ -27,7 +27,7 @@
* authorization.
*
*****/
/*
- * $Id: test_instr.c,v 1.13 2024/06/29 18:42:53 tom Exp $
+ * $Id: test_instr.c,v 1.15 2024/10/06 21:11:54 tom Exp $
*
* Author: Thomas E Dickey
*
@@ -56,13 +56,13 @@
}

static
void
-show_1st(WINDOW *win, int line, char *buffer)
+show_1st(WINDOW *win, int line, NCURSES_CONST char *buffer)
{
    MvWAddStr(win, line, 5, buffer);
}

```

```

static void
-showmore(WINDOW *win, int line, char *buffer)
+showmore(WINDOW *win, int line, NCURSES_CONST char *buffer)
{
    wmove(win, line, 0);
    wclrtoeol(win);
@@ -72,7 +72,7 @@
static void
show_help(WINDOW *win)
{
-    static const char *msgs[] =
+    static NCURSES_CONST char *msgs[] =
    {
        "Show file contents and a viewport from the variants of winstr."
        ,"Use h/j/k/l or arrow keys to move the viewport."
Index: test/test_inwstr.c
Prereq: 1.9
--- ncurses-6.5-20240928+/test/test_inwstr.c 2024-06-29 18:40:02.000000000 +0000
+++ ncurses-6.5-20241006/test/test_inwstr.c 2024-10-06 23:15:38.000000000 +0000
@@ -27,7 +27,7 @@
* authorization.
*
*****/
/*
- * $Id: test_inwstr.c,v
1.9 2024/06/29 18:40:02 tom Exp $
+ * $Id: test_inwstr.c,v 1.11 2024/10/06 23:15:38 tom Exp $
*
* Author: Thomas E Dickey
*
@@ -59,13 +59,13 @@
}

static void
-show_1st(WINDOW *win, int line, wchar_t *buffer)
+show_1st(WINDOW *win, int line, const wchar_t *buffer)
{
    (void) mvwaddwstr(win, line, 5, buffer);
}

static void
-showmore(WINDOW *win, int line, wchar_t *buffer)
+showmore(WINDOW *win, int line, const wchar_t *buffer)
{
    wmove(win, line, 0);
    wclrtoeol(win);
@@ -75,7 +75,7 @@
static void
show_help(WINDOW *win)

```



```

{
- static const char *msgs[] =
+ static NCURSES_CONST char *msgs[] =
{
"Show file contents and a viewport from the variants of winwstr."
,"Use h/j/k/l or arrow keys to move the viewport."
Index: test/test_mouse.c
Prereq: 1.32
--- ncurses-6.5-20240928+/test/test_mouse.c 2024-08-31 10:46:01.000000000 +0000
+++ ncurses-6.5-20241006/test/test_mouse.c 2024-10-05 18:47:56.000000000 +0000
@@ -22,7 +22,7 @@
* THE USE OR OTHER DEALINGS
IN THE SOFTWARE.
*****/
/*
- * $Id: test_mouse.c,v 1.32 2024/08/31 10:46:01 Rafael.Kitover Exp $
+ * $Id: test_mouse.c,v 1.33 2024/10/05 18:47:56 tom Exp $
*
* Author: Leonid S Usov
*
@@ -38,7 +38,7 @@
static void
raw_loop(void)
{
- char *xtermcap;
+ const char *xtermcap;

printf("Entering raw mode. Ctrl-c to quit.\n");

Index: test/test_opaque.c
Prereq: 1.15
--- ncurses-6.5-20240928+/test/test_opaque.c 2022-12-11 00:03:10.000000000 +0000
+++ ncurses-6.5-20241006/test/test_opaque.c 2024-10-05 19:27:33.000000000 +0000
@@ -1,5 +1,5 @@
/*****
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*
*
*
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@@ -27,7 +27,7 @@
* authorization.
*****/
/*
- * $Id: test_opaque.c,v 1.15 2022/12/11 00:03:10 tom Exp $
+ * $Id: test_opaque.c,v 1.16 2024/10/05 19:27:33 tom Exp $
*

```

```

* Author: Thomas E Dickey
*
@@ -157,13 +157,13 @@
}

```

```

static int
-status_y(WINDOW *stswin, int cell)
+status_y(const WINDOW *stswin, int cell)
{
    return (cell % getmaxy(stswin));
}

```

```

static int
-status_x(WINDOW *stswin, int cell)
+status_x(const WINDOW *stswin, int cell)
{
    return (15 * (cell / getmaxy(stswin)));
}

```

Index: test/test\_sgr.c

Prereq: 1.22

--- ncurses-6.5-20240928+/test/test\_sgr.c 2023-05-27 20:13:10.000000000 +0000

+++ ncurses-6.5-20241006/test/test\_sgr.c 2024-10-06 21:05:50.000000000 +0000

```
@@ -1,5 +1,5 @@
```

```

/*****

```

```
-
```

```

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*                                     *

```

```

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```

```
@@ -30,7 +30,7 @@
```

```
/*
```

```

* Author: Thomas E. Dickey

```

```
*
```

```
- * $Id: test_sgr.c,v 1.22 2023/05/27 20:13:10 tom Exp $
```

```
+ * $Id: test_sgr.c,v 1.25 2024/10/06 21:05:50 tom Exp $
```

```
*
```

```

* A simple demo of the sgr/sgr0 terminal capabilities.

```

```
*/
```

```
@@ -142,10 +142,10 @@
```

```
#define MASK_REV (1 << 2)
```

```
static void
```

```
-dumpit(unsigned bits, unsigned ignore, const char *sgr, const char *sgr0)
```

```
+dumpit(unsigned bits, unsigned ignore, NCURSES_CONST char *sgr, NCURSES_CONST char *sgr0)
```

```
{
```

```
-    static const char sample[] = "abcdefghijklm";
```

```
-    static
```

```

char params[] = "SURBDBIPA";
+ static NCURSES_CONST char sample[] = "abcdefghijklm";
+ static NCURSES_CONST char params[] = "SURBDBIPA";
    unsigned n;

    printf("%4u ", bits);
@@ -177,12 +177,11 @@
static void
brute_force(const char *name)
{
-   unsigned count;
-   char *my_sgr;
-   char *my_sgr0;
-   char *my_bold;
-   char *my_revs;
-   char *my_smso;
+   NCURSES_CONST char *my_sgr;
+   NCURSES_CONST char *my_sgr0;
+   NCURSES_CONST char *my_bold;
+   NCURSES_CONST char *my_revs;
+   NCURSES_CONST char *my_smso;
    char *my_name = strdup(name);

    if (db_list) {
@@ -219,6 +218,7 @@
    unsigned ignore = 0;
    unsigned reason = 0;
    unsigned repeat = 0;
+   unsigned count;
    for (count = 0; count < MAXSGR; ++count) {
        values[count] = tparm(my_sgr,
            BITS2P(1),
@@ -334,7 +334,7 @@
main(int argc, char *argv[])
{
    int ch;
-   char *name;
+   const char *name;

    while ((ch = getopt(argc, argv, OPTS_COMMON "d:e:nq")) != -1) {
switch (ch)
{
@@ -369,7 +369,7 @@
        } else if ((name = getenv("TERM")) != 0) {
            brute_force(name);
        } else {
- static char dumb[] = "dumb";
+ static const char dumb[] = "dumb";

```

```
brute_force(dumb);
}
```

Index: test/test\_tparm.c

Prereq: 1.39

--- ncurses-6.5-20240928+/test/test\_tparm.c 2023-11-11 01:00:03.000000000 +0000

+++ ncurses-6.5-20241006/test/test\_tparm.c 2024-10-06 20:50:27.000000000 +0000

@@ -1,5 +1,5 @@

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@@ -29,7 +29,7 @@

/\*

\* Author: Thomas E. Dickey

\*

- \* \$Id: test\_tparm.c,v 1.39 2023/11/11 01:00:03

tom Exp \$

+ \* \$Id: test\_tparm.c,v 1.42 2024/10/06 20:50:27 tom Exp \$

\*

\* Exercise tparm/tparm, either for all possible capabilities with fixed

\* parameters, or one capability with specific combinations of parameters.

@@ -107,7 +107,7 @@

}

static int

-isNumeric(char \*source)

+isNumeric(NCURSES\_CONST char \*source)

{

char \*next = 0;

long value = strtol(source, &next, 0);

@@ -245,7 +245,7 @@

#define NS\_9(fmt) NS\_8(fmt), NumStr(8)

static void

-test\_tparm(const char \*name, const char \*format, long \*number, char \*\*string)

+test\_tparm(const char \*name, NCURSES\_CONST char \*format, long \*number, char \*\*string)

{

char \*use\_strings[MAX\_PARM];

char \*result = NULL;

@@ -527,7 +527,7 @@

}

} else {

char \*s = t\_opt;

- char \*t;

+ NCURSES\_CONST char \*t;

```

    while ((t = strtok(s, ",")) != 0) {
    s = 0;
    if (len_terms + 2 >= max_terms) {
@@ -603,7 +603,7 @@
#if NCURSES_XNAMES
    len_caps = std_caps;
    if (cur_term) {
- TERMTYPE *term =
(TERMTYPE *) cur_term;
+ NCURSES_CONST TERMTYPE *term = (TERMTYPE *) cur_term;
    for (n = STRCOUNT; n < NUM_STRINGS(term); ++n) {
        GrowArray(all_caps, max_caps, len_caps);
        GrowArray(cap_name, max_name, len_caps);
Index: test/test_vidputs.c
Prereq: 1.15
--- ncurses-6.5-20240928+/test/test_vidputs.c 2022-12-10 23:23:27.000000000 +0000
+++ ncurses-6.5-20241006/test/test_vidputs.c 2024-10-06 21:17:54.000000000 +0000
@@ -1,5 +1,5 @@
/*****
- * Copyright 2020-2021,2022 Thomas E. Dickey                *
+ * Copyright 2020-2022,2024 Thomas E. Dickey                *
* Copyright 2013-2014,2017 Free Software Foundation, Inc.    *
*                                                              *
* Permission is hereby granted, free of charge, to any person obtaining a *
@@ -27,7 +27,7 @@
* authorization.
*
*****
/*
- * $Id: test_vidputs.c,v 1.15 2022/12/10 23:23:27 tom Exp $
+ * $Id: test_vidputs.c,v 1.16 2024/10/06 21:17:54 tom Exp $
*
* Demonstrate the vidputs and vidattr functions.
* Thomas Dickey - 2013/01/12
@@ -51,7 +51,7 @@
}

```

```

static bool
-outs(const char *s)
+outs(NCURSES_CONST char *s)
{

```

```

    if (VALID_STRING(s)) {
    tputs(s, 1, outc);

```

Index: test/testcurs.c

Prereq: 1.58

--- ncurses-6.5-20240928+/test/testcurs.c 2023-05-28 14:23:34.000000000 +0000

+++ ncurses-6.5-20241006/test/testcurs.c 2024-10-05 19:17:19.000000000 +0000

@@ -6,7 +6,7 @@

```

* wrs(5/28/93) -- modified to be consistent (perform identically) with either
*      PDCurses or under Unix System V, R4
*
- * $Id: testcurs.c,v 1.58 2023/05/28 14:23:34 tom Exp $
+ * $Id: testcurs.c,v 1.59 2024/10/05 19:17:19 tom Exp $
*/

#include <test.priv.h>
@@ -245,7 +245,7 @@
wclrtobot(win);
if (c >= KEY_MIN)
    wprintw(win, "Key Pressed: %s", keyname(c));
- else if (isprint(c))
+ else if (isprint(UChar(c)))
    wprintw(win, "Key Pressed: %c", c);
else
    wprintw(win, "Key Pressed: %s", unctrl(UChar(c)));
@@ -748,8 +748,8 @@
 keypad(stdscr, TRUE);
 raw();
 key = getch();
- if (key < KEY_MIN && key > 0 && isalpha(key)) {
-     if (islower(key))
+ if (key < KEY_MIN && key > 0 && isalpha(UChar(key))) {
+     if (islower(UChar(key)))
        key = toupper(key);
        for (n = 0; n < MAX_OPTIONS; ++n) {
            if (key == command[n].text[0]) {
Index: test/testscanw.c
Prereq: 1.15
--- ncurses-6.5-20240928+/test/testscanw.c 2022-12-11 00:10:29.000000000 +0000
+++ ncurses-6.5-20241006/test/testscanw.c 2024-10-05 19:27:33.000000000 +0000
@@ -1,5 +1,5 @@
/*****
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+ * Copyright 2019-2022,2024 Thomas E. Dickey                *
*
Copyright 1998-2002,2006 Free Software Foundation, Inc.      *
*
* Permission is hereby granted, free of charge, to any person obtaining a *
@@ -30,7 +30,7 @@
* Date: 1997/03/17
* From: bayern@morpheus.cis.yale.edu
*
- * $Id: testscanw.c,v 1.15 2022/12/11 00:10:29 tom Exp $
+ * $Id: testscanw.c,v 1.16 2024/10/05 19:27:33 tom Exp $
*/

#include <test.priv.h>

```

```

@@ -85,7 +85,7 @@
    curses_trace	TRACE_UPDATE | TRACE_CALLS);
#endif
    while (optind < argc) {
- char *token = argv[optind++];
+ const char *token = argv[optind++];
    if (isdigit(UChar(*token)))
        move(atoi(token), 0);
    else if (!strcmp(token, "k+"))
Index: test/view.c
Prereq: 1.145
--- ncurses-6.5-20240928+/test/view.c 2022-12-04 00:40:11.000000000 +0000
+++ ncurses-6.5-20241006/test/view.c 2024-10-06 21:08:05.000000000 +0000
@@ -1,5 +1,5 @@
/*****
-
- * Copyright 2019-2021,2022 Thomas E. Dickey		*
+ * Copyright 2019-2022,2024 Thomas E. Dickey		*
- * Copyright 1998-2016,2017 Free Software Foundation, Inc.	*
+ *
+ * Permission is hereby granted, free of charge, to any person obtaining a *
@@ -52,7 +52,7 @@
- * scroll operation worked, and the refresh() code only had to do a
- * partial repaint.
- *
- * $Id: view.c,v 1.145 2022/12/04 00:40:11 tom Exp $
+ * $Id: view.c,v 1.147 2024/10/06 21:08:05 tom Exp $
- */

#include <test.priv.h>
@@ -93,8 +93,7 @@

#if USE_WIDEC_SUPPORT
    for (;;) {
- int count;
- TEST_CCHAR(src, count, {
+ TEST_CCHAR(src, {
        int len = wcwidth(test_wch[0]);
        result += (len > 0) ? len : 1;
        ++src;
@@ -186,12 +185,10 @@
        */
        {
            int j;
- int width = 1;
+ int width;

```

```

    for (j = actual = 0; j < shift; ++j) {
-   int count;
-
-
        TEST_CCHAR(s + j, count, {
+   TEST_CCHAR(s + j, {
        width = wcwidth(test_wch[0]);
        }
        , {
@@ -294,7 +291,7 @@

#if USE_WIDEC_SUPPORT
    if (!memcmp("\357\273\277", my_blob, 3)) {
- char *s = my_blob + 3;
+ const char *s = my_blob + 3;
    char *d = my_blob;
    Trace(("trim BOM"));
    do {
@@ -329,7 +326,7 @@
    char *s;
    int y, x;
#if USE_WIDEC_SUPPORT
- char *last = my_vec[k] + (int) strlen(my_vec[k]);
+ const char *last = my_vec[k] + (int) strlen(my_vec[k]);
    wchar_t wch[2];
    size_t rc;
#ifdef state_unused
@@ -408,7 +405,7 @@
int
main(int argc, char *argv[])
{
- static const char *help[] =
+ static NCURSES_CONST char *help[] =
    {
        "Commands:",
        " q,^Q,ESC    - quit this program",
@@ -659,7 +656,7 @@
        beep();
        break;
    }
- if (c >= KEY_MIN || (c > 0 && !isdigit(c))) {
+ if (c >= KEY_MIN || (c > 0 && !isdigit(UChar(c)))) {
        got_number = FALSE;
        value = 0;
    }
}

Found in path(s):
* /ncurses-6.5-20241006-patch-gz/ncurses-6.5-20241006.patch

```



# 1.12 py3-pip-pyc 24.3.1-r0

## 1.12.1 Available under license :

### A. HISTORY OF THE SOFTWARE

=====

Python was created in the early 1990s by Guido van Rossum at Stichting Mathematisch Centrum (CWI, see <http://www.cwi.nl>) in the Netherlands as a successor of a language called ABC. Guido remains Python's principal author, although it includes many contributions from others.

In 1995, Guido continued his work on Python at the Corporation for National Research Initiatives (CNRI, see <http://www.cnri.reston.va.us>) in Reston, Virginia where he released several versions of the software.

In May 2000, Guido and the Python core development team moved to BeOpen.com to form the BeOpen PythonLabs team. In October of the same year, the PythonLabs team moved to Digital Creations (now Zope Corporation, see <http://www.zope.com>). In 2001, the Python Software Foundation (PSF, see <http://www.python.org/psf/>) was formed, a non-profit organization created specifically to own Python-related Intellectual Property. Zope Corporation is a sponsoring member of the PSF.

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| 1.3 thru 1.5.2 | 1.2          | 1995-1999 | CNRI       | yes                 |
| 1.6            | 1.5.2        | 2000      | CNRI       | no                  |
| 2.0            | 1.6          | 2000      | BeOpen.com | no                  |
| 1.6.1          | 1.6          | 2001      | CNRI       | yes (2)             |
| 2.1            | 2.0+1.6.1    | 2001      | PSF        | no                  |
| 2.0.1          | 2.0+1.6.1    | 2001      | PSF        | yes                 |
| 2.1.1          | 2.1+2.0.1    | 2001      | PSF        | yes                 |
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| 2.1.2          | 2.1.1        | 2002      | PSF        | yes                 |
| 2.1.3          |              |           |            |                     |

|       |       |           |     |     |
|-------|-------|-----------|-----|-----|
| 2.1.2 | 2002  | PSF       | yes |     |
| 2.2.1 | 2.2   | 2002      | PSF | yes |
| 2.2.2 | 2.2.1 | 2002      | PSF | yes |
| 2.2.3 | 2.2.2 | 2003      | PSF | yes |
| 2.3   | 2.2.2 | 2002-2003 | PSF | yes |
| 2.3.1 | 2.3   | 2002-2003 | PSF | yes |
| 2.3.2 | 2.3.1 | 2002-2003 | PSF | yes |
| 2.3.3 | 2.3.2 | 2002-2003 | PSF | yes |
| 2.3.4 | 2.3.3 | 2004      | PSF | yes |
| 2.3.5 | 2.3.4 | 2005      | PSF | yes |
| 2.4   | 2.3   | 2004      | PSF | yes |
| 2.4.1 | 2.4   | 2005      | PSF | yes |
| 2.4.2 | 2.4.1 | 2005      | PSF | yes |
| 2.4.3 | 2.4.2 | 2006      | PSF | yes |
| 2.4.4 | 2.4.3 | 2006      | PSF | yes |
| 2.5   | 2.4   | 2006      | PSF | yes |
| 2.5.1 | 2.5   | 2007      | PSF | yes |
| 2.5.2 | 2.5.1 | 2008      | PSF | yes |
| 2.5.3 | 2.5.2 | 2008      | PSF | yes |
| 2.6   | 2.5   | 2008      | PSF | yes |
| 2.6.1 | 2.6   | 2008      | PSF | yes |
| 2.6.2 | 2.6.1 | 2009      | PSF | yes |
| 2.6.3 | 2.6.2 | 2009      | PSF | yes |
| 2.6.4 | 2.6.3 | 2009      | PSF | yes |
| 2.6.5 | 2.6.4 | 2010      | PSF | yes |
| 3.0   | 2.6   | 2008      | PSF | yes |
| 3.0.1 | 3.0   | 2009      | PSF | yes |
| 3.1   | 3.0.1 | 2009      | PSF | yes |
| 3.1.1 | 3.1   | 2009      | PSF | yes |
| 3.1.2 | 3.1   | 2010      | PSF | yes |
| 3.2   | 3.1   | 2010      | PSF | yes |

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| 1.6            | 1.5.2        | 2000      | CNRI       | no                  |
| 2.0            | 1.6          | 2000      | BeOpen.com | no                  |
| 1.6.1          | 1.6          | 2001      | CNRI       | yes (2)             |
| 2.1            | 2.0+1.6.1    | 2001      | PSF        | no                  |
| 2.0.1          | 2.0+1.6.1    | 2001      | PSF        | yes                 |
| 2.1.1          | 2.1+2.0.1    | 2001      | PSF        | yes                 |
| 2.1.2          | 2.1.1        | 2002      | PSF        | yes                 |
| 2.1.3          | 2.1.2        | 2002      | PSF        | yes                 |
| 2.2 and above  | 2.1.1        | 2001-now  | PSF        | yes                 |

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```
Index: tdbsa/tdb.c
=====
--- tdbsa.orig/tdb.c
+++ tdbsa/tdb.c
@@ -4,11 +4,11 @@ Rev: 23371
Last Changed Date: 2007-06-06 20:14:06 -0400 (Wed, 06 Jun 2007)
*/
/*
- Unix SMB/CIFS implementation.
+ trivial database library - standalone version
```

- trivial database library - private includes
- 
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Theodore Ts'o  
23-June-2007

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library `Frob' (a library for tweaking knobs) written by James Random Hacker.

<signature of Ty Coon>, 1 April 1990  
Ty Coon, President of Vice

That's all there is to it!

```
#  
# This is a Makefile stub which handles the creation of BSD shared  
# libraries.  
#  
# In order to use this stub, the following makefile variables must be defined.  
#  
# BSDLIB_VERSION = 1.0  
# BSDLIB_IMAGE = libce  
# BSDLIB_MYDIR = et  
# BSDLIB_INSTALL_DIR = $(SHLIBDIR)  
#
```

all:: image

```
real-subdirs:: Makefile  
@echo " MKDIR pic"  
@mkdir -p pic
```

```
BSD_LIB = $(BSDLIB_IMAGE).so.$(BSDLIB_VERSION)  
BSDLIB_PIC_FLAG = -fpic
```

```
image: $(BSD_LIB)
```

```
$(BSD_LIB): $(OBJS)  
(cd pic; ld -Bshareable -o $(BSD_LIB) $(LDFLAGS_SHLIB) $(OBJS))  
$(MV) pic/$(BSD_LIB) .  
$(RM) -f ../$(BSD_LIB)  
(cd ..; $(LN) $(LINK_BUILD_FLAGS) \  
`echo $(my_dir) | sed -e 's;lib/;;'/'$(BSD_LIB) $(BSD_LIB))
```

```
install-shlibs install:: $(BSD_LIB)
```

```
@echo " INSTALL_PROGRAM $(BSDLIB_INSTALL_DIR)/$(BSD_LIB)"
@$(INSTALL_PROGRAM) $(BSD_LIB) \
$(DESTDIR)$ (BSDLIB_INSTALL_DIR)/$(BSD_LIB)
@-$(LDCONFIG)
```

install-strip: install

install-shlibs-strip:: install-shlibs

uninstall-shlibs uninstall::

```
$(RM) -f $(DESTDIR)$ (BSDLIB_INSTALL_DIR)/$(BSD_LIB)
```

clean::

```
$(RM)
```

```
-rf pic
```

```
$(RM) -f $(BSD_LIB)
```

```
$(RM) -f ../$(BSD_LIB)
```

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Format: <https://www.debian.org/doc/packaging-manuals/copyright-format/1.0/>

Upstream-Name: e2fsprogs

Upstream-Contact: Theodore Ts'o <tytso@mit.edu>

Source: <http://sourceforge.net/projects/e2fsprogs>

Comment:

This is the Debian GNU/Linux prepackaged version of the EXT2 file system utilities (e2fsck, mke2fs, etc.). The EXT2 utilities were written by Theodore Ts'o <tytso@mit.edu> and Remy Card <card@masi.ibp.fr>.

Files: \*

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2001 Alcove <<http://www.alcove.com/>>

1997 Klee Dienes

1995-1996 Michael Nonweiler <mrn20@cam.ac.uk>

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Files: lib/et/\*

lib/ss/\*

Copyright: 1987-1988 MIT Student Information Processing Board

2003 Theodore Ts'o

License: Expat

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Files: lib/et/com\_right.c

Comment: Taken from lib/com\_err/error.c from Kerberos4kth distribution.

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Files: lib/et/test\_cases/imap\_err.et

Copyright: 1994-2008 Carnegie Mellon University.

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Files: lib/ext2fs/\*

lib/e2p/\*

lib/support/print\_fs\_flags.c

misc/e2fuzz.c

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1992-1994 Remy Card <card@masi.ibp.fr>

Laboratoire

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Universite Pierre et Marie Curie (Paris VI)

2001 Andreas Gruenbacher, <a.gruenbacher@computer.org>

2007 IBM Corporation

2010 Red Hat, Inc., Lukas Czerner <lczerner@redhat.com>

2014 Oracle

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2012 Intel Corporation

2001 Daniel Phillips

2002 Theodore Ts'o.

2002 Andreas Dilger

2006 Cluster File Systems, Inc.

2006, 2007 by Andreas Dilger <adilger@clusterfs.com>

2003,2004 Cluster File Systems, Inc <info@clusterfs.com>

1995 Theodore Ts'o.

2003 VMware, Inc.

2015 Jan Kara

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2011 Whamcloud, Inc.

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Files: lib/ext2fs/kernel-jbd.h

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Files: lib/ext2fs/nls\_utf8.c

lib/ext2fs/utf8n.h

util/mkutf8data.c

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Files: lib/ext2fs/crc16.\*

Copyright: 2005 Ben Gardner <bgardner@wabtec.com>

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Files: lib/ext2fs/crc32c\*

Copyright:

August 26, 2011 Darrick J. Wong <djwong at us.ibm.com>

Reuse Bob Pearson's slice-by-8 implementation  
for e2fsprogs.

.

July 20, 2011 Bob Pearson <rpearson at systemfabricworks.com>

...

Oct 15, 2000 Matt Domsch <Matt\_Domsch@dell.com>

...

Oct 12, 2000 Matt Domsch <Matt\_Domsch@dell.com>

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Files: e2fsck/\*  
debugfs/do\_journal.c  
debugfs/journal.\*  
debugfs/logdump.c  
debugfs/xattrs.c  
lib/support/plausible.c  
misc/fuse2fs.c  
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Files: lib/blkid/\*

misc/blkid.c

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2001 Andreas Dilger

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Files: misc/blkid.8.in

misc/uuidgen.1.in

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Files: misc/create\_inode.c

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```
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```

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```
{
"testfiles": [
  "test/*.uts",
  "test/scapy/layers/*.uts",
  "test/contrib/automotive/*.uts",
  "test/contrib/automotive/obd/*.uts",
  "test/contrib/automotive/scanner/*.uts",
  "test/contrib/automotive/gm/*.uts",
  "test/contrib/automotive/bmw/*.uts",
  "test/contrib/automotive/xcp/*.uts",
```

```

    "test/contrib/automotive/autosar/*.uts",
    "test/contrib/*.uts"
  ],
  "remove_testfiles": [
    "test/linux.uts",
    "test/windows.uts",
    "test/contrib/automotive/ecu_am.uts",
    "test/contrib/automotive/gm/gmlanutils.uts",
    "test/contrib/isotp_packet.uts",
    "test/contrib/isotpscan.uts",
    "test/contrib/isotp_soft_socket.uts"
  ],
  "onlyfailed": true,
  "preexec": {
    "test/contrib/*.uts": "load_contrib(\"%name%\")",
    "test/cert.uts": "load_layer(\"tls\")",
    "test/ssl2.uts": "load_layer(\"tls\")",
    "test/tls*.uts": "load_layer(\"tls\")"
  },
  "kw_ko": [
    "linux",
    "windows",
    "ipv6",
    "vcan_socket",
    "tun",
    "tap"
  ]
}

```

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```

## 1.27 git-zsh-completion 5.9-r4

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INFO-DIR-SECTION Utilities

START-INFO-DIR-ENTRY

```
* ZSH: (zsh).          The Z Shell Manual.
```

END-INFO-DIR-ENTRY

File: zsh.info, Node: Calendar System User Functions, Next: Calendar Styles, Prev: Calendar File and Date



### 23.3 User Functions

=====

This section describes functions that are designed to be called directly by the user. The first part describes those functions associated with the user's calendar; the second part describes the use in glob qualifiers.

#### 23.3.1 Calendar system functions

-----

```
calendar [ -abdDsv ] [ -C CALFILE ] [ -n NUM ] [ -S SHOWPROG ]  
    [ [ START ] END ]  
calendar -r [ -abdDrsv ] [ -C CALFILE ] [ -n NUM ] [ -S SHOWPROG ]  
    [ START ]  
    Show events in the calendar.
```

With no arguments, show events from the start of today until the end of the next working day after today. In other words, if today is Friday, Saturday, or Sunday, show up to the end of the following Monday, otherwise show today and tomorrow.

If END is given, show events from the start of today up to the time and date given, which is in the format described in the previous section. Note that if this is a date the time is assumed to be midnight at the start of the date, so that effectively this shows all events before the given date.

END may start with a +, in which case the remainder of the specification is a relative time format as described in the previous section indicating the range of time from the start time that is to be included.

If START is also given, show events starting from that time and date. The word now can be used to indicate the current time.

To implement an alert when events are due, include calendar -s in your ~/.zshrc file.

Options:

-a

Show all items in the calendar, regardless of the start and end.

-b

Brief: don't display continuation lines (i.e. indented lines following the line with the date/time), just the first line.

-B LINES

Brief: display at most the first LINES lines of the calendar entry. ``-B 1'` is equivalent to ``-b'`.

-C CALFILE

Explicitly specify a calendar file instead of the value of the calendar-file style or the default `~/calendar`.

-d

Move any events that have passed from the calendar file to the "done" file, as given by the done-file style or the default which is the calendar file with `.done` appended. This option is implied by the `-s` option.

-D

Turns off the option `-d`, even if the `-s` option is also present.

-n NUM, -NUM

Show at least NUM events, if present in the calendar file, regardless of the start and end.

-r

Show all the remaining options in the calendar, ignoring the given END time. The START time is respected; any argument given is treated as a START time.

-s

Use the shell's `sched` command to schedule a timed event that will warn the user when an event is due. Note that the `sched` command only runs if the shell is at an interactive prompt; a foreground task blocks the scheduled task from running until it is finished.

The timed event usually runs the programme `calendar_show` to show the event, as described in *\*Note Calendar Utility Functions::*.

By default, a warning of the event is shown five minutes

before it is due. The warning period can be configured by the style warn-time or for a single calendar entry by including WARN RELTIME in the first line of the entry, where RELTIME is one of the usual relative time formats.

A repeated event may be indicated by including RPT RELDATE in the first line of the entry. After the scheduled event has been displayed it will be re-entered into the calendar file at a time RELDATE after the existing event. Note that this is currently the only use made of the repeat count, so that it is not possible to query the schedule for a recurrence of an event in the calendar until the previous event has passed.

If RPT is used, it is also possible to specify that certain recurrences of an event are rescheduled or cancelled. This is done with the OCCURRENCE keyword, followed by whitespace and the date and time of the occurrence in the regular sequence, followed by whitespace and either the date and time of the rescheduled event or the exact string CANCELLED. In this case the date and time must be in exactly the "date with local time" format used by the text/calendar MIME type (RFC 2445), <YYYY><MM><DD>T<HH><MM><SS> (note the presence of the literal character T). The first word (the regular recurrence) may be something other than a proper date/time to indicate that the event is additional to the normal sequence; a convention that retains the formatting appearance is XXXXXXXXTXXXXXX.

Furthermore, it is useful to record the next regular recurrence (as then the displayed date may be for a rescheduled event so cannot be used for calculating the regular sequence). This is specified by RECURRENCE and a time or date in the same format. calendar\_add adds such an indication when it encounters a recurring event that does not include one, based on the headline date/time.

If calendar\_add is used to update occurrences the UID keyword described there should be present in both the existing entry and the added occurrence in order to identify recurring event sequences.

For example,

Thu May 6, 2010 11:00 Informal chat RPT 1 week

```
# RECURRENCE 20100506T110000
# OCCURRENCE 20100513T110000 20100513T120000
# OCCURRENCE 20100520T110000 CANCELLED
```

The event that occurs at 11:00 on 13th May 2010 is rescheduled an hour later. The event that occurs a week later is cancelled. The occurrences are given on a continuation line starting with a # character so will not usually be displayed as part of the event. As elsewhere, no account of time zones is taken with the times. After the next event occurs the headline date/time will be `Thu May 13, 2010 12:00' while the RECURRENCE date/time will be `20100513T110000' (note that cancelled and moved events are not taken account of in the RECURRENCE, which records what the next regular recurrence is, but they are accounted for in the headline date/time).

It is safe to run `calendar -s` to reschedule an existing event (if the calendar file has changed, for example), and also to have it running in multiples instances of the shell since the calendar file is locked when in use.

By default, expired events are moved to the "done" file; see the `-d` option. Use `-D` to prevent this.

#### `-S SHOWPROG`

Explicitly specify a programme to be used for showing events instead of the value of the `show-prog` style or the default `calendar_show`.

#### `-v`

Verbose: show more information about stages of processing. This is useful for confirming that the function has successfully parsed the dates in the calendar file.

`calendar_add [ -BL ] EVENT ...`

Adds a single event to the calendar in the appropriate location.

The event can contain multiple lines, as described in *\*Note Calendar File and Date Formats::*. Using this function ensures that the calendar file is sorted in date and time order. It also makes special arrangements for locking the file while it is altered. The old calendar is left in a file with the suffix `.old`.

The option `-B` indicates that backing up the calendar file will be handled by the caller and should not be performed by `calendar_add`. The option `-L` indicates that `calendar_add` does not need to lock

the calendar file as it is already locked. These options will not usually be needed by users.

If the style reformat-date is true, the date and time of the new entry will be rewritten into the standard date format: see the descriptions of this style and the style date-format.

The function can use a unique identifier stored with each event to ensure that updates to existing events are treated correctly. The entry should contain the word UID, followed by whitespace, followed by a word consisting entirely of hexadecimal digits of arbitrary length (all digits are significant, including leading zeroes). As the UID is not directly useful to the user, it is convenient to hide it on an indented continuation line starting with a #, for example:

```
Aug 31, 2007 09:30 Celebrate the end of the holidays
# UID 045B78A0
```

The second line will not be shown by the calendar function.

It is possible to specify the RPT keyword followed by CANCELLED instead of a relative time. This causes any matched event or series of events to be cancelled (the original event does not have to be marked as recurring in order to be cancelled by this method). A UID is required in order to match an existing event in the calendar.

calendar\_add will attempt to manage recurrences and occurrences of repeating events as described for event scheduling by calendar -s above. To reschedule or cancel a single event calendar\_add should be called with an entry that includes the correct UID but does not include the RPT keyword as this is taken to mean the entry applies to a series of repeating events and hence replaces all existing information. Each rescheduled or cancelled occurrence must have an OCCURRENCE keyword in the entry passed to calendar\_add which will be merged into the calendar file. Any existing reference to the occurrence is replaced. An occurrence that does not refer to a valid existing event is added as a one-off occurrence to the same calendar entry.

calendar\_edit

This calls the user's editor to edit the calendar file. If there are arguments, they are taken as the editor to use (the file name is appended to the commands); otherwise, the editor is given by the

variable VISUAL,  
if set, else the variable EDITOR.

If the calendar scheduler was running, then after editing the file  
calendar -s is called to update it.

This function locks out the calendar system during the edit.  
Hence it should be used to edit the calendar file if there is any  
possibility of a calendar event occurring meanwhile. Note this  
can lead to another shell with calendar functions enabled hanging  
waiting for a lock, so it is necessary to quit the editor as soon  
as possible.

#### calendar\_parse CALENDAR-ENTRY

This is the internal function that analyses the parts of a calendar  
entry, which is passed as the only argument. The function returns  
status 1 if the argument could not be parsed as a calendar entry  
and status 2 if the wrong number of arguments were passed; it also  
sets the parameter reply to an empty associative array. Otherwise,  
it returns status 0 and sets elements of the associative array  
reply as follows:

##### time

The time as a string of digits in the same units as  
\$EPOCHSECONDS

##### schedtime

The regularly scheduled time. This may differ from the  
actual event time if this is a recurring event and the  
next occurrence has been rescheduled. Then time gives the  
actual time and schedtime the time of the regular recurrence  
before modification.

##### text1

The text from the line not including the date and time of the  
event, but including any WARN or RPT keywords and values.

##### warntime

Any warning time given by the WARN keyword as a string of  
digits containing the time at which to warn in the same units  
as \$EPOCHSECONDS. (Note this is an absolute time, not the  
relative time passed down.) Not set if no WARN keyword and  
value were matched.

##### warnstr

The raw string matched after the WARN keyword, else unset.

rpttime

Any recurrence

time given by the RPT keyword as a string of

digits containing the time of the recurrence in the same units as \$EPOCHSECONDS. (Note this is an absolute time.) Not set if no RPT keyword and value were matched.

schedrpttime

The next regularly scheduled occurrence of a recurring event before modification. This may differ from rpttime, which is the actual time of the event that may have been rescheduled from the regular time.

rptstr

The raw string matched after the RPT keyword, else unset.

text2

The text from the line after removal of the date and any keywords and values.

calendar\_showdate [ -r ] [ -f FMT ] DATE-SPEC ...

The given DATE-SPEC is interpreted and the corresponding date and time printed. If the initial DATE-SPEC begins with a + or - it is treated as relative to the current time; DATE-SPECs after the first are treated as relative

to the date calculated so far and a

leading + is optional in that case. This allows one to use the system as a date calculator. For example, calendar\_showdate '+1 month, 1st Friday' shows the date of the first Friday of next month.

With the option -r nothing is printed but the value of the date and time in seconds since the epoch is stored in the parameter `REPLY`.

With the option -f FMT the given date/time conversion format is passed to strftime; see notes on the date-format style below.

In order to avoid ambiguity with negative relative date specifications, options must occur in separate words; in other words, -r and -f should not be combined in the same word.

calendar\_sort

Sorts the calendar file into date and time order. The old calendar is left in a file with the suffix .old.

### 23.3.2 Glob qualifiers

-----

#### age

The function age can be autoloaded and use separately from the calendar

system, although it uses the function calendar\_scandate for date formatting. It requires the zsh/stat builtin, but uses only the builtin zstat.

age selects files having a given modification time for use as a glob qualifier. The format of the date is the same as that understood by the calendar system, described in \*Note Calendar File and Date Formats::.

The function can take one or two arguments, which can be supplied either directly as command or arguments, or separately as shell parameters.

```
print *(e:age 2006/10/04 2006/10/09:)
```

The example above matches all files modified between the start of those dates. The second argument may alternatively be a relative time introduced by a +:

```
print *(e:age 2006/10/04 +5d:)
```

The example above is equivalent to the previous example.

In addition to the special use of days of the week, today and yesterday, times with no date may be specified; these apply to today. Obviously such uses become problematic around midnight.

```
print *(e-age 12:00 13:30-)
```

The example above shows files modified between 12:00 and 13:00 today.

```
print *(e:age 2006/10/04:)
```

The example above matches all files modified on that date. If the



second argument is omitted it is taken to be exactly 24 hours after the first argument (even if the first argument contains a time).

```
print *(e-age 2006/10/04:10:15 2006/10/04:10:45-)
```

The example above supplies times. Note that whitespace within the time and date specification must be quoted to ensure age receives the correct arguments, hence the use of the additional colon to separate the date and time.

```
AGEREF=2006/10/04:10:15
AGEREF2=2006/10/04:10:45
print *(+age)
```

This shows the same example before using another form of argument passing. The dates and times in the parameters AGEREF and AGEREF2

stay in effect until unset, but will be overridden if any argument is passed as an explicit argument to age. Any explicit argument causes both parameters to be ignored.

Instead of an explicit date and time, it's possible to use the modification time of a file as the date and time for either argument by introducing the file name with a colon:

```
print *(e-age :file1-)
```

matches all files created on the same day (24 hours starting from midnight) as file1.

```
print *(e-age :file1 :file2-)
```

matches all files modified no earlier than file1 and no later than file2; precision here is to the nearest second.

after

before

The functions after and before are simpler versions of age that take just one argument. The argument is parsed similarly to an argument of age; if it is not given the variable AGEREF is consulted. As the names of the functions suggest, a file matches if its modification time

is after or before the time and date specified. If a time only is given the date is today.

The two following examples are therefore equivalent:

```
print *(e-after 12:00-)
print *(e-after today:12:00-)
```

File: zsh.info, Node: Calendar Styles, Next: Calendar Utility Functions, Prev: Calendar System User Functions, Up: Calendar Function System

## 23.4 Styles

=====

The zsh style mechanism using the `zstyle` command is describe in `*Note The zsh/zutil Module::`. This is the same mechanism used in the completion system.

The styles below are all examined in the context `:datetime:FUNCTION;`, for example `:datetime:calendar::`.

### calendar-file

The location of the main calendar. The default is `~/calendar`.

### date-format

A `strftime` format string (see `strftime(3)`) with the zsh extensions providing various numbers with no leading zero or space if the number is a single digit as described for the `%D{STRING}` prompt format in `*Note Prompt`

Expansion::

This is used for outputting dates in calendar, both to support the `-v` option and when adding recurring events back to the calendar file, and in `calendar_showdate` as the final output format.

If the style is not set, the default used is similar the standard system format as output by the `date` command (also known as ``ctime format``): ``%a %b %d %H:%M:%S %Z %Y'`.

### done-file

The location of the file to which events which have passed are appended. The default is the calendar file location with the suffix `.done`. The style may be set to an empty string in which case a "done" file will not be maintained.

#### reformat-date

Boolean, used by `calendar_add`. If it is true, the date and time of new entries added to the calendar will be reformatted to the format given by the style `date-format` or its default. Only the date and time of the event itself is reformatted; any subsidiary dates and times such as those associated

with repeat and warning times are left alone.

#### show-prog

The programme run by `calendar` for showing events. It will be passed the start time and stop time of the events requested in seconds since the epoch followed by the event text. Note that `calendar -s` uses a start time and stop time equal to one another to indicate alerts for specific events.

The default is the function `calendar_show`.

#### warn-time

The time before an event at which a warning will be displayed, if the first line of the event does not include the text `EVENT RELTIME`. The default is 5 minutes.

File: `zsh.info`, Node: Calendar Utility Functions, Next: Calendar Bugs, Prev: Calendar Styles, Up: Calendar Function System

### 23.5 Utility functions

=====

#### `calendar_lockfiles`

Attempt to lock the files given in the argument. To prevent problems with network file locking this is done in an ad hoc fashion by attempting to create a symbolic

link to the file with

the name `FILE.lockfile`. No other system level functions are used for locking, i.e. the file can be accessed and modified by any utility that does not use this mechanism. In particular, the user is not prevented from editing the calendar file at the same time unless `calendar_edit` is used.

Three attempts are made to lock the file before giving up. If the module `zsh/zselect` is available, the times of the attempts are jittered so that multiple instances of the calling function are unlikely to retry at the same time.

The files locked are appended to the array lockfiles, which should be local to the caller.

If all files were successfully locked, status zero is returned, else status one.

This function may be used as a general file locking function, although this will only work if only this mechanism is used to lock files.

#### calendar\_read

This is a backend used by various other functions to parse the calendar file, which is passed as the only argument. The array calendar\_entries is set to the list of events in the file; no pruning is done except that ampersands are removed from the start of the line. Each entry may contain multiple lines.

#### calendar\_scandate

This is a generic function to parse dates and times that may be used separately from the calendar system. The argument is a date or time specification as described in \*Note Calendar File and Date Formats::. The parameter REPLY is set to the number of seconds since the epoch corresponding to that date or time. By default, the date and time may occur anywhere within the given argument.

Returns status zero if the date and time were successfully parsed, else one.

Options:

-a

The date and time are anchored to the start of the argument; they will not be matched if there is preceding text.

-A

The date and time are anchored to both the start and end of the argument; they will not be matched if there is any other text in the argument.

-d

Enable additional debugging output.

-m

Minus. When -R ANCHOR\_TIME is also given the relative time is calculated backwards from ANCHOR\_TIME.

-r

The argument passed is to be parsed as a relative time.

-R ANCHOR\_TIME

The argument passed is to be parsed as a relative time. The time is relative to ANCHOR\_TIME, a time in seconds since the epoch, and the returned value is the absolute time corresponding to advancing ANCHOR\_TIME by the relative time given. This allows lengths of months to be correctly taken into account. If the final day does not exist in the given month, the last day of the final month is given. For example, if the anchor time is during 31st January 2007 and the relative time

is 1 month, the final time is the same time of day during 28th February 2007.

-s

In addition to setting REPLY, set REPLY2 to the remainder of the argument after the date and time have been stripped. This is empty if the option -A was given.

-t

Allow a time with no date specification. The date is assumed to be today. The behaviour is unspecified if the iron tongue of midnight is tolling twelve.

calendar\_show

The function used by default to display events. It accepts a start time and end time for events, both in epoch seconds, and an event description.

The event is always printed to standard output. If the command line editor is active (which will usually be the case) the command line will be redisplayed after the output.

If the parameter DISPLAY is set and the start and end times are the same (indicating a scheduled event), the function uses the command

xmessage to display a window with the event details.

File: zsh.info, Node: Calendar Bugs, Prev: Calendar Utility Functions, Up: Calendar Function System

23.6 Bugs

=====

As the system is based entirely on shell functions (with a little support from the zsh/datetime module) the mechanisms used are not as robust as those provided by a dedicated calendar utility. Consequently the user should not rely on the shell for vital alerts.

There is no calendar\_delete function.

There is no localization support for dates and times, nor any support for the use of time zones.

Relative periods of months and years do not take into account the variable number of days.

The calendar\_show function is currently hardwired to use xmessage for displaying alerts on X Window System displays. This should be configurable and ideally integrate better with the desktop.

calendar\_lockfiles hangs the shell while waiting for a lock on a file. If called from a scheduled task, it should instead reschedule the event that caused it.

File: zsh.info, Node: TCP Function System, Next: Zftp Function System, Prev: Calendar Function System, Up: Top

## 24 TCP Function System

\*\*\*\*\*

### 24.1 Description

=====

A module zsh/net/tcp is provided to provide network I/O over TCP/IP from within the shell; see its description in \*Note Zsh Modules::. This manual page describes a function suite based on the module. If the module is installed, the functions are usually installed at the same time, in which case they will be available for autoloading in the default function search path. In addition to the zsh/net/tcp module, the zsh/zselect module is used to implement timeouts on read operations. For troubleshooting tips, consult the corresponding advice for the zftp functions described in \*Note Zftp Function System::.

There are functions corresponding to the basic I/O operations open, close, read and send, named tcp\_open etc., as well as a function tcp\_expect for pattern

match analysis of data read as input. The system makes it easy to receive data from and send data to multiple named sessions at once. In addition, it can be linked with the shell's line editor in such a way that input data is automatically shown at the terminal. Other facilities available including logging, filtering and configurable output prompts.

To use the system where it is available, it should be enough to ``autoload -U tcp_open'` and run `tcp_open` as documented below to start a session. The `tcp_open` function will autoload the remaining functions.

\* Menu:

\* TCP Functions::

\* TCP Parameters::

\* TCP Examples::

\* TCP Bugs::

File: `zsh.info`, Node: TCP Functions, Next: TCP Parameters, Up: TCP Function System

## 24.2 TCP User Functions

=====

### 24.2.1 Basic I/O

-----

`tcp_open [ -qz ] HOST PORT [ SESS ]`

`tcp_open [ -qz ] [ -s SESS | -l SESS[...] ] ...`

`tcp_open [ -qz ] [ -a FD | -f FD ] [ SESS ]`

Open a new session. In the first and simplest form, open a TCP

connection to host `HOST` at port `PORT`; numeric and symbolic forms are understood for both.

If `SESS` is given, this becomes the name of the session which can be used to refer to multiple different TCP connections. If `SESS` is not given, the function will invent a numeric name value (note this is `_not_` the same as the file descriptor to which the session is attached). It is recommended that session names not include 'funny' characters, where funny characters are not well-defined but certainly do not include alphanumerics or underscores, and

certainly do include whitespace.

In the second case, one or more sessions to be opened are given by name. A single session name is given after `-s` and a comma-separated list after `-l`; both options may be repeated as many times as necessary. A failure to open any session causes `tcp_open` to abort. The host and port are read from the file `.ztcp_sessions` in the same directory as the user's `zsh` initialisation files, i.e. usually the home directory, but `$ZDOTDIR` if that is set. The file consists of lines each giving a session name and the corresponding host and port, in that order (note the session name comes first, not last), separated by whitespace.

The third form allows passive and fake TCP connections. If the option `-a` is used, its argument is a file descriptor open for listening for connections. No function front-end is provided to open such a file descriptor, but a call to ``ztcp -l PORT'` will create one with the file descriptor stored in the parameter `$REPLY`. The listening port can be closed with ``ztcp -c FD'`. A call to ``tcp_open -a FD'` will block until a remote TCP connection is made to `PORT` on the local machine. At this point, a session is created in the usual way and is largely indistinguishable from an active connection created with one of the first two forms.

If the option `-f` is used, its argument is a file descriptor which is used directly as if it were a TCP session. How well the remainder of the TCP function system copes with this depends on what actually underlies this file descriptor. A regular file is likely to be unusable; a FIFO (pipe) of some sort will work better, but note that it is not a good idea for two different sessions to attempt to read from the same FIFO at once.

If the option `-q` is given with any of the three forms, `tcp_open` will not print informational messages, although it will in any case exit with an appropriate status.

If the line editor (`zle`) is in use, which is typically the case if the shell is interactive, `tcp_open` installs a handler inside `zle` which will check for new data at the same time as it checks for keyboard input. This is convenient as the shell consumes no CPU time while waiting; the test is performed by the operating system.

Giving the option `-z` to any of the forms of `tcp_open` prevents the handler from being installed, so data must be read explicitly.

Note, however, this is not necessary for executing complete sets



of send and read commands from a function, as zle is not active at this point. Generally speaking, the handler is only active when the shell is waiting for input at a command prompt or in the vared builtin. The option has no effect if zle is not active; ``[[ -o zle]]'` will test for this.

The first session to be opened becomes the current session and subsequent calls to `tcp_open` do not change it. The current session is stored in the parameter `$TCP_SESS`; see below for more detail about the parameters used by the system.

The function `tcp_on_open`, if defined, is called when a session is opened. See the description below.

`tcp_close [ -qn ] [ -a | -l SESS[...] | SESS ... ]`

Close the named sessions, or the current session if none is given,

or all open sessions if `-a` is given. The options `-l` and `-s` are both handled for consistency with `tcp_open`, although the latter is redundant.

If the session being closed is the current one, `$TCP_SESS` is unset, leaving no current session, even if there are other sessions still open.

If the session was opened with `tcp_open -f`, the file descriptor is closed so long as it is in the range 0 to 9 accessible directly from the command line. If the option `-n` is given, no attempt will be made to close file descriptors in this case. The `-n` option is not used for genuine ztcp session; the file descriptors are always closed with the session.

If the option `-q` is given, no informational messages will be printed.

`tcp_read [ -bdq ] [ -t TO ] [ -T TO ]`

`[ -a | -u FD[...] | -l SESS[...] | -s SESS ... ]`

Perform a read operation on the current session, or on a list of sessions

if any are given with `-u`, `-l` or `-s`, or all open sessions

if the option `-a` is given. Any of the `-u`, `-l` or `-s` options may be repeated or mixed together. The `-u` option specifies a file descriptor directly (only those managed by this system are useful), the other two specify sessions as described for `tcp_open` above.

The function checks for new data available on all the sessions listed. Unless the `-b` option is given, it will not block waiting

for new data. Any one line of data from any of the available sessions will be read, stored in the parameter `$TCP_LINE`, and displayed to standard output unless `$TCP_SILENT` contains a non-empty string. When printed to standard output the string `$TCP_PROMPT` will be shown at the start of the line; the default form for this includes the name of the session being read. See below for more information on these parameters. In this mode, `tcp_read` can be called repeatedly until it returns status 2 which indicates all pending input from all specified sessions has been handled.

With the option `-b`, equivalent to an infinite timeout, the function will block until a line is available to read from one of the specified sessions. However, only a single line is returned.

The option `-d` indicates that all pending input should be drained. In this case `tcp_read` may process multiple lines in the manner given above; only the last is stored in `$TCP_LINE`, but the complete set is stored in the array `$tcp_lines`. This is cleared at the start of each call to `tcp_read`.

The options `-t` and `-T` specify a timeout in seconds, which may be a floating point number for increased accuracy. With `-t` the timeout is applied before each line read. With `-T`, the timeout applies to the overall operation, possibly including multiple read operations if the option `-d` is present; without this option, there is no distinction between `-t` and `-T`.

The function does not print informational messages, but if the option `-q` is given, no error message is printed for a non-existent session.

A return status of 2 indicates a timeout or no data to read. Any other non-zero return status indicates some error condition.

See `tcp_log` for how to control where data is sent by `tcp_read`.

```
tcp_send [ -cnq ] [ -s SESS | -l SESS[...] ] DATA ...
tcp_send [ -cnq ] -a DATA ...
```

Send the supplied data strings to all the specified sessions in turn. The underlying operation differs little from a ``print -r'` to the session's file descriptor, although it attempts to prevent the shell from dying owing to a SIGPIPE caused by an attempt to write to a defunct session.

The option `-c` causes `tcp_send` to behave like `cat`. It reads lines

from standard input until end of input and sends them in turn to the specified session(s) exactly as if they were given as DATA

arguments to individual tcp\_send commands.

The option -n prevents tcp\_send from putting a newline at the end of the data strings.

The remaining options all behave as for tcp\_read.

The data arguments are not further processed once they have been passed to tcp\_send; they are simply passed down to print -r.

If the parameter \$TCP\_OUTPUT is a non-empty string and logging is enabled then the data sent to each session will be echoed to the log file(s) with \$TCP\_OUTPUT in front where appropriate, much in the manner of \$TCP\_PROMPT.

#### 24.2.2 Session Management

-----

tcp\_alias [ -q ] ALIAS=SESS ...

tcp\_alias [ -q ] [ ALIAS ... ]

tcp\_alias -d [ -q ] ALIAS ...

This function is not particularly well tested.

The first form creates an alias for a session name; ALIAS can then be used to refer to the existing session SESS. As many aliases may be listed as required.

The second form lists any aliases specified,  
or all aliases if  
none.

The third form deletes all the aliases listed. The underlying sessions are not affected.

The option -q suppresses an inconsistently chosen subset of error messages.

tcp\_log [ -asc ] [ -n | -N ] [ LOGFILE ]

With an argument LOGFILE, all future input from tcp\_read will be logged to the named file. Unless -a (append) is given, this file will first be truncated or created empty. With no arguments, show the current status of logging.

With the option -s, per-session logging is enabled. Input from `tcp_read` is output to the file `LOGFILE.SESS`. As the session is automatically discriminated by the filename, the contents are raw (no `$TCP_PROMPT`). The option -a applies as above. Per-session logging and logging of all data in one file are not mutually exclusive.

The option -c closes all logging, both complete and per-session logs.

The options -n and -N respectively turn off or restore output of data read by `tcp_read` to standard output; hence ``tcp_log -cn'` turns off all output by `tcp_read`.

The function is purely a convenient front end to setting the parameters `$TCP_LOG`, `$TCP_LOG_SESS`, `$TCP_SILENT`, which are described below.

`tcp_rename OLD NEW`

Rename session OLD to session NEW. The old name becomes invalid.

`tcp_sess [ SESS [ COMMAND [ ARG ... ] ] ]`

With no arguments, list all the open sessions and associated file descriptors. The current session is marked with a star. For use in functions, direct access to the parameters `$tcp_by_name`, `$tcp_by_fd` and `$TCP_SESS` is probably more convenient; see below.

With a SESS argument, set the current session to SESS. This is equivalent to changing `$TCP_SESS` directly.

With additional arguments, temporarily set the current session while executing ``COMMAND ARG ...'`. `COMMAND` is re-evaluated so as to expand aliases etc., but the remaining ARGs are passed through as that appear to `tcp_sess`. The original session is restored when `tcp_sess` exits.

### 24.2.3 Advanced I/O

-----

`tcp_command SEND-OPTION ... SEND-ARGUMENT ...`

This is a convenient front-end to `tcp_send`. All arguments are passed to `tcp_send`, then the function pauses waiting for data.

While data is arriving at least every `$TCP_TIMEOUT` (default 0.3) seconds, data is handled and printed out according to the current settings. Status 0 is always returned.

This is generally only useful for interactive use, to prevent the display becoming fragmented by output returned from the connection. Within a programme or function it is generally better to handle reading data by a more explicit method.

```
tcp_expect [ -q ] [ -p VAR | -P VAR ] [ -t TO | -T TO ]  
          [ -a | -s SESS | -l SESS[...] ] PATTERN ...
```

Wait for input matching any of the given PATTERNs from any of the specified sessions.

Input is ignored until an input line matches

one of the given patterns; at this point status zero is returned, the matching line is stored in `$TCP_LINE`, and the full set of lines read during the call to `tcp_expect` is stored in the array `$tcp_expect_lines`.

Sessions are specified in the same way as `tcp_read`: the default is to use the current session, otherwise the sessions specified by `-a`, `-s`, or `-l` are used.

Each PATTERN is a standard zsh extended-globbing pattern; note that it needs to be quoted to avoid it being expanded immediately by filename generation. It must match the full line, so to match a substring there must be a ``*'` at the start and end. The line matched against includes the `$TCP_PROMPT` added by `tcp_read`. It is possible to include the globbing flags ``#b'` or ``#m'` in the patterns to make backreferences available in the parameters `$MATCH`, `$match`, etc., as described in the base zsh documentation on pattern matching.

Unlike `tcp_read`, the default behaviour of `tcp_expect` is to block indefinitely until the required input is found. This can be modified by specifying a timeout with `-t` or `-T`; these function as in `tcp_read`, specifying a per-read or overall timeout, respectively, in seconds, as an integer or floating-point number. As `tcp_read`, the function returns status 2 if a timeout occurs.

The function returns as soon as any one of the patterns given match. If the caller needs to know which of the patterns matched, the option `-p VAR` can be used; on return, `$var` is set to the number of the pattern using ordinary zsh indexing, i.e. the first is 1, and so on. Note the absence of a ``$'` in front of `VAR`. To avoid clashes, the parameter cannot begin with ``_expect'`. The index -1 is used if there is a timeout and 0 if there is no match.

The option -P VAR works similarly to -p, but instead of numerical indexes

the regular arguments must begin with a prefix followed by a colon: that prefix is then used as a tag to which VAR is set when the argument matches. The tag timeout is used if there is a timeout and the empty string if there is no match. Note it is acceptable for different arguments to start with the same prefix if the matches do not need to be distinguished.

The option -q is passed directly down to tcp\_read.

As all input is done via tcp\_read, all the usual rules about output of lines read apply. One exception is that the parameter \$tcp\_lines will only reflect the line actually matched by tcp\_expect; use \$tcp\_expect\_lines for the full set of lines read during the function call.

#### tcp\_proxy

This is a simple-minded function to accept a TCP connection and execute a command with I/O redirected to the connection. Extreme caution should be taken as there is no security whatsoever and this can leave your computer open to the world. Ideally, it should only be used behind a firewall.

The first argument is a TCP port on which the function will listen.

The remaining arguments give a command and its arguments to execute with standard input, standard output and standard error redirected to the file descriptor on which the TCP session has been accepted. If no command is given, a new zsh is started. This gives everyone on your network direct access to your account, which in many cases will be a bad thing.

The command is run in the background, so tcp\_proxy can then accept new connections. It continues to accept new connections until interrupted.

tcp\_spam [ -ertv ] [ -a | -s SESS | -l SESS[...] ] CMD [ ARG ... ]

Execute `CMD [ ARG ... ]` for each session in turn. Note this executes the command and arguments; it does not send the command line as data unless the -t (transmit) option is given.

The sessions may be selected explicitly with the standard -a, -s or

-l options, or may be chosen implicitly. If none of the three options is given the rules are: first, if the array \$tcp\_spam\_list is set, this is taken as the list of sessions, otherwise all

sessions are taken. Second, any sessions given in the array `$tcp_no_spam_list` are removed from the list of sessions.

Normally, any sessions added by the ``-a'` flag or when all sessions are chosen implicitly are spammed in alphabetic order; sessions given by the `$tcp_spam_list` array or on the command line are spammed in the order given. The `-r` flag reverses the order however it was arrived it.

The `-v` flag specifies that a `$TCP_PROMPT` will be output before each session. This is output after any modification to `TCP_SESS` by the user-defined `tcp_on_spam` function described below. (Obviously that function is able to generate its own output.)

If the option `-e` is present, the line given as ``CMD [ ARG ... ]'` is executed using `eval`, otherwise it is executed without any further processing.

#### `tcp_talk`

This is a fairly simple-minded attempt to force input to the line editor to go straight to the default `TCP_SESS`.

An escape string, `$TCP_TALK_ESCAPE`, default ``:'`, is used to allow access to normal shell operation. If it is on its own at the start of the line, or followed only by whitespace, the line editor returns to normal operation. Otherwise, the string and any following whitespace are skipped and the remainder of the line executed as shell input without any change of the line editor's operating mode.

The current implementation is somewhat deficient in terms of use of the command history. For this reason, many users will prefer to use some form of alternative approach for sending data easily to the current session. One simple approach is to alias some special character (such as ``%'`) to ``tcp_command --'`.

#### `tcp_wait`

The sole argument is an integer or floating point number which gives the seconds to delay. The shell will do nothing for that period except wait for input on all TCP sessions by calling `tcp_read -a`. This is similar to the interactive behaviour at the command prompt when `zle` handlers are installed.

### 24.2.4 'One-shot' file transfer

-----

tcp\_point PORT

tcp\_shoot HOST PORT

This pair of functions provide a simple way to transfer a file between two hosts within the shell. Note, however, that bulk data transfer is currently done using cat. tcp\_point reads any data arriving at PORT and sends it to standard output; tcp\_shoot connects to PORT on HOST and sends its standard input. Any unused PORT may be used; the standard mechanism for picking a port is to think of a random four-digit number above 1024 until one works.

To transfer a file from host woodcock to host springes,  
on  
springes:

tcp\_point 8091 >output\_file

and on woodcock:

tcp\_shoot springes 8091 <input\_file

As these two functions do not require tcp\_open to set up a TCP connection first, they may need to be autoloaded separately.

### 24.3 TCP User-defined Functions

=====

Certain functions, if defined by the user, will be called by the function system in certain contexts. This facility depends on the module zsh/parameter, which is usually available in interactive shells as the completion system depends on it. None of the functions need be defined; they simply provide convenient hooks when necessary.

Typically, these are called after the requested action has been taken, so that the various parameters will reflect the new state.

tcp\_on\_alias ALIAS FD

When an alias is defined, this function will be called with two arguments: the name of the alias, and the file descriptor of the corresponding session.



tcp\_on\_awol

SESS FD

If the function `tcp_fd_handler` is handling input from the line editor and detects that the file descriptor is no longer reusable, by default it removes it from the list of file descriptors handled by this method and prints a message. If the function `tcp_on_awol` is defined it is called immediately before this point. It may return status 100, which indicates that the normal handling should still be performed; any other return status indicates that no further action should be taken and the `tcp_fd_handler` should return immediately with the given status. Typically the action of `tcp_on_awol` will be to close the session.

The variable `TCP_INVALIDATE_ZLE` will be a non-empty string if it is necessary to invalidate the line editor display using ``zle -I'` before printing output from the function.

(``AWOL'` is military jargon for ``absent without leave'` or some variation. It has no pre-existing technical meaning known to the author.)

tcp\_on\_close SESS FD

This is called with the name of a session being closed and the file descriptor which corresponded to that session. Both will be invalid by the time the function is called.

tcp\_on\_open SESS FD

This is called after a new session has been defined with the session name and file descriptor as arguments. If it returns a non-zero status, opening the session is assumed to fail and the session is closed again; however, `tcp_open` will continue to attempt to open any remaining sessions given on the command line.

tcp\_on\_rename OLDSESS FD NEWSESS

This is called after a session has been renamed with the three arguments old session name, file descriptor, new session name.

tcp\_on\_spam SESS COMMAND ...

This is called once for each session spammed, just `_before_` a command is executed for a session by `tcp_spam`. The arguments are the session name followed by the command list to be executed. If `tcp_spam` was called with the option `-t`, the first command will be `tcp_send`.

This function is called after `$TCP_SESS` is set to reflect the session to be spammed, but before any use of it is made. Hence it

is possible to alter the value of `$TCP_SESS` within this function. For example, the session arguments to `tcp_spam` could include extra information to be stripped off and processed in `tcp_on_spam`.

If the function sets the parameter `$REPLY` to ``done'`, the command line is not executed; in addition, no prompt is printed for the `-v` option to `tcp_spam`.

`tcp_on_unalias ALIAS FD`

This is called with the name of an alias and the corresponding session's file descriptor after an alias has been deleted.

## 24.4 TCP Utility Functions

=====

The following functions are used by the TCP function system but will rarely if ever need to be called directly.

`tcp_fd_handler`

This is the function installed by `tcp_open` for handling input from within the line editor, if that is required. It is in the format documented for the builtin ``zle -F'` in `*Note Zle Builtins::`.

While active, the function sets the parameter `TCP_HANDLER_ACTIVE` to 1. This allows shell code called internally (for example, by setting `tcp_on_read`) to tell if is being called when the shell is otherwise idle at the editor prompt.

`tcp_output [ -q ] -P PROMPT -F FD -S SESS`

This function is used for both logging and handling output to standard output, from within `tcp_read` and (if `$TCP_OUTPUT` is set) `tcp_send`.

The `PROMPT` to use is specified by `-P`; the default is the empty string. It can contain:

`%c`

Expands to 1 if the session is the current session, otherwise 0. Used with ternary expressions such as ``%(c.-.)'` to output ``+'` for the current session and ``-'` otherwise.

`%f`

Replaced by the session's file descriptor.

`%s`

Replaced by the session name.

%%

Replaced by a single `%'.

The option -q suppresses output to standard output, but not to any log files which are configured.

The -S and -F options are used to pass in the session name and file descriptor for possible replacement in the prompt.

File: zsh.info, Node: TCP Parameters, Next: TCP Examples, Prev: TCP Functions, Up: TCP Function System

## 24.5 TCP User Parameters

=====

Parameters follow the usual convention that uppercase is used for scalars and integers, while lowercase is used for normal and associative array. It is always safe for user code to read these parameters. Some parameters may also be set; these are noted explicitly. Others are included in this group as they are set by the function system for the user's benefit, i.e. setting them is typically not useful but is benign.

It is often also useful to make settable parameters local to a function. For example, `local

TCP\_SILENT=1' specifies that data read during the function call will not be printed to standard output, regardless of the setting outside the function. Likewise, `local TCP\_SESS=SESS' sets a session for the duration of a function, and `local TCP\_PROMPT=' specifies that no prompt is used for input during the function.

tcp\_expect\_lines

Array. The set of lines read during the last call to tcp\_expect, including the last (\$TCP\_LINE).

tcp\_filter

Array. May be set directly. A set of extended globbing patterns which, if matched in tcp\_output, will cause the line not to be printed to standard output. The patterns should be defined as described for the arguments to tcp\_expect. Output of line to log files is not affected.

## TCP\_HANDLER\_ACTIVE

Scalar. Set to 1 within `tcp_fd_handler` to indicate to functions called recursively that they have been called during an editor session. Otherwise unset.

## TCP\_LINE

The last line read by `tcp_read`, and hence also `tcp_expect`.

## TCP\_LINE\_FD

The file descriptor from which `$TCP_LINE` was read.  
`${tcp_by_fd[$TCP_LINE_FD]}` will give the corresponding session name.

## tcp\_lines

Array. The set of lines read during the last call to `tcp_read`, including the last (`$TCP_LINE`).

## TCP\_LOG

May be set directly, although it is also controlled by `tcp_log`.  
The name of a file to which output from all sessions will be sent.  
The output is preceded by the usual `$TCP_PROMPT`. If it is not an absolute path name, it will follow the user's current directory.

## TCP\_LOG\_SESS

May be set directly, although it is also controlled by `tcp_log`.  
The prefix for a set of files to which output from each session separately will be sent; the full filename is `${TCP_LOG_SESS}.SESS`.  
Output to each file is raw; no prompt is added. If it is not an absolute path name, it will follow the user's current directory.

## tcp\_no\_spam\_list

Array. May be set directly.  
See `tcp_spam` for how this is used.

## TCP\_OUTPUT

May be set directly. If a non-empty string, any data sent to a session by `tcp_send` will be logged. This parameter gives the prompt to be used in a file specified by `$TCP_LOG` but not in a file generated from `$TCP_LOG_SESS`. The prompt string has the same format as `TCP_PROMPT` and the same rules for its use apply.

## TCP\_PROMPT

May be set directly. Used as the prefix for data read by `tcp_read` which is printed to standard output or to the log file given by `$TCP_LOG`, if any. Any ``%s'`, ``%f'` or ``%%'` occurring in the string will be replaced by the name of the session, the session's

underlying file descriptor, or a single `%', respectively. The expression `%c' expands to 1 if the session being read is the current session, else 0; this is most useful in ternary expressions such as `%(c.-.+)' which outputs `+' if the session is the current one, else `-'.

If the prompt starts with %P, this is stripped and the complete result of the previous stage is passed through standard prompt %-style formatting before being output.

#### TCP\_READ\_DEBUG

May be set directly. If this has non-zero length, tcp\_read will give some limited diagnostics about data being read.

#### TCP\_SECONDS\_START

This value is created and initialised to zero by tcp\_open.

The functions tcp\_read and tcp\_expect use the shell's SECONDS parameter for their own timing purposes. If that parameter is not of floating point type on entry to one of the functions, it will create a local parameter SECONDS which is floating point and set the parameter TCP\_SECONDS\_START to the previous value of \$SECONDS. If the parameter is already floating point, it is used without a local copy being created and TCP\_SECONDS\_START is not set. As the global value is zero, the shell elapsed time is guaranteed to be the sum of \$SECONDS and \$TCP\_SECONDS\_START.

This can be avoided by setting SECONDS globally to a floating point value using `typeset -F SECONDS'; then the TCP functions will never make a local copy and never set TCP\_SECONDS\_START to a non-zero value.

#### TCP\_SESS

May be set directly. The current session; must refer to one of the sessions established by tcp\_open.

#### TCP\_SILENT

May be set directly, although it is also controlled by tcp\_log. If of non-zero length, data read by tcp\_read will not be written to standard output, though may still be written to a log file.

#### tcp\_spam\_list

Array. May be set directly. See the description of the function tcp\_spam for how this is used.

#### TCP\_TALK\_ESCAPE

May be set directly. See the description of the function tcp\_talk

for how this is used.

## TCP\_TIMEOUT

May be set directly. Currently this is only used by the function `tcp_command`, see above.

## 24.6 TCP User-defined Parameters

=====

The following parameters are not set by the function system, but have a special effect if set by the user.

### `tcp_on_read`

This should be an associative array; if it is not, the behaviour is undefined. Each key is the name of a shell function or other command, and the corresponding value is a shell pattern (using `EXTENDED_GLOB`). Every line read from a TCP session directly or indirectly using `tcp_read` (which includes lines read by `tcp_expect`) is compared against the pattern. If the line matches, the command given in the key is called with two arguments: the name of the session from which the line was read, and the line itself.

If any function called to handle a line returns a non-zero status, the line is not output. Thus a `tcp_on_read` handler containing only the instruction ``return 1'` can be used to suppress output of particular lines (see, however, `tcp_filter` above). However, the line is still stored in `TCP_LINE` and `tcp_lines`;

this occurs after

all `tcp_on_read` processing.

## 24.7 TCP Utility Parameters

=====

These parameters are controlled by the function system; they may be read directly, but should not usually be set by user code.

### `tcp_aliases`

Associative array. The keys are the names of sessions established with `tcp_open`; each value is a space-separated list of aliases which refer to that session.

tcp\_by\_fd

Associative array. The keys are session file descriptors; each value is the name of that session.

tcp\_by\_name

Associative array. The keys are the names of sessions; each value is the file descriptor associated with that session.

File: zsh.info, Node: TCP Examples, Next: TCP Bugs, Prev: TCP Parameters, Up: TCP Function System

## 24.8 TCP Examples

=====

Here is a trivial example using a remote calculator.

To create a calculator server on port 7337 (see the dc manual page for quite how infuriating the underlying command is):

```
tcp_proxy 7337 dc
```

To connect to this from the same host with a session also named `dc`:

```
tcp_open localhost 7337 dc
```

To send a command to the remote session and wait a short while for output (assuming dc is the current session):

```
tcp_command 2 4 + p
```

To close the session:

```
tcp_close
```

The tcp\_proxy needs to be killed to be stopped. Note this will not usually kill any connections which have already been accepted, and also that the port is not immediately available for reuse.

The following chunk of code puts a list of sessions into an xterm header, with the current session followed by a star.

```
print -n "\033]2;TCP:" "${(k)tcp_by_name:/$TCP_SESS/$TCP_SESS\*} "\a"
```

File: zsh.info, Node: TCP Bugs, Prev: TCP Examples, Up: TCP Function System

## 24.9 TCP Bugs

=====

The function `tcp_read` uses the shell's normal `read` builtin. As this reads a complete line at once, data arriving without a terminating newline can cause the function to block indefinitely.

Though the function suite works well for interactive use and for data arriving in small amounts, the performance when large amounts of data are being exchanged is likely to be extremely poor.

File: zsh.info, Node: Zftp Function System, Next: User Contributions, Prev: TCP Function System, Up: Top

## 25 Zftp Function System

\*\*\*\*\*

### 25.1 Description

=====

This describes the set of shell functions supplied with the source distribution as an interface to the `zftp` builtin command, allowing you to perform FTP operations from the shell command line or within functions or scripts. The interface is similar to a traditional FTP client (e.g. the `ftp` command itself, see `ftp(1)`), but as it is entirely done within the shell all the familiar completion, editing and globbing features, and so on, are present, and macros are particularly simple to write as they are just ordinary shell functions.

The prerequisite is that the `zftp` command, as described in \*Note The `zsh/zftp` Module::, must be available in the version of `zsh` installed at your site. If the shell is configured to load new commands at run time, it probably is: typing ``zmodload zsh/zftp'` will make sure (if that runs silently, it has worked). If this is not the case, it is possible `zftp` was linked into the shell anyway: to test this, type ``which zftp'` and if `zftp` is available you will get the message ``zftp:`



shell built-in command'.

Commands given directly with zftp builtin may be interspersed between the functions in this suite; in a few cases, using zftp directly may cause some of the status information stored in shell parameters to become invalid. Note in particular the description of the variables \$ZFTP\_TMOUT, \$ZFTP\_PREFS and \$ZFTP\_VERBOSE for zftp.

\* Menu:

\* Installation::

\* Zftp Functions::

\* Miscellaneous Features::

File: zsh.info, Node: Installation, Next: Zftp Functions, Up: Zftp Function System

## 25.2 Installation

=====

You should

make sure all the functions from the Functions/Zftp directory of the source distribution are available; they all begin with the two letters `zf'. They may already have been installed on your system; otherwise, you will need to find them and copy them. The directory should appear as one of the elements of the \$fpath array (this should already be the case if they were installed), and at least the function zfinit should be autoloaded; it will autoload the rest. Finally, to initialize the use of the system you need to call the zfinit function. The following code in your .zshrc will arrange for this; assume the functions are stored in the directory ~/myfns:

```
fpath=(~/myfns $fpath)
autoload -U zfinit
zfinit
```

Note that zfinit assumes you are using the zmodload method to load the zftp command. If it is already built into the shell, change zfinit to zfinit -n. It is helpful (though not essential) if the call to zfinit appears after any code to initialize the new completion system, else unnecessary compctl commands will be given.

## 25.3 Functions

=====

The sequence of operations in performing a file transfer is essentially the same as that in a standard FTP client. Note that, due to a quirk of the shell's getopts builtin, for those functions that handle options you must use `--` rather than `-` to ensure the remaining arguments are treated literally (a single `-` is treated as an argument).

### 25.3.1 Opening a connection

-----

`zfpargs [ HOST [ USER [ PASSWORD ... ] ] ]`

Set or show the parameters for a future `zfpopen` with no arguments.

If no arguments are given, the current parameters are displayed (the password will be shown as a line of asterisks). If a `HOST` is given, and either the `USER` or `PASSWORD` is not, they will be prompted for; also, any parameter given as `?` will be

prompted

for, and if the `?` is followed by a string, that will be used as the prompt. As `zfpopen` calls `zfpargs` to store the parameters, this usually need not be called directly.

A single argument `-` will delete the stored parameters. This will also cause the memory of the last directory (and so on) on the other host to be deleted.

`zfpopen [ -1 ] [ HOST [ USER [ PASSWORD [ ACCOUNT ] ] ] ]`

If `HOST` is present, open a connection to that host under username `USER` with password `PASSWORD` (and, on the rare occasions when it is necessary, account `ACCOUNT`). If a necessary parameter is missing or given as `?` it will be prompted for. If `HOST` is not present, use a previously stored set of parameters.

If the command was successful, and the terminal is compatible with `xterm` or is `sun-cmd`, a summary will appear in the title bar, giving the local host:directory and the remote host:directory; this is handled by the function

`zftp_chpwd`, described below.

Normally, the `HOST`, `USER` and `PASSWORD` are internally recorded for

later re-opening, either by a `zopen` with no arguments, or automatically (see below). With the option ``-1'`, no information is stored. Also, if an open command with arguments failed, the parameters will not be retained (and any previous parameters will also be deleted). A `zopen` on its own, or a `zopen -1`, never alters the stored parameters.

Both `zopen` and `zfanon` (but not `zfparams`) understand URLs of the form `ftp://HOST/PATH...` as meaning to connect to the `HOST`, then change directory to `PATH` (which must be a directory, not a file). The ``ftp:/'` can be omitted; the trailing ``/'` is enough to trigger recognition of the `PATH`. Note prefixes other than ``ftp:'` are not recognized, and that all characters after the first slash beyond `HOST` are significant in `PATH`.

`zfanon [ -1 ] HOST`

Open a connection `HOST` for anonymous

FTP. The username used is

``anonymous'`. The password (which will be reported the first time) is generated as `USER@HOST`; this is then stored in the shell parameter `$EMAIL_ADDR` which can alternatively be set manually to a suitable string.

### 25.3.2 Directory management

-----

`zfcd [ DIR ]`

`zfcd -`

`zfcd OLD NEW`

Change the current directory on the remote server: this is implemented to have many of the features of the shell builtin `cd`.

In the first form with `DIR` present, change to the directory `DIR`. The command ``zfcd .'` is treated specially, so is guaranteed to work on non-UNIX servers (note this is handled internally by `zftp`). If `DIR` is omitted, has the effect of ``zfcd ~'`.

The second form changes to the directory previously current.

The third form attempts to change the current directory by replacing the first occurrence of the string `OLD` with the string `NEW` in the current directory.

Note

that in this command, and indeed anywhere a remote filename is expected, the string which on the local host corresponds to ``~'` is converted back to a ``~'` before being passed to the remote machine. This is convenient because of the way expansion is performed on the command line before `zgcd` receives a string. For example, suppose the command is ``zgcd ~/foo'`. The shell will expand this to a full path such as ``zgcd /home/user2/pws/foo'`. At this stage, `zgcd` recognises the initial path as corresponding to ``~'` and will send the directory to the remote host as `~/foo`, so that the ``~'` will be expanded by the server to the correct remote host directory. Other named directories of the form ``~name'` are not treated in this fashion.

#### `zfhire`

Change directory on the remote server to the one corresponding to the current local directory, with special handling of ``~'` as in `zgcd`. For example, if the current local directory is `~/foo/bar`, then `zfhire` performs the effect of ``zgcd ~/foo/bar'`.

#### `zfdi [ -rfd ] [ - ] [ DIR-OPTIONS ] [ DIR ]`

Produce a long directory listing. The arguments `DIR-OPTIONS` and `DIR` are passed directly to the server and their effect is implementation dependent, but specifying a particular remote directory `DIR` is usually possible. The output is passed through a pager given by the environment variable `$PAGER`, or ``more'` if that is not set.

The directory is usually cached for re-use. In fact, two caches are maintained. One is for use when there is no `DIR-OPTIONS` or `DIR`, i.e. a full listing of the current remote directory; it is flushed when the current remote directory changes. The other is kept for repeated use of `zfdi` with the same arguments; for example, repeated use of ``zfdi /pub/gnu'` will only require the directory to be retrieved on the first call. Alternatively, this cache can be re-viewed with the `-r` option.

#### As relative

directories will confuse `zfdi`, the `-f` option can be used to force the cache to be flushed before the directory is listed. The option `-d` will delete both caches without showing a directory listing; it will also delete the cache of file names in the current remote directory, if any.

#### `zfls [ LS-OPTIONS ] [ DIR ]`

List files on the remote server. With no arguments, this will produce a simple list of file names for the current remote directory. Any arguments are passed directly to the server. No pager and no caching is used.

### 25.3.3 Status commands

-----

#### zftype [ TYPE ]

With no arguments, show the type of data to be transferred, usually ASCII or binary. With an argument, change the type: the types `A` or `ASCII` for ASCII data and `B` or `BINARY`, `I` or `IMAGE` for binary data are understood case-insensitively.

#### zfstat [ -v ]

Show the status of the current or last connection, as well as the status of some of zftp's status variables. With the -v option, a more verbose listing is produced by querying the server for its version of events, too.

### 25.3.4 Retrieving files

-----

The commands for retrieving files all take at least two options. -G suppresses remote filename expansion which would otherwise be performed (see below for a more detailed description of that). -t attempts to set the modification time of the local file to that of the remote file: see the description of the function zftime below for more information.

#### zfget [ -Gtc ] FILE1 ...

Retrieve all the listed files FILE1 ... one at a time from the remote server. If a file contains a `/`, the full name is passed to the remote server, but the file is stored locally under the name given by the part after the final `/`. The option -c (cat) forces all files to be sent as a single stream to standard output; in this case the -t option has no effect.

#### zfuget [ -Gvst ] FILE1 ...

As zfget, but only retrieve files where the version on the remote server is newer (has a later modification time), or where the local file does not exist. If the remote file is older but the files have different sizes, or if the sizes are the same but the remote file is newer, the user will usually be queried. With the option -s, the command runs silently and will always retrieve the file in either of those two cases. With the option -v, the

command prints more information about the files while it is working out whether or not to transfer them.

`zfcget [ -Gt ] FILE1 ...`

As `zfget`, but if any of the local files exists, and is shorter than the corresponding remote file, the command assumes that it is the result of a partially completed transfer and attempts to transfer the rest of the file. This is useful on a poor connection which keeps failing.

Note that this requires a commonly implemented, but non-standard, version of the FTP protocol, so is not guaranteed to work on all servers.

`zfgcp [ -Gt ] REMOTE-FILE LOCAL-FILE`

`zfgcp [ -Gt ] RFILE1 ... LDIR`

This retrieves files from the remote server with arguments behaving similarly to the `cp` command.

In the first form, copy `REMOTE-FILE` from the server to the local file `LOCAL-FILE`.

In the second form, copy all the remote files `RFILE1 ...` into the local directory `LDIR` retaining the same basenames. This assumes UNIX directory semantics.

### 25.3.5 Sending files

-----

`zfput [ -r ] FILE1 ...`

Send all the `FILE1 ...` given separately to the remote server. If a filename contains a ```, the full filename is used locally to find the file, but only the basename is used for the remote file name.

With the option `-r`, if any of the `FILES` are directories they are sent recursively with all their subdirectories, including files beginning with ```. This requires that the remote machine understand UNIX file semantics, since ``` is used as a directory separator.

`zfuput [ -vs ] FILE1 ...`

As `zfput`, but only send files which are newer than their remote equivalents, or if the remote file does not exist. The logic is

the same as for `zfuget`, but reversed between local and remote files.

`zfcput FILE1 ...`

As `zfput`, but if any remote file already exists and is shorter than the local equivalent, assume it is the result of an incomplete transfer and send the rest of the file to append to the existing part. As the FTP append command is part of the standard set, this is in principle more likely to work than `zfcget`.

`zfcpc LOCAL-FILE REMOTE-FILE`

`zfcpc LFILE1 ... RDIR`

This sends files to the remote server with arguments behaving similarly to the `cp` command.

With two arguments, copy `LOCAL-FILE` to the server as `REMOTE-FILE`.

With more than two arguments,  
copy all the local files `LFILE1 ...`  
into the existing remote directory `RDIR` retaining the same basenames. This assumes UNIX directory semantics.

A problem arises if you attempt to use `zfcpc LFILE1 RDIR`, i.e. the second form of copying but with two arguments, as the command has no simple way of knowing if `RDIR` corresponds to a directory or a filename. It attempts to resolve this in various ways. First, if the `RDIR` argument is ``.'` or ``..'` or ends in a slash, it is assumed to be a directory. Secondly, if the operation of copying to a remote file in the first form failed, and the remote server sends back the expected failure code 553 and a reply including the string ``Is a directory'`, then `zfcpc` will retry using the second form.

### 25.3.6 Closing the connection

-----

`zfclose`

Close the connection.

### 25.3.7 Session management

-----

zfsession [ -lvod ] [ SESSNAME ]

Allows

you to manage multiple FTP sessions at once. By default, connections take place in a session called `default`; by giving the command `zfsession SESSNAME` you can change to a new or existing session with a name of your choice. The new session remembers its own connection, as well as associated shell parameters, and also the host/user parameters set by zfparams. Hence you can have different sessions set up to connect to different hosts, each remembering the appropriate host, user and password.

With no arguments, zfsession prints the name of the current session; with the option -l it lists all sessions which currently exist, and with the option -v it gives a verbose list showing the host and directory for each session, where the current session is marked with an asterisk. With -o, it will switch to the most recent previous session.

With -d, the given session (or else the current one) is removed; everything to do with it is completely forgotten. If it was the only session, a new session called `default` is created and made current. It is safest not to delete sessions while background commands using zftp are active.

zfttransfer SESS1:FILE1 SESS2:FILE2

Transfer files between two sessions; no local copy is made. The file is read from the session SESS1 as FILE1 and written to session SESS2 as file FILE2; FILE1 and FILE2 may be relative to the current directories of the session. Either SESS1 or SESS2 may be omitted (though the colon should be retained if there is a possibility of a colon appearing in the file name) and defaults to the current session; FILE2 may be omitted or may end with a slash, in which case the basename of FILE1 will be added. The sessions SESS1 and SESS2 must be distinct.

The operation is performed using pipes, so it is required that the connections still be valid in a subshell, which is not the case under versions of some operating systems, presumably due to a system bug.

### 25.3.8 Bookmarks

-----

The two functions zfmark and zfgoto allow you to `bookmark` the present location (host, user and directory) of the current FTP connection for



later use. The file to be used for storing and retrieving bookmarks is given by the parameter `$ZFTP_BMFILE`; if not set when one of the two functions is called, it will be set to the file `.zfbkmarks` in the directory where your zsh startup files live (usually `~`).

#### `zfmark [ BOOKMARK ]`

If given an argument, mark the current host, user and directory under the name `BOOKMARK` for later use by `zfgoto`. If there is no connection open, use the values for the last connection immediately before it was closed; it is an error if there was none. Any existing bookmark under the same name will be silently replaced.

If not given an argument, list the existing bookmarks and the points to which they refer in the form `USER@HOST:DIRECTORY`; this is the format in which they are stored, and the file may be edited directly.

#### `zfgoto [ -n ] BOOKMARK`

Return to the location given by `BOOKMARK`, as previously set by `zfmark`. If the location has user `'ftp'` or `'anonymous'`, open the connection with `zfanon`, so that no password is required. If the user and host parameters match those stored for the current session, if any, those will be used, and again no password is required. Otherwise a password will be prompted for.

With the option `-n`, the bookmark is taken to be a nickname stored by the `ncftp` program in its bookmark file, which is assumed to be `~/.ncftp/bookmarks`. The function works identically in other ways. Note that there is no mechanism for adding or modifying `ncftp` bookmarks from the `zftp` functions.

### 25.3.9 Other functions

-----

Mostly, these functions will not be called directly (apart from `zfinit`), but are described here for completeness. You may wish to alter `zftp_chpwd` and `zftp_progress`, in particular.

#### `zfinit [ -n ]`

As described above, this is used to initialize the `zftp` function system. The `-n` option should be used if the `zftp` command is

already built into the shell.

#### zfautocheck [ -dn ]

This function is called to implement automatic reopening behaviour, as described in more detail below. The options must appear in the first argument; -n prevents the command from changing to the old directory, while -d prevents it from setting the variable `do_close`, which it otherwise does as a flag for automatically closing the connection after a transfer. The host and directory for the last session are stored in the variable `$zflastsession`, but the internal host/user/password parameters must also be correctly set.

#### zfcd\_match PREFIX SUFFIX

This performs matching for completion of remote directory names.

If the remote server is UNIX, it will attempt to persuade the server to list the remote directory with subdirectories marked, which usually works but is not guaranteed. On other hosts it simply calls `zfget_match` and hence completes all files, not just directories. On some systems, directories may not even look like filenames.

#### zfget\_match PREFIX SUFFIX

This performs matching for completion of remote filenames. It caches files for the current directory (only) in the shell parameter `$zftp_fcache`. It is in the form to be called by the -K option of `compctl`, but also works when called from a widget-style completion function with `PREFIX` and `SUFFIX` set appropriately.

#### zfrglob VARNAME

Perform remote globbing, as describes in more detail below.

`VARNAME` is the name of a variable containing the pattern to be expanded; if there were any matches, the same variable will be set to the expanded set of filenames on return.

#### zfrtime LFILE RFILE [ TIME ]

Set the local file `LFILE` to have the same modification time as the remote file `RFILE`, or the explicit time `TIME` in FTP format `CCYYMMDDhhmmSS` for the GMT timezone. This uses the shell's `zsh/datetime` module to perform the conversion from GMT to local time.

#### zftp\_chpwd

This function is called every time a connection is opened, or closed, or the remote directory changes. This version alters the title bar of an xterm-compatible or sun-cmd terminal emulator to

reflect the local and remote hostnames and current directories.  
It works best when combined with the function `chpwd`. In particular, a function of the form

```
chpwd() {  
  if [[ -n $ZFTP_USER ]]; then  
    zftp_chpwd  
  else  
    # usual chpwd e.g put host:directory in title bar  
  fi  
}
```

fits in well.

#### `zftp_progress`

This function shows the status of the transfer. It will not write anything unless

the output is going to a terminal; however, if you

transfer files in the background, you should turn off progress reports by hand using ``zstyle ':zftp:*' progress none'`. Note also that if you alter it, any output must be to standard error, as standard output may be a file being received. The form of the progress meter, or whether it is used at all, can be configured without altering the function, as described in the next section.

#### `zffcache`

This is used to implement caching of files in the current directory for each session separately. It is used by `zfget_match` and `zfrglob`.

File: `zsh.info`, Node: Miscellaneous Features, Prev: Zftp Functions, Up: Zftp Function System

## 25.4 Miscellaneous Features

=====

### 25.4.1 Configuration

-----

Various styles are available using the standard shell style mechanism, described in `*Note The zsh/zutil Module::`. Briefly, the command ``zstyle`

`:zftp:*` STYLE VALUE

`...'` defines the STYLE to have value VALUE;

more than one value may be given, although that is not useful in the cases described here. These values will then be used throughout the zftp function system. For more precise control, the first argument, which gives a pattern that matches `_contexts_` in which the style applies, can be modified to include a particular function, as for example `:zftp:zfget'`: the style will then have the given value only in the `zfget` function, and will override styles set under `:zftp:*`. Note that only the top level function name, as called by the user, is used; calling of lower level functions is transparent to the user. Hence modifications to the title bar in `zftp_chpwd` use the contexts `:zftp:zlopen`, `:zftp:zfcd`, etc., depending where it was called from. The following styles are understood:

progress

Controls the way that `zftp_progress` reports on the progress of a transfer. If empty, unset, or ``none'`, no progress report is made;

if

``bar'` a growing bar of inverse video is shown; if ``percent'` (or any other string, though this may change in future), the percentage of the file transferred is shown. The bar meter requires that the width of the terminal be available via the `$COLUMNS` parameter (normally this is set automatically). If the size of the file being transferred is not available, bar and percent meters will simply show the number of bytes transferred so far.

When `zfini` is run, if this style is not defined for the context `:zftp:*`, it will be set to ``bar'`.

update

Specifies the minimum time interval between updates of the progress meter in seconds. No update is made unless new data has been received, so the actual time interval is limited only by `$ZFTP_TIMEOUT`.

As described for progress, `zfini` will force this to default to 1.

remote-glob

If set to ``1'`, ``yes'` or ``true'`, filename generation (globbing) is performed on the remote machine instead of by `zsh` itself; see below.

titlebar

If set to ``1'`, ``yes'` or ``true'`, `zftp_chpwd` will put the remote

host and remote directory into the titlebar of terminal emulators such as xterm or sun-cmd that allow this.

As described for progress, zfininit will force this to default to 1.

#### chpwd

If set to `1` `yes` or `true`, zftp\_chpwd will call the function chpwd when a connection is closed. This is useful if the remote host details were put into the terminal title bar by zftp\_chpwd and your usual chpwd also modifies the title bar.

When zfininit is run, it will determine whether chpwd exists and if so it will set the default value for the style to 1 if none exists already.

Note that there is also an associative array zfconfig which contains values used by the function system. This should not be modified or overwritten.

#### 25.4.2 Remote globbing

-----

The commands for retrieving files usually perform filename generation (globbing) on their arguments; this can be turned off by passing the option -G to each of the commands. Normally this operates by retrieving a complete list of files for the directory in question, then matching these locally against the pattern supplied. This has the advantage that the full range of zsh patterns (respecting the setting of the option EXTENDED\_GLOB) can be used. However, it means that the directory part of a filename will not be expanded and must be given exactly. If the remote server does not support the UNIX directory semantics, directory handling is problematic and it is recommended that globbing only be used within the current directory. The list of files in the current directory, if retrieved, will be cached, so that subsequent globs in the same directory without an intervening zlcd are much faster.

If the remote-glob style (see above) is set, globbing is instead performed on the remote host: the server is asked for a list of matching files.

This is highly dependent on how the server is implemented, though typically UNIX servers will provide support for basic glob

patterns. This may in some cases be faster, as it avoids retrieving the entire list of directory contents.

### 25.4.3 Automatic and temporary reopening

-----

As described for the `zlopen` command, a subsequent `zlopen` with no parameters will reopen the connection to the last host (this includes connections made with the `zfanon` command). Opened in this fashion, the connection starts in the default remote directory and will remain open until explicitly closed.

Automatic re-opening is also available. If a connection is not currently open and a command requiring a connection is given, the last connection is implicitly reopened. In this case the directory which was current when the connection was closed again becomes the current directory (unless, of course, the command given changes it). Automatic reopening will also take place if the connection was closed by the remote server for whatever reason (e.g. a timeout). It is not available if the `-1` option to `zlopen` or `zfanon` was used.

Furthermore, if the command issued is a file transfer, the connection will be closed after the transfer is finished, hence providing a one-shot mode for transfers. This does not apply to directory changing or listing commands; for example a `zfdi` may reopen a connection but will leave it open. Also, automatic closure will only ever happen in the same command as automatic opening, i.e. a `zfdi` directly followed by a `zfgt` will never close the connection automatically.

Information about the previous connection is given by the `zfst` function. So, for example, if that reports:

```
Session:    default
Not connected.
Last session: ftp.bar.com:/pub/textfiles
```

then the command `zfgt file.txt` will attempt to reopen a connection to `ftp.bar.com`, retrieve the file `/pub/textfiles/file.txt`, and immediately close the connection again. On the other hand, `zfd ..` will open the connection in the directory `/pub` and leave it open.

Note that all the above is local to each session; if you return to a previous session, the connection for that session is the one which will be reopened.

#### 25.4.4 Completion

-----

Completion of local and remote files, directories, sessions and bookmarks is supported. The older, compctl-style completion is defined when zfnit is called; support for the new widget-based completion system is provided in the function Completion/Zsh/Command/\_zftp, which should be installed with the other functions of the completion system and hence should automatically be available.

File: zsh.info, Node: User Contributions, Prev: Zftp Function System, Up: Top

### 26 User Contributions

\*\*\*\*\*

#### 26.1 Description

=====

The Zsh source distribution includes a number of items contributed by the user community. These are not inherently a part of the shell, and some may not be available in every zsh installation. The most significant of these are documented here. For documentation on other contributed items such as shell functions, look for comments in the function source files.

\* Menu:

\* Utilities::

\* Recent Directories::

\* Other Directory Functions::

\* Version Control Information::

\* Prompt Themes::

\* ZLE Functions::

\* Exception Handling::

\* MIME Functions::

\* Mathematical Functions::

\* User Configuration Functions::

\* Other Functions::

File: zsh.info, Node: Utilities, Next: Recent Directories, Up: User Contributions

## 26.2 Utilities

=====

### 26.2.1 Accessing On-Line Help

-----

The key sequence ESC h is normally bound by ZLE to execute the run-help widget (see \*Note Zsh Line Editor::). This invokes the run-help command with the command word from the current input line as its argument. By default, run-help is an alias for the man command, so this often fails when the command word is a shell builtin or a user-defined function. By redefining the run-help alias, one can improve the on-line help provided by the shell.

The helpfiles utility, found in the Util directory of the distribution, is a Perl program that can be used to process the zsh manual to produce a separate help file for each shell builtin and for many other shell features as well. The autoloadable run-help function, found in Functions/Misc, searches for these helpfiles and performs several other tests to produce the most complete help possible for the command.

Help files are installed by default to a subdirectory of /usr/share/zsh or /usr/local/share/zsh.

To create your own help files with helpfiles, choose or create a directory where the individual command help files will reside. For example, you might choose ~/zsh\_help. If you unpacked the zsh distribution in your home directory, you would use the commands:

```
mkdir ~/zsh_help
perl ~/zsh-5.9/Util/helpfiles ~/zsh_help
```

The HELPDIR parameter

tells run-help where to look for the help files.

When unset, it uses the default installation path. To use your own set



of help files, set this to the appropriate path in one of your startup files:

```
HELPPDIR=~/.zsh_help
```

To use the run-help function, you need to add lines something like the following to your .zshrc or equivalent startup file:

```
unalias run-help
autoload run-help
```

Note that in order for 'autoload run-help' to work, the run-help file must be in one of the directories named in your fpath array (see \*Note Parameters Used By The Shell:). This should already be the case if you have a standard zsh installation; if it is not, copy Functions/Misc/run-help to an appropriate directory.

### 26.2.2 Recompiling Functions

-----

If you frequently edit your zsh functions, or periodically update your zsh installation to track the latest developments, you may find that function digests compiled with the zcompile builtin are frequently out of date

with respect to the function source files. This is not usually a problem, because zsh always looks for the newest file when loading a function, but it may cause slower shell startup and function loading. Also, if a digest file is explicitly used as an element of fpath, zsh won't check whether any of its source files has changed.

The zrecompile autoloadable function, found in Functions/Misc, can be used to keep function digests up to date.

```
zrecompile [ -qt ] [ NAME ... ]
zrecompile [ -qt ] -p ARG ... [ -- ARG ... ]
```

This tries to find \*.zwc files and automatically re-compile them if at least one of the original files is newer than the compiled file. This works only if the names stored in the compiled files are full paths or are relative to the directory that contains the .zwc file.

In the first form, each NAME is the name of a compiled file or a directory containing \*.zwc files that should be checked. If no arguments are given, the directories and \*.zwc files in fpath are used.

When -t is given, no compilation is performed, but a return status of zero (true) is set if there are files that need to be re-compiled and non-zero (false) otherwise. The -q option quiets the chatty output that describes what zrecompile is doing.

Without the -t option, the return status is zero if all files that needed re-compilation could be compiled and non-zero if compilation for at least one of the files failed.

If the -p option is given, the ARGs are interpreted as one or more sets of arguments for zcompile, separated by '--'. For example:

```
zrecompile -p \  
-R ~/.zshrc -- \  
-M ~/.zcompdump -- \  
~/zsh/comp.zwc ~/zsh/Completion/*/_*
```

This compiles ~/.zshrc into ~/.zshrc.zwc if that doesn't exist or if it is older than ~/.zshrc. The compiled file will be marked for reading instead of mapping. The same is done for ~/.zcompdump and ~/.zcompdump.zwc, but this compiled file is marked for mapping. The last line re-creates the file ~/zsh/comp.zwc if any of the files matching the given pattern is newer than it.

Without the -p option, zrecompile does not create function digests that do not already exist, nor does it add new functions to the digest.

The following shell loop is an example of a method for creating function digests for all functions in your fpath, assuming that you have write permission to the directories:

```
for ((i=1; i <= $#fpath; ++i)); do  
  dir=${fpath[i]}  
  zwc=${dir:t}.zwc  
  if [[ $dir == (|..)|* ]] || $dir == (|..)/_* ]; then  
    continue  
  fi
```

```

files=( $dir/*(N-.))
if [[ -w $dir:h && -n $files ]]; then
    files=( ${$(M)files%/*/*}#/)
    if ( cd $dir:h &&
        zrecompile -p -U -z $zwc $files ); then
        fpath[i]=$fpath[i].zwc
    fi
fi
done

```

The -U and -z options are appropriate for functions in the default zsh installation fpath; you may need to use different options for your personal function directories.

Once the digests have been created and your fpath modified to refer to them, you can keep them up to date by running zrecompile with no arguments.

### 26.2.3 Keyboard Definition

-----

The large number of possible combinations of keyboards, workstations, terminals, emulators, and window systems makes it impossible for zsh to have built-in key bindings for every situation. The zkbd utility, found in Functions/Misc, can help you quickly create key bindings for your configuration.

Run zkbd either as an autoloading function, or as a shell script:

```
zsh -f ~/zsh-5.9/Functions/Misc/zkbd
```

When you run zkbd, it first asks you to enter your terminal type; if the default it offers is correct, just press return. It then asks you to press a number of different keys to determine characteristics of your keyboard and terminal;

zkbd warns you if it finds anything out of the ordinary, such as a Delete key that sends neither ^H nor ^?.

The keystrokes read by zkbd are recorded as a definition for an associative array named key, written to a file in the subdirectory .zkbd within either your HOME or ZDOTDIR directory. The name of the file is composed from the TERM, VENDOR and OSTYPE parameters, joined by

hyphens.

You may read this file into your `.zshrc` or another startup file with the ``source'` or ``.'` commands, then reference the key parameter in bindkey commands, like this:

```
source ${ZDOTDIR:-$HOME}/.zkbd/$TERM-$VENDOR-$OSTYPE
[[ -n ${key[Left]} ]] && bindkey "${key[Left]}" backward-char
[[ -n ${key[Right]} ]] && bindkey "${key[Right]}" forward-char
# etc.
```

Note that in order for ``autoload zkbd'` to work, the `zkdb` file must be in one of the directories named in your `fpath` array (see *\*Note Parameters Used By The Shell::*). This should already be the case if you have a standard `zsh` installation;  
if it is not, copy  
Functions/Misc/zkbd to an appropriate directory.

## 26.2.4 Dumping Shell State

-----

Occasionally you may encounter what appears to be a bug in the shell, particularly if you are using a beta version of `zsh` or a development release. Usually it is sufficient to send a description of the problem to one of the `zsh` mailing lists (see *\*Note Mailing Lists::*), but sometimes one of the `zsh` developers will need to recreate your environment in order to track the problem down.

The script named `reporter`, found in the `Util` directory of the distribution, is provided for this purpose. (It is also possible to `autoload reporter`, but `reporter` is not installed in `fpath` by default.) This script outputs a detailed dump of the shell state, in the form of another script that can be read with ``zsh -f'` to recreate that state.

To use `reporter`, read the script into your shell with the ``.'` command and redirect the output into a file:

```
. ~/zsh-5.9/Util/reporter
> zsh.report
```

You should check the `zsh.report` file for any sensitive information such as passwords and delete them by hand before sending the script to the

developers. Also, as the output can be voluminous, it's best to wait for the developers to ask for this information before sending it.

You can also use `reporter` to dump only a subset of the shell state. This is sometimes useful for creating startup files for the first time. Most of the output from `reporter` is far more detailed than usually is necessary for a startup file, but the aliases, options, and `zstyles` states may be useful because they include only changes from the defaults. The bindings state may be useful if you have created any of your own keymaps, because `reporter` arranges to dump the keymap creation commands as well as the bindings for every keymap.

As is usual with automated tools, if you create a startup file with `reporter`, you should edit the results to remove unnecessary commands. Note that if you're using the new completion system, you should `_not_` dump the functions state to your startup files with `reporter`; use the `compdump` function instead (see `*Note Completion System::`).

`reporter [ STATE ... ]`

Print to standard output the indicated subset of the current shell state. The `STATE` arguments may be one or more of:

`all`

Output everything listed below.

`aliases`

Output alias definitions.

`bindings`

Output ZLE key maps and bindings.

`completion`

Output old-style `compctl` commands. New completion is covered by functions and `zstyles`.

`functions`

Output autoloads and function definitions.

`limits`

Output limit commands.

`options`

Output `setopt` commands.

`styles`

Same as zstyles.

#### variables

Output shell parameter assignments, plus export commands for any environment variables.

#### zstyles

Output zstyle commands.

If the STATE  
is omitted, all is assumed.

With the exception of `all', every STATE can be abbreviated by any prefix, even a single letter; thus a is the same as aliases, z is the same as zstyles, etc.

### 26.2.5 Manipulating Hook Functions

-----

#### add-zsh-hook [ -L | -dD ] [ -Uzk ] HOOK FUNCTION

Several functions are special to the shell, as described in the section Special Functions, \*Note Functions::, in that they are automatically called at specific points during shell execution. Each has an associated array consisting of names of functions to be called at the same point; these are so-called `hook functions'. The shell function add-zsh-hook provides a simple way of adding or removing functions from the array.

HOOK is one of chpwd, periodic, precmd, preexec, zshaddhistory, zshexit, or zsh\_directory\_name, the special functions in question. Note that zsh\_directory\_name is called in a different way from

the other functions, but may still be manipulated as a hook.

FUNCTION is name of an ordinary shell function. If no options are given this will be added to the array of functions to be executed in the given context. Functions are invoked in the order they were added.

If the option -L is given, the current values for the hook arrays are listed with typeset.

If the option -d is given, the FUNCTION is removed from the array of functions to be executed.

If the option `-D` is given, the `FUNCTION` is treated as a pattern and any matching names of functions are removed from the array of functions to be executed.

The options `-U`, `-z` and `-k` are passed as arguments to `autoload` for `FUNCTION`. For functions contributed with `zsh`, the options `-Uz` are appropriate.

`add-zle-hook-widget [ -L | -dD ] [ -Uzk ] HOOK WIDGETNAME`

Several widget names are special to the line editor, as described in the section `Special Widgets`,

\*Note Zle Widgets::, in that they

are automatically called at specific points during editing.

Unlike function hooks, these do not use a predefined array of other names to call at the same point; the shell function `add-zle-hook-widget` maintains a similar array and arranges for the special widget to invoke those additional widgets.

`HOOK` is one of `isearch-exit`, `isearch-update`, `line-pre-redraw`, `line-init`, `line-finish`, `history-line-set`, or `keymap-select`, corresponding to each of the special widgets `zle-isearch-exit`, etc. The special widget names are also accepted as the `HOOK` argument.

`WIDGETNAME` is the name of a ZLE widget. If no options are given this is added to the array of widgets to be invoked in the given hook context. Widgets are invoked in the order they were added, with

```
zle WIDGETNAME -Nw -f "nolast" -- "$@"
```

Note that this means that the ``WIDGET'` special parameter tracks the `WIDGETNAME`

when the widget function is called, rather than tracking the name of the corresponding special hook widget.

If the option `-d` is given, the `WIDGETNAME` is removed from the array of widgets to be executed.

If the option `-D` is given, the `WIDGETNAME` is treated as a pattern and any matching names of widgets are removed from the array.

If `WIDGETNAME` does not name an existing widget when added to the array, it is assumed that a shell function also named `WIDGETNAME` is meant to provide the implementation of the widget. This name is therefore marked for autoloading, and the options `-U`, `-z` and `-k` are passed as arguments to `autoload` as with `add-zsh-hook`. The widget is also created with ``zle -N WIDGETNAME'` to cause the

corresponding function to be loaded the first time the hook is called.

The arrays of WIDGETNAME are currently maintained in zstyle contexts, one for each HOOK context, with a style of `widgets'.

If

the -L option is given, this set of styles is listed with

`zstyle -L'. This implementation may change, and the special widgets that refer to the styles are created only if add-zle-hook-widget is called to add at least one widget, so if this function is used for any hooks, then all hooks should be managed only via this function.

File: zsh.info, Node: Recent Directories, Next: Other Directory Functions, Prev: Utilities, Up: User Contributions

## 26.3 Remembering Recent Directories

=====

The function `cdr` allows you to change the working directory to a previous working directory from a list maintained automatically. It is similar in concept to the directory stack controlled by the `pushd`, `popd` and `dirs` builtins, but is more configurable, and as it stores all entries in files it is maintained across sessions and (by default) between terminal emulators in the current session. Duplicates are automatically removed, so that the list reflects the single most recent use of each directory.

Note that the `pushd` directory stack is not actually modified or used by `cdr` unless you configure it to do so as described in the configuration section below.

### 26.3.1 Installation

-----

The system works by means of a hook function that is called every time the directory changes. To install the system, autoload the required functions and use the `add-zsh-hook` function described above:

```
autoload -Uz chpwd_recent_dirs cdr add-zsh-hook
add-zsh-hook chpwd chpwd_recent_dirs
```



Now every time you change directly interactively, no matter which command you use, the directory to which you change will be remembered in most-recent-first order.

### 26.3.2 Use

-----

All direct user interaction is via the `cdr` function.

The argument to `cdr` is a number `N` corresponding to the `N`th most recently changed-to directory. `1` is the immediately preceding directory; the current directory is remembered but is not offered as a destination. Note that if you have multiple windows open `1` may refer to a directory changed to in another window; you can avoid this by having per-terminal files for storing directory as described for the `recent-dirs-file` style below.

If you set the `recent-dirs-default` style described below `cdr` will behave the same as `cd` if given a non-numeric argument, or more than one argument. The recent directory list is updated just the same however you change directory.

If the argument is omitted, `1` is assumed. This is similar to `pushd`'s behaviour of swapping the two most recent directories on the stack.

Completion for the argument to `cdr` is available if `compinit` has been run; menu selection is recommended, using:

```
zstyle ':completion:*:*:cdr:*:*' menu selection
```

to allow you to cycle through recent directories; the order is preserved, so the first choice is the most recent directory before the current one. The verbose style is also recommended to ensure the directory is shown; this style is on by default so no action is required unless you have changed it.

### 26.3.3 Options

-----

The behaviour of `cdr` may be modified by the following options.

-l

lists the numbers and the corresponding directories in abbreviated form (i.e. with ~ substitution reapplied), one per line. The directories here are not quoted (this would only be an issue if a directory name contained a newline). This is used by the completion system.

-r

sets the variable reply to the current set of directories. Nothing is printed and the directory is not changed.

-e

allows you to edit the list of directories, one per line. The list can be edited to any extent you like; no sanity checking is performed. Completion is available. No quoting is necessary (except for newlines, where I have in any case no sympathy); directories are in unabbreviated form and contain an absolute path, i.e. they start with /. Usually the first entry should be left as the current directory.

-p 'PATTERN'

Prunes any items in the directory list that match the given extended glob pattern; the pattern needs to be quoted from immediate expansion on the command line. The pattern is matched against each completely expanded file name in the list; the full string must match, so wildcards at the end (e.g. '\*removeme\*') are needed to remove entries with a given substring.

If output is to a terminal, then the function will print the new list after pruning and prompt for confirmation by the user. This output and confirmation step can be skipped by using -P instead of -p.

#### 26.3.4 Configuration

-----

Configuration is by means of the styles mechanism that should be familiar from completion; if not, see the description of the `zstyle` command in \*Note The zsh/zutil Module::. The context for setting styles should be `:chpwd:*` in case the meaning of the context is extended in future, for example:

```
zstyle ':chpwd:*' recent-dirs-max 0
```

sets the value of the recent-dirs-max style to 0. In practice the style name is specific enough that a context of '\*' should be fine.

An exception is recent-dirs-insert, which is used exclusively by the completion system and so has the usual completion system context (':completion:\*' if nothing more specific is needed), though again '\*' should be fine in practice.

#### recent-dirs-default

If true, and the command is expecting a recent directory index, and either there is more than one argument or the argument is not an integer, then fall through to "cd". This allows the lazy to use only one command for directory changing. Completion recognises this, too; see recent-dirs-insert for how to control completion when this option is in use.

#### recent-dirs-file

The file where the list of directories is saved. The default is `${ZDOTDIR:-$HOME}/.chpwd-recent-dirs`, i.e. this is in your home directory unless you have set the variable ZDOTDIR to point somewhere else. Directory names are saved in '\$...' quoted form, so each line in the file can be supplied directly to the shell as an argument.

The value of this style may be an array. In this case, the first file in the list will always be used for saving directories while any other files are left untouched. When reading the recent directory list, if there are fewer than the maximum number of entries in the first file, the contents of later files in the array will be appended with duplicates removed from the list shown. The contents of the two files are not sorted together, i.e. all the entries in the first file are shown first. The special value + can appear in the list to indicate the default file should be read at that point. This allows effects like the following:

```
zstyle ':chpwd:*' recent-dirs-file \
~/.chpwd-recent-dirs-${TTY##*/}
```

+

Recent directories are read from a file numbered according to the terminal. If there are insufficient entries the list is supplemented from the default file.

It is possible to use `zstyle -e` to make the directory configurable at run time:

```
zstyle -e ':chpwd:*' recent-dirs-file pick-recent-dirs-file
pick-recent-dirs-file() {
    if [[ $PWD = ~/text/writing(/|*) ]]; then
        reply=(~/chpwd-recent-dirs-writing)
    else
        reply=(+)
    fi
}
```

In this example, if the current directory is `~/text/writing` or a directory under it, then use a special file for saving recent directories, else use the default.

#### recent-dirs-insert

Used by completion. If `recent-dirs-default` is true, then setting this to true causes the actual directory, rather than its index, to be inserted on the command line; this has the same effect as using the corresponding

index, but makes the history clearer and the line

easier to edit. With this setting, if part of an argument was already typed, normal directory completion rather than recent directory completion is done; this is because recent directory completion is expected to be done by cycling through entries menu fashion.

If the value of the style is `always`, then only recent directories will be completed; in that case, use the `cd` command when you want to complete other directories.

If the value is `fallback`, recent directories will be tried first, then normal directory completion is performed if recent directory completion failed to find a match.

Finally, if the value is `both` then both sets of completions are presented; the usual tag mechanism can be used to distinguish results, with recent directories tagged as `recent-dirs`. Note that the recent directories inserted are abbreviated with directory names where appropriate.

#### recent-dirs-max

The maximum number of directories to save to the file. If this is zero or negative there is no maximum. The default is 20. Note this includes the current directory, which isn't offered, so the highest number of directories you will be offered is one less than

the maximum.

#### recent-dirs-prune

This style is an array determining what directories should (or should not) be added to the recent list. Elements of the array can include:

#### parent

Prune parents (more accurately, ancestors) from the recent list. If present, changing directly down by any number of directories causes the current directory to be overwritten. For example, changing from `~pws` to `~pws/some/other/dir` causes `~pws` not to be left on the recent directory stack. This only applies to direct changes to descendant directories; earlier directories on the list are not pruned. For example, changing from `~pws/yet/another` to `~pws/some/other/dir` does not cause `~pws` to be pruned.

#### pattern:PATTERN

Gives a zsh pattern for directories that should not be added to the recent list (if not already there). This element can be repeated to add different patterns. For example, `'pattern:/tmp(/*)'` stops `/tmp` or its descendants from being added. The `EXTENDED_GLOB` option is always turned on for these patterns.

#### recent-dirs-pushd

If set to true, `cdr` will use `pushd` instead of `cd` to change the directory, so the directory is saved on the directory stack. As the directory stack is completely separate from the list of files saved by the mechanism used in this file there is no obvious reason to do this.

### 26.3.5 Use with dynamic directory naming

-----

It is possible to refer to recent directories using the dynamic directory name syntax by using the supplied function `zsh_directory_name_cdr` a hook:

```
autoload -Uz add-zsh-hook
```

```
add-zsh-hook -Uz zsh_directory_name zsh_directory_name_cdr
```

When this is done, ~[1] will refer to the most recent directory other than \$PWD, and so on. Completion after ~[...] also works.

### 26.3.6 Details of directory handling

-----

This section is for the curious or confused; most users will not need to know this information.

Recent directories are saved to a file immediately and hence are preserved across sessions. Note currently no file locking is applied: the list is updated immediately on interactive commands and nowhere else (unlike history), and it is assumed you are only going to change directory in one window at once. This is not safe on shared accounts, but in any case the system has limited utility when someone else is changing to a different set of directories behind your back.

To make this a little safer, only directory changes instituted from the command

line, either directly or indirectly through shell function calls (but not through subshells, evals, traps, completion functions and the like) are saved. Shell functions should use cd -q or pushd -q to avoid side effects if the change to the directory is to be invisible at the command line. See the contents of the function chpwd\_recent\_dirs for more details.

File: zsh.info, Node: Other Directory Functions, Next: Version Control Information, Prev: Recent Directories, Up: User Contributions

### 26.4 Abbreviated dynamic references to directories

=====

The dynamic directory naming system is described in the subsection `_Dynamic named directories_` of `*Note Filename Expansion::`. In this, a reference to ~[...] is expanded by a function found by the hooks mechanism.

The contributed function `zsh_directory_name_generic` provides a system allowing the user to refer to directories with only a limited amount of new code. It supports all three of the standard interfaces for directory naming: converting from a name to a directory, converting in

the reverse direction to find a short name, and completion of names.

The main feature of this function is a path-like syntax, combining abbreviations at multiple levels separated by ":". As an example, ~[g:p:s] might specify:

g

The top level directory for your git area. This first component has to match, or the function will return indicating another directory name hook function should be tried.

p

The name of a project within your git area.

s

The source area within that project.

This allows you to collapse references to long hierarchies to a very compact form, particularly if the hierarchies are similar across different areas of the disk.

Name components may be completed: if a description is shown at the top of the list of completions, it includes the path to which previous components expand, while the description for an individual completion shows

the path segment it would add. No additional configuration is needed for this as the completion system is aware of the dynamic directory name mechanism.

#### 26.4.1 Usage

-----

To use the function, first define a wrapper function for your specific case. We'll assume it's to be autoloaded. This can have any name but we'll refer to it as `zdn_mywrapper`. This wrapper function will define various variables and then call this function with the same arguments that the wrapper function gets. This configuration is described below.

Then arrange for the wrapper to be run as a `zsh_directory_name` hook:

```
autoload -Uz add-zsh-hook zsh_directory_name_generic zdn_mywrapper
add-zsh-hook -U zsh_directory_name zdn_mywrapper
```

#### 26.4.2 Configuration

-----

The wrapper function should define a local associative array `zdn_top`. Alternatively, this can be set with a style called mapping. The context for the style is `:zdn:WRAPPER-NAME` where `WRAPPER-NAME` is the function calling `zsh_directory_name_generic`; for example:

```
zstyle :zdn:zdn_mywrapper: mapping zdn_mywrapper_top
```

The keys in this associative array correspond to the first component of the name. The values are matching directories. They may have an optional suffix with a slash followed by a colon and the name of a variable in the same format to give the next component. (The slash before the colon is to disambiguate the case where a colon is needed in the path for a drive. There is otherwise no syntax for escaping this, so path components whose names start with a colon are not supported.) A special component `:default:` specifies a variable in the form `/:VAR` (the path section is ignored and so is usually empty) that will be used for the next component if no variable is given for the path. Variables referred to within `zdn_top` have the same format as `zdn_top` itself, but contain relative paths.

For example,

```
local -A zdn_top=(
  g ~/git
  ga ~/alternate/git
  gs
  /scratch/$USER/git/:second2
  :default: /:second1
)
```

This specifies the behaviour of a directory referred to as `~[g:...]` or `~[ga:...]` or `~[gs:...]`. Later path components are optional; in that case `~[g]` expands to `~/git`, and so on. `gs` expands to `/scratch/$USER/git` and uses the associative array `second2` to match the second component; `g` and `ga` use the associative array `second1` to match the second component.

When expanding a name to a directory, if the first component is not `g` or `ga` or `gs`, it is not an error; the function simply returns 1 so that a later hook function can be tried. However, matching the first component commits the function, so if a later component does not match, an error is printed (though this still does not stop later hooks from being executed).



For components after the first, a relative path is expected, but note that multiple levels may still appear. Here is an example of second1:

```
local -A second1=(
  p myproject
  s somproject
  os otherproject/subproject/:third
)
```

The path as found from `zdn_top` is extended with the matching directory, so `~[g;p]` becomes `~/git/myproject`. The slash between is added automatically (it's not possible to have a later component modify the name of a directory already matched). Only `os` specifies a variable for a third component, and there's no `:default:`, so it's an error to use a name like `~[g;p:x]` or `~[ga:s:y]` because there's nowhere to look up the `x` or `y`.

The associative arrays need to be visible within this function; the generic function therefore uses internal variable names beginning `_zdn_` in order to avoid clashes. Note that the variable `reply` needs to be passed back to the shell, so should not be local in the calling function.

The function does not test whether directories assembled by component actually exist; this allows the system to work across automounted file systems. The error from the command trying to use a non-existent directory should be sufficient to indicate the problem.

#### 26.4.3 Complete example

Here is a full fictitious but usable autoloadable definition of the example function defined by the code above. So `~[gs;p:s]` expands to `/scratch/$USER/git/myscratchproject/top/srcdir` (with `$USER` also expanded).

```
local -A zdn_top=(
  g ~/git
  ga ~/alternate/git
  gs /scratch/$USER/git/:second2
  :default: /:second1
)
```

```

local -A second1=(
  p myproject
  s somproject
  os otherproject/subproject/:third
)

```

```

local -A second2=(
  p myscratchproject
  s somescratchproject
)

```

```

local -A third=(
  s top/srcdir
  d top/documentation
)

```

```

# autoload not needed if you did this at initialisation...
autoload -Uz zsh_directory_name_generic
zsh_directory_name_generic "$@"

```

It is also possible to use global associative arrays, suitably named, and set the style for the context of your wrapper function to refer to this. Then your set up code would contain the following:

```

typeset -A zdn_mywrapper_top=(...)
# ... and so on for other associative arrays ...
zstyle ':zdn:zdn_mywrapper:' mapping zdn_mywrapper_top
autoload -Uz add-zsh-hook zsh_directory_name_generic zdn_mywrapper
add-zsh-hook -U zsh_directory_name zdn_mywrapper

```

and the function `zdn_mywrapper` would contain only the following:

```

zsh_directory_name_generic "$@"

```

File: [zsh.info](#), Node: [Version Control Information](#), Next: [Prompt Themes](#), Prev: [Other Directory Functions](#), Up: [User Contributions](#)

## 26.5 Gathering information from version control systems

```

=====

```

In a lot of cases, it is nice to automatically retrieve information from

version control systems (VCSs), such as subversion, CVS or git, to be able to provide it to the user; possibly in the user's prompt. So that you can instantly tell which branch you are currently on, for example.

In order to  
do that, you may use the `vcs_info` function.

The following VCSs are supported, showing the abbreviated name by which they are referred to within the system:

Bazaar (bzd)

``https://bazaar.canonical.com/'`

Codeville (cdv)

``http://freecode.com/projects/codeville/'`

Concurrent Versioning System (cvs)

``https://www.nongnu.org/cvs/'`

Darcs (darcs)

``http://darcs.net/'`

Fossil (fossil)

``https://fossil-scm.org/'`

Git (git)

``https://git-scm.com/'`

GNU arch (tla)

``https://www.gnu.org/software/gnu-arch/'`

Mercurial (hg)

``https://www.mercurial-scm.org/'`

Monotone (mtn)

``https://monotone.ca/'`

Perforce (p4)

``https://www.perforce.com/'`

Subversion (svn)

``https://subversion.apache.org/'`

SVK (svk)

``https://svk.bestpractical.com/'`

There is also support for the patch management system quilt  
(``https://savannah.nongnu.org/projects/quilt'`). See `*Note vcs_info`  
Quilt Support:: below for details.

To load vcs\_info:

```
autoload -Uz vcs_info
```

It can

be used in any existing prompt, because it does not require any specific \$psvar entries to be available.

\* Menu:

- \* vcs\_info Quickstart::
- \* vcs\_info Configuration::
- \* vcs\_info Oddities::
- \* vcs\_info Quilt Support::
- \* vcs\_info API::
- \* vcs\_info Variables::
- \* vcs\_info Hooks::
- \* vcs\_info Examples::

File: zsh.info, Node: vcs\_info Quickstart, Next: vcs\_info Configuration, Up: Version Control Information

## 26.5.1 Quickstart

-----

To get this feature working quickly (including colors), you can do the following (assuming, you loaded vcs\_info properly - see above):

```
zstyle 'vcs_info:*' actionformats \
    '%F{5}(%f%s%F{5})%F{3}-%F{5}[%F{2}%b%F{3}]%F{1}%a%F{5}]%f '
zstyle 'vcs_info:*' formats \
    '%F{5}(%f%s%F{5})%F{3}-%F{5}[%F{2}%b%F{5}]%f '
zstyle 'vcs_info:(sv[nk]|bzs):*' branchformat '%b%F{1}:%F{3}%r'
precmd () { vcs_info }
PS1='%F{5}[%F{2}%n%F{5}] %F{3}%3~ ${vcs_info_msg_0_}%f%# '
```

Obviously, the last two lines are there for demonstration. You need to call vcs\_info from your precmd function. Once that is done you need a \_single quoted\_ '\${vcs\_info\_msg\_0\_}' in your prompt.

To be able to use '\${vcs\_info\_msg\_0\_}' directly in your prompt like

this, you will need to have the PROMPT\_SUBST option enabled.

Now call the vcs\_info\_printsys utility from the command line:

```
% vcs_info_printsys
## list of supported version control backends:
## disabled systems are prefixed by a hash sign (#)
bzd
cdv
cvs
darcs
fossil
git
hg
mtn
p4
svk
svn
tla
## flavours (cannot be used in the enable or disable styles; they
## are enabled and disabled with their master [git-svn -> git])
## they *can* be used in contexts: ':vcs_info:git-svn:*'.
git-p4
git-svn
hg-git
hg-hgsubversion
hg-hgsvn
```

You may not want all of these because there is no point in running the code to detect systems you do not use. So there is a way to disable some backends altogether:

```
zstyle ':vcs_info:*' disable bzd cdv darcs mtn svk tla
```

You may also pick a few from that list and enable only those:

```
zstyle ':vcs_info:*' enable git cvs svn
```

If you rerun vcs\_info\_printsys after one of these commands, you will see the backends listed in the disable style (or backends not in the enable style - if you used that) marked as disabled by a hash sign. That means the detection of these systems is skipped completely. No wasted time there.

## 26.5.2 Configuration

-----

The vcs\_info feature can be configured via zstyle.

First, the context in which we are working:

```
:vcs_info:VCS-STRING:USER-CONTEXT:REPO-ROOT-NAME
```

### VCS-STRING

is one of: git, git-svn, git-p4, hg, hg-git, hg-hgsubversion, hg-hgsvn, darcs, bzd, cdv, mtn, svn, cvs, svk, tla, p4 or fossil.

This is

followed by ``.quilt-QUILT-MODE'` in Quilt mode (see *\*Note vcs\_info Quilt Support::* for details) and by ``+HOOK-NAME'` while hooks are active (see *\*Note vcs\_info Hooks::* for details).

Currently, hooks in quilt mode don't add the ``.quilt-QUILT-MODE'` information. This may change in the future.

### USER-CONTEXT

is a freely configurable string, assignable by the user as the first argument to vcs\_info (see its description below).

### REPO-ROOT-NAME

is the name of a repository in which you want a style to match.

So, if you want a setting specific to `/usr/src/zsh`, with that being a CVS checkout, you can set REPO-ROOT-NAME to `zsh` to make it so.

There are three special values for VCS-STRING: The first is named `-init-`, that is in effect as long as there was no decision what VCS backend to use. The second is `-preinit-`; it is used `_before_` vcs\_info is run, when initializing the data exporting variables. The third special value is `formats` and is used by the `vcs_info_lastmsg` for looking up its styles.

The initial value of REPO-ROOT-NAME is `-all-` and it is replaced with the actual name, as soon as it is known. Only use this part of the context for defining the `formats`, `actionformats` or `branchformat` styles,

as it is guaranteed that REPO-ROOT-NAME is set up correctly for these only. For all other styles, just use '\*' instead.

There are two pre-defined values for USER-CONTEXT:

default

the one used if none is specified

command

used by vcs\_info\_lastmsg to lookup its styles

You can of course use 'vcs\_info:\*' to match all VCSs in all user-contexts at once.

This is a description of all styles that are looked up.

formats

A list of formats, used when actionformats is not used (which is most of the time).

actionformats

A list of formats, used if there is a special action going on in your current repository; like an interactive rebase or a merge conflict.

branchformat

Some backends replace %b in the formats and actionformats styles above, not only by a branch name but also by a revision number. This style lets you modify how that string should look.

nvcsformats

These "formats" are set when we didn't detect a version control system for the current directory or vcs\_info was disabled. This is useful if you want vcs\_info to completely take over the generation of your prompt. You would do something like PS1='\${vcs\_info\_msg\_0\_}' to accomplish that.

hgrevformat

hg uses both a hash and a revision number to reference a specific changeset in a repository. With this style you can format the revision string (see branchformat) to include either or both. It's only useful when get-revision is true. Note, the full 40-character revision id is not available (except when using the use-simple option) because executing hg more than once per prompt is too slow; you may customize this behavior using hooks.

max-exports

Defines

the maximum number of `vcs_info_msg_*` variables `vcs_info` will set.

enable

A list of backends you want to use. Checked in the `-init-` context.

If this list contains an item called `NONE` no backend is used at all and `vcs_info` will do nothing. If this list contains `ALL`, `vcs_info` will use all known backends. Only with `ALL` in enable will the `disable` style have any effect. `ALL` and `NONE` are case insensitive.

disable

A list of VCSs you don't want `vcs_info` to test for repositories (checked in the `-init-` context, too). Only used if enable contains `ALL`.

disable-patterns

A list of patterns that are checked against `$PWD`. If a pattern matches, `vcs_info` will be disabled. This style is checked in the `:vcs_info:-init-*:-all-` context.

Say, `~/zsh` is a directory under version control, in which you do not want `vcs_info` to be active, do:

```
zstyle ':vcs_info:*' disable-patterns "${(b)HOME}/.zsh(/*)"
```

use-quilt

If enabled,

the quilt support code is active in ``addon'` mode. See

`*Note vcs_info Quilt Support::` for details.

quilt-standalone

If enabled, ``standalone'` mode detection is attempted if no VCS is active in a given directory. See `*Note vcs_info Quilt Support::` for details.

quilt-patch-dir

Overwrite the value of the `$QUILT_PATCHES` environment variable. See

`*Note vcs_info Quilt Support::` for details.

quiltcommand

When quilt itself is called in quilt support, the value of this style is used as the command name.

check-for-changes

If enabled, this style causes the `%c` and `%u` format escapes to show when the working directory has uncommitted changes. The strings displayed by these escapes can be controlled via the `stagedstr` and



unstagedstr styles. The only backends that currently support this option are git, hg, and bzip (the latter two only support unstaged).

For this style to be evaluated with the hg backend, the `get-revision` style needs to be set and the `use-simple` style needs to be unset. The latter is the default; the former is not.

With the bzip backend, `_lightweight checkouts_` only honor this style if the `use-server` style is set.

Note, the actions taken if this style is enabled are potentially expensive (read: they may be slow, depending on how big the current repository is). Therefore, it is disabled by default.

#### check-for-staged-changes

This style is like `check-for-changes`, but it never checks the worktree files, only the metadata in the `.${vcs}` dir. Therefore, this style initializes only the `%c` escape (with `stagedstr`) but not the `%u` escape. This style is faster than `check-for-changes`.

In the git backend, this style checks for changes in the index. Other backends do not currently implement this style.

This style is disabled by default.

#### stagedstr

This string will be used in the `%c` escape if there are staged changes in the repository.

#### unstagedstr

This string will be used in the `%u` escape if there are unstaged changes in the repository.

#### command

This style causes `vcs_info` to use the supplied string as the command to use as the VCS's binary. Note, that setting this in `':vcs_info:*` is not a good idea.

If the value of this style is empty (which is the default), the used binary name is the name of the backend in use (e.g. `svn` is used in an `svn` repository).

The `repo-root-name` part in the context is always the default `-all-` when this style is looked up.

For example, this style can be used to use binaries from

non-default installation directories. Assume, git is installed in /usr/bin but your sysadmin installed a newer version in /usr/local/bin. Instead of changing the order of your \$PATH parameter, you can do this:

```
zstyle 'vcs_info:git:*:-all-' command /usr/local/bin/git
```

#### use-server

This is used by the Perforce

backend (p4) to decide if it should

contact the Perforce server to find out if a directory is managed by Perforce. This is the only reliable way of doing this, but runs the risk of a delay if the server name cannot be found. If the server (more specifically, the HOST:PORT pair describing the server) cannot be contacted, its name is put into the associative array `vcs_info_p4_dead_servers` and is not contacted again during the session until it is removed by hand. If you do not set this style, the p4 backend is only usable if you have set the environment variable `P4CONFIG` to a file name and have corresponding files in the root directories of each Perforce client. See comments in the function `VCS_INFO_detect_p4` for more detail.

The Bazaar backend (bzzr) uses this to permit contacting the server about lightweight checkouts, see the `check-for-changes` style.

#### use-simple

If there are two different ways of gathering information, you can

select the simpler one by setting this style to true; the default is to use the not-that-simple code, which is potentially a lot slower but might be more accurate in all possible cases. This style is used by the bzzr, hg, and git backends. In the case of hg it will invoke the external hexdump program to parse the binary `dirstate` cache file; this method will not return the local revision number.

#### get-revision

If set to true, `vcs_info` goes the extra mile to figure out the revision of a repository's work tree (currently for the git and hg backends, where this kind of information is not always vital). For git, the hash value of the currently checked out commit is available via the `%i` expansion. With hg, the local revision number and the corresponding global hash are available via `%i`.

#### get-mq

If set to true, the hg backend will look for a Mercurial Queue (mq) patch directory. Information will be

available via the ``%m'`  
replacement.

#### get-bookmarks

If set to true, the hg backend will try to get a list of current bookmarks. They will be available via the ``%m'` replacement.

The default is to generate a comma-separated list of all bookmark names that refer to the currently checked out revision. If a bookmark is active, its name is suffixed an asterisk and placed first in the list.

#### use-prompt-escapes

Determines if we assume that the assembled string from `vcs_info` includes prompt escapes. (Used by `vcs_info_lastmsg`.)

#### debug

Enable debugging output to track possible problems. Currently this style is only used by `vcs_info`'s hooks system.

#### hooks

A list style that defines hook-function names. See *\*Note vcs\_info Hooks::* below for details.

#### patch-format

#### nopatch-format

This pair of styles format the patch information used by the `%m` expando in formats and actionformats for the git and hg backends.

The value is subject

to certain %-expansions described below. The

expanded value is made available in the global `backend_misc` array as `${backend_misc[patches]}` (also if a `set-patch-format` hook is used).

#### get-unapplied

This boolean style controls whether a backend should attempt to gather a list of unapplied patches (for example with Mercurial Queue patches).

Used by the quilt, hg, and git backends.

The default values for these styles in all contexts are:

#### formats

`" (%s)-[%b]%u%c-`

actionformats

" (%s)-[%b|%a]%u%c-

branchformat

"%b:%r" (for bzt, svn, svk and hg)

nvcsformats

""

hgrevformat

"%r:%h"

max-exports

2

enable

ALL

disable

(empty list)

disable-patterns

(empty list)

check-for-changes

false

check-for-staged-changes

false

stagedstr

(string: "S")

unstagedstr

(string: "U")

command

(empty string)

use-server

false

use-simple

false

get-revision

false

get-mq

true

get-bookmarks

false

use-prompt-escapes

true

debug

false

hooks

(empty list)

use-quilt

false

quilt-standalone

false

quilt-patch-dir

empty - use \$QUILT\_PATCHES

quiltcommand

quilt

patch-format

BACKEND DEPENDENT

nopatch-format

BACKEND DEPENDENT

get-unapplied

false

In normal formats and actionformats the following replacements are done:

%s

The VCS in use (git, hg, svn, etc.).

%b

Information about the current branch.

%a

An identifier that describes the action. Only makes sense in

actionformats.

%i

The current revision number or identifier. For hg the hgrevformat style may be used to customize the output.

%c

The string from the stagedstr style if there are staged changes in the repository.

%u

The string from the unstagedstr style if there are unstaged changes in the repository.

%R

The base directory of the repository.

%r

The repository name. If %R is /foo/bar/repoXY, %r is repoXY.

%S

A subdirectory within a repository. If \$PWD is /foo/bar/repoXY/beer/tasty, %S is beer/tasty.

%m

A "misc" replacement. It is at the discretion of the backend to decide what this replacement expands to.

The hg and git backends use this expando to display patch information. hg sources patch information from the mq extensions; git from in-progress rebase and cherry-pick operations and from the stgit extension. The patch-format and nopatch-format styles control the generated string. The former is used when at least one patch from the patch queue has been applied, and the latter otherwise.

The hg backend displays bookmark information in this expando (in addition to mq information). See the get-mq and get-bookmarks styles. Both of these styles may be enabled at the same time. If both are enabled, both resulting strings will be shown separated by a semicolon (that cannot currently be customized).

The quilt `standalone' backend sets this expando to the same value as the %Q expando.

%Q

Quilt series information. When quilt is used (either in `addon' mode or as a `standalone' backend), this expando is set to the quilt series' patch-format string. The set-patch-format hook and nopatch-format style are honoured.

See *\*Note vcs\_info Quilt Support::* below for details.

In branchformat these replacements are done:

%b

The branch name. For hg, the branch name can include a topic name.

%r

The current revision number or the hgrevformat style for hg.

In hgrevformat these replacements are done:

%r

The current local revision number.

%h

The current global revision identifier.

In patch-format and nopatch-format these replacements are done:

%p

The name of the top-most applied patch; may be overridden by the applied-string hook.

%u

The number of unapplied patches; may be overridden by the

unapplied-string hook.

%n

The number of applied patches.

%c

The number of unapplied patches.

%a

The number of all patches ( $%a = %n + %c$ ).

%g

The names of active mq guards (hg backend).

%G

The number of active mq guards (hg backend).

Not all VCS backends have to support all replacements. For nvcsformats no replacements are performed at all, it is just a string.

File: zsh.info, Node: vcs\_info Oddities, Next: vcs\_info Quilt Support, Prev: vcs\_info Configuration, Up: Version Control Information

### 26.5.3 Oddities

-----

If you want to use the %b (bold off) prompt expansion in formats, which expands %b itself, use %%b. That will cause the vcs\_info expansion to replace %%b with %b, so that zsh's prompt expansion mechanism can handle it. Similarly, to hand down %b from branchformat, use %%%b. Sorry for this inconvenience, but it cannot be easily avoided. Luckily we do not clash with a lot of prompt expansions and this only needs to be done for those.

When one of the gen-applied-string, gen-unapplied-string, and set-patch-format hooks is defined, applying %-escaping (`foo=${foo//'%'/%%}`) to the interpolated values for use in the prompt is the responsibility of those hooks (jointly); when neither of those hooks is defined, vcs\_info handles escaping by itself. We regret this coupling, but it was required for backwards compatibility.

File: zsh.info, Node: vcs\_info Quilt Support, Next: vcs\_info API, Prev: vcs\_info Oddities, Up: Version Control Information

### 26.5.4 Quilt Support

-----

`Quilt' is not a version control system, therefore this is not implemented as a backend. It can help keeping track of a series of patches. People use it to keep a set of changes they want to use on top of software packages (which is tightly integrated into the package build process - the Debian project does this for a large number of packages). Quilt can also help individual developers keep track of



their own patches on  
top of real version control systems.

The `vcs_info` integration tries to support both ways of using quilt by having two slightly different modes of operation: `'addon'` mode and `'standalone'` mode).

Quilt integration is off by default; to enable it, set the `use-quilt` style, and add `%Q` to your formats or `actionformats` style:

```
zstyle ':vcs_info:*' use-quilt true
```

Styles looked up from the Quilt support code include ``.quilt-QUILT-MODE'` in the `VCS-STRING` part of the context, where `QUILT-MODE` is either `addon` or `standalone`. Example:

```
:vcs_info:git,quilt-addon:default:REPO-ROOT-NAME.
```

For `'addon'` mode to become active `vcs_info` must have already detected a real version control system controlling the directory. If that is the case, a directory that holds quilt's patches needs to be found. That directory is configurable via the `'QUILT_PATCHES'` environment variable. If that variable exists its value is used, otherwise the value `'patches'` is assumed. The value from `$QUILT_PATCHES` can be overwritten using the `'quilt-patch-dir'` style. (Note: you can use `vcs_info` to keep the value of `$QUILT_PATCHES` correct all the time via the `post-quilt` hook).

When the directory in question is found, quilt is assumed to be active. To gather more information, `vcs_info` looks for a directory called ``.pc'`; Quilt uses that directory to track its current state. If this directory does not exist we know that quilt has not done anything to the working directory (read: no patches have been applied yet).

If patches are applied, `vcs_info` will try to find out which. If you want to know which patches of a series are not yet applied, you need to activate the `get-unapplied` style in the appropriate context.

`vcs_info` allows for very detailed control over how the gathered information is presented (see `*Note vcs_info Configuration::` and `*Note vcs_info Hooks::`), all of which are documented below. Note there are a number of other patch tracking systems that work on top of a certain version control system (like `stgit` for `'git'`, or `mq` for `'hg'`); the configuration for systems like that are generally configured the same way as the `'quilt'` support.

If the `'quilt'` support is working in `'addon'` mode, the produced string is available as a simple format replacement (`%Q` to be precise), which

can be used in formats and actionformats; see below for details).

If, on the other hand, the support code is working in ``standalone'` mode, `vcs_info` will pretend as if quilt were an actual version control system. That means that the version control system identifier (which otherwise would be something like ``svn'` or ``cvs'`) will be set to ``-quilt-'`. This has implications on the used style context where this identifier is the second element. `vcs_info` will have filled in a proper value for the "repository's" root directory and the string containing the information about quilt's state will be available as the ``misc'` replacement (and `%Q` for compatibility with ``addon'` mode).

What is left to discuss is how ``standalone'` mode is detected. The detection itself is a series of searches for directories. You can have this detection enabled all the time in every directory that is not otherwise under version control. If you know there is only a limited set of trees where you would like `vcs_info` to try and look for Quilt in ``standalone'` mode to minimise the amount of searching on every call to `vcs_info`, there are a number of ways to do that:

Essentially, ``standalone'` mode detection is controlled by a style called ``quilt-standalone'`. It is a string style and its value can have different effects. The simplest values are: ``always'` to run detection every time `vcs_info` is run, and ``never'` to turn the detection off entirely.

If the value of `quilt-standalone` is something else, it is interpreted differently. If the value is the name of a scalar variable the value of that variable is checked and that value is used in the same ``always'/'never'` way as described above.

If the value of `quilt-standalone` is an array, the elements of that array are used as directory names under which you want the detection to be active.

If `quilt-standalone` is an associative array, the keys are taken as directory names under which you want the detection to be active, but only if the corresponding value is the string ``true'`.

Last, but not least, if the value of `quilt-standalone` is the name of a function, the function is called without arguments and the return value decides whether detection should be active. A ``0'` return value is true; a non-zero return value is interpreted as false.

Note, if there is both a function and a variable by the name of `quilt-standalone`, the function will take precedence.

### 26.5.5 Function Descriptions (Public API)

-----

#### `vcs_info [USER-CONTEXT]`

The main function, that runs all backends and assembles all data into `${vcs_info_msg_*}`.

This is the function you want to call from

`precmd` if you want to include up-to-date information in your prompt (see *\*Note vcs\_info Variables::* below). If an argument is given, that string will be used instead of default in the `USER-CONTEXT` field of the style context.

#### `vcs_info_hookadd`

Statically registers a number of functions to a given hook. The hook needs to be given as the first argument; what follows is a list of hook-function names to register to the hook. The ``+vi'` prefix needs to be left out here. See *\*Note vcs\_info Hooks::* below for details.

#### `vcs_info_hookdel`

Remove hook-functions from a given hook. The hook needs to be given as the first non-option argument; what follows is a list of hook-function names to un-register from the hook. If ``-a'` is used as the first argument, all occurrences of the functions are unregistered. Otherwise only the last occurrence is removed (if a function was

registered to a hook more than once). The ``+vi'`

prefix needs to be left out here. See *\*Note vcs\_info Hooks::* below for details.

#### `vcs_info_lastmsg`

Outputs the current values of `${vcs_info_msg_*}`. Takes into account the value of the `use-prompt-escapes` style in `'vcs_info:formats:command:-all-'`. It also only prints `max-exports` values.

#### `vcs_info_printsys [USER-CONTEXT]`

Prints a list of all supported version control systems. Useful to find out possible contexts (and which of them are enabled) or values for the `disable` style.

## `vcs_info_setsys`

Initializes `vcs_info`'s internal list of available backends. With this function, you can add support for new VCSs without restarting the shell.

All functions named `VCS_INFO_*` are for internal use only.

File: `zsh.info`, Node: `vcs_info Variables`, Next: `vcs_info Hooks`, Prev: `vcs_info API`, Up: `Version Control Information`

### 26.5.6 Variable Description

-----

#### `${vcs_info_msg_N_}`

(Note the trailing underscore)

Where `N` is an integer, e.g., `vcs_info_msg_0_`. These variables are the storage for the informational message the last `vcs_info` call has assembled. These are strongly connected to the formats, actionformats and nvcsformats styles described above. Those styles are lists. The first member of that list gets expanded into `${vcs_info_msg_0_}`, the second into `${vcs_info_msg_1_}` and the `N`th into `${vcs_info_msg_N-1_}`. (See the max-exports style above.)

All variables named `VCS_INFO_*` are for internal use only.

File: `zsh.info`, Node: `vcs_info Hooks`, Next: `vcs_info Examples`, Prev: `vcs_info Variables`, Up: `Version Control Information`

### 26.5.7 Hooks in `vcs_info`

-----

Hooks are places in `vcs_info` where you can run your own code. That code can communicate with the code that called it and through that, change the system's behaviour.

For configuration, hooks change the style context:

`:vcs_info:VCS-STRING+HOOK-NAME:USER-CONTEXT:REPO-ROOT-NAME`

To register functions to a hook, you need to list them in the hooks style in the appropriate context.

Example:

```
zstyle ':vcs_info:*+foo:*' hooks bar baz
```

This registers functions to the hook ``foo'` for all backends. In order to avoid namespace problems, all registered function names are prepended by a ``+vi-'`, so the actual functions called for the ``foo'` hook are ``+vi-bar'` and ``+vi-baz'`.

If you would like to register a function to a hook regardless of the current context, you may use the `vcs_info_hookadd` function. To remove a function that was added like that, the `vcs_info_hookdel` function can be used.

If something seems weird, you can enable the ``debug'` boolean style in the proper context and the hook-calling code will print what it tried to execute and whether the function in question existed.

When you register more than one function to a hook, all functions are executed one after another until one function returns non-zero or until all functions have been called. Context-sensitive hook functions are executed before statically registered ones (the ones added by `vcs_info_hookadd`).

You may pass data between functions via an associative array, `user_data`. For example:

```
+vi-git-myfirsthook(){
    user_data[myval]=$myval
}
+vi-git-mysecondhook(){
    # do something with ${user_data[myval]}
}
```

There are a number of variables that are special in hook contexts:

`ret`

The return value that the hooks system will return to the caller. The default is an integer ``zero'`. If and how a changed `ret` value changes the execution of the caller depends on the specific hook. See the hook documentation below for details.

`hook_com`

An associated array which is used for bidirectional communication from the caller to hook functions. The used keys depend on the specific hook.

#### context

The active context of the hook. Functions that wish to change this variable should make it local scope first.

#### vcs

The current VCS after it was detected. The same values as in the enable/disable style are used. Available in all hooks except start-up.

Finally, the full list of currently available hooks:

#### start-up

Called after starting vcs\_info but before the VCS in this directory is determined. It can be used to deactivate vcs\_info temporarily if necessary. When ret is set to 1, vcs\_info aborts and does nothing; when set to 2, vcs\_info sets up everything as if no version control were active and exits.

#### pre-get-data

Same as start-up but after the VCS was detected.

#### gen-hg-bookmark-string

Called in the Mercurial backend when a bookmark string is generated; the get-revision and get-bookmarks styles must be true.

This hook gets the names of the Mercurial bookmarks that vcs\_info collected from 'hg'.

If a bookmark is active, the key `${hook_com[hg-active-bookmark]}` is set to its name. The key is otherwise unset.

When setting ret to non-zero, the string in `${hook_com[hg-bookmark-string]}` will be used in the %m escape in formats and actionformats and will be available in the global backend\_misc array as `${backend_misc[bookmarks]}`.

#### gen-applied-string

Called in the git (with stgit or during rebase or merge), and hg (with mq) backends and in quilt support when the applied-string is generated; the use-quilt zstyle must be true for quilt (the mq and

stgit backends are active by default).

The arguments to this hook describe applied patches in the opposite order, which means that the first argument is the top-most patch and so forth.

When the patches' log messages can be extracted, those are embedded within each argument after a space, so each argument is of the form `PATCH-NAME FIRST LINE OF THE LOG MESSAGE', where PATCH-NAME contains no whitespace. The mq backend passes arguments of the form `PATCH NAME', with possible embedded spaces, but without extracting the patch's log message.

When setting ret to non-zero, the string in `${hook_com[applied-string]}` will be available as %p in the patch-format and nopatch-format styles. This hook is, in concert with set-patch-format, responsible for %-escaping that value for use in the prompt. (See \*Note vcs\_info Oddities::.)

The quilt backend passes to this hook the inputs `${hook_com[quilt-patches-dir]}` and, if it has been determined, `${hook_com[quilt-pc-dir]}`.

#### gen-unapplied-string

Called in the git (with stgit or during rebase), and hg (with mq) backend and in quilt support when the unapplied-string is generated; the get-unapplied style must be true.

This hook gets the names of all unapplied patches which vcs\_info in order, which means that the first argument is the patch next-in-line to be applied and so forth.

The format of each argument is as for gen-applied-string, above.

When setting ret to non-zero, the string in `${hook_com[unapplied-string]}` will be available as %u in the patch-format and nopatch-format styles. This hook is, in concert with set-patch-format, responsible for %-escaping that value for use in the prompt. (See \*Note vcs\_info Oddities::.)

The quilt backend passes to this hook the inputs `${hook_com[quilt-patches-dir]}` and, if it has been determined, `${hook_com[quilt-pc-dir]}`.

#### gen-mqguards-string

Called in the hg backend when guards-string is generated; the

get-mq style must be true (default).

This hook gets the names of any active mq guards.

When setting ret to non-zero, the string in `${hook_com[guards-string]}` will be used in the %g escape in the patch-format and nopatch-format styles.

#### no-vcs

This hooks is called when no version control system was detected.

The ``hook_com'` parameter is not used.

#### post-backend

Called as soon as the backend has finished collecting information.

The ``hook_com'` keys available are as for the set-message hook.

#### post-quilt

Called after the quilt support is done. The following information is passed as arguments to the hook: 1. the quilt-support mode ('addon' or 'standalone'); 2. the directory that contains the patch series; 3. the directory that holds quilt's status information (the ``.pc'` directory) or the string "-nopc-" if that directory wasn't found.

The ``hook_com'` parameter is not used.

#### set-branch-format

Called before ``branchformat'` is set. The only argument to the hook is the format that is configured at this point.

The ``hook_com'` keys considered are ``branch'` and ``revision'`. They are set to the values figured out so far by `vcs_info` and any change will be used directly when the actual replacement is done.

If ret is set to non-zero, the string in `${hook_com[branch-replace]}` will be used unchanged as the ``%b'` replacement in the variables set by `vcs_info`.

#### set-hgrev-format

Called before a ``hgrevformat'` is set. The only argument to the hook is the format that is configured at this point.

The ``hook_com'` keys considered are ``hash'` and ``localrev'`. They are set to the values figured out so far by `vcs_info` and any



change will be used directly when the actual replacement is done.

If `ret` is set to non-zero, the string in `${hook_com[rev-replace]}` will be used unchanged as the ``%i'` replacement in the variables set by `vcs_info`.

#### pre-addon-quilt

This hook is used when `vcs_info`'s quilt functionality is active in "addon" mode (quilt used on top of a real version control system). It is activated right before any quilt specific action is taken.

Setting the ``ret'` variable in this hook to a non-zero value avoids any quilt specific actions from being run at all.

#### set-patch-format

This hook is used to control some of the possible expansions in `patch-format` and `nopatch-format` styles with patch queue systems such as quilt, mqueue and the like.

This hook is used in the `git`, `hg` and quilt backends.

The hook allows the control of the `%p` (`${hook_com[applied]}`) and `%u` (`${hook_com[unapplied]}`) expansion in all backends that use the hook. With the mercurial backend, the `%g` (`${hook_com[guards]}`) expansion is controllable in addition to that.

If `ret` is set to non-zero, the string in `${hook_com[patch-replace]}` will be used unchanged instead of an expanded format from `patch-format` or `nopatch-format`.

This hook is, in concert with the `gen-applied-string` or `gen-unapplied-string` hooks if they are defined, responsible for %-escaping the final patch-format value for use in the prompt. (See *\*Note vcs\_info Oddities::*.)

The quilt backend passes to this hook the inputs `${hook_com[quilt-patches-dir]}` and, if it has been determined, `${hook_com[quilt-pc-dir]}`.

#### set-message

Called each time before a ``vcs_info_msg_N_'` message is set. It takes two arguments; the first being the ``N'` in the message variable name, the second is the currently configured formats or actionformats.

There are a number of ``hook_com'` keys, that are used here: ``action'`, ``branch'`, ``base'`, ``base-name'`, ``subdir'`, ``staged'`,

`unstaged', `revision', `misc', `vcs' and one `miscN' entry for each backend-specific data field (N starting at zero). They are set to the values figured out so far by vcs\_info and any change will be used directly when the actual replacement is done.

Since this hook is triggered multiple times (once for each configured formats or actionformats), each of the `hook\_com' keys mentioned above (except for the miscN entries) has an `\_orig' counterpart, so even if you changed a value to your liking you can still get the original value in the next run. Changing the `\_orig' values is probably not a good idea.

If ret is set to non-zero, the string in `${hook_com[message]}` will be used unchanged as the message by vcs\_info.

If all of this sounds rather confusing, take a look at \*Note vcs\_info Examples:: and also in the Misc/vcs\_info-examples file in the Zsh source. They contain some explanatory code.

File: zsh.info, Node: vcs\_info Examples, Prev: vcs\_info Hooks, Up: Version Control Information

## 26.5.8 Examples

-----

Don't use vcs\_info at all (even though it's in your prompt):

```
zstyle ':vcs_info:*' enable NONE
```

Disable the backends for bzz and svk:

```
zstyle ':vcs_info:*' disable bzz svk
```

Disable everything \_but\_ bzz and svk:

```
zstyle ':vcs_info:*' enable bzz svk
```

Provide a special formats for git:

```
zstyle ':vcs_info:git:*' formats      ' GIT, BABY! [%b]'\nzstyle ':vcs_info:git:*' actionformats ' GIT ACTION! [%b|%a]'
```

All %x expansion in all sorts of formats (formats, actionformats, branchformat, you name it) are done using the `zformat' builtin from the `zsh/zutil' module. That means you can do everything with these %x items what zformat supports. In particular, if you want something that is really long to have a fixed width, like a hash in a mercurial

branchformat, you can do this: %12.12i. That'll shrink the 40 character hash to its 12 leading characters. The form is actually '%MIN.MAXx'. More is possible. See \*Note The zsh/zutil Module:: for details.

Use the quicker bzd backend

```
zstyle ':vcs_info:bzd:*' use-simple true
```

If you do use use-simple, please report if it does  
'the-right-thing[tm]'.

Display the revision number in yellow for bzd and svn:

```
zstyle ':vcs_info:(svn|bzd):*' \  
  branchformat '%b%%F{yellow}:%r'
```

The doubled percent sign is explained in \*Note vcs\_info Oddities::.

Alternatively, one can use the raw colour codes directly:

```
zstyle ':vcs_info:(svn|bzd):*' \  
  branchformat '%b%{'${fg[yellow]}'}%':%r'
```

Normally when a variable

is interpolated into a format string, the variable needs to be %-escaped. In this example we skipped that because we assume the value of \${fg[yellow]} doesn't contain any % signs.

Make sure you enclose the color codes in %{...%} if you want to use the string provided by vcs\_info in prompts.

Here is how to print the VCS information as a command (not in a prompt):

```
vcsi() { vcs_info interactive; vcs_info_lastmsg }
```

This way, you can even define different formats for output via vcs\_info\_lastmsg in the ':vcs\_info:\*:interactive:\*' namespace.

Now as promised, some code that uses hooks: say, you'd like to replace the string 'svn' by 'subversion' in vcs\_info's %s formats replacement.

First, we will tell vcs\_info to call a function when populating the message variables with the gathered information:

```
zstyle ':vcs_info:*+set-message:*' hooks svn2subversion
```

Nothing happens. Which is reasonable, since we didn't define the actual function yet. To see what the hooks subsystem is trying to do, enable

the 'debug' style:

```
zstyle ':vcs_info:*+*:*' debug true
```

That should give you an idea what is going on. Specifically, the function that we are looking for is ``+vi-svn2subversion'`. Note, the ``+vi-'` prefix. So, everything is in order, just as documented. When you are done checking out the debugging output, disable it again:

```
zstyle ':vcs_info:*+*:*' debug false
```

Now, let's define the function:

```
function +vi-svn2subversion() {  
    [[ ${hook_com[vcs_orig]} == svn ]] && hook_com[vcs]=subversion  
}
```

Simple enough. And it could have even been simpler, if only we had registered our function in a less generic context. If we do it only in the ``svn'` backend's context, we don't need to test which the active backend is:

```
zstyle ':vcs_info:svn+set-message:*' hooks svn2subversion
```

```
function +vi-svn2subversion() {  
    hook_com[vcs]=subversion  
}
```

And finally a little more elaborate example, that uses a hook to create a customised bookmark string for the hg backend.

Again, we start off by registering a function:

```
zstyle ':vcs_info:hg+gen-hg-bookmark-string:*' hooks hgbookmarks
```

And then we define the ``+vi-hgbookmarks'` function:

```
function +vi-hgbookmarks() {  
    # The default is to connect all bookmark names by  
    # commas. This mixes things up a little.  
    # Imagine, there's one type of bookmarks that is  
    # special to you. Say, because it's *your* work.  
    # Those bookmarks look always like this: "sh/*"  
    # (because your initials are sh, for example).  
    # This makes the bookmarks string use only those  
    # bookmarks. If there's more than one, it  
    # concatenates them using commas.  
    # The bookmarks returned by `hg' are available in  
    # the function's positional parameters.  
    local s="${(Mj;,:)@:#sh/*}"  
    # Now, the communication with the code that calls  
    # the hook functions is done via the hook_com[]
```

```

# hash. The key
at which the `gen-hg-bookmark-string'
# hook looks is `hg-bookmark-string'. So:
hook_com[hg-bookmark-string]=$s
# And to signal that we want to use the string we
# just generated, set the special variable `ret' to
# something other than the default zero:
ret=1
return 0
}

```

Some longer examples and code snippets which might be useful are available in the examples file located at Misc/vcs\_info-examples in the Zsh source directory.

This concludes our guided tour through zsh's vcs\_info.

File: zsh.info, Node: Prompt Themes, Next: ZLE Functions, Prev: Version Control Information, Up: User Contributions

## 26.6 Prompt Themes

=====

### 26.6.1 Installation

-----

You should make sure all the functions from the Functions/Prompts directory of the source distribution are available; they all begin with the string `prompt\_' except for the special function `promptinit'. You also need the `colors' and

`add-zsh-hook' functions from Functions/Misc.

All these functions may already be installed on your system; if not, you will need to find them and copy them. The directory should appear as one of the elements of the fpath array (this should already be the case if they were installed), and at least the function promptinit should be autoloaded; it will autoload the rest. Finally, to initialize the use of the system you need to call the promptinit function. The following code in your .zshrc will arrange for this; assume the functions are stored in the directory ~/myfns:

```

fpath=(~/myfns $fpath)
autoload -U promptinit

```

promptinit

## 26.6.2 Theme Selection

-----

Use the prompt command to select your preferred theme. This command may be added to your .zshrc following the call to promptinit in order to start zsh with a theme already selected.

```
prompt [ -c | -l ]
prompt [ -p | -h ] [ THEME ... ]
prompt [ -s ] THEME [ ARG ... ]
```

Set or examine the prompt theme. With no options and a THEME argument, the theme with that name is set as the current theme. The available themes are determined at run time; use the -l option to see a list. The special THEME `random' selects at random one of the available themes and sets your prompt to that.

In some cases the THEME may be modified by one or more arguments, which should be given after the theme name. See the help for each theme for descriptions of these arguments.

Options are:

- c  
Show the currently selected theme and its parameters, if any.
- l  
List all available prompt themes.
- p  
Preview the theme named by THEME, or all themes if no THEME is given.
- h  
Show help for the theme named by THEME, or for the prompt function if no THEME is given.
- s  
Set THEME as the current theme and save state.

prompt\_THEME\_setup

Each available THEME has a setup function which

is called by the

prompt function to install that theme. This function may define other functions as necessary to maintain the prompt, including functions used to preview the prompt or provide help for its use. You should not normally call a theme's setup function directly.

### 26.6.3 Utility Themes

-----

#### prompt off

The theme ``off'` sets all the prompt variables to minimal values with no special effects.

#### prompt default

The theme ``default'` sets all prompt variables to the same state as if an interactive zsh was started with no initialization files.

#### prompt restore

The special theme ``restore'` erases all theme settings and sets prompt variables to their state before the first time the ``prompt'` function was run, provided each theme has properly defined its cleanup (see below).

Note that you can undo ``prompt off'` and ``prompt default'` with ``prompt restore'`, but a second restore does not undo the first.

### 26.6.4

#### Writing Themes

-----

The first step for adding your own theme is to choose a name for it, and create a file ``prompt_NAME_setup'` in a directory in your `fpath`, such as `~/myfns` in the example above. The file should at minimum contain assignments for the prompt variables that your theme wishes to modify. By convention, themes use `PS1`, `PS2`, `RPS1`, etc., rather than the longer `PROMPT` and `RPROMPT`.

The file is autoloaded as a function in the current shell context, so it may contain any necessary commands to customize your theme, including defining additional functions. To make some complex tasks easier, your setup function may also do any of the following:

### Assign prompt\_opts

The array `prompt_opts` may be assigned any of "bang", "cr", "percent", "sp", and/or "subst" as values. The corresponding setopts (`promptbang`, etc.) are turned on, all other prompt-related options are turned off. The `prompt_opts` array preserves setopts even beyond

the scope of `localoptions`, should your function need that.

### Modify hooks

Use of `add-zsh-hook` and `add-zle-hook-widget` is recommended (see the 'Manipulating Hook Functions' section above). All hooks that follow the naming pattern `prompt_THEME_HOOK` are automatically removed when the prompt theme changes or is disabled.

### Declare cleanup

If your function makes any other changes that should be undone when the theme is disabled, your setup function may call

```
prompt_cleanup COMMAND
```

where `COMMAND` should be suitably quoted. If your theme is ever disabled or replaced by another, `COMMAND` is executed with `eval`. You may declare more than one such cleanup hook.

### Define preview

Define or autoload a function `prompt_NAME_preview` to display a simulated version of your prompt. A simple default previewer is defined by `promptinit` for themes that do not define their own. This preview function is called by ``prompt -p'`.

### Provide

#### help

Define or autoload a function `prompt_NAME_help` to display documentation or help text for your theme. This help function is called by ``prompt -h'`.

File: [zsh.info](#), Node: ZLE Functions, Next: [Exception Handling](#), Prev: [Prompt Themes](#), Up: [User Contributions](#)

## 26.7 ZLE Functions

=====



## 26.7.1 Widgets

-----

These functions all implement user-defined ZLE widgets (see \*Note Zsh Line Editor::) which can be bound to keystrokes in interactive shells. To use them, your .zshrc should contain lines of the form

```
autoload FUNCTION
zle -N FUNCTION
```

followed by an appropriate bindkey command to associate the function with a key sequence. Suggested bindings are described below.

### bash-style word functions

If you are looking for functions to implement moving over and editing words in the manner of bash, where only alphanumeric characters are considered word characters, you can use the functions described in the next section.

The following is sufficient:

```
autoload -U select-word-style
select-word-style bash
```

forward-word-match, backward-word-match  
kill-word-match, backward-kill-word-match  
transpose-words-match, capitalize-word-match  
up-case-word-match, down-case-word-match  
delete-whole-word-match, select-word-match  
select-word-style, match-word-context, match-words-by-style

The first eight `-match` functions are drop-in replacements for the builtin widgets without the suffix. By default they behave in a similar way. However, by the use of styles and the function `select-word-style`, the way words are matched can be altered. `select-word-match` is intended to be used as a text object in vi mode but with custom word styles. For comparison, the widgets described in \*Note Text Objects:: use fixed definitions of words, compatible with the vim editor.

The simplest way of configuring the functions is to use `select-word-style`, which can either be called as a normal function with the appropriate argument, or invoked as a user-defined widget that will prompt for the first character of the word style to be

used. The first time it is invoked, the first eight -match functions will automatically replace the builtin versions, so they do not need to be loaded explicitly.

The word styles available are as follows. Only the first character is examined.

#### bash

Word characters are alphanumeric characters only.

#### normal

As in normal shell operation: word characters are alphanumeric characters plus any characters present in the string given by the parameter \$WORDCHARS.

#### shell

Words are complete shell command arguments, possibly including complete quoted strings, or any tokens special to the shell.

#### whitespace

Words are any set of characters delimited by whitespace.

#### default

Restore

the default settings; this is usually the same as  
`normal'.

All but `default' can be input as an upper case character, which has the same effect but with subword matching turned on. In this case, words with upper case characters are treated specially: each separate run of upper case characters, or an upper case character followed by any number of other characters, is considered a word. The style subword-range can supply an alternative character range to the default `[:upper:]'; the value of the style is treated as the contents of a `[...]' pattern (note that the outer brackets should not be supplied, only those surrounding named ranges).

More control can be obtained using the `zstyle` command, as described in \*Note The zsh/zutil Module::. Each style is looked up in the context `:zle:WIDGET` where WIDGET is the name of the user-defined widget, not the name of the function implementing it, so in the case

of the definitions supplied by `select-word-style` the appropriate contexts are `:zle:forward-word`, and so on. The function `select-word-style` itself always defines styles for the

context ``:zle:*'` which can be overridden by more specific (longer) patterns as well as explicit contexts.

The style word-style specifies the rules to use. This may have the following values.

#### normal

Use the standard shell rules, i.e. alphanumerics and `$WORDCHARS`, unless overridden by the styles word-chars or word-class.

#### specified

Similar to normal, but `_only_` the specified characters, and not also alphanumerics, are considered word characters.

#### unspecified

The negation of specified. The given characters are those which will `_not_` be considered part of a word.

#### shell

Words are obtained by using the syntactic rules for generating shell command arguments. In addition, special tokens which are never command arguments such as ``()` are also treated as words.

#### whitespace

Words are whitespace-delimited strings of characters.

The first three of those rules usually use `$WORDCHARS`, but the value in the parameter can be overridden by the style word-chars, which works in exactly the same way as `$WORDCHARS`. In addition, the style word-class uses character class syntax to group characters and takes precedence over word-chars if both are set. The word-class style does not include the surrounding brackets of the character class; for example, ``-[:alnum:]'` is a valid word-class to include all alphanumerics plus the characters ``-'` and ``.'` . Be careful including `]', `^' and `-' as these are special inside character classes.`

word-style may also have ``-subword'` appended to its value to turn on subword matching, as described above.

The style skip-chars is mostly useful for transpose-words and similar functions. If set, it gives a count of characters starting at the cursor position which will not be considered part

of the word and are treated as space, regardless of what they actually are. For example, if

```
zstyle ':zle:transpose-words' skip-chars 1
```

has been set, and transpose-words-match is called with the cursor on the X of fooXbar, where X can be any character, then the resulting expression is barXfoo.

Finer grained control can be obtained by setting the style word-context to an array of pairs of entries. Each pair of entries consists of a PATTERN and a SUBCONTEXT. The shell argument the cursor is on is matched against each PATTERN in turn until one matches; if it does, the context is extended by a colon and the corresponding SUBCONTEXT. Note that the test is made against the original word on the line, with no stripping of quotes. Special handling is done between words: the current context is examined and if it contains the string between the word is set to a single space; else if it contains the string back, the word before the cursor is considered, else the word after cursor is considered. Some examples are given below.

The style skip-whitespace-first is only used with the forward-word widget. If it is set to true, then forward-word skips any non-word-characters, followed by any non-word-characters: this is similar to the behaviour of other word-orientated widgets, and also that used by other editors, however it differs from the standard zsh behaviour. When using select-word-style the widget is set in the context :zle:\* to true if the word style is bash and false otherwise. It may be overridden by setting it in the more specific context :zle:forward-word\*.

It is possible to create widgets with specific behaviour by defining a new widget implemented by the appropriate generic function, then setting a style for the context of the specific widget. For example, the following defines a widget backward-kill-space-word using backward-kill-word-match, the generic widget implementing backward-kill-word behaviour, and ensures that the new widget always implements space-delimited behaviour.

```
zle -N backward-kill-space-word backward-kill-word-match
zstyle :zle:backward-kill-space-word word-style space
```

The widget backward-kill-space-word can now be bound to a key.

Here are some further examples of use of the styles, actually taken from the simplified interface in select-word-style:

```
zstyle ':zle:*' word-style standard
zstyle ':zle:*' word-chars "
```

Implements bash-style word handling for all widgets, i.e. only alphanumerics are word characters; equivalent to setting the parameter WORDCHARS empty for the given context.

```
style ':zle:*kill*'
word-style space
```

Uses space-delimited words for widgets with the word `kill' in the name. Neither of the styles word-chars nor word-class is used in this case.

Here are some examples of use of the word-context style to extend the context.

```
zstyle ':zle:*' word-context \
    "**/*" filename "[[:space:]]" whitespace
zstyle ':zle:transpose-words:whitespace' word-style shell
zstyle ':zle:transpose-words:filename' word-style normal
zstyle ':zle:transpose-words:filename' word-chars "
```

This provides two different ways of using transpose-words depending on whether the cursor is on whitespace between words or on a filename, here any word containing a /. On whitespace, complete arguments as defined by standard shell rules will be transposed. In a filename, only alphanumerics will be transposed. Elsewhere, words will be transposed using the default style for :zle:transpose-words.

The word matching and all the handling of zstyle settings is actually implemented by the function match-words-by-style. This can be used to create new user-defined widgets. The calling function should set the local parameter curcontext to :zle:WIDGET, create the local parameter matched\_words and call match-words-by-style with no arguments. On return, matched\_words will be set to an array with the elements: (1) the start of the line (2) the word before the cursor (3) any non-word characters between that word and the cursor (4) any non-word character at the

cursor position plus any remaining non-word characters before the next word, including all characters specified by the skip-chars style, (5) the word at or following the cursor (6) any non-word characters following that word (7) the remainder of the line. Any of the elements may be an empty string; the calling function should test for this to decide whether it can perform its function.

If the variable `matched_words` is defined by the caller to `match-words-by-style` as an associative array (local `-A matched_words`), then the seven values given above should be retrieved from it as elements named `start`, `word-before-cursor`, `ws-before-cursor`, `ws-after-cursor`, `word-after-cursor`, `ws-after-word`, and `end`. In addition the element `is-word-start` is 1 if the cursor is on the start of a word or subword, or on white space before it (the cases can be distinguished by testing the `ws-after-cursor` element) and 0 otherwise. This form is recommended for future compatibility.

It is possible to pass options with arguments to `match-words-by-style` to override the use of styles. The options are:

```
-w
  WORD-STYLE

-s
  SKIP-CHARS

-c
  WORD-CLASS

-C
  WORD-CHARS

-r
  SUBWORD-RANGE
```

For example, `match-words-by-style -w shell -c 0` may be used to extract the command argument around the cursor.

The word-context style is implemented by the function `match-word-context`. This should not usually need to be called directly.

bracketed-paste-magic

The bracketed-paste widget (see `*Note Miscellaneous::` in `*Note Standard Widgets::`) inserts pasted text literally into the editor

buffer rather than interpret it as keystrokes. This disables some common usages where the self-insert widget is replaced in order to accomplish some extra processing. An example is the contributed url-quote-magic widget described below.

The bracketed-paste-magic widget is meant to replace bracketed-paste with a wrapper that re-enables these self-insert actions, and other actions as selected by zstyles. Therefore this widget is installed with

```
autoload -Uz bracketed-paste-magic
zle -N bracketed-paste bracketed-paste-magic
```

Other than enabling some widget processing, bracketed-paste-magic attempts to replicate bracketed-paste as faithfully as possible.

The following zstyles may be set to control processing of pasted text. All are looked up in the context `:bracketed-paste-magic'.

#### active-widgets

A list of patterns matching widget names that should be activated during the paste. All other key sequences are processed as self-insert-unmeta. The default is `self-\*' so any user-defined widgets named with that prefix are active along with the builtin self-insert.

If this style is not set (explicitly deleted) or set to an empty value, no widgets are active and the pasted text is inserted literally. If the value includes `undefined-key', any unknown sequences are discarded from the pasted text.

#### inactive-keys

The inverse of active-widgets, a list of key sequences that always use self-insert-unmeta even when bound to an active widget. Note that this is a list of literal key sequences, not patterns.

#### paste-init

A list of function names, called in widget context (but not as widgets). The functions are called in order until one of them returns a non-zero status. The parameter `PASTED' contains the initial state of the pasted text. All other ZLE parameters such as `BUFFER' have their normal values and side-effects, and full history is available, so for example paste-init functions may move words from BUFFER into PASTED

to make those words visible to the active-widgets.

A non-zero return from a paste-init function does `_not_` prevent the paste itself from proceeding.

Loading bracketed-paste-magic defines backward-extend-paste, a helper function for use in paste-init.

```
zstyle :bracketed-paste-magic paste-init \
```

backward-extend-paste

When a paste would insert into the middle of a word or append text to a word already on the line, backward-extend-paste moves the prefix from LBUFFER into PASTED so that the active-widgets see the full word so far. This may be useful with url-quote-magic.

paste-finish

Another list of function names called in order until one returns non-zero. These functions are called `_after_` the pasted text has been processed by the active-widgets, but `_before_` it is inserted into ``BUFFER'`. ZLE parameters have their normal values and side-effects.

A non-zero return from a paste-finish function does `_not_` prevent the paste itself from proceeding.

Loading bracketed-paste-magic also defines quote-paste, a helper function for use in paste-finish.

```
zstyle :bracketed-paste-magic paste-finish \
```

quote-paste

```
zstyle :bracketed-paste-magic:finish quote-style \
qqq
```

When the pasted text is inserted into BUFFER, it is quoted per the quote-style value. To forcibly turn off the built-in numeric prefix quoting of bracketed-paste, use:

```
zstyle :bracketed-paste-magic:finish quote-style \
none
```



`_Important:` During active-widgets processing of the paste (after paste-init and before paste-finish), BUFFER starts empty and history is restricted, so cursor motions, etc., may not pass outside of the pasted content. Text assigned to BUFFER by the active widgets is copied back into PASTED before paste-finish.

#### copy-earlier-word

This widget works like a combination of insert-last-word and copy-prev-shell-word. Repeated invocations of the widget retrieve earlier words on the relevant history line. With a numeric argument N, insert the Nth word from the history line; N may be negative to count from the end of the line.

If insert-last-word has been used to retrieve the last word on a previous history line, repeated invocations will replace that word with earlier words from the same line.

Otherwise, the widget applies to words on the line currently being edited. The widget style can be set to the name of another widget that should be called to retrieve words. This widget must accept the same three arguments as insert-last-word.

#### cycle-completion-positions

After inserting an unambiguous string into the command line, the new function based completion system may know about multiple places in this string where characters are missing or differ from at least one of the possible matches. It will then place the cursor on the position it considers to be the most interesting one, i.e. the one where one can disambiguate between as many matches as possible with as little typing as possible.

This widget allows the cursor to be easily moved to the other interesting spots. It can be invoked repeatedly to cycle between all positions reported by the completion system.

#### delete-whole-word-match

This is another function which works like the -match functions described immediately above, i.e. using styles to decide the word boundaries. However, it is not a replacement for any existing function.

The basic behaviour is to delete the word around the cursor. There is no numeric argument handling; only the single word around the cursor is considered. If the widget contains the string kill, the removed text will be placed in the cutbuffer for future yanking. This can be obtained by defining kill-whole-word-match

as follows:

```
zle -N kill-whole-word-match delete-whole-word-match
```

and then binding the widget kill-whole-word-match.

up-line-or-beginning-search, down-line-or-beginning-search

These widgets are similar to the builtin functions up-line-or-search and down-line-or-search: if in a multiline buffer they move up or down within the buffer, otherwise they search for a history line matching the start of the current line. In this case, however, they search for a line which matches the current line up to the current cursor position, in the manner of history-beginning-search-backward and -forward, rather than the first word on the line.

edit-command-line

Edit the command line using your visual editor, as in ksh.

```
bindkey -M vicmd v edit-command-line
```

The editor to be used can also be specified using the editor style in the context of the widget. It is specified as an array of command and arguments:

```
zstyle :zle:edit-command-line editor gvim -f
```

expand-absolute-path

Expand the file name under the cursor to an absolute path, resolving symbolic links. Where possible, the initial path segment is turned into a named directory or reference to a user's home directory.

history-search-end

This function implements the widgets history-beginning-search-backward-end and history-beginning-search-forward-end. These commands work by first calling the corresponding builtin widget (see \*Note History Control:.) and then moving the cursor to the end of the line. The original cursor position is remembered and restored before calling the builtin widget a second time, so that the same search is repeated to look farther through the history.

Although you autoload only one function, the commands to use it are

slightly different because it implements two widgets.

```
zle -N history-beginning-search-backward-end \  
    history-search-end  
zle -N history-beginning-search-forward-end \  
    history-search-end  
bindkey '^P' history-beginning-search-backward-end  
bindkey '^N' history-beginning-search-forward-end
```

#### history-beginning-search-menu

This function implements yet another form of history searching. The text before the cursor is used to select lines from the history, as for history-beginning-search-backward except that all matches are shown in a numbered menu. Typing the appropriate digits inserts the full history line. Note that leading zeroes must be typed (they are only shown when necessary for removing ambiguity). The entire history is searched; there is no distinction between forwards and backwards.

With a numeric argument, the search is not anchored to the start of the line; the string typed by the user may appear anywhere in the line in the history.

If the widget name contains ``-end'` the cursor is moved to the end of the line inserted. If the widget name contains ``-space'` any space in the text typed is treated as a wildcard and can match

anything (hence a leading space is equivalent to giving a numeric argument). Both forms can be combined, for example:

```
zle -N history-beginning-search-menu-space-end \  
    history-beginning-search-menu
```

#### history-pattern-search

The function history-pattern-search implements widgets which prompt for a pattern with which to search the history backwards or forwards. The pattern is in the usual zsh format, however the first character may be `^` to anchor the search to the start of the line, and the last character may be `$` to anchor the search to the end of the line. If the search was not anchored to the end of the line the cursor is positioned just after the pattern found.

The commands to create bindable widgets are similar to those in the example immediately above:

```
autoload -U history-pattern-search
zle -N history-pattern-search-backward history-pattern-search
zle -N history-pattern-search-forward
history-pattern-search
```

#### incarg

Typing the keystrokes for this widget with the cursor placed on or to the left of an integer causes that integer to be incremented by one. With a numeric argument, the number is incremented by the amount of the argument (decremented if the numeric argument is negative). The shell parameter `incarg` may be set to change the default increment to something other than one.

```
bindkey '^X+' incurg
```

#### incremental-complete-word

This allows incremental completion of a word. After starting this command, a list of completion choices can be shown after every character you type, which you can delete with `^H` or `DEL`. Pressing return accepts the completion so far and returns you to normal editing (that is, the command line is *not* immediately executed). You can hit `TAB` to do normal completion, `^G` to abort back to the state when you started, and `^D` to list the matches.

This works  
only with the new function based completion system.

```
bindkey '^Xi' incremental-complete-word
```

#### insert-composed-char

This function allows you to compose characters that don't appear on the keyboard to be inserted into the command line. The command is followed by two keys corresponding to ASCII characters (there is no prompt). For accented characters, the two keys are a base character followed by a code for the accent, while for other special characters the two characters together form a mnemonic for the character to be inserted. The two-character codes are a subset of those given by RFC 1345 (see for example ``http://www.faqs.org/rfcs/rfc1345.html'`).

The function may optionally be followed by up to two characters which replace one or both of the characters read from the keyboard; if both characters are supplied, no input is read. For example, `insert-composed-char a:` can be used within a widget to insert

an a with umlaut into the command line. This has the advantages over use of a literal character that it is more portable.

For best results zsh should have been built with support for multibyte characters (configured with `-enable-multibyte`); however, the function works for the limited range of characters available in single-byte character sets such as ISO-8859-1.

The character is converted into the local representation and inserted into the command line at the cursor position. (The conversion is done within the shell, using whatever facilities the C library provides.) With a numeric argument, the character and its code are previewed in the status line

The function may be run outside zle in which case it prints the character (together with a newline) to standard output. Input is still read from keystrokes.

See `insert-unicode-char` for an alternative way of inserting Unicode characters using their hexadecimal character number.

The set of accented characters is reasonably complete up to Unicode character U+0180, the set of special characters less so. However, it is very sporadic from that point. Adding new characters is easy, however; see the function `define-composed-chars`. Please send any additions to [zsh-workers@zsh.org](mailto:zsh-workers@zsh.org).

The codes for the second character when used to accent the first are as follows. Note that not every character can take every accent.

!

Grave.

,

Acute.

>

Circumflex.

?

Tilde. (This is not ~ as RFC 1345 does not assume that character is present on the keyboard.)

-

Macron. (A horizontal bar over the base character.)

- ( Breve. (A shallow dish shape over the base character.)
- . Dot above the base character, or in the case of i no dot, or in the case of L and l a centered dot.
- : Diaeresis (Umlaut).
- c Cedilla.
- Underline, however there are currently no underlined characters.
- / Stroke through the base character.
- " Double acute (only supported on a few letters).
- ; Ogonek. (A little forward facing hook at the bottom right of the character.)
- < Caron. (A little v over the letter.)
- 0 Circle over the base character.
- 2 Hook over the base character.
- 9 Horn over the base character.

The most common characters from the Arabic, Cyrillic, Greek and Hebrew alphabets are available; consult RFC 1345 for the appropriate sequences. In addition, a set of two letter codes not in RFC 1345 are available for the double-width characters corresponding to ASCII characters from ! to ~ (0x21 to 0x7e) by preceding the character with ^, for example ^A for a double-width A.

The following other two-character sequences are understood.

#### ASCII characters

These are already present on most keyboards:

<{

Left square bracket

//

Backslash (solidus)

>}

Right square bracket

(!

Left brace (curly bracket)

!!

Vertical bar (pipe symbol)

!)

Right brace (curly bracket)

'?

Tilde

#### Special letters

Characters found in various variants of the Latin alphabet:

ss

Eszett (scharfes S)

D-, d-

Eth

TH, th

Thorn

kk

Kra

'n

'n

NG, ng

Ng

OI, oi

Oi

yr

yr

ED

ezh

#### Currency symbols

Ct

Cent

Pd

Pound sterling (also lira and others)

Cu

Currency

Ye

Yen

Eu

Euro (N.B. not in RFC 1345)

#### Punctuation characters

References to "right" quotes indicate the shape (like a 9 rather than 6) rather than their grammatical use. (For example, a "right" low double quote is used to open quotations in German.)

!I

Inverted exclamation mark

BB

Broken vertical bar

SE

Section

Co

Copyright

-a

Spanish feminine ordinal indicator

<<

Left guillemet



--  
Soft hyphen

Rg  
Registered trade mark

PI  
Pilcrow (paragraph)

-o  
Spanish masculine ordinal indicator

>>  
Right guillemet

?I  
Inverted question mark

-1  
Hyphen

-N  
En dash

-M  
Em dash

-3  
Horizontal bar

:3  
Vertical ellipsis

.3  
Horizontal midline ellipsis

!2  
Double vertical line

=2  
Double low line

'6  
Left single quote

'9  
Right single quote

.9  
"Right" low quote

9'  
Reversed "right" quote

"6  
Left double quote

"9  
Right double quote

:9  
"Right" low double quote

9"  
Reversed "right" double quote

/-  
Dagger

/=  
Double dagger

#### Mathematical symbols

DG  
Degree

-2, +-, -+  
- sign, +/- sign, -/+ sign

2S  
Superscript 2

3S  
Superscript 3

1S  
Superscript

1

My  
Micro

.M  
Middle dot

14

Quarter

12

Half

34

Three quarters

\*X

Multiplication

-:

Division

%0

Per mille

FA, TE, /0

For all, there exists, empty set

dP, DE, NB

Partial derivative, delta (increment), del (nabla)

(-, -)

Element of, contains

\*P, +Z

Product, sum

\*-, Ob, Sb

Asterisk, ring, bullet

RT, 0(, 00

Root sign, proportional to, infinity

Other symbols

cS, cH, cD, cC

Card suits: spades, hearts, diamonds, clubs

Md, M8, M2, Mb, Mx, MX

Musical notation: crotchet (quarter note), quaver  
(eighth note), semiquavers (sixteenth notes), flag sign,  
natural sign,

sharp sign

Fm, Ml

Female, male

#### Accents on their own

'>

Circumflex (same as caret, ^)

'!

Grave (same as backtick, `)

',

Cedilla

':

Diaeresis (Umlaut)

'm

Macron

"

Acute

#### insert-files

This function allows you type a file pattern, and see the results of the expansion at each step. When you hit return, all expansions are inserted into the command line.

bindkey '^Xf' insert-files

#### insert-unicode-char

When first executed, the user inputs a set of hexadecimal digits. This is terminated with another call to insert-unicode-char. The digits are then turned into the corresponding Unicode character. For example, if the widget is bound to ^XU, the character sequence ^XU 4 c ^XU inserts L (Unicode U+004c).

See insert-composed-char for a way of inserting characters using a two-character mnemonic.

narrow-to-region [ -p PRE ] [ -P POST ]

[ -S STATEPM | -R STATEPM | [ -l LBUFVAR ] [ -r RBUFVAR ] ]

[ -n ] [ START END ]

#### narrow-to-region-invisible

Narrow the editable portion of the buffer to the region between

the cursor and the mark, which may be in either order. The region may not be empty.

narrow-to-region may be used as a widget or called as a function from a user-defined widget; by default, the text outside the editable area remains visible. A recursive-edit is performed and the original widening status is then restored. Various options and arguments are available when it is called as a function.

The options -p PRETEXT and -P POSTTEXT may be used to replace the text before and after the display for the duration of the function; either or both may be an empty string.

If the option -n is also given, PRETEXT or POSTTEXT will only be inserted if there is text before or after the region respectively which will be made invisible.

Two numeric arguments may be given which will be used instead of the cursor and mark positions.

The option -S STATEPM is used to narrow according to the other options while saving the original state in the parameter with name STATEPM, while the option -R STATEPM is used to restore the state from the parameter; note in both cases the `_name_` of the parameter is required. In the second case, other options and arguments are irrelevant. When this method is used, no recursive-edit is performed; the calling widget should call this function with the option -S, perform its own editing on the command line or pass control to the user via ``zle recursive-edit'`, then call this function with the option -R. The argument STATEPM must be a suitable name for an ordinary parameter, except that parameters beginning with the prefix `_ntr_` are reserved for use within narrow-to-region. Typically the parameter will be local to the calling function.

The options -l LBUFVAR and -r RBUFVAR may be used to specify parameters where the widget will store the resulting text from the operation. The parameter LBUFVAR will contain LBUFFER and RBUFVAR will contain RBUFFER. Neither of these two options may be used with -S or -R.

narrow-to-region-invisible is a simple widget which calls narrow-to-region with arguments which replace any text outside the region with ``...'`. It does not take any arguments.

The display is restored (and the widget returns) upon any `zle`

command which would usually cause the line to be accepted or aborted. Hence an additional such command is required to accept or abort the current line.

The return status of both widgets is zero if the line was accepted, else non-zero.

Here is a trivial example of a widget using this feature.

```
local state
narrow-to-region -p '$Editing restricted region\n' \
  -P " -S state
zle recursive-edit
narrow-to-region -R state
```

predict-on

This set of functions implements predictive typing using history search. After predict-on, typing characters causes the editor to look backward in the history for the first line beginning with what you have typed so far. After predict-off, editing returns to normal for the line found. In fact, you often don't even need to use predict-off, because if the line doesn't match something in the history, adding a key performs standard completion, and then inserts itself if no completions were found. However, editing in the middle of a line is liable to confuse prediction; see the toggle style below.

With the function based completion system (which is needed for this), you should be able to type TAB at almost any point to advance

the cursor to the next ``interesting" character position (usually the end of the current word, but sometimes somewhere in the middle of the word). And of course as soon as the entire line is what you want, you can accept with return, without needing to move the cursor to the end first.

The first time predict-on is used, it creates several additional widget functions:

delete-backward-and-predict

Replaces the backward-delete-char widget. You do not need to bind this yourself.

insert-and-predict

Implements predictive typing by replacing the self-insert widget. You do not need to bind this yourself.

## predict-off

Turns off predictive typing.

Although you autoload only the predict-on function, it is necessary to create a keybinding for predict-off as well.

```
zle -N predict-on
```

```
zle -N predict-off
```

```
bindkey '^X^Z' predict-on
```

```
bindkey '^Z' predict-off
```

## read-from-minibuffer

This is most useful when called as a function from inside a widget, but will work correctly as a widget in its own right. It prompts for a value below the current command line; a value may be input using all of the standard zle operations (and not merely the restricted set available when executing, for example, execute-named-cmd). The value is then returned to the calling function in the parameter \$REPLY and the editing buffer restored to its previous state. If the read was aborted by a keyboard break (typically ^G), the function returns status 1 and \$REPLY is not set.

If one argument is supplied to the function it is taken as a prompt, otherwise `?' is used. If two arguments are supplied, they are the prompt and the initial value of \$LBUFFER, and if a third argument is given it is the initial value of \$RBUFFER. This provides a default value and starting cursor placement. Upon

return the entire buffer is the value of \$REPLY.

One option is available: `-k NUM' specifies that NUM characters are to be read instead of a whole line. The line editor is not invoked recursively in this case, so depending on the terminal settings the input may not be visible, and only the input keys are placed in \$REPLY, not the entire buffer. Note that unlike the read builtin NUM must be given; there is no default.

The name is a slight misnomer, as in fact the shell's own minibuffer is not used. Hence it is still possible to call executed-named-cmd and similar functions while reading a value.

## replace-argument, replace-argument-edit

The function replace-argument can be used to replace a command line argument in the current command line or, if the current command line is empty, in the last command line executed (the new command line is not executed). Arguments are as delimited by

standard shell syntax,

If a numeric argument is given, that specifies the argument to be replaced. 0 means the command name, as in history expansion. A negative numeric argument counts backward from the last word.

If no numeric argument is given, the current argument is replaced; this is the last argument if the previous history line is being used.

The function prompts for a replacement argument.

If the widget contains the string edit, for example is defined as

```
zle -N replace-argument-edit replace-argument
```

then the function presents the current value of the argument for editing, otherwise the editing buffer for the replacement is initially empty.

replace-string, replace-pattern

replace-string-again, replace-pattern-again

The function replace-string implements three widgets. If defined under the same name as the function, it prompts for two strings; the first (source) string will be replaced by the second everywhere it occurs in the line editing buffer.

If the widget name contains the word 'pattern', for example by defining the widget using the command 'zle -N replace-pattern replace-string', then the matching is performed using zsh patterns. All zsh extended globbing patterns can be used in the source string; note that unlike filename generation the pattern does not need to match an entire word, nor do glob qualifiers have any effect. In addition, the replacement string can contain parameter or command substitutions. Furthermore, a '&' in the replacement string will be replaced with the matched source string, and a backquoted digit 'N' will be replaced by the Nth parenthesised expression matched. The form '{N}' may be used to protect the digit from following digits.

If the widget instead contains the word 'regex' (or 'regexp'), then the matching is performed using regular expressions, respecting the setting of the option

RE\_MATCH\_PCRE (see the description of the function regexp-replace below). The special



replacement facilities described above for pattern matching are available.

By default the previous source or replacement string will not be offered for editing. However, this feature can be activated by setting the style `edit-previous` in the context `:zle:WIDGET` (for example, `:zle:replace-string`) to `true`. In addition, a positive numeric argument forces the previous values to be offered, a negative or zero argument forces them not to be.

The function `replace-string-again` can be used to repeat the previous replacement; no prompting is done. As with `replace-string`, if the name of the widget contains the word ``pattern'` or ``regex'`, pattern or regular expression matching is performed, else a literal string replacement. Note that the previous source and replacement text are the same whether pattern, regular expression or string matching is used.

In addition, `replace-string` shows the previous replacement above the prompt, so long as there was one during the current session; if the source string is empty, that replacement will be repeated without the widget prompting for a replacement string.

For example, starting from the line:

```
print This line contains fan and fond
```

and invoking `replace-pattern` with the source string ``f(?)n'` and the replacement string ``c\1r'` produces the not very useful line:

```
print This line contains car and cord
```

The range of the replacement string can be limited by using the `narrow-to-region-invisible` widget. One limitation of the current version is that undo will cycle through changes to the replacement and source strings before undoing the replacement itself.

`send-invisible`

This is similar to `read-from-minibuffer` in that it may be called as a function from a widget or as a widget of its own, and interactively reads input from the keyboard. However, the input being typed is concealed and a string of asterisks (``*'`) is shown instead. The value is saved in the parameter `$INVISIBLE` to which a reference is inserted into the editing buffer at the restored

cursor position. If the read was aborted by a keyboard break (typically ^G) or another escape from editing such as push-line, \$INVISIBLE is set to empty and the original buffer is restored unchanged.

If one argument is supplied to the function it is taken as a prompt, otherwise `Non-echoed text: ' is used (as in emacs). If a second and third argument are supplied they are used to begin and end the reference to \$INVISIBLE that is inserted into the buffer. The default is to open with \${, then INVISIBLE, and close with }, but many other effects are possible.

#### smart-insert-last-word

This function may replace the insert-last-word widget, like so:

```
zle -N insert-last-word smart-insert-last-word
```

With a numeric argument, or when passed command line arguments in a call from another widget, it behaves like insert-last-word, except that words in comments are ignored when INTERACTIVE\_COMMENTS is set.

Otherwise, the rightmost ``interesting" word from the previous command is found and inserted. The default definition of ``interesting" is that the word contains at least one alphabetic character, slash, or backslash. This definition may be overridden by use of the match style. The context used to look up the style is the widget name, so usually the context is :insert-last-word. However, you can bind this function to different widgets to use different patterns:

```
zle -N insert-last-assignment smart-insert-last-word
zstyle :insert-last-assignment match '[:alpha:][:alnum:]]#=*'
bindkey ^e= insert-last-assignment
```

If no interesting

word is found and the auto-previous style is set

to a true value, the search continues upward through the history.

When auto-previous is unset or false (the default), the widget must be invoked repeatedly in order to search earlier history lines.

#### transpose-lines

Only useful with a multi-line editing buffer; the lines here are lines within the current on-screen buffer, not history lines. The

effect is similar to the function of the same name in Emacs.

Transpose the current line with the previous line and move the cursor to the start of the next line. Repeating this (which can be done by providing a positive numeric argument) has the effect of moving the line above the cursor down by a number of lines.

With a negative numeric argument, requires two lines above the cursor. These two lines are transposed and the cursor moved to the start of the previous line. Using a numeric argument less than -1 has the effect of moving the line above the cursor up by minus that number of lines.

#### url-quote-magic

This widget replaces the built-in self-insert to make it easier to type URLs as command line arguments. As you type, the input character is analyzed and, if it may need quoting, the current word is checked for a URI scheme. If one is found and the current word is not already in quotes, a backslash is inserted before the input character.

Styles to control quoting behavior:

#### url-metas

This style is looked up in the context ``:url-quote-magic:SCHEME'` (where SCHEME is that of the current URL, e.g. "ftp"). The value is a string listing the characters to be treated as globbing metacharacters when appearing in a URL using that scheme. The default is to quote all zsh extended globbing characters, excluding '<' and '>' but including braces (as in brace expansion). See also `url-seps`.

#### url-seps

Like `url-metas`, but lists characters that should be considered command separators, redirections, history references, etc. The default is to quote the standard set of shell separators, excluding those that overlap with the extended globbing characters, but including '<' and '>' and the first character of `$histchars`.

#### url-globbers

This style is looked up in the context ``:url-quote-magic'`. The values form a list of command names that are expected to do their own globbing on the URL string. This implies that they are aliased to use the ``noglob'` modifier. When the

first word on the line matches one of the values `_and_` the URL refers to a local file (see `url-local-schema`), only the `url-seps` characters are quoted; the `url-metas` are left alone, allowing them to affect command-line parsing, completion, etc. The default

values are a literal ``noglob'` plus (when the `zsh/parameter` module is available) any commands aliased to the helper function ``urlglobber'` or its alias ``globurl'`.

#### `url-local-schema`

This style is always looked up in the context ``:urlglobber'`, even though it is used by both `url-quote-magic` and `urlglobber`. The values form a list of URI schema that should be treated as referring to local files by their real local path names, as opposed to files which are specified relative to a web-server-defined document root. The defaults are `"ftp"` and `"file"`.

#### `url-other-schema`

Like `url-local-schema`, but lists all other URI schema upon which `urlglobber` and `url-quote-magic` should act. If the URI on the command line does not have a scheme appearing either in this list or in `url-local-schema`, it is not magically quoted. The default values are `"http"`, `"https"`,

and `"ftp"`.

When a scheme appears both here and in `url-local-schema`, it is quoted differently depending on whether the command name appears in `url-globbers`.

Loading `url-quote-magic` also defines a helper function ``urlglobber'` and aliases ``globurl'` to ``noglob urlglobber'`. This function takes a local URL apart, attempts to pattern-match the local file portion of the URL path, and then puts the results back into URL format again.

#### `vi-pipe`

This function reads a movement command from the keyboard and then prompts for an external command. The part of the buffer covered by the movement is piped to the external command and then replaced by the command's output. If the movement command is bound to `vi-pipe`, the current line is used.

The function serves as an example for reading a vi movement command from within a user-defined widget.

#### `which-command`

This function is a drop-in replacement for the builtin

widget

which-command. It has enhanced behaviour, in that it correctly detects whether or not the command word needs to be expanded as an alias; if so, it continues tracing the command word from the expanded alias until it reaches the command that will be executed.

The style whence is available in the context :zle:\$WIDGET; this may be set to an array to give the command and options that will be used to investigate the command word found. The default is whence -c.

zcalc-auto-insert

This function is useful together with the zcalc function described in \*Note Mathematical Functions::. It should be bound to a key representing a binary operator such as `+', `-', `\*' or `/'. When running in zcalc, if the key occurs at the start of the line or immediately following an open parenthesis, the text "ans " is inserted before the representation of the key itself. This allows easy use of the answer from the previous calculation in the current line. The text to be inserted before the symbol typed can be modified by setting the variable ZCALC\_AUTO\_INSERT\_PREFIX.

Hence, for example, typing `+12' followed by return adds 12 to the previous result.

If zcalc is in RPN mode (-r option) the effect of this binding is automatically suppressed as operators alone on a line are meaningful.

When not in zcalc, the key simply inserts the symbol itself.

## 26.7.2 Utility Functions

-----

These functions are useful in constructing widgets. They should be loaded with `autoload -U FUNCTION' and called as indicated from user-defined widgets.

split-shell-arguments

This function splits the line currently being edited into shell arguments and whitespace. The result is stored in the array reply. The array contains all the parts of the line in order, starting with any whitespace before the first argument, and finishing with any whitespace

after the last argument. Hence (so

long as the option KSH\_ARRAYS is not set) whitespace is given by odd indices in the array and arguments by even indices. Note that no stripping of quotes is done; joining together all the elements of reply in order is guaranteed to produce the original line.

The parameter REPLY is set to the index of the word in reply which contains the character after the cursor, where the first element has index 1. The parameter REPLY2 is set to the index of the character under the cursor in that word, where the first character has index 1.

Hence reply, REPLY and REPLY2 should all be made local to the enclosing function.

See the function modify-current-argument, described below, for an example of how to call this function.

`modify-current-argument [ EXPR-USING-$ARG | FUNC ]`

This function provides a simple method of allowing user-defined widgets to modify the command line argument under the cursor (or immediately to the left of the cursor if the cursor is between arguments).

The argument can be an expression which when evaluated operates on the shell parameter ARG, which will have been set to the command line argument under the cursor. The expression should be suitably quoted to prevent it being evaluated too early.

Alternatively, if the argument does not contain the string ARG, it is assumed to be a shell function, to which the current command line argument is passed as the only argument. The function should set the variable REPLY to the new value for the command line argument. If the function returns non-zero status, so does the calling function.

For example, a user-defined widget containing the following code converts the characters in the argument under the cursor into all upper case:

```
modify-current-argument '${(U)ARG}'
```

The following strips any quoting from the current word (whether backslashes or one of the styles of quotes), and replaces it with single quoting throughout:

```
modify-current-argument '${(qq)${(Q)ARG}}'
```

The following performs directory expansion on the command line argument and replaces it by the absolute path:

```
expand-dir() {  
    REPLY=${~1}  
    REPLY=${REPLY:a}  
}  
modify-current-argument expand-dir
```

In practice the function `expand-dir` would probably not be defined within the widget where `modify-current-argument` is called.

### 26.7.3 Styles

-----

The behavior of several of the above widgets can be controlled by the use of the `zstyle` mechanism. In particular, widgets that interact with the completion system pass along their context to any completions that they invoke.

#### `break-keys`

This style is used by the `incremental-complete-word` widget. Its value should be a pattern, and all keys matching this pattern will cause

the widget to stop incremental completion without the key having any further effect. Like all styles used directly by `incremental-complete-word`, this style is looked up using the context ``:incremental'`.

#### `completer`

The `incremental-complete-word` and `insert-and-predict` widgets set up their top-level context name before calling completion. This allows one to define different sets of completer functions for normal completion and for these widgets. For example, to use completion, approximation and correction for normal completion, completion and correction for incremental completion and only completion for prediction one could use:

```
zstyle ':completion:*' completer \
```

```

    _complete _correct _approximate
zstyle ':completion:incremental:*' completer \
    _complete _correct
zstyle ':completion:predict:*' completer \
    _complete

```

It is a good idea to restrict the completers used in prediction,

because they may be automatically invoked as you type. The `_list` and `_menu` completers should never be used with prediction. The `_approximate`, `_correct`, `_expand`, and `_match` completers may be used, but be aware that they may change characters anywhere in the word behind the cursor, so you need to watch carefully that the result is what you intended.

#### cursor

The insert-and-predict widget uses this style, in the context ``:predict'`, to decide where to place the cursor after completion has been tried. Values are:

#### complete

The cursor is left where it was when completion finished, but only if it is after a character equal to the one just inserted by the user. If it is after another character, this value is the same as ``key'`.

#### key

The cursor is left after the Nth occurrence of the character just inserted, where N is the number of times that character appeared in the word before completion was attempted. In short, this has the effect of leaving the cursor after the character just typed even if the completion code found out that no other characters need to be inserted at that position.

Any other value for this style unconditionally leaves the cursor at the position where the completion code left it.

#### list

When using the incremental-complete-word widget, this style says if the matches should be listed on every key press (if they fit on the screen). Use the context prefix ``:completion:incremental'`.

The insert-and-predict widget uses this style to decide if the completion should be shown even if there is only one possible completion. This is done if the value of this style is the string `always`. In this case the context is ``:predict' (_not_`



`:completion:predict').

#### match

This style is used by smart-insert-last-word to provide a pattern (using full EXTENDED\_GLOB syntax) that matches an interesting word. The context is the name of the widget to which smart-insert-last-word is bound (see above). The default behavior of smart-insert-last-word is equivalent to:

```
zstyle :insert-last-word match '*[[:alpha:]]\|)*'
```

However, you might want to include words that contain spaces:

```
zstyle :insert-last-word match '*[[:alpha:]][[:space:]]\|)*'
```

Or include numbers as long as the word is at least two characters long:

```
zstyle :insert-last-word match '*([[:digit:]]?[[:alpha:]]\|)*'
```

The above example causes redirections like "2>" to be included.

#### prompt

The incremental-complete-word widget shows the value of this style in the status line during incremental completion. The string value may contain any of the following substrings in the manner of the PS1 and other prompt parameters:

%c

Replaced by the name of the completer function that generated the matches (without the leading underscore).

%l

When the list style is set, replaced by `...' if the list of matches is too long to fit on the screen and with an empty string otherwise. If the list style is `false' or not set, `%l' is always removed.

%n

Replaced by the number of matches generated.

%s

Replaced by `no match-', `no prefix-', or an empty string

if there is no completion matching the word on the line, if the matches have no common prefix different from the word on the line, or if there is such a common prefix, respectively.

`%u`

Replaced by the unambiguous part of all matches, if there is any, and if it is different from the word on the line.

Like ``break-keys'`, this uses the ``incremental'` context.

`stop-keys`

This style is used by the incremental-complete-word widget. Its value is treated similarly

to the one for the break-keys style

(and uses the same context: ``incremental'`). However, in this case all keys matching the pattern given as its value will stop incremental completion and will then execute their usual function.

`toggle`

This boolean style is used by predict-on and its related widgets in the context ``predict'`. If set to one of the standard ``true'` values, predictive typing is automatically toggled off in situations where it is unlikely to be useful, such as when editing a multi-line buffer or after moving into the middle of a line and then deleting a character. The default is to leave prediction turned on until an explicit call to predict-off.

`verbose`

This boolean style is used by predict-on and its related widgets in the context ``predict'`. If set to one of the standard ``true'` values, these widgets display a message below the prompt when the predictive state is toggled. This is most useful in

combination

with the toggle style. The default does not display these messages.

`widget`

This style is similar to the command style: For widget functions that use `zle` to call other widgets, this style can sometimes be used to override the widget which is called. The context for this style is the name of the calling widget (`_not_` the name of the calling function, because one function may be bound to multiple widget names).

`zstyle :copy-earlier-word widget smart-insert-last-word`

Check the documentation for the calling widget or function to determine whether the widget style is used.

File: zsh.info, Node: Exception Handling, Next: MIME Functions, Prev: ZLE Functions, Up: User Contributions

## 26.8 Exception Handling

=====

Two functions are provided to enable zsh to provide exception handling in a form that should be familiar from other languages.

### throw EXCEPTION

The function throw throws the named EXCEPTION. The name is an arbitrary string and is only used by the throw and catch functions. An exception is for the most part treated the same as a shell error, i.e. an unhandled exception will cause the shell to abort all processing in a function or script and to return to the top level in an interactive shell.

### catch EXCEPTION-PATTERN

The function catch returns status zero if an exception was thrown and the pattern EXCEPTION-PATTERN matches its name. Otherwise it returns status 1. EXCEPTION-PATTERN is a standard shell pattern, respecting the current setting of the EXTENDED\_GLOB option. An alias catch is also defined to prevent the argument to the function from matching filenames, so patterns may be used unquoted. Note that as exceptions are not fundamentally different from other shell errors it is possible to catch shell errors by using an empty string as the exception name. The shell variable

CAUGHT is set by catch to the name of the exception caught. It is possible to rethrow an exception by calling the throw function again once an exception has been caught.

The functions are designed to be used together with the always construct described in \*Note Complex Commands:. This is important as only this construct provides the required support for exceptions. A typical example is as follows.

```
{  
  # "try" block
```

```

# ... nested code here calls "throw MyExcept"
} always {
# "always" block
if catch MyExcept; then
    print "Caught exception MyExcept"
elif catch "; then
    print "Caught a shell error. Propagating..."
    throw "
fi
# Other exceptions are not handled but may be caught further
# up the call stack.
}

```

If all exceptions should be caught, the following idiom might be preferable.

```

{
# ... nested code here throws an exception
} always {
    if catch *;
then
    case $CAUGHT in
        (MyExcept)
            print "Caught my own exception"
            ;;
        (*)
            print "Caught some other exception"
            ;;
    esac
fi
}

```

In common with exception handling in other languages, the exception may be thrown by code deeply nested inside the ``try'` block. However, note that it must be thrown inside the current shell, not in a subshell forked for a pipeline, parenthesised current-shell construct, or some form of command or process substitution.

The system internally uses the shell variable `EXCEPTION` to record the name of the exception between throwing and catching. One drawback of this scheme is that if the exception is not handled the variable `EXCEPTION` remains set and may be incorrectly recognised as the name of an exception if a shell error subsequently occurs. Adding `unset EXCEPTION` at the start of the outermost layer of any code that uses exception handling will eliminate this problem.

File:

zsh.info, Node: MIME Functions, Next: Mathematical Functions, Prev: Exception Handling, Up: User Contributions

## 26.9 MIME Functions

=====

Three functions are available to provide handling of files recognised by extension, for example to dispatch a file text.ps when executed as a command to an appropriate viewer.

```
zsh-mime-setup [ -fv ] [ -l [ SUFFIX ... ] ]
```

```
zsh-mime-handler [ -l ] COMMAND ARGUMENT ...
```

These two functions use the files `~/.mime.types` and `/etc/mime.types`, which associate types and extensions, as well as `~/.mailcap` and `/etc/mailcap` files, which associate types and the programs that handle them. These are provided on many systems with the Multimedia Internet Mail Extensions.

To enable the system, the function `zsh-mime-setup` should be autoloaded and run. This allows files with extensions to be treated as executable; such files be completed by the function completion system. The function `zsh-mime-handler` should not need to be called by the user.

The system works by setting up suffix aliases with ``alias -s'`. Suffix aliases already installed by the user will not be overwritten.

For suffixes defined in lower case, upper case variants will also automatically be handled (e.g. PDF is automatically handled if handling for the suffix pdf is defined), but not vice versa.

Repeated calls to `zsh-mime-setup` do not override the existing mapping between suffixes and executable files unless the option `-f` is given. Note, however, that this does not override existing suffix aliases assigned to handlers other than `zsh-mime-handler`.

Calling `zsh-mime-setup` with the option `-l` lists the existing mappings without altering them. Suffixes to list (which may contain pattern characters that should be quoted from immediate interpretation on the command line) may be given as additional arguments, otherwise all suffixes are listed.

Calling `zsh-mime-setup` with the option `-v` causes verbose output to be shown during the setup operation.

The system respects the mailcap flags `needsterminal` and `copiousoutput`; see `mailcap(4)` or `mailcap(5)` (the man page's name varies across platforms).

The functions use the following styles, which are defined with the `zstyle` builtin command (\*Note The `zsh/zutil` Module:). They should be defined before `zsh-mime-setup` is run. The contexts used all start with `:mime:`, with additional components in some cases. It is recommended that a trailing `*` (suitably quoted) be appended to style patterns in case the system is extended in future. Some examples are given below.

For files that have multiple suffixes, e.g. `.pdf.gz`, where the context includes the suffix it will be looked up starting with the longest possible suffix until a match for the style is found. For example, if `.pdf.gz` produces a match for the handler, that will be used; otherwise the handler for `.gz` will be used. Note that, owing to the way suffix aliases work, it is always required that there be a handler for the shortest possible suffix, so in this example `.pdf.gz` can only be handled if `.gz` is also handled (though not necessarily in the same way). Alternatively, if no handling for `.gz` on its own is needed, simply adding the command

```
alias -s gz=zsh-mime-handler
```

to the initialisation code is sufficient; `.gz` will not be handled on its own, but may be in combination with other suffixes.

#### current-shell

If this boolean style is true, the mailcap handler for the context in question is run using the `eval` builtin instead of by starting a new `sh` process. This is more efficient, but may not work in the occasional cases where the mailcap handler uses strict POSIX syntax.

#### disown

If this boolean style is true, mailcap handlers started in the background will be disowned, i.e. not subject to job control within the parent shell. Such handlers nearly always produce their own windows, so the only likely harmful side effect of setting the style is that it becomes harder to kill jobs from

within the shell.

#### execute-as-is

This style gives a list of patterns to be matched against files passed for execution with a handler program. If the file matches the pattern, the entire command line is executed in its current form, with no handler. This is useful for files which might have suffixes but nonetheless be executable in their own right. If the style is not set, the pattern `*(*) *(/)` is used; hence executable files are executed directly and not passed to a handler, and the option `AUTO_CD` may be used to change to directories that happen to have MIME

suffixes.

#### execute-never

This style is useful in combination with `execute-as-is`. It is set to an array of patterns corresponding to full paths to files that should never be treated as executable, even if the file passed to the MIME handler matches `execute-as-is`. This is useful for file systems that don't handle execute permission or that contain executables from another operating system. For example, if `/mnt/windows` is a Windows mount, then

```
zstyle ':mime:*' execute-never '/mnt/windows/*'
```

will ensure that any files found in that area will be executed as MIME types even if they are executable. As this example shows, the complete file name is matched against the pattern, regardless of how the file was passed to the handler. The file is resolved to a full path using the `:P` modifier described in `*Note Modifiers::`; this means that

symbolic links are resolved where possible, so that links into other file systems behave in the correct fashion.

#### file-path

Used if the style `find-file-in-path` is true for the same context. Set to an array of directories that are used for searching for the file to be handled; the default is the command path given by the special parameter `path`. The shell option `PATH_DIRS` is respected; if that is set, the appropriate path will be searched even if the name of the file to be handled as it appears on the command line contains a ```. The full context is `:mime:.SUFFIX:`, as described for the style handler.

#### find-file-in-path

If set, allows files whose names do not contain absolute paths to be searched for in the command path or the path specified by the file-path style. If the file is not found in the path, it is looked for locally (whether

or not the current

directory is in the path); if it is not found locally, the handler will abort unless the handle-nonexistent style is set. Files found in the path are tested as described for the style execute-as-is. The full context is :mime:.SUFFIX:, as described for the style handler.

#### flags

Defines flags to go with a handler; the context is as for the handler style, and the format is as for the flags in mailcap.

#### handle-nonexistent

By default, arguments that don't correspond to files are not passed to the MIME handler in order to prevent it from intercepting commands found in the path that happen to have suffixes. This style may be set to an array of extended glob patterns for arguments that will be passed to the handler even if they don't exist. If it is not explicitly set it defaults to `[[[:alpha:]]#:/*` which allows URLs to be passed

to

the MIME handler even though they don't exist in that format in the file system. The full context is :mime:.SUFFIX:, as described for the style handler.

#### handler

Specifies a handler for a suffix; the suffix is given by the context as :mime:.SUFFIX:, and the format of the handler is exactly that in mailcap. Note in particular the `.' and trailing colon to distinguish this use of the context. This overrides any handler specified by the mailcap files. If the handler requires a terminal, the flags style should be set to include the word needsterminal, or if the output is to be displayed through a pager (but not if the handler is itself a pager), it should include copiousoutput.

#### mailcap

A list of files in the format of ~/.mailcap and /etc/mailcap to be read during setup, replacing the default list which consists of those two

files. The context is :mime:. A + in

the list will be replaced by the default files.

#### mailcap-priorities



This style is used to resolve multiple mailcap entries for the same MIME type. It consists of an array of the following elements, in descending order of priority; later entries will be used if earlier entries are unable to resolve the entries being compared. If none of the tests resolve the entries, the first entry encountered is retained.

#### files

The order of files (entries in the mailcap style) read. Earlier files are preferred. (Note this does not resolve entries in the same file.)

#### priority

The priority flag from the mailcap entry. The priority is an integer from 0 to 9 with the default value being 5.

#### flags

The test given by the mailcap-prio-flags option is used to resolve entries.

#### place

Later entries are preferred; as the entries are strictly ordered, this test always succeeds.

Note that as this style is handled during initialisation, the context is always :mime:, with no discrimination by suffix.

#### mailcap-prio-flags

This style is used when the keyword flags is encountered in the list of tests specified by the mailcap-priorities style. It should be set to a list of patterns, each of which is tested against the flags specified in the mailcap entry (in other words, the sets of assignments found with some entries in the mailcap file). Earlier patterns in the list are preferred to later ones, and matched patterns are preferred to unmatched ones.

#### mime-types

A list of files in the format of ~/.mime.types and /etc/mime.types to be read during setup, replacing the default list which consists of those two files. The context is :mime:. A + in the list will be replaced by the default files.

never-background

If this boolean style is set, the handler for the given context is always run in the foreground, even if the flags provided in the mailcap entry suggest it need not be (for example, it doesn't require a terminal).

pager

If set, will be used instead of \$PAGER or more to handle suffixes where the copiousoutput flag is set. The context is as for handler, i.e. :mime:.SUFFIX: for handling a file with the given SUFFIX.

Examples:

```
zstyle 'mime:*' mailcap ~/.mailcap /usr/local/etc/mailcap
zstyle 'mime:.txt:' handler less %s
zstyle 'mime:.txt:' flags needsterminal
```

When zsh-mime-setup is subsequently run, it will look for mailcap entries in the two files given. Files of suffix .txt will be handled by running `less FILE.TXT'. The flag needsterminal is set to show that this program must run attached to a terminal.

As there are several steps to dispatching a command, the following should be checked if attempting to execute a file by extension .EXT does not have the expected effect.

The command `alias -s EXT' should show `ps=zsh-mime-handler'. If it shows something else, another suffix alias was already installed and was not overwritten. If it shows nothing, no handler was installed: this is most likely because no handler was found in the .mime.types and mailcap combination for .ext files. In that case, appropriate handling should be added to ~/.mime.types and mailcap.

If the extension is handled by zsh-mime-handler but the file is not opened correctly, either the handler defined for the type is incorrect, or the flags associated with it are inappropriate. Running zsh-mime-setup -l will show the handler and, if there are any, the flags. A %s in the handler is replaced by the file (suitably quoted if necessary). Check that the handler program listed lists and can be run in the way shown. Also check that the flags needsterminal or copiousoutput are set if the handler needs to be run under a terminal; the second flag is used if the output

should be sent to a pager. An example of a suitable mailcap entry for such a program is:

```
text/html; /usr/bin/lynx '%s'; needsterminal
```

Running ``zsh-mime-handler -l COMMAND LINE'` prints the command line that would be executed, simplified to remove the effect of any flags, and quoted so that the output can be run as a complete zsh command line. This is used by the completion system to decide how to complete after a file handled by `zsh-mime-setup`.

#### `pick-web-browser`

This function is separate from the two MIME functions described above and can be assigned directly to a suffix:

```
autoload -U pick-web-browser
alias -s html=pick-web-browser
```

It is provided as an intelligent front end to dispatch a web browser. It may be run as either a function or a shell script. The status 255 is returned if no browser could be started.

Various styles are available to customize the choice of browsers:

#### `browser-style`

The value of the style is an array giving preferences in decreasing order for the type of browser to use. The values of elements may be

#### `running`

Use a GUI browser that is already running when an X Window display is available. The browsers listed in the `x-browsers` style are tried in order until one is found; if it is, the file will be displayed in that browser, so the user may need to check whether it has appeared. If no running browser is found, one is not started.

Browsers other than Firefox, Opera and Konqueror are assumed to understand the Mozilla syntax for opening a URL remotely.

#### `x`

Start a new GUI browser when an X Window display is

available. Search for the availability of one of the browsers listed in the x-browsers style and start the first one that is found. No check is made for an already running browser.

tty

Start a terminal-based browser. Search for the availability of one of the browsers listed in the tty-browsers style and start the first one that is found.

If the style is not set the default running x tty is used.

x-browsers

An array in decreasing order of preference of browsers to use when running under the X Window System. The array consists of the command name under which to start the browser. They are

looked up in the context :mime: (which may be extended in future, so appending `\*` is recommended). For example,

```
zstyle ':mime:*' x-browsers opera konqueror firefox
```

specifies that pick-web-browser should first look for a running instance of Opera, Konqueror or Firefox, in that order, and if it fails to find any should attempt to start Opera. The default is firefox mozilla netscape opera konqueror.

tty-browsers

An array similar to x-browsers, except that it gives browsers to use when no X Window display is available. The default is elinks links lynx.

command

If it is set this style is used to pick the command used to open a page for a browser. The context is  
:mime:browser:new:\$browser: to start a new browser or  
:mime:browser:running:\$browser: to open a URL in a browser already running on the current X display, where

\$browser is

the value matched in the x-browsers or tty-browsers style. The escape sequence %b in the style's value will be replaced by the browser, while %u will be replaced by the URL. If the style is not set, the default for all new instances is equivalent to %b %u and the defaults for using running browsers are equivalent to the values kfmclient openURL %u for

Konqueror, firefox -new-tab %u for Firefox, opera -newpage %u for Opera, and %b -remote "openUrl(%u)" for all others.

File: zsh.info, Node: Mathematical Functions, Next: User Configuration Functions, Prev: MIME Functions, Up: User Contributions

## 26.10 Mathematical Functions

=====

`zcalc [ -erf ] [ EXPRESSION ... ]`

A reasonably powerful calculator based on zsh's arithmetic evaluation facility. The syntax is similar to that of formulae in most programming languages; see *\*Note Arithmetic Evaluation::* for details.

Non-programmers should note that, as in many other programming languages, expressions involving only integers (whether constants without a ```, variables containing such constants as strings, or variables declared to be integers) are by default evaluated using integer arithmetic, which is not how an ordinary desk calculator operates. To force floating point operation, pass the option `-f`; see further notes below.

If the file `~/.zcalcrc` exists it will be sourced inside the function once it is set up and about to process the command line. This can be used, for example, to set shell options; emulate `-L zsh` and `setopt extendedglob` are in effect at this point. Any failure to source the file if it exists is treated as fatal. As with other initialisation files, the directory `$ZDOTDIR` is used instead of `$HOME` if it is set.

The mathematical library `zsh/mathfunc` will be loaded if it is available; see *\*Note The zsh/mathfunc Module::*. The mathematical functions correspond to the raw system libraries, so trigonometric functions are evaluated using radians, and so on.

Each line typed is evaluated as an expression. The prompt shows a number, which corresponds to a positional parameter where the result of that calculation is stored. For example, the result of the calculation on the line preceded by ``4> '` is available as `$4`. The last value calculated is available as `ans`. Full command line

editing, including the history of previous calculations, is available; the history is saved in the file `~/.zcalc_history`. To exit, enter a blank line or type ``:q'` on its own (``q'` is allowed for historical compatibility).

A line ending with a single backslash is treated in the same fashion as it is in command line editing: the backslash is removed, the function prompts for more input (the prompt is preceded by ``...'`

to indicate this), and the lines are combined

into one to get the final result. In addition, if the input so far contains more open than close parentheses `zcalc` will prompt for more input.

If arguments are given to `zcalc` on start up, they are used to prime the first few positional parameters. A visual indication of this is given when the calculator starts.

The constants `PI` (3.14159...) and `E` (2.71828...) are provided. Parameter assignment is possible, but note that all parameters will be put into the global namespace unless the `:local` special command is used. The function creates local variables whose names start with `_`, so users should avoid doing so. The variables `ans` (the last answer) and `stack` (the stack in RPN mode) may be referred to directly; `stack` is an array but elements of it are numeric. Various other special variables are used locally with their standard meaning, for example `compcontext`, `match`, `mbegin`, `mend`, `psvar`.

The output base can be initialised by passing the option ``-#BASE'`, for example ``zcalc -#16'` (the ``#'` may have to be quoted, depending on the globbing options set).

If the option ``-e'` is set, the function runs non-interactively: the arguments are treated as expressions to be evaluated as if entered interactively line by line.

If the option ``-f'` is set, all numbers are treated as floating point, hence for example the expression ``3/4'` evaluates to 0.75 rather than 0. Options must appear in separate words.

If the option ``-r'` is set, RPN (Reverse Polish Notation) mode is entered. This has various additional properties:

#### Stack

Evaluated values are maintained in a stack; this is contained in an array named `stack` with the most recent value in `${stack[1]}`.

### Operators and functions

If the line entered matches an operator (+, -, \*, /, \*\*, ^, | or &) or

a function supplied by the zsh/mathfunc library, the

bottom element or elements of the stack are popped to use as the argument or arguments. The higher elements of stack (least recent) are used as earlier arguments. The result is then pushed into `${stack[1]}`.

### Expressions

Other expressions are evaluated normally, printed, and added to the stack as numeric values. The syntax within expressions on a single line is normal shell arithmetic (not RPN).

### Stack listing

If an integer follows the option -r with no space, then on every evaluation that many elements of the stack, where available, are printed instead of just the most recent result. Hence, for example, `zcalc -r4` shows `${stack[4]}` to `${stack[1]}` each time results are printed.

### Duplication: =

The pseudo-operator = causes the most recent element of the stack to be duplicated onto the stack.

### pop

The pseudo-function pop causes the most recent element of the stack to be popped. A ``>'` on its own has the same effect.

### >IDENT

The expression > followed (with no space) by a shell identifier causes the most recent element of the stack to be popped and assigned to the variable with that name. The variable is local to the `zcalc` function.

### <IDENT

The expression < followed (with no space) by a shell identifier causes the value of the variable with that name to be pushed onto the stack. IDENT may be an integer, in which case the previous result with that number (as shown before the > in the standard `zcalc` prompt) is put on the stack.

### Exchange: xy

The pseudo-function xy causes the most recent two elements of the stack to be exchanged. ``<>'` has the same effect.

The prompt is configurable via the parameter ZCALCPROMPT, which undergoes standard prompt expansion. The index of the current entry is stored locally in the first element of the array psvar, which can be referred to in ZCALCPROMPT as '%1v'. The default prompt is '%1v> '.

The variable ZCALC\_ACTIVE is set within the function and can be tested by nested functions; it has the value rpn if RPN mode is active, else 1.

A few special commands are available; these are introduced by a colon. For backward compatibility, the colon may be omitted for certain commands. Completion is available if compinit has been run.

The output precision may be specified within zcalc by special commands familiar from many calculators.

:norm

The default output format. It corresponds to the printf %g specification. Typically this shows six decimal digits.

:sci DIGITS

Scientific notation, corresponding to the printf %g output format with the precision

given by DIGITS. This produces

either fixed point or exponential notation depending on the value output.

:fix DIGITS

Fixed point notation, corresponding to the printf %f output format with the precision given by DIGITS.

:eng DIGITS

Exponential notation, corresponding to the printf %E output format with the precision given by DIGITS.

:raw

Raw output: this is the default form of the output from a math evaluation. This may show more precision than the number actually possesses.

Other special commands:

!:LINE...

Execute LINE... as a normal shell command line. Note that it



is executed in the context of the function, i.e. with local variables. Space is optional after :!.

:local ARG ...

Declare variables local to the function. Other variables may be used, too, but they will be taken from or put into the global

scope.

:function NAME [ BODY ]

Define a mathematical function or (with no BODY) delete it.

:function may be abbreviated to :func or simply :f. The NAME may contain the same characters as a shell function name.

The function is defined using zmathfuncdef, see below.

Note that zcalc takes care of all quoting. Hence for example:

```
:f cube $1 * $1 * $1
```

defines a function to cube the sole argument. Functions so defined, or indeed any functions defined directly or indirectly using functions -M, are available to execute by typing only the name on the line in RPN mode; this pops the appropriate number of arguments off the stack to pass to the function, i.e. 1 in the case of the example cube function. If there are optional arguments only the mandatory arguments are supplied by this means.

[#BASE]

This is not a special command, rather part of normal arithmetic syntax; however, when this form appears on a line by itself the default output radix is set to BASE. Use, for example, `[#16]' to display hexadecimal output preceded by an indication of the base, or `##16]' just to display the raw number in the given base. Bases themselves are always specified in decimal. `[#]' restores the normal output format. Note that setting an output base suppresses floating point output; use `[#]' to return to normal operation.

\$VAR

Print out the value of var literally; does not affect the calculation. To use the value of var, omit the leading `\$'.

See the comments in the function for a few extra tips.

min(ARG, ...)  
max(ARG, ...)  
sum(ARG, ...)  
zmathfunc

The function zmathfunc defines the three mathematical functions min, max, and sum. The functions min and max take one or more arguments. The function

sum takes zero or more arguments.

Arguments can be of different types (ints and floats).

Not to be confused with the zsh/mathfunc module, described in

\*Note The zsh/mathfunc Module::.

zmathfuncdef [ MATHFUNC [ BODY ] ]

A convenient front end to functions -M.

With two arguments, define a mathematical function named MATHFUNC which can be used in any form of arithmetic evaluation. BODY is a mathematical expression to implement the function. It may contain references to position parameters \$1, \$2, ... to refer to mandatory parameters and \${1:-DEFVALUE} ... to refer to optional parameters. Note that the forms must be strictly adhered to for the function to calculate the correct number of arguments. The implementation is held in a shell function named zsh\_math\_func\_MATHFUNC; usually the user will not need to refer to the shell function directly. Any existing function of the same name is silently replaced.

With one argument, remove the mathematical function MATHFUNC as well as the shell function implementation.

With no arguments, list all MATHFUNC functions in a form suitable for restoring the definition. The functions have not necessarily been defined by zmathfuncdef.

File: zsh.info, Node: User Configuration Functions, Next: Other Functions, Prev: Mathematical Functions, Up: User Contributions

## 26.11 User Configuration Functions

=====

The zsh/newuser module comes with a function to aid in configuring shell options for new users. If the module is installed, this function can also be run by hand. It is available even if the module's default behaviour, namely running the function for a new user logging in without

startup files, is inhibited.

`zsh-newuser-install [ -f ]`

The function presents the user with various options for customizing their initialization scripts. Currently only `~/.zshrc` is handled.

`$ZDOTDIR/.zshrc` is used instead if the parameter `ZDOTDIR` is set; this provides a way for the user to configure a file without altering an existing `.zshrc`.

By default the function exits immediately if it finds any of the files `.zshenv`, `.zprofile`, `.zshrc`, or `.zlogin` in the appropriate directory. The option `-f` is required in order to force the function to continue. Note this may happen even if `.zshrc` itself does not exist.

As currently configured, the function will exit immediately if the user has root privileges; this behaviour cannot be overridden.

Once activated, the function's behaviour is supposed to be self-explanatory. Menus are present allowing the user to alter the value of options and parameters. Suggestions for improvements are always welcome.

When the script exits, the user is given the opportunity to save the new file or not; changes are not irreversible until this point. However, the script is careful to restrict changes to the file only to a group marked by the lines ``# Lines configured by zsh-newuser-install'` and ``# End of lines configured by zsh-newuser-install'`. In addition, the old version of `.zshrc` is saved to a file with the suffix `.zni` appended.

If the function edits an existing `.zshrc`, it is up to the user to ensure that the changes made will take effect. For example, if control usually returns early from the existing `.zshrc` the lines will not be executed; or a later initialization file may override options or parameters, and so on. The function itself does not attempt to detect any such conflicts.

File: `zsh.info`, Node: Other Functions, Prev: User Configuration Functions, Up: User Contributions

26.12 Other Functions

=====

There are a large number of helpful functions in the Functions/Misc directory of the zsh distribution. Most are very simple and do not require documentation here, but a few are worthy of special mention.

### 26.12.1 Descriptions

-----

#### colors

This function initializes several associative arrays to map color names to (and from) the ANSI standard eight-color terminal codes. These are used by the prompt theme system (\*Note Prompt Themes:). You seldom should need to run colors more than once.

The eight base colors are: black, red, green, yellow, blue, magenta, cyan, and white. Each of these has codes for foreground and background. In addition there are seven intensity attributes: bold, faint, standout, underline, blink, reverse, and conceal. Finally, there are seven codes used to negate attributes: none (reset all attributes to the defaults), normal (neither bold nor faint), no-standout, no-underline, no-blink, no-reverse, and no-conceal.

Some terminals do not support all combinations of colors and intensities.

The associative arrays are:

#### color

##### colour

Map all the color names to their integer codes, and integer codes to the color names. The eight base names map to the foreground color codes, as do names prefixed with `fg-', such as `fg-red'. Names prefixed with `bg-', such as `bg-blue', refer to the background codes. The reverse mapping from code to color yields base name for foreground codes and the bg-form for backgrounds.

Although it is a misnomer to call them `colors', these arrays also map the other fourteen attributes from names to codes and codes to names.

#### fg

fg\_bold  
fg\_no\_bold

Map the eight basic color names to ANSI terminal escape sequences that set the corresponding foreground text properties. The fg sequences change the color without changing the eight intensity attributes.

bg  
bg\_bold  
bg\_no\_bold

Map the eight basic color names to ANSI terminal escape sequences that set the corresponding background properties. The bg sequences change the color without changing the eight intensity attributes.

In addition, the scalar parameters `reset_color` and `bold_color` are set to the ANSI terminal escapes that turn off all attributes and turn on bold intensity, respectively.

`fned [ -x NUM ] NAME`

Same as `zed -f`. This function does not appear in the zsh distribution, but can be created by linking `zed` to the name `fned` in some directory in your `fpath`.

`histed [ [ NAME ] SIZE ]`

Same as `zed -h`. This function does not appear in the zsh distribution, but can be created by linking `zed` to the name `histed` in some directory in your `fpath`.

`is-at-least NEEDED [ PRESENT ]`

Perform a greater-than-or-equal-to comparison of two strings having the format of a zsh version number; that is, a string of numbers and text with segments separated by dots or dashes.

If

the `PRESENT` string is not provided, `$ZSH_VERSION` is used. Segments are paired left-to-right in the two strings with leading non-number parts ignored. If one string has fewer segments than the other, the missing segments are considered zero.

This is useful in startup files to set options and other state that are not available in all versions of zsh.

```
is-at-least 3.1.6-15 && setopt NO_GLOBAL_RCS
is-at-least 3.1.0 && setopt HIST_REDUCE_BLANKS
is-at-least 2.6-17 || print "You can't use is-at-least here."
```

nslookup [ ARG ... ]

This wrapper function for the nslookup command requires the zsh/zpty module (see *\*Note The zsh/zpty Module::*). It behaves exactly like the standard nslookup except that it provides customizable prompts (including a right-side prompt) and completion of nslookup commands, host names, etc. (if you use the function-based completion system). Completion styles may be set

with the context prefix ``:completion:nslookup'`.

See also the pager, prompt and rprompt styles below.

regex-replace VAR REGEXP REPLACE

Use regular expressions to perform a global search and replace operation on a variable. POSIX extended regular expressions (ERE) are used, unless the option RE\_MATCH\_PCRE has been set, in which case Perl-compatible regular expressions are used (this requires the shell to be linked against the pcre library).

VAR is the name of the variable containing the string to be matched. The variable will be modified directly by the function. The variables MATCH, MBEGIN, MEND, match, mbegin, mend should be avoided as these are used by the regular expression code.

REGEXP is the regular expression to match against the string.

REPLACE is the replacement text. This can contain parameter, command and arithmetic expressions which will be replaced: in particular, a reference to \$MATCH will be replaced by the text matched by the pattern.

The return status is 0 if at least one match was performed, else 1.

Note that if using POSIX EREs, the ^ or word boundary operators (where available) may not work properly.

run-help CMD

This function is designed to be invoked by the run-help ZLE widget, in place of the default alias. See ``Accessing On-Line Help'` (*\*Note Utilities::*) for setup instructions.

In the discussion which follows, if CMD is a file system path, it is first reduced to its rightmost component (the file name).

Help is first sought by looking for a file named CMD in the directory named by the HELPDIR parameter. If no file is found, an

assistant function, alias, or command named run-help-CMD is sought. If found, the assistant is executed with the rest of the current command line (everything after the command name CMD) as its arguments. When neither file nor assistant is found, the external command ``man CMD'` is run.

An example assistant for the "ssh" command:

```
run-help-ssh() {
    emulate -LR zsh
    local -a args
    # Delete the "-l username" option
    zparseopts -D -E -a args l:
    # Delete other options, leaving: host command
    args=(${@:#-*})
    if [[ ${#args} -lt 2 ]]; then
        man ssh
    else
        run-help $args[2]
    fi
}
```

Several of these assistants are provided in the Functions/Misc directory. These must be autoloaded, or placed as executable scripts in your search path, in order to be found and used by run-help.

run-help-btrfs  
run-help-git  
run-help-ip  
run-help-openssl  
run-help-p4  
run-help-sudo  
run-help-svk  
run-help-svn

Assistant functions for the btrfs, git, ip, openssl, p4, sudo, svk, and svn, commands.

tetris

Zsh was once accused of not being as complete as Emacs, because it lacked a Tetris game. This function was written to refute this vicious slander.

This function must be used as a ZLE widget:

```
autoload -U tetris
zle -N tetris
bindkey KEYS tetris
```

To start a game, execute the widget by typing the KEYS. Whatever command line you were editing disappears temporarily, and your keymap is also temporarily replaced by the Tetris control keys. The previous editor state is restored when you quit the game (by pressing `q') or when you lose.

If you quit in the middle of a game, the next invocation of the tetris widget will continue where you left off. If you lost, it will start a new game.

#### tetriscurses

This is a port of the above to zcurses. The input handling is improved a bit so that moving a block sideways doesn't automatically advance a timestep, and the graphics use unicode block graphics.

This version does not save the game state between invocations, and is not invoked as a widget, but rather as:

```
autoload -U tetriscurses
tetriscurses
```

`zargs [ OPTION ... -- ] [ INPUT ... ] [ -- COMMAND [ ARG ... ] ]`

This function has a similar purpose to GNU xargs. Instead of reading lines of arguments from the standard input, it takes them from the command line. This is useful because zsh, especially with recursive glob operators, often can construct a command line for a shell function that is longer than can be accepted by an external command.

The OPTION list represents options of the zargs command itself, which are the same as those of xargs. The INPUT list is the collection of strings (often file names) that become the arguments of the command, analogous to the standard input of xargs. Finally, the ARG list consists of those arguments (usually options) that are passed to the COMMAND each time it runs.

The

ARG list precedes the elements from the input list in each run.

If no COMMAND is provided, then no ARG list may be provided, and



in that event the default command is ``print'` with arguments ``-r --'`.

For example, to get a long `ls` listing of all non-hidden plain files in the current directory or its subdirectories:

```
autoload -U zargs
zargs -- **/*(.) -- ls -ld --
```

The first and third occurrences of ``--'` are used to mark the end of options for `zargs` and `ls` respectively to guard against filenames starting with ``.'`, while the second is used to separate the list of files from the command to run (``ls -ld -'`).

The first ``--'` would also be needed if there was a chance the list might be empty as in:

```
zargs -r -- /*.back(#qN) -- rm -f
```

In the event that the string ``--'` is or may be an INPUT, the `-e` option may be used to change the end-of-inputs marker. Note that this does not change the end-of-options marker. For example, to use ``..'` as the marker:

```
zargs -e.. -- **/*(.) .. ls -ld --
```

This is a good choice in that example because no plain file can be named ``..'`, but the best end-marker depends on the circumstances.

The options `-i`, `-I`, `-l`, `-L`, and `-n` differ slightly from their usage in `xargs`. There are no input lines for `zargs` to count, so `-l` and `-L` count through the INPUT list, and `-n` counts the number of arguments passed to each execution of COMMAND, including any ARG list. Also, any time `-i` or `-I` is used, each INPUT is processed separately as if by ``-L 1'`.

For details of the other `zargs` options, see the `xargs(1)` man page (but note the difference in function between `zargs` and `xargs`) or run `zargs` with the `--help` option.

```
zed [ -f [ -x NUM ] ] NAME
zed [ -h [ NAME ] SIZE ]
zed -b
```

This function uses the ZLE editor to edit a file or function.

Only one NAME argument is allowed.

If the -f option is given, the

name is taken to be that of a function; if the function is marked for autoloading, zed searches for it in the fpath and loads it.

Note that functions edited this way are installed into the current shell, but `_not_` written back to the autoload file. In this case the -x option specifies that leading tabs indenting the function according to syntax should be converted into the given number of spaces; ``-x 2'` is consistent with the layout of functions distributed with the shell.

Without -f, NAME is the path name of the file to edit, which need not exist; it is created on write, if necessary. With -h, the file is presumed to contain history events.

When no file name is provided for -h the current shell history is edited in place. The history is renumbered when zed exits successfully.

When editing history, multi-line events must have a trailing backslash on every line before the last.

While editing, the function sets the main keymap to zed and the vi command keymap to zed-vicmd. These will be copied from the existing main and vicmd keymaps if they do not exist the first time zed is run. They can be used to provide special key bindings used only in zed.

If it creates the keymap, zed rebinds the return key to insert a line break and `^X^W` to accept the edit in the zed keymap, and binds `ZZ` to accept the edit in the zed-vicmd keymap.

The bindings alone can be installed by running ``zed -b'`. This is suitable for putting into a startup file. Note that, if rerun, this will overwrite the existing zed and zed-vicmd keymaps.

Completion is available, and styles may be set with the context prefix ``:completion:zed:'`.

A zle widget `zed-set-file-name` is available. This can be called by name from within zed using ``ex zed-set-file-name'` or can be bound to a key in either of the zed or zed-vicmd keymaps after

``zed -b'` has been run. When the widget is called, it prompts for a new name for the file being edited. When zed exits the file will be written under that name and the original file will be left

alone. The widget has no effect when invoked from ``zed -f'`. The completion context is changed to ``:completion:zed-set-file-name:'`. When editing the current history with ``zed -h'`, the history is first updated and then the file is written, but the global setting of HISTFILE is not altered.

While `zed-set-file-name` is running, `zed` uses the keymap `zed-normal-keymap`, which is linked from the main keymap in effect at the time `zed` initialised its bindings. (This is to make the return key operate normally.) The result is that if the main keymap has been changed, the widget won't notice. This is not a concern for most users.

`zcp [ -finqQvwW ] SRCPAT DEST`

`zln [ -finqQsvwW ] SRCPAT DEST`

Same as `zmv`

`-C` and `zmv -L`, respectively. These functions do not appear in the `zsh` distribution, but can be created by linking `zmv` to the names `zcp` and `zln` in some directory in your `fpath`.

`zkbd`

See 'Keyboard Definition' (\*Note Utilities:).

`zmv [ -finqQsvwW ] [ -C | -L | -M | -{p|P} PROGRAM ] [ -o OPTSTRING ] SRCPAT DEST`

Move (usually, rename) files matching the pattern `SRCPAT` to corresponding files having names of the form given by `DEST`, where `SRCPAT` contains parentheses surrounding patterns which will be replaced in turn by `$1`, `$2`, ... in `DEST`. For example,

```
zmv '(*).lis' '$1.txt'
```

renames ``foo.lis'` to ``foo.txt'`, ``my.old.stuff.lis'` to ``my.old.stuff.txt'`, and so on.

The pattern is always treated as an EXTENDED\_GLOB pattern. Any file whose name is not changed by the substitution is simply ignored. Any error (a substitution resulted in an empty string, two substitutions gave the same result, the destination was an

existing regular file and `-f` was not given) causes the entire function to abort without doing anything.

In addition to pattern replacement, the variable `$f` can be referred to in the second (replacement) argument. This makes it possible to use variable substitution to alter the argument; see examples below.

Options:

-f

Force overwriting of destination files. Not currently passed down to the mv/cp/ln command due to vagaries of implementations (but you can use -o-f to do that).

-i

Interactive: show each line to be executed and ask the user whether to execute it. `Y` or `y` will execute it, anything else will skip it. Note that you just need to type one character.

-n

No execution: print what would happen, but don't do it.

-q

Turn bare glob qualifiers off: now assumed by default, so this has no effect.

-Q

Force bare glob qualifiers on. Don't turn this on unless you are actually using glob qualifiers in a pattern.

-s

Symbolic, passed down to ln; only works with -L.

-v

Verbose: print each command as it's being executed.

-w

Pick out wildcard parts of the pattern, as described above, and implicitly add parentheses for referring to them.

-W

Just like -w, with the addition of turning wildcards in the replacement pattern into sequential \${1} .. \${N} references.

-C

-L

-M

Force cp, ln or mv, respectively, regardless of the name of the function.

-p PROGRAM

Call PROGRAM instead of cp, ln or mv. Whatever it does, it should at least understand the form

PROGRAM -- OLDNAME NEWNAME

where OLDNAME and NEWNAME are filenames generated by zmv.

PROGRAM will be split into words, so might be e.g. the name of an archive tool plus

a copy or rename subcommand.

#### -P PROGRAM

As -p PROGRAM, except that PROGRAM does not accept a following -- to indicate the end of options. In this case filenames must already be in a sane form for the program in question.

#### -o OPTSTRING

The OPTSTRING is split into words and passed down verbatim to the cp, ln or mv command called to perform the work. It should probably begin with a '-'.

Further examples:

```
zmv -v '(* *)' '${1// /_}'
```

For any file in the current directory with at least one space in the name, replace every space by an underscore and display the commands executed.

```
zmv -v '* *' '${f// /_}'
```

This does exactly the same by referring to the file name stored in \$f.

For more complete examples and other implementation details, see the zmv source file, usually located in one of the directories named in your fpath, or in Functions/Misc/zmv in the zsh distribution.

#### zrecompile

See 'Recompiling Functions' (\*Note Utilities:).

#### zstyle+ CONTEXT STYLE VALUE [ + SUBCONTEXT STYLE VALUE ... ]

This makes defining styles a bit simpler by using a single '+' as a special token that allows you to append a context name to the previously used context name. Like this:

```
zstyle+ ':foo:bar' STYLE1 VALUE1 \  
+':baz'   STYLE2 VALUE2 \  
+':frob'  STYLE3 VALUE3
```

This defines STYLE1 with VALUE1 for the context :foo:bar as usual, but it also defines STYLE2 with VALUE2 for the context :foo:bar:baz and STYLE3 with VALUE3 for :foo:bar:frob. Any SUBCONTEXT may be the empty string to re-use the first context unchanged.

## 26.12.2 Styles

-----

### insert-tab

The zed function `_sets_` this style in context ``:completion:zed:*'` to turn off completion when TAB is typed at the beginning of a line. You may override this by setting your own value for this context and style.

### pager

The `nslookup` function looks up this style in the context ``:nslookup'` to determine the program used to display output that does not fit on a single screen.

### prompt

#### rprompt

The `nslookup` function looks up this style in the context ``:nslookup'` to set the prompt and the right-side prompt, respectively. The usual expansions for the PS1 and RPS1 parameters may be used (see `*Note Prompt Expansion::`).

Found in path(s):

\* /zsh-5-9-doc-tar-xz/zsh-5.9/Doc/zsh.info-5

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the mailing list (see question [6.2](FAQ06.html#62)). Zsh is distributed under a

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more details.

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## 1.28 lua5.4-libs 5.4.7-r0

### 1.28.1 Available under license :

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@Ci{\$Id: manual.of \$}

@C{[(-----)}

@manual{

@sect1{@title{Introduction}}

Lua is a powerful, efficient, lightweight, embeddable scripting language.  
It supports procedural programming,  
object-oriented programming, functional programming,  
data-driven programming, and data description.

Lua combines simple procedural syntax with powerful data description  
constructs based on associative arrays and extensible semantics.

Lua is dynamically typed,  
runs by interpreting bytecode with a register-based  
virtual machine,  
and has automatic memory management with  
a generational garbage collection,  
making it ideal for configuration, scripting,  
and rapid prototyping.

Lua is implemented as a library, written in @emphx{clean C},  
the common subset of @N{standard C} and C++.

The Lua distribution includes a host program called @id{lua},  
which uses the Lua library to offer  
a complete,  
standalone Lua interpreter,  
for interactive or batch use.

Lua is intended to be used both as a powerful, lightweight,

embeddable scripting language for any program that needs one,  
and as a powerful but lightweight and efficient stand-alone language.

As an extension language, Lua has no notion of a `@Q{main}` program:  
it works `@emph{embedded}` in a host client,  
called the `@emph{embedding program}` or simply the `@emphx{host}`.  
(Frequently, this host is the stand-alone `@id{lua}` program.)  
The host program can invoke functions to execute a piece of Lua code,  
can write and read Lua variables,  
and can register `@N{C functions}` to be called by Lua code.  
Through the use of `@N{C functions}`, Lua can be augmented to cope with  
a wide range of different domains,  
thus creating customized programming languages sharing a syntactical framework.

Lua is free software,  
and is provided as usual with no guarantees,  
as stated in its license.  
The implementation described in this manual is available  
at  
Lua's official web site, `@id{www.lua.org}`.

Like any other reference manual,  
this document is dry in places.  
For a discussion of the decisions behind the design of Lua,  
see the technical papers available at Lua's web site.  
For a detailed introduction to programming in Lua,  
see Roberto's book, `@emphx{Programming in Lua}`.

}

`@C{-----}`  
`@sect1{basic| @title{Basic Concepts}`

`@simplesect{`

This section describes the basic concepts of the language.

}

`@sect2{TypesSec| @title{Values and Types}`

Lua is a dynamically typed language.  
This means that  
variables do not have types; only values do.  
There are no type definitions in the language.  
All values carry their own type.



All values in Lua are first-class values.  
This means that all values can be stored in variables,  
passed as arguments to other functions, and returned as results.

There are eight @x{basic types} in Lua:

@def{nil}, @def{boolean}, @def{number},  
@def{string},  
@def{function}, @def{userdata},  
@def{thread}, and @def{table}.

The type @emph{nil} has one single value, @nil,  
whose main property is to be different from any other value;  
it often represents the absence of a useful value.

The type @emph{boolean} has two values, @false and @true.

Both @nil and @false make a condition false;  
they are collectively called @def{false values}.

Any other value makes a condition true.

Despite its name,

@false is frequently used as an alternative to @nil,  
with the key difference that @false behaves  
like a regular value in a table,  
while a @nil in a table represents an absent key.

The type @emph{number} represents both  
integer numbers and real (floating-point) numbers,  
using two @x{subtypes}: @def{integer} and @def{float}.  
Standard Lua uses 64-bit integers and double-precision (64-bit) floats,  
but you can also compile Lua so that it  
uses 32-bit integers and/or single-precision (32-bit) floats.  
The option with 32 bits for both integers and floats  
is particularly  
attractive  
for small machines and embedded systems.  
(See macro @id{LUA\_32BITS} in file @id{luaconf.h}.)

Unless stated otherwise,  
any overflow when manipulating integer values @def{wrap around},  
according to the usual rules of two-complement arithmetic.  
(In other words,  
the actual result is the unique representable integer  
that is equal modulo  $2^M$  to the mathematical result,  
where  $M$  is the number of bits of the integer type.)

Lua has explicit rules about when each subtype is used,  
but it also converts between them automatically as needed @see{coercion}.  
Therefore,  
the programmer may choose to mostly ignore the difference  
between integers and floats  
or to assume complete control over the representation of each number.

The type `@emph{string}` represents immutable sequences of bytes.

`@index{eight-bit clean}`

Lua is 8-bit clean:

strings can contain any 8-bit value,

including `@x{embedded zeros}` (`@Char{\\0}`).

Lua is also encoding-agnostic;

it makes no assumptions about the contents

of a string.

The length of any string in Lua must fit in a Lua integer.

Lua can call (and manipulate) functions written in Lua and

functions written in C `@see{functioncall}`.

Both are represented by the type `@emph{function}`.

The type `@emph{userdata}` is provided to allow arbitrary `@N{C data}` to be stored in Lua variables.

A userdata value represents a block of raw memory.

There are two kinds of userdata:

`@emphx{full userdata}`,

which is an object with a block of memory managed by Lua,

and `@emphx{light userdata}`,

which is simply a `@N{C pointer}` value.

Userdata has no predefined operations in Lua,

except assignment and identity test.

By using `@emph{metatables}`,

the programmer can define operations for full userdata values

`@see{metatable}`.

Userdata values cannot be created or modified in Lua,

only through the `@N{C API}`.

This guarantees the integrity of data owned by

the host program and `@N{C libraries}`.

The type `@def{thread}` represents independent threads of execution and it is used to

implement coroutines `@see{coroutine}`.

Lua threads are not related to operating-system threads.

Lua supports coroutines on all systems,

even those that do not support threads natively.

The type `@emph{table}` implements `@x{associative arrays}`, that is, `@x{arrays}` that can have as indices not only numbers, but any Lua value except `@nil` and `@x{NaN}`.

(`@emphx{Not a Number}` is a special floating-point value

used by the `@x{IEEE 754}` standard to represent

undefined numerical results, such as `@T{0/0}`.)

Tables can be `@emph{heterogeneous}`;

that is, they can contain values of all types (except `@nil`).

Any key associated to the value `@nil` is not considered part of the table. Conversely, any key that is not part of a table has an associated value `@nil`.

Tables are the sole data-structuring mechanism in Lua; they can be used to represent ordinary arrays, lists, symbol tables, sets, records, graphs, trees, etc. To represent `@x{records}`, Lua uses the field name as an index. The language supports this representation by providing `@id{a.name}` as syntactic sugar for `@T{a["name"]}`. There are several convenient ways to create tables in Lua `@see{tableconstructor}`.

Like indices, the values of table fields can be of any type. In particular, because functions are first-class values, table fields can contain functions. Thus tables can also carry `@emph{methods}` `@see{func-def}`.

The indexing of tables follows the definition of raw equality in the language. The expressions `@T{a[i]}` and `@T{a[j]}` denote the same table element if and only if `@id{i}` and `@id{j}` are raw equal (that is, equal without metamethods). In particular, floats with integral values are equal to their respective integers (e.g., `@T{1.0 == 1}`). To avoid ambiguities, any float used as a key that is equal to an integer is converted to that integer. For instance, if you write `@T{a[2.0] = true}`, the actual key inserted into the table will be the integer `@T{2}`.

Tables, functions, threads, and (full) userdata values are `@emph{objects}`: variables do not actually `@emph{contain}` these values, only `@emph{references}` to them. Assignment, parameter passing, and function returns always manipulate references to such values; these operations do not imply any kind of copy.

The library function `@Lid{type}` returns a string describing the type of a given value `@seeF{type}`.

}

@sect2{globalenv| @title{Environments and the Global Environment}}

As we will discuss further in @refsec{variables} and @refsec{assignment}, any reference to a free name

(that is, a name not bound to any declaration) @id{var}

is syntactically translated to @T{\_ENV.var}.

Moreover, every chunk is compiled in the scope of an external local variable named @id{\_ENV} @see{chunks}, so @id{\_ENV} itself is never a free name in a chunk.

Despite the existence of this external @id{\_ENV} variable and the translation of free names,

@id{\_ENV} is a completely regular name.

In particular,

you can define new variables and parameters with that name.

Each reference to a free

name uses the @id{\_ENV} that is

visible at that point in the program,

following the usual visibility rules of Lua @see{visibility}.

Any table used as the value of @id{\_ENV} is called an @def{environment}.

Lua keeps a distinguished environment called the @def{global environment}.

This value is kept at a special index in the C registry @see{registry}.

In Lua, the global variable @Lid{\_G} is initialized with this same value.

(@Lid{\_G} is never used internally,

so changing its value will affect only your own code.)

When Lua loads a chunk,

the default value for its @id{\_ENV} variable

is the global environment @seeF{load}.

Therefore, by default,

free names in Lua code refer to entries in the global environment

and, therefore, they are also called @def{global variables}.

Moreover, all standard libraries are loaded in the global environment

and some functions there operate on that environment.

You can use @Lid{load} (or @Lid{loadfile})

to load a chunk with a different environment.

(In C,

you have to load the chunk and then change the value of its first upvalue; see @See{lua\_setupvalue}.)

}

@sect2{error| @title{Error Handling}}

Several operations in Lua can `@emph{raise}` an error.  
An error interrupts the normal flow of the program,  
which can continue by `@emph{catching}` the error.

Lua code can explicitly raise an error by calling the  
`@Lid{error}` function.  
(This function never returns.)

To catch errors in Lua,  
you can do a `@def{protected call}`,  
using `@Lid{pcall}` (or `@Lid{xpcall}`).  
The function `@Lid{pcall}` calls a given function in `@def{protected mode}`.  
Any error while running the function stops its execution,  
and control returns immediately to `@id{pcall}`,  
which returns a status code.

Because Lua is an embedded extension language,  
Lua code starts running by a call  
from `@N{C code}` in the host program.  
(When you use Lua standalone,  
the `@id{lua}` application is the host program.)  
Usually, this call is protected;  
so, when an otherwise unprotected error occurs during  
the compilation  
or execution of a Lua chunk,  
control returns to the host,  
which can take appropriate measures,  
such as printing an error message.

Whenever there is an error,  
an `@def{error object}`  
is propagated with information about the error.  
Lua itself only generates errors whose error object is a string,  
but programs can generate errors with  
any value as the error object.  
It is up to the Lua program or its host to handle such error objects.  
For historical reasons,  
an error object is often called an `@def{error message}`,  
even though it does not have to be a string.

When you use `@Lid{xpcall}` (or `@Lid{lua_pcall}`, in C)  
you can give a `@def{message handler}`  
to be called in case of errors.  
This function is called with the original error object  
and returns a new error object.  
It is called before the error unwinds the stack,  
so that it can gather more information about the error,

for instance by inspecting the stack and creating a stack traceback.  
 This message handler is still protected by the  
 protected call;  
 so, an error inside the message handler  
 will call the message handler again.  
 If this loop goes on for too long,  
 Lua breaks it and returns an appropriate message.  
 The message handler is called only for regular runtime errors.  
 It is not called for memory-allocation errors  
 nor for errors while running finalizers or other message handlers.

Lua also offers a system of `@emph{warnings}` `@seeF{warn}`.  
 Unlike errors, warnings do not interfere  
 in any way with program execution.  
 They typically only generate a message to the user,  
 although this behavior can be adapted from C `@seeC{lua_setwarnf}`.

}

`@sect2{metatable| @title{Metatables and Metamethods}}`

Every value in Lua can have a `@emph{metatable}`.  
 This `@def{metatable}` is an ordinary Lua table  
 that defines the behavior of the original value  
 under certain events.  
 You can change several aspects of the behavior  
 of a value by setting specific fields in its metatable.  
 For instance, when a non-numeric value is the operand of an addition,  
 Lua  
 checks for a function in the field `@idx{__add}` of the value's metatable.  
 If it finds one,  
 Lua calls this function to perform the addition.

The key for each event in a metatable is a string  
 with the event name prefixed by two underscores;  
 the corresponding value is called a `@def{metavalue}`.  
 For most events, the metavalue must be a function,  
 which is then called a `@def{metamethod}`.  
 In the previous example, the key is the string `@St{__add}`  
 and the metamethod is the function that performs the addition.  
 Unless stated otherwise,  
 a metamethod can in fact be any `@x{callable value}`,  
 which is either a function or a value with a `@idx{__call}` metamethod.

You can query the metatable of any value  
 using the `@Lid{getmetatable}` function.  
 Lua queries metamethods in metatables using a raw access `@seeF{rawget}`.

You can replace the metatable of tables using the `@Lid{setmetatable}` function. You cannot change the metatable of other types from Lua code, except by using the `@link{debuglib|debug library}`.

Tables and full userdata have individual metatables, although multiple tables and userdata can share their metatables. Values of all other types share one single metatable per type; that is, there is one single metatable for all numbers, one for all strings, etc. By default, a value has no metatable, but the string library sets a metatable for the string type `@see{strlib}`.

A detailed list of operations controlled by metatables is given next. Each event is identified by its corresponding key. By convention, all metatable keys used by Lua are composed by two underscores followed by lowercase Latin letters.

`@description{`

`@item{@idx{__add}|`  
the addition (`@T{+}`) operation.  
If any operand for an addition is not a number,  
Lua will try to call a metamethod.  
It starts by checking the first operand (even if it is a number);  
if that operand does not define a metamethod for `@idx{__add}`,  
then Lua will check the second operand.  
If Lua can find a metamethod,  
it calls the metamethod with the two  
operands as arguments,  
and the result of the call  
(adjusted to one value)  
is the result of the operation.  
Otherwise, if no metamethod is found,  
Lua raises an error.  
`}`

`@item{@idx{__sub}|`  
the subtraction (`@T{-}`) operation.  
Behavior similar to the addition operation.  
`}`

`@item{@idx{__mul}|`  
the multiplication (`@T{*}`) operation.  
Behavior similar to the addition operation.  
`}`

@item{@idx{\_\_div}|  
the division (@T{/}) operation.  
Behavior similar to the addition operation.  
}

@item{@idx{\_\_mod}|  
the modulo (@T{%}) operation.  
Behavior similar to the addition operation.  
}

@item{@idx{\_\_pow}|  
the exponentiation (@T{^}) operation.  
Behavior similar to the addition operation.  
}

@item{@idx{\_\_unm}|  
the negation (unary @T{-}) operation.  
Behavior similar to the addition operation.  
}

@item{@idx{\_\_idiv}|  
the floor division (@T{//}) operation.  
Behavior similar to the addition operation.  
}

@item{@idx{\_\_band}|  
the bitwise AND (@T{&}) operation.  
Behavior similar to the addition operation,  
except that Lua will  
try a metamethod  
if any operand is neither an integer  
nor a float coercible to an integer @see{coercion}.  
}

@item{@idx{\_\_bor}|  
the bitwise OR (@T{|}) operation.  
Behavior similar to the bitwise AND operation.  
}

@item{@idx{\_\_bxor}|  
the bitwise exclusive OR (binary @T{~}) operation.  
Behavior similar to the bitwise AND operation.  
}

@item{@idx{\_\_bnot}|  
the bitwise NOT (unary @T{~}) operation.  
Behavior similar to the bitwise AND operation.  
}



@item{@idx{\_\_shl}|  
the bitwise left shift (@T{<<}) operation.  
Behavior similar to the bitwise AND operation.  
}

@item{@idx{\_\_shr}|  
the bitwise right shift (@T{>>}) operation.  
Behavior similar to the bitwise AND operation.  
}

@item{@idx{\_\_concat}|  
the concatenation (@T{..}) operation.  
Behavior similar to the addition operation,  
except that Lua will try a metamethod  
if any operand is neither a string nor a number  
(which is always coercible to a string).  
}

@item{@idx{\_\_len}|  
the length (@T{#}) operation.  
If the object is not a string,  
Lua will try its  
metamethod.  
If there is a metamethod,  
Lua calls it with the object as argument,  
and the result of the call  
(always adjusted to one value)  
is the result of the operation.  
If there is no metamethod but the object is a table,  
then Lua uses the table length operation @see{len-op}.  
Otherwise, Lua raises an error.  
}

@item{@idx{\_\_eq}|  
the equal (@T{==}) operation.  
Behavior similar to the addition operation,  
except that Lua will try a metamethod only when the values  
being compared are either both tables or both full userdata  
and they are not primitively equal.  
The result of the call is always converted to a boolean.  
}

@item{@idx{\_\_lt}|  
the less than (@T{<}) operation.  
Behavior similar to the addition operation,  
except that Lua will try a metamethod only when the values  
being compared are neither both numbers nor both strings.

Moreover, the result of the call is always converted to a boolean.

}

@item{@idx{\_\_le}|

the less equal (@T{<=}) operation.

Behavior similar to the less than operation.

}

@item{@idx{\_\_index}|

The

indexing access operation @T{table[key]}.

This event happens when @id{table} is not a table or

when @id{key} is not present in @id{table}.

The metavalue is looked up in the metatable of @id{table}.

The metavalue for this event can be either a function, a table,  
or any value with an @idx{\_\_index} metavalue.

If it is a function,

it is called with @id{table} and @id{key} as arguments,

and the result of the call

(adjusted to one value)

is the result of the operation.

Otherwise,

the final result is the result of indexing this metavalue with @id{key}.

This indexing is regular, not raw,

and therefore can trigger another @idx{\_\_index} metavalue.

}

@item{@idx{\_\_newindex}|

The indexing assignment @T{table[key] = value}.

Like the index event,

this event happens when @id{table} is not a table or

when @id{key} is not present in @id{table}.

The metavalue is looked up in the metatable of @id{table}.

Like with indexing,

the metavalue for this event can be either a function,

a table,

or any value with an @idx{\_\_newindex} metavalue.

If it is a function,

it is called with @id{table}, @id{key}, and @id{value} as arguments.

Otherwise,

Lua repeats the indexing assignment over this metavalue

with the same key and value.

This assignment is regular, not raw,

and therefore can trigger another @idx{\_\_newindex} metavalue.

Whenever a @idx{\_\_newindex} metavalue is invoked,

Lua does not perform the primitive assignment.

If needed,

the metamethod itself can call `@Lid{rawset}`

to do the assignment.

}

`@item{@idx{__call}|`

The call operation `@T{func(args)}`.

This event happens when Lua tries to call a non-function value (that is, `@id{func}` is not a function).

The metamethod is looked up in `@id{func}`.

If present,

the metamethod is called with `@id{func}` as its first argument, followed by the arguments of the original call (`@id{args}`).

All results of the call

are the results of the operation.

This is the only metamethod that allows multiple results.

}

}

In addition to

the previous list,

the interpreter also respects the following keys in metatables:

`@idx{__gc}` `@see{finalizers}`,

`@idx{__close}` `@see{to-be-closed}`,

`@idx{__mode}` `@see{weak-table}`,

and `@idx{__name}`.

(The entry `@idx{__name}`,

when it contains a string,

may be used by `@Lid{tostring}` and in error messages.)

For the unary operators (negation, length, and bitwise NOT),

the metamethod is computed and called with a dummy second operand, equal to the first one.

This extra operand is only to simplify Lua's internals

(by making these operators behave like a binary operation)

and may be removed in future versions.

For most uses this extra operand is irrelevant.

Because metatables are regular tables,

they can contain arbitrary fields,

not only the event names defined above.

Some functions in the standard library

(e.g., `@Lid{tostring}`)

use other fields in metatables for their own purposes.

It is a good practice to add all needed metamethods to a table

before setting it as a metatable of some object.

In

particular, the `@idx{__gc}` metamethod works only when this order is followed `@see{finalizers}`.

It is also a good practice to set the metatable of an object right after its creation.

```
}
```

```
@sect2{GC| @title{Garbage Collection}
```

```
@simplesect{
```

Lua performs automatic memory management.

This means that

you do not have to worry about allocating memory for new objects or freeing it when the objects are no longer needed.

Lua manages memory automatically by running

a `@def{garbage collector}` to collect all `@emph{dead}` objects.

All memory used by Lua is subject to automatic management:

strings, tables, userdata, functions, threads, internal structures, etc.

An object is considered `@def{dead}`

as soon as the collector can be sure the object

will not be accessed again in the normal execution of the program.

(`@Q{Normal execution}` here excludes finalizers,

which can resurrect dead objects `@see{finalizers}`,

and excludes also operations using the debug library.)

Note that the time when the collector can

be sure that an object

is dead may not coincide with the programmer's expectations.

The only guarantees are that Lua will not collect an object

that may still be accessed in the normal execution of the program,

and it will eventually collect an object

that is inaccessible from Lua.

(Here,

`@emph{inaccessible from Lua}` means that neither a variable nor another live object refer to the object.)

Because Lua has no knowledge about `@N{C code}`,

it never collects objects accessible through the registry `@see{registry}`,

which includes the global environment `@see{globalenv}`.

The garbage collector (GC) in Lua can work in two modes:

incremental and generational.

The default GC mode with the default parameters

are adequate for most uses.

However, programs that waste a large proportion of their time allocating and freeing memory can benefit from other settings. Keep in mind that the GC behavior is non-portable both across platforms and across different Lua releases; therefore, optimal settings are also non-portable.

You can change the GC mode and parameters by calling `@Lid{lua_gc} @N{in C}` or `@Lid{collectgarbage}` in Lua. You can also use these functions to control the collector directly (e.g., to stop and restart it).

}

@sect3{incmode| @title{Incremental Garbage Collection}

In incremental mode, each GC cycle performs a mark-and-sweep collection in small steps interleaved with the program's execution.

In this mode, the collector uses three numbers to control its garbage-collection cycles: the `@def{garbage-collector pause}`, the `@def{garbage-collector step multiplier}`, and the `@def{garbage-collector step size}`.

The garbage-collector pause controls how long the collector waits before starting a new cycle. The collector starts a new cycle when the use of memory hits `@M{n%}` of the use after the previous collection. Larger values make the collector less aggressive. Values equal to or less than 100 mean the collector will not wait to start a new cycle. A value of 200 means that the collector waits for the total memory in use to double before starting a new cycle. The default value is 200; the maximum value is 1000.

The garbage-collector step multiplier controls the speed of the collector relative to memory allocation, that is, how many elements it marks or sweeps for each kilobyte of memory allocated. Larger values make the collector more aggressive but also increase the size of each incremental step. You should not use values less than 100, because they make the collector too slow and

can result in the collector never finishing a cycle.  
The default value is 100; the maximum value is 1000.

The garbage-collector step size controls the size of each incremental step, specifically how many bytes the interpreter allocates before performing a step.

This parameter is logarithmic:

A value of  $2^n$  means the interpreter will allocate  $2^n$  bytes between steps and perform equivalent work during the step.

A large value (e.g., 60) makes the collector a stop-the-world (non-incremental) collector.

The default value is 13, which means steps of approximately 8 Kbytes.

}

@sect3{genmode| @title{Generational Garbage Collection}}

In generational mode, the collector does frequent *minor* collections, which traverses only objects recently created. If after a minor collection the use of memory is still above a limit, the collector does a stop-the-world *major* collection, which traverses all objects. The generational mode uses two parameters: the *minor multiplier* and the *major multiplier*.

The minor multiplier controls the frequency of minor collections. For a minor multiplier  $x$ , a new minor collection will be done when memory grows  $x\%$  larger than the memory in use after the previous major collection. For instance, for a multiplier of 20, the collector will do a minor collection when the use of memory gets 20% larger than the use after the previous major collection. The default value is 20; the maximum value is 200.

The major multiplier controls the frequency of major collections. For a major multiplier  $x$ , a new major collection will be done when memory grows  $x\%$  larger than the memory in use after the previous major collection. For instance, for a multiplier of 100, the collector will do a major collection when the use of memory gets larger than twice the use after the previous collection.

The default value is 100; the maximum value is 1000.

```
}
```

@sect3{finalizers| @title{Garbage-Collection Metamethods}

You can set garbage-collector metamethods for tables and, using the @N{C API}, for full userdata @see{metatable}.

These metamethods, called @def{finalizers}, are called when the garbage collector detects that the corresponding table or userdata is dead.

Finalizers allow you to coordinate Lua's garbage collection with external resource management such as closing files, network or database connections, or freeing your own memory.

For an object (table or userdata) to be finalized when collected, you

must @emph{mark} it for finalization.

@index{mark (for finalization)}

You mark an object for finalization when you set its metatable and the metatable has a @idx{\_\_gc} metamethod.

Note that if you set a metatable without a @idx{\_\_gc} field and later create that field in the metatable, the object will not be marked for finalization.

When a marked object becomes dead, it is not collected immediately by the garbage collector.

Instead, Lua puts it in a list.

After the collection,

Lua goes through that list.

For each object in the list,

it checks the object's @idx{\_\_gc} metamethod:

If it is present,

Lua calls it with the object as its single argument.

At the end of each garbage-collection cycle, the finalizers are called in the reverse order that the objects were marked for finalization, among those collected in that cycle; that is, the first finalizer to be called is the one associated with the object marked last in the program.

The execution of each finalizer may occur at any point during the execution of the regular code.

Because the object being collected must still be used by the finalizer,

that object (and other objects accessible only through it) must be `@emph{resurrected}` by `Lua.@index{resurrection}`. Usually, this resurrection is transient, and the object memory is freed in the next garbage-collection cycle. However, if the finalizer stores the object in some global place (e.g., a global variable), then the resurrection is permanent. Moreover, if the finalizer marks a finalizing object for finalization again, its finalizer will be called again in the next cycle where the object is dead. In any case, the object memory is freed only in a GC cycle where the object is dead and not marked for finalization.

When you close a state `@seeF{lua_close}`, Lua calls the finalizers of all objects marked for finalization, following the reverse order that they were marked. If any finalizer marks objects for collection during that phase, these marks have no effect.

#### Finalizers

cannot yield nor run the garbage collector. Because they can run in unpredictable times, it is good practice to restrict each finalizer to the minimum necessary to properly release its associated resource.

Any error while running a finalizer generates a warning; the error is not propagated.

}

#### `@sect3{weak-table| @title{Weak Tables}`

A `@def{weak table}` is a table whose elements are `@def{weak references}`. A weak reference is ignored by the garbage collector. In other words, if the only references to an object are weak references, then the garbage collector will collect that object.

A weak table can have weak keys, weak values, or both. A table with weak values allows the collection of its values, but prevents the collection of its keys. A table with both weak keys and weak values allows the collection of both keys and values. In any case, if either the key or the value is collected, the whole pair is removed from the table.



The weakness of a table is controlled by the

`@idx{__mode}`

field of its metatable.

This metavalue, if present, must be one of the following strings:

`@St{k}`, for a table with weak keys;

`@St{v}`, for a table with weak values;

or `@St{kv}`, for a table with both weak keys and values.

A table with weak keys and strong values

is also called an `@def{ephemeron table}`.

In an ephemeron table,

a value is considered reachable only if its key is reachable.

In particular,

if the only reference to a key comes through its value,

the pair is removed.

Any change in the weakness of a table may take effect only at the next collect cycle.

In particular, if you change the weakness to a stronger mode,

Lua may still collect some items from that table

before the change takes effect.

Only objects that have an explicit construction

are removed from weak tables.

Values, such as numbers and `@x{light @N{C functions}}`,

are not subject to garbage collection,

and therefore are not removed from weak tables

(unless their associated values are collected).

Although strings

are subject to garbage collection,

they do not have an explicit construction and

their equality is by value;

they behave more like values than like objects.

Therefore, they are not removed from weak tables.

Resurrected objects

(that is, objects being finalized

and objects accessible only through objects being finalized)

have a special behavior in weak tables.

They are removed from weak values before running their finalizers,

but are removed from weak keys only in the next collection

after running their finalizers, when such objects are actually freed.

This behavior allows the finalizer to access properties

associated with the object through weak tables.

If a weak table is among the resurrected objects in a collection cycle,

it may not be properly cleared until the next cycle.

}

}

@sect2{coroutine| @title{Coroutines}

Lua supports coroutines,  
also called @emphx{collaborative multithreading}.  
A coroutine in Lua represents an independent thread of execution.  
Unlike threads in multithread  
systems, however,  
a coroutine only suspends its execution by explicitly calling  
a yield function.

You create a coroutine by calling @Lid{coroutine.create}.  
Its sole argument is a function  
that is the main function of the coroutine.  
The @id{create} function only creates a new coroutine and  
returns a handle to it (an object of type @emph{thread});  
it does not start the coroutine.

You execute a coroutine by calling @Lid{coroutine.resume}.  
When you first call @Lid{coroutine.resume},  
passing as its first argument  
a thread returned by @Lid{coroutine.create},  
the coroutine starts its execution by  
calling its main function.  
Extra arguments passed to @Lid{coroutine.resume} are passed  
as arguments to that function.  
After the coroutine starts running,  
it runs until it terminates or @emph{yields}.

A coroutine can terminate its execution in two ways:  
normally, when its main function returns  
(explicitly or implicitly, after the last instruction);  
and abnormally, if there is an unprotected  
error.  
In case of normal termination,  
@Lid{coroutine.resume} returns @true,  
plus any values returned by the coroutine main function.  
In case of errors, @Lid{coroutine.resume} returns @false  
plus the error object.  
In this case, the coroutine does not unwind its stack,  
so that it is possible to inspect it after the error  
with the debug API.

A coroutine yields by calling @Lid{coroutine.yield}.  
When a coroutine yields,

the corresponding `@Lid{coroutine.resume}` returns immediately, even if the yield happens inside nested function calls (that is, not in the main function, but in a function directly or indirectly called by the main function). In the case of a yield, `@Lid{coroutine.resume}` also returns `@true`, plus any values passed to `@Lid{coroutine.yield}`. The next time you resume the same coroutine, it continues its execution from the point where it yielded, with the call to `@Lid{coroutine.yield}` returning any extra arguments passed to `@Lid{coroutine.resume}`.

Like `@Lid{coroutine.create}`, the `@Lid{coroutine.wrap}` function also creates a coroutine, but instead of returning the coroutine itself, it returns a function that, when called, resumes the coroutine. Any arguments passed to this function go as extra arguments to `@Lid{coroutine.resume}`. `@Lid{coroutine.wrap}` returns all the values returned by `@Lid{coroutine.resume}`, except the first one (the boolean error code). Unlike `@Lid{coroutine.resume}`, the function created by `@Lid{coroutine.wrap}` propagates any error to the caller. In this case, the function also closes the coroutine `@seeF{coroutine.close}`.

As an example of how coroutines work, consider the following code:

```
@verbatim{
function foo (a)
  print("foo", a)
  return coroutine.yield(2*a)
end

co = coroutine.create(function (a,b)
  print("co-body", a, b)
  local r = foo(a+1)
  print("co-body", r)
  local r, s = coroutine.yield(a+b, a-b)
  print("co-body", r, s)
  return b, "end"
end)

print("main", coroutine.resume(co, 1, 10))
print("main", coroutine.resume(co,
  "r"))
print("main", coroutine.resume(co, "x", "y"))
print("main", coroutine.resume(co, "x", "y"))
```

```
}
```

When you run it, it produces the following output:

```
@verbatim{
```

```
co-body 1    10
```

```
foo    2
```

```
main   true  4
```

```
co-body r
```

```
main   true  11  -9
```

```
co-body x    y
```

```
main   true  10   end
```

```
main   false  cannot resume dead coroutine
```

```
}
```

You can also create and manipulate coroutines through the C API:

see functions `@Lid{lua_newthread}`, `@Lid{lua_resume}`,

and `@Lid{lua_yield}`.

```
}
```

```
}
```

```
@C{-----}
```

```
@sect1{language| @title{The Language}}
```

```
@simplesect{
```

This section describes the lexis, the syntax, and the semantics of Lua.

In other words,

this section describes

which tokens are valid,

how they can be combined,

and what their combinations mean.

Language constructs will be explained using the usual extended BNF notation,

in which

`@N{@bnfrep{@rep{a}}` means 0 or more `@rep{a}`'s, and

`@N{@bnfopt{@rep{a}}` means } an

optional `@rep{a}`.

Non-terminals are shown like `@bnfNter{non-terminal}`,

keywords are shown like `@rw{kword}`,

and other terminal symbols are shown like `@bnfter{=}`.

The complete syntax of Lua can be found in `@refsec{BNF}`

at the end of this manual.

```
}
```

```
@sect2{lexical| @title{Lexical Conventions}}
```

Lua is a @x{free-form} language.

It ignores spaces and comments between lexical elements (@x{tokens}), except as delimiters between two tokens.

In source code,

Lua recognizes as spaces the standard ASCII whitespace characters space, form feed, newline, carriage return, horizontal tab, and vertical tab.

@def{Names}

(also called @def{identifiers})

in Lua can be any string of Latin letters,

Arabic-Indic digits, and underscores,

not beginning with a digit and

not being a reserved word.

Identifiers are used to name variables, table fields, and labels.

The following @def{keywords} are reserved and cannot be used as names:

@index{reserved words}

@verbatim{

and    break    do       else    elseif  
      end

false   for    function goto   if    in

local   nil    not    or    repeat   return

then    true    until   while

}

Lua is a case-sensitive language:

@id{and} is a reserved word, but @id{And} and @id{AND} are two different, valid names.

As a convention,

programs should avoid creating

names that start with an underscore followed by

one or more uppercase letters (such as @Lid{\_VERSION}).

The following strings denote other @x{tokens}:

@verbatim{

+   -   \*   /   %   ^   #

&   ~   |   <<   >>   //

==   ~=   <=   >=   <   >   =

(   )   {   }   [   ]   ::

;   :   ,   .   ..   ...

}

A @def{short literal string}

can be delimited by matching single or double quotes,

and can contain the following C-like escape sequences:

@Char{a} (bell),  
@Char{b} (backspace),  
@Char{f} (form feed),  
@Char{n} (newline),  
@Char{r} (carriage return),  
@Char{t} (horizontal tab),  
@Char{v} (vertical tab),  
@Char{\\} (backslash),  
@Char{\"}  
(quotation mark [double quote]),  
and @Char{'} (apostrophe [single quote]).

A backslash followed by a line break  
results in a newline in the string.

The escape sequence @Char{z} skips the following span  
of whitespace characters,  
including line breaks;

it is particularly useful to break and indent a long literal string  
into multiple lines without adding the newlines and spaces  
into the string contents.

A short literal string cannot contain unescaped line breaks  
nor escapes not forming a valid escape sequence.

We can specify any byte in a short literal string,  
including @x{embedded zeros},  
by its numeric value.

This can be done

with the escape sequence @T{x@rep{XX}},  
where @rep{XX} is a sequence of exactly two hexadecimal digits,  
or with the escape sequence @T{@rep{ddd}},

where @rep{ddd} is a sequence of up to three decimal digits.

(Note that if a decimal escape sequence is to be followed by a digit,  
it must be expressed using exactly three digits.)

The @x{UTF-8} encoding

of a @x{Unicode} character

can be inserted in a literal string with

the escape sequence @T{@rep{XXX}}

(with mandatory enclosing braces),

where @rep{XXX} is a sequence of one or more hexadecimal digits  
representing the character code point.

This code point can be any value less than @M{2@sp{31}}.

(Lua uses the original UTF-8 specification here,

which is not restricted to valid Unicode code points.)

Literal strings can also be defined using a long format

enclosed by @def{long brackets}.

We define an @def{opening long bracket of level @rep{n}} as an opening  
square bracket followed by @rep{n} equal signs followed by another

opening square bracket.

So, an opening long bracket of @N{level 0} is written as @T{[[[}, @C{]]]}

an opening long bracket of @N{level 1} is written as @T{[=[}, @C{]]]}

and so on.

A @emph{closing long bracket} is defined similarly;

for instance,

a closing long bracket of @N{level 4} is written as @C{[[[ @T{]===}]}

A @def{long literal} starts with an opening long bracket

of any level and

ends at the first closing long bracket of the same level.

It can contain any text except a closing bracket of the same level.

Literals in this bracketed form can run for several lines,

do not interpret any escape sequences,

and ignore long brackets of any other level.

Any kind of end-of-line sequence

(carriage return, newline, carriage return followed by newline,

or newline followed by carriage return)

is converted to a simple newline.

When the opening long bracket is immediately followed by a newline,

the newline is not included in the string.

As an example, in a system using ASCII

(in which @Char{a} is coded @N{as 97},

newline is coded @N{as 10}, and @Char{1} is coded @N{as 49}),

the five literal strings below denote the same string:

```
@verbatim{
```

```
a = 'alo\n123'''
```

```
a = "alo\n123\""
```

```
a = "\97lo\10\04923"
```

```
a = [[alo
```

```
123"]]
```

```
a = [=[
```

```
alo
```

```
123"]]=]
```

```
}
```

Any byte in a literal string not

explicitly affected by the previous rules represents itself.

However, Lua opens files for

parsing in text mode,

and the system's file functions may have problems with

some control characters.

So, it is safer to represent

binary data as a quoted literal with

explicit escape sequences for the non-text characters.

A @def{numeric constant} (or @def{numeral})

can be written with an optional fractional part

and an optional decimal exponent,  
marked by a letter `@Char{e}` or `@Char{E}`.  
Lua also accepts `@x{hexadecimal constants}`,  
which start with `@T{0x}` or `@T{0X}`.  
Hexadecimal constants also accept an optional fractional part  
plus an optional binary exponent,  
marked by a letter `@Char{p}` or `@Char{P}` and written in decimal.  
(For instance, `@T{0x1.fp10}` denotes 1984,  
which is `@M{0x1f / 16}` multiplied by `@M{2@sp{10}}.`)

A numeric constant with a radix point or an exponent  
denotes a float;  
otherwise,  
if its value fits in an integer or it is a hexadecimal constant,  
it denotes an integer;  
otherwise (that is, a decimal integer numeral that overflows),  
it denotes a float.  
Hexadecimal numerals  
with neither a radix point nor an exponent  
always denote an integer value;  
if the value overflows, it `@emph{wraps around}`  
to fit into a valid integer.

Examples of valid integer constants are

```
@verbatim{
3 345 0xff 0xBEBADA
}
```

Examples of valid float constants are

```
@verbatim{
3.0 3.1416 314.16e-2 0.31416E1 34e1
0x0.1E 0xA23p-4 0X1.921FB54442D18P+1
}
```

A `@def{comment}` starts with a double hyphen (`@T{--}`)  
anywhere outside a string.  
If the text immediately after `@T{--}` is not an opening long bracket,  
the comment is a `@def{short comment}`,  
which runs until the end of the line.  
Otherwise, it is a `@def{long comment}`,  
which runs until the corresponding closing long bracket.

}

`@sect2{variables| @title{Variables}}`

Variables are places that store values.  
There are three kinds of variables in Lua:  
global variables, local variables, and table fields.



A single name can denote a global variable or a local variable  
(or a function's formal parameter,  
which is a particular kind of  
local variable):

```
@Produc{
@producname{var}@producbody{@bnfNter{Name}}
}
@bnfNter{Name} denotes identifiers @see{lexical}.
```

Any variable name is assumed to be global unless explicitly declared  
as a local @see{localvar}.

@x{Local variables} are @emph{lexically scoped}:  
local variables can be freely accessed by functions  
defined inside their scope @see{visibility}.

Before the first assignment to a variable, its value is @nil.

Square brackets are used to index a table:

```
@Produc{
@producname{var}@producbody{prefixexp @bnfter{[] exp @bnfter{[]}}
}
```

The meaning of accesses to table fields can be changed via metatables  
@see{metatable}.

The syntax @id{var.Name} is just syntactic sugar for

```
@T{var["Name"]}:
@Produc{
@producname{var}@producbody{prefixexp @bnfter{.} @bnfNter{Name}}
}
```

An access to a global variable @id{x}  
is equivalent to @id{\_ENV.x}.

Due to the way that chunks are compiled,  
the variable @id{\_ENV} itself is never global @see{globalenv}.

```
}
```

```
@sect2{stats| @title{Statements}}
```

```
@simplesect{
```

Lua

supports an almost conventional set of @x{statements},  
similar to those in other conventional languages.

This set includes

blocks, assignments, control structures, function calls,  
and variable declarations.

```
}
```

```
@sect3{@title{Blocks}}
```

A `@x{block}` is a list of statements,  
which are executed sequentially:

```
@Produc{  
@producname{block}@producbody{@bnfrep{stat}}  
}
```

Lua has `@def{empty statements}`  
that allow you to separate statements with semicolons,  
start a block with a semicolon  
or write two semicolons in sequence:

```
@Produc{  
@producname{stat}@producbody{@bnfter{;}}  
}
```

Both function calls and assignments  
can start with an open parenthesis.  
This possibility leads to an ambiguity in Lua's grammar.  
Consider the following fragment:

```
@verbatim{  
a = b + c  
(print or io.write)('done')  
}
```

The grammar could see this fragment in two ways:

```
@verbatim{  
a = b + c(print or io.write)('done')
```

```
a = b + c; (print or io.write)('done')  
}
```

The current parser always sees such constructions  
in the first way,  
interpreting  
the open parenthesis  
as the start of the arguments to a call.  
To avoid this ambiguity,  
it is a good practice to always precede with a semicolon  
statements that start with a parenthesis:

```
@verbatim{  
;(print or io.write)('done')  
}
```

A block can be explicitly delimited to produce a single statement:

```
@Produc{  
@producname{stat}@producbody{@Rw{do} block @Rw{end}}  
}
```

Explicit blocks are useful  
to control the scope of variable declarations.  
Explicit blocks are also sometimes used to  
add a `@Rw{return}` statement in the middle  
of another block `@see{control}`.

}

`@sect3{chunks| @title{Chunks}}`

The unit of compilation of Lua is called a `@def{chunk}`.

Syntactically,

a chunk is simply a block:

```
@Produc{
@producname{chunk}@producbody{block}
}
```

Lua handles a chunk as the body of an anonymous function  
with a variable number of arguments

`@see{func-def}`.

As such, chunks can define local variables,  
receive arguments, and return values.

Moreover, such anonymous function is compiled as in the  
scope of

an external local variable called `@id{_ENV}` `@see{globalenv}`.

The resulting function always has `@id{_ENV}` as its only external variable,  
even if it does not use that variable.

A chunk can be stored in a file or in a string inside the host program.

To execute a chunk,

Lua first `@emph{loads}` it,

precompiling the chunk's code into instructions for a virtual machine,

and then Lua executes the compiled code

with an interpreter for the virtual machine.

Chunks can also be precompiled into binary form;

see the program `@idx{luac}` and the function `@Lid{string.dump}` for details.

Programs in source and compiled forms are interchangeable;

Lua automatically detects the file type and acts accordingly `@seeF{load}`.

}

`@sect3{assignment| @title{Assignment}}`

Lua allows `@x{multiple assignments}`.

Therefore, the syntax for assignment

defines a list of variables on the left side

and a list of expressions on the right side.

The elements in both lists are separated by commas:

```
@Produc{
@producname{stat}@producbody{varlist
@bnfter{=} explist}
@producname{varlist}@producbody{var @bnfrep{@bnfter{,} var}}
@producname{explist}@producbody{exp @bnfrep{@bnfter{,} exp}}
}
```

Expressions are discussed in @See{expressions}.

Before the assignment,  
the list of values is @emph{adjusted} to the length of  
the list of variables @see{multires}.

If a variable is both assigned and read  
inside a multiple assignment,  
Lua ensures that all reads get the value of the variable  
before the assignment.

Thus the code

```
@verbatim{
i = 3
i, a[i] = i+1, 20
}
sets @T{a[3]} to 20, without affecting @T{a[4]}
because the @id{i} in @T{a[i]} is evaluated (to 3)
before it is @N{assigned 4}.
```

Similarly, the line

```
@verbatim{
x, y = y, x
}
exchanges the values of @id{x} and @id{y},
and
```

```
@verbatim{
x, y, z = y, z, x
}
cyclically permutes the values of @id{x}, @id{y}, and @id{z}.
```

Note that this guarantee covers only accesses  
syntactically inside the assignment statement.  
If a function or a metamethod called during the assignment  
changes  
the value of a variable,  
Lua gives no guarantees about the order of that access.

An assignment to a global name @T{x = val}  
is equivalent to the assignment  
@T{\_ENV.x = val} @see{globalenv}.

The meaning of assignments to table fields and

global variables (which are actually table fields, too)  
can be changed via metatables `@see{metatable}`.

}

`@sect3{control| @title{Control Structures}`

The control structures

`@Rw{if}`, `@Rw{while}`, and `@Rw{repeat}` have the usual meaning and familiar syntax:

`@index{while-do statement}`

`@index{repeat-until statement}`

`@index{if-then-else statement}`

`@Produc{`

`@producname{stat}@produciblebody{@Rw{while} exp @Rw{do} block @Rw{end}}`

`@producname{stat}@produciblebody{@Rw{repeat} block @Rw{until} exp}`

`@producname{stat}@produciblebody{@Rw{if} exp @Rw{then} block`

`@bnfrep{@Rw{elseif} exp @Rw{then} block}`

`@bnfopt{@Rw{else} block} @Rw{end}}`

}

Lua also has a `@Rw{for}` statement, in two flavors `@see{for}`.

The `@x{condition expression}` of a control structure can return any value.

Both

`@false` and `@nil` test false.

All values different from `@nil` and `@false` test true.

In particular, the number 0 and the empty string also test true.

In the `@Rw{repeat}@En@Rw{until}` loop, the inner block does not end at the `@Rw{until}` keyword, but only after the condition.

So, the condition can refer to local variables declared inside the loop block.

The `@Rw{goto}` statement transfers the program control to a label.

For syntactical reasons,

labels in Lua are considered statements too:

`@index{goto statement}`

`@index{label}`

`@Produc{`

`@producname{stat}@produciblebody{@Rw{goto} Name}`

`@producname{stat}@produciblebody{label}`

`@producname{label}@produciblebody{@bnfter{::} Name @bnfter{::}}`

}

A label is visible in the entire block where it is defined, except inside nested functions.

A goto can jump to any visible label as long as it does not

enter into the scope of a local variable.

A label should not be declared

where a label with the same name is visible,

even if this other label has been declared in an enclosing block.

The `@Rw{break}` statement terminates the execution of a

`@Rw{while}`, `@Rw{repeat}`, or `@Rw{for}` loop,

skipping to the next statement after the loop:

```
@index{break statement}
```

```
@Produc{
```

```
@producname{stat}@producbody{@Rw{break}}
```

```
}
```

A `@Rw{break}` ends the innermost enclosing loop.

The `@Rw{return}` statement is used to return values

from a function or a chunk

(which is handled as an anonymous function).

```
@index{return statement}
```

Functions can return more than one value,

so the syntax for the `@Rw{return}` statement is

```
@Produc{
```

```
@producname{stat}@producbody{@Rw{return} @bnfopt{explist} @bnfopt{@bnfter{;}}}
```

```
}
```

The `@Rw{return}` statement can only be written

as the last statement of a block.

If it is necessary to `@Rw{return}` in the middle of a block,

then an explicit inner block can be used,

as in the idiom `@T{do return end}`,

because now `@Rw{return}` is the last statement in its (inner) block.

```
}
```

```
@sect3{for| @title{For Statement}
```

```
@index{for statement}
```

The `@Rw{for}` statement has two forms:

one

numerical and one generic.

```
@sect4{@title{The numerical @Rw{for} loop}
```

The numerical `@Rw{for}` loop repeats a block of code while a

control variable goes through an arithmetic progression.

It has the following syntax:

```
@Produc{
```

```
@producname{stat}@producbody{@Rw{for} @bnfNter{Name} @bnfter{=}
```

```
exp @bnfter{,} exp @bnftpt{@bnfter{,} exp} @Rw{do} block @Rw{end}}  
}
```

The given identifier (@bnfNter{Name}) defines the control variable,  
which is a new variable local to the loop body (@emph{block}).

The loop starts by evaluating once the three control expressions.

Their values are called respectively

the @emph{initial value}, the @emph{limit}, and the @emph{step}.

If the step is absent, it defaults @N{to 1}.

If both the initial value and the step are integers,

the loop is done with integers;

note that the limit may not be an integer.

Otherwise, the three values are converted to

floats and the loop is done with floats.

Beware of floating-point accuracy in this case.

After that initialization,

the

loop body is repeated with the value of the control variable

going through an arithmetic progression,

starting at the initial value,

with a common difference given by the step.

A negative step makes a decreasing sequence;

a step equal to zero raises an error.

The loop continues while the value is less than

or equal to the limit

(greater than or equal to for a negative step).

If the initial value is already greater than the limit

(or less than, if the step is negative),

the body is not executed.

For integer loops,

the control variable never wraps around;

instead, the loop ends in case of an overflow.

You should not change the value of the control variable

during the loop.

If you need its value after the loop,

assign it to another variable before exiting the loop.

```
}
```

@sect4{@title{The generic @Rw{for} loop}

The generic @Rw{for} statement works over functions,

called @def{iterators}.

On each iteration, the iterator function is called to produce a new value, stopping when this new value is `@nil`.

The generic `@Rw{for}` loop has the following syntax:

```
@Produc{
  @producname{stat}@produciblebody{@Rw{for} namelist @Rw{in} explist
    @Rw{do} block @Rw{end}}
  @producname{namelist}@produciblebody{@bnfNter{Name} @bnfrep{@bnfter{,} @bnfNter{Name}}}
}
```

A `@Rw{for}` statement like

```
@verbatim{
  for @rep{var_1}, @Cdots, @rep{var_n} in @rep{explist} do @rep{body} end
}
```

works as follows.

The names `@rep{var_i}` declare loop variables local to the loop body.

The first of these variables is the `@emph{control variable}`.

The loop starts by evaluating `@rep{explist}`

to produce four values:

an `@emph{iterator function}`,

a `@emph{state}`,

an initial value for the control variable,

and a `@emph{closing value}`.

Then, at each iteration,

Lua calls the iterator function with two arguments:

the state and the control variable.

The results from this call are then assigned to the loop variables,

following the rules of multiple assignments `@see{assignment}`.

If the control variable becomes `@nil`,

the

loop terminates.

Otherwise, the body is executed and the loop goes

to the next iteration.

The closing value behaves like a

to-be-closed variable `@see{to-be-closed}`,

which can be used to release resources when the loop ends.

Otherwise, it does not interfere with the loop.

You should not change the value of the control variable

during the loop.

```
}
```

```
}
```



@sect3{funcstat| @title{Function Calls as Statements}}

To allow possible side-effects,

function calls can be executed as statements:

@Produc{

@producname{stat}@producbody{functioncall}

}

In this case, all returned values are thrown away.

Function calls are explained in @See{functioncall}.

}

@sect3{localvar| @title{Local Declarations}}

@x{Local variables} can be declared anywhere inside a block.

The declaration can include an initialization:

@Produc{

@producname{stat}@producbody{@Rw{local} atnamelist @bnfopt{@bnfter{=} explist}}

@producname{atnamelist}@producbody{

@bnfNter{Name} attrib @bnfrep{@bnfter{,} @bnfNter{Name} attrib}}

}

If

present, an initial assignment has the same semantics

of a multiple assignment @see{assignment}.

Otherwise, all variables are initialized with @nil.

Each variable name may be postfixed by an attribute

(a name between angle brackets):

@Produc{

@producname{attrib}@producbody{@bnfopt{@bnfter{<} @bnfNter{Name} @bnfter{>}}

}

There are two possible attributes:

@id{const}, which declares a @x{constant variable},

that is, a variable that cannot be assigned to

after its initialization;

and @id{close}, which declares a to-be-closed variable @see{to-be-closed}.

A list of variables can contain at most one to-be-closed variable.

A chunk is also a block @see{chunks},

and so local variables can be declared in a chunk outside any explicit block.

The visibility rules for local variables are explained in @See{visibility}.

}

@sect3{to-be-closed| @title{To-be-closed Variables}}

A to-be-closed variable behaves like a constant local variable,

except that its value is @emph{closed} whenever the variable

goes

out of scope, including normal block termination,  
exiting its block by `@Rw{break}/@Rw{goto}/@Rw{return}`,  
or exiting by an error.

Here, to `@emph{close}` a value means  
to call its `@idx{__close}` metamethod.  
When calling the metamethod,  
the value itself is passed as the first argument  
and the error object that caused the exit (if any)  
is passed as a second argument;  
if there was no error, the second argument is `@nil`.

The value assigned to a to-be-closed variable  
must have a `@idx{__close}` metamethod  
or be a false value.  
(`@nil` and `@false` are ignored as to-be-closed values.)

If several to-be-closed variables go out of scope at the same event,  
they are closed in the reverse order that they were declared.

If there is any error while running a closing method,  
that error is handled like an error in the regular code  
where the variable was defined.  
After an error,  
the other pending closing methods will still be called.

If a coroutine yields and is never resumed again,  
some variables may  
never go out of scope,  
and therefore they will never be closed.  
(These variables are the ones created inside the coroutine  
and in scope at the point where the coroutine yielded.)  
Similarly, if a coroutine ends with an error,  
it does not unwind its stack,  
so it does not close any variable.  
In both cases,  
you can either use finalizers  
or call `@Lid{coroutine.close}` to close the variables.  
However, if the coroutine was created  
through `@Lid{coroutine.wrap}`,  
then its corresponding function will close the coroutine  
in case of errors.

}

}

`@sect2{expressions| @title{Expressions}}`

@simplesect{

The basic expressions in Lua are the following:

```
@Produc{
  @producname{exp}@producbody{prefixexp}
  @producname{exp}@producbody{@Rw{nil} @Or @Rw{false} @Or @Rw{true}}
  @producname{exp}@producbody{@bnfNter{Numeral}}
  @producname{exp}@producbody{@bnfNter{LiteralString}}
  @producname{exp}@producbody{functiondef}
  @producname{exp}@producbody{tableconstructor}
  @producname{exp}@producbody{@bnfter{...}}
  @producname{exp}@producbody{exp
    binop exp}
  @producname{exp}@producbody{unop exp}
  @producname{prefixexp}@producbody{var @Or functioncall @Or
    @bnfter{() exp @bnfter{}}}
}
```

Numerals and literal strings are explained in @See{lexical};

variables are explained in @See{variables};

function definitions are explained in @See{func-def};

function calls are explained in @See{functioncall};

table constructors are explained in @See{tableconstructor}.

Vararg expressions,

denoted by three dots (@Char{...}), can only be used when

directly inside a variadic function;

they are explained in @See{func-def}.

Binary operators comprise arithmetic operators @see{arith},

bitwise operators @see{bitwise},

relational operators @see{rel-ops}, logical operators @see{logic},

and the concatenation operator @see{concat}.

Unary operators comprise the unary minus @see{arith},

the unary bitwise NOT @see{bitwise},

the unary logical @Rw{not} @see{logic},

and the unary @def{length operator} @see{len-op}.

}

@sect3{arith|

@title{Arithmetic Operators}

Lua supports the following @x{arithmetic operators}:

@description{

@item{@T{+}|addition}

```

@item{@T{-}|subtraction}
@item{@T{*}|multiplication}
@item{@T{/}|float division}
@item{@T{//}|floor division}
@item{@T{%}|modulo}
@item{@T{^}|exponentiation}
@item{@T{-}|unary minus}
}

```

With the exception of exponentiation and float division, the arithmetic operators work as follows:

If both operands are integers, the operation is performed over integers and the result is an integer.

Otherwise, if both operands are numbers, then they are converted to floats, the operation is performed following the machine's rules for floating-point arithmetic (usually the `@x{IEEE 754}` standard), and the result is a float.

(The string library coerces strings to numbers in arithmetic operations; see `@See{coercion}` for details.)

Exponentiation and float division (`@T{/}`) always convert their operands to floats and the result is always a float.

Exponentiation uses the `@ANSI{pow}`, so that it works for non-integer exponents too.

Floor division (`@T{//}`) is a division that rounds the quotient towards minus infinity, resulting in the floor of the division of its operands.

Modulo is defined as the remainder of a division that rounds the quotient towards minus infinity (floor division).

In case of overflows in integer arithmetic, all operations `@emphx{wrap around}`.

```

@sect3{bitwise| @title{Bitwise Operators}
Lua supports the following @x{bitwise operators}:
@description{
@item{@T{&}|bitwise AND}
@item{@T{@VerBar}|bitwise OR}
@item{@T{~}|bitwise exclusive OR}
@item{@T{>>}|right shift}
@item{@T{<<}|left shift}

```

```
@item{@T{~}|unary bitwise NOT}
}
```

All bitwise operations convert its operands to integers  
@see{coercion},  
operate on all bits of those integers,  
and result in an integer.

Both right and left shifts fill the vacant bits with zeros.  
Negative displacements shift to the other direction;  
displacements with absolute values equal to or higher than  
the  
number of bits in an integer  
result in zero (as all bits are shifted out).

```
}
```

@sect3{coercion| @title{Coercions and Conversions}  
Lua provides some automatic conversions between some  
types and representations at run time.  
Bitwise operators always convert float operands to integers.  
Exponentiation and float division  
always convert integer operands to floats.  
All other arithmetic operations applied to mixed numbers  
(integers and floats) convert the integer operand to a float.  
The C API also converts both integers to floats and  
floats to integers, as needed.  
Moreover, string concatenation accepts numbers as arguments,  
besides strings.

In a conversion from integer to float,  
if the integer value has an exact representation as a float,  
that is the result.  
Otherwise,  
the conversion gets the nearest higher or  
the nearest lower representable value.  
This kind of conversion never fails.

The conversion from float to integer  
checks whether the float has an exact representation as an integer  
(that  
is, the float has an integral value and  
it is in the range of integer representation).  
If it does, that representation is the result.  
Otherwise, the conversion fails.

Several places in Lua coerce strings to numbers when necessary.  
In particular,

the string library sets metamethods that try to coerce strings to numbers in all arithmetic operations.

If the conversion fails,

the library calls the metamethod of the other operand (if present) or it raises an error.

Note that bitwise operators do not do this coercion.

It is always a good practice not to rely on the

implicit coercions from strings to numbers,

as they are not always applied;

in particular, `@T{"1"==1}` is false and `@T{"1"<1}` raises an error

`@see{rel-ops}`.

These coercions exist mainly for compatibility and may be removed in future versions of the language.

A string is converted to an integer or a float

following its syntax and the rules of the Lua lexer.

The string may have also leading and trailing whitespaces and a sign.

All

conversions from strings to numbers

accept both a dot and the current locale mark

as the radix character.

(The Lua lexer, however, accepts only a dot.)

If the string is not a valid numeral,

the conversion fails.

If necessary, the result of this first step is then converted

to a specific number subtype following the previous rules

for conversions between floats and integers.

The conversion from numbers to strings uses a

non-specified human-readable format.

To convert numbers to strings in any specific way,

use the function `@Lid{string.format}`.

}

@sect3{rel-ops| @title{Relational Operators}

Lua supports the following `@x{relational operators}`:

@description{

@item{@T{==}|equality}

@item{@T{~=}|inequality}

@item{@T{<}|less than}

@item{@T{>}|greater than}

@item{@T{<=}|less or equal}

@item{@T{>=}|greater or equal}

}

These operators always result in `@false` or `@true`.

Equality (`@T{==}`) first compares the type of its operands.

If the types are different, then the result is `@false`.

Otherwise,

the values of the operands are compared.

Strings are equal if they have the same byte content.

Numbers are equal if they denote the same mathematical value.

Tables, userdata, and threads

are compared by reference:

two objects are considered equal only if they are the same object.

Every time you create a new object

(a table, a userdata, or a thread),

this new object is different from any previously existing object.

A function is always equal to itself.

Functions with any detectable difference

(different behavior, different definition) are always different.

Functions created at different times but with no detectable differences

may be classified as equal or not

(depending on internal caching details).

You can change the way that Lua compares tables and userdata

by using the `@idx{__eq}` metamethod `@see{metatable}`.

Equality comparisons do not convert strings to numbers

or vice versa.

Thus, `@T{"0"==0}` evaluates to `@false`,

and `@T{t[0]}` and `@T{t["0"]}` denote different

entries in a table.

The

operator `@T{~=}` is exactly the negation of equality (`@T{==}`).

The order operators work as follows.

If both arguments are numbers,

then they are compared according to their mathematical values,

regardless of their subtypes.

Otherwise, if both arguments are strings,

then their values are compared according to the current locale.

Otherwise, Lua tries to call the `@idx{__lt}` or the `@idx{__le}`

metamethod `@see{metatable}`.

A comparison `@T{a > b}` is translated to `@T{b < a}`

and `@T{a >= b}` is translated to `@T{b <= a}`.

Following the `@x{IEEE 754}` standard,

the special value `@x{NaN}` is considered neither less than,

nor equal to, nor greater than any value, including itself.

}

@sect3{logic| @title{Logical Operators}

The @x{logical operators} in Lua are

@Rw{and}, @Rw{or}, and @Rw{not}.

Like the control structures @see{control},

all logical operators consider both @false and @nil as false  
and anything else as true.

The negation operator @Rw{not} always returns @false or @true.

The conjunction

operator @Rw{and} returns its first argument

if this value is @false or @nil;

otherwise, @Rw{and} returns its second argument.

The disjunction operator @Rw{or} returns its first argument

if this value is different from @nil and @false;

otherwise, @Rw{or} returns its second argument.

Both @Rw{and} and @Rw{or} use @x{short-circuit evaluation};  
that is,

the second operand is evaluated only if necessary.

Here are some examples:

```
@verbatim{
10 or 20      --> 10
10 or error() --> 10
nil or "a"    --> "a"
nil and 10    --> nil
false and error() --> false
false and nil --> false
false or nil  --> nil
10 and 20     --> 20
}
}
```

@sect3{concat| @title{Concatenation}

The string @x{concatenation} operator in Lua is  
denoted by two dots (@Char{..}).

If both operands are strings or numbers,

then the numbers are converted to strings

in a non-specified format @see{coercion}.

Otherwise, the @idx{\_\_concat} metamethod is called @see{metatable}.

}

@sect3{len-op|

@title{The Length Operator}

The length operator is denoted by the unary prefix operator @T{#}.



The length of a string is its number of bytes.  
(That is the usual meaning of string length when each character is one byte.)

The length operator applied on a table  
returns a `@x{border}` in that table.

A `@def{border}` in a table `@id{t}` is any non-negative integer  
that satisfies the following condition:

```
@verbatim{
(border == 0 or t[border] ~= nil) and
(t[border + 1] == nil or border == math.maxinteger)
}
```

In words,

a border is any positive integer index present in the table  
that is followed by an absent index,

plus two limit cases:

zero, when index 1 is absent;

and the maximum value for an integer, when that index is present.

Note that keys that are not positive integers

do not interfere with borders.

A table with exactly one border is called a `@def{sequence}`.

For instance, the table `@T{{10, 20, 30, 40, 50}}` is a sequence,  
as it has only one border (5).

The table `@T{{10, 20, 30, nil, 50}}` has  
two borders (3 and 5),

and therefore it is not a sequence.

(The `@nil` at index 4 is called a `@emphx{hole}`.)

The table `@T{{nil, 20, 30, nil, nil, 60, nil}}`

has three borders (0, 3, and 6),

so it is not a sequence, too.

The table `@T{{}}` is a sequence with border 0.

When `@id{t}` is a sequence,

`@T{#t}` returns its only border,

which corresponds to the intuitive notion of the length of the sequence.

When `@id{t}` is not a sequence,

`@T{#t}` can return any of its borders.

(The exact one depends on details of  
the internal representation of the table,

which in turn can depend on how the table was populated and  
the memory addresses of its non-numeric keys.)

The computation of the length of a table

has a guaranteed worst time of `@M{O(log n)}`,

where `@M{n}` is the largest integer key in the table.

A program can modify the behavior of the length operator for

any value but strings through the @idx{\_\_len} metamethod @see{metatable}.

}

@sect3{prec| @title{Precedence}

@x{Operator precedence} in Lua follows

the table below,

from lower to higher priority:

@verbatim{

or

and

< > <= >= ~= ==

|

~

&

<< >>

..

+ -

\* / // %

unary operators (not # - ~)

^

}

As usual,

you can use parentheses to change the precedences of an expression.

The concatenation (@Char{..}) and exponentiation (@Char{^})

operators are right associative.

All other binary operators are left associative.

}

@sect3{tableconstructor| @title{Table Constructors}

Table @x{constructors} are expressions that create tables.

Every time a constructor is evaluated, a new table is created.

A constructor can be used to create an empty table

or to create a table and initialize some of its fields.

The general syntax for constructors is

@Produc{

@producname{tableconstructor}@prodcbody{@bnfter{@Open} @bnfopt{fieldlist} @bnfter{@Close}}

@producname{fieldlist}@prodcbody{field @bnfrep{fieldsep field} @bnfopt{fieldsep}}

@producname{field}@prodcbody{@bnfter{[] exp @bnfter{[]} @bnfter{=} exp @Or

@bnfNter{Name} @bnfter{=} exp @Or exp}

@producname{fieldsep}@prodcbody{@bnfter{,} @Or @bnfter{;}}

}

Each field of the form @T{[exp1] = exp2} adds to the new table an entry with key @id{exp1} and value @id{exp2}.

A field of the form @T{name = exp} is equivalent to

@T{"name"} = exp}.

Fields of the form @id{exp} are equivalent to

@T{[i] = exp}, where @id{i} are consecutive integers starting with 1;

fields in the other formats do not affect this counting.

For example,

@verbatim{

```
a = { [f(1)] = g; "x", "y"; x = 1, f(x), [30] = 23; 45 }
```

is equivalent to

@verbatim{

do

```
local t = { }
```

```
t[f(1)] = g
```

```
t[1] = "x"      -- 1st exp
```

```
t[2] = "y"      -- 2nd exp
```

```
t.x = 1         -- t["x"] = 1
```

```
t[3] = f(x)     -- 3rd exp
```

```
t[30] = 23
```

```
t[4] = 45       -- 4th exp
```

```
a = t
```

end

}

The order of the assignments in a constructor is undefined.

(This order would be relevant only when there are repeated keys.)

If the last field in the list has the form @id{exp}

and the expression

is a multires expression,

then all values returned by this expression enter the list consecutively

@see{multires}.

The field list can have an optional trailing separator,

as a convenience for machine-generated code.

}

@sect3{functioncall| @title{Function Calls}

A @x{function call} in Lua has the following syntax:

@Produc{

@producname{functioncall}@producbody{prefixexp args}

}

In a function call,

first @bnfNter{prefixexp} and @bnfNter{args} are evaluated.

If the value of @bnfNter{prefixexp} has type @emph{function},

then this function is called

with the given arguments.

Otherwise, if present,  
the `@bnfNter{prefixexp} @idx{__call}` metamethod is called:  
its first argument is the value of `@bnfNter{prefixexp}`,  
followed by the original call arguments  
`@see{metatable}`.

The form

```
@Produc{  
  @producname{functioncall}@producbody{prefixexp @bnfter{:} @bnfNter{Name} args}  
}
```

can be used to emulate methods.

A call `@T{v:name(@rep{args})}`  
is syntactic sugar for `@T{v.name(v,@rep{args})}`,  
except that `@id{v}`  
is evaluated only once.

Arguments have the following syntax:

```
@Produc{  
  @producname{args}@producbody{@bnfter{(} @bnfopt{explist} @bnfter{)}}  
  @producname{args}@producbody{tableconstructor}  
  @producname{args}@producbody{@bnfNter{LiteralString}}  
}
```

All argument expressions are evaluated before the call.

A call of the form `@T{f{@rep{fields}}}` is  
syntactic sugar for `@T{f({@rep{fields}})}`;  
that is, the argument list is a single new table.

A call of the form `@T{f'@rep{string}'}`  
(or `@T{f"@rep{string}"}` or `@T{f[[@rep{string}]]}`)  
is syntactic sugar for `@T{f('@rep{string}')`;  
that is, the argument list is a single literal string.

A call of the form `@T{return @rep{functioncall}}` not in the  
scope of a to-be-closed variable is called a `@def{tail call}`.

Lua implements `@def{proper tail calls}`  
(or `@def{proper tail recursion}`):

In a tail call,  
the called function reuses the stack entry of the calling function.  
Therefore, there is no limit on the number of nested tail calls that  
a program can execute.

However,

a tail call erases any debug information about the  
calling function.

Note that a tail call only happens with a particular syntax,  
where the `@Rw{return}` has one single function call as argument,  
and it is outside the scope of any to-be-closed variable.

This syntax makes the calling function return exactly  
the returns of the called function,  
without any intervening action.

So, none of the following examples are tail calls:

```
@verbatim{
return (f(x))    -- results adjusted to 1
return 2 * f(x)  -- result multiplied by 2
return x, f(x)   -- additional results
f(x); return     -- results discarded
return x or f(x) -- results adjusted to 1
}

}
```

@sect3{func-def| @title{Function Definitions}

The syntax for function definition is

```
@Produc{
@producname{functiondef}@producbody{@Rw{function} funcbody}
@producname{funcbody}@producbody{@bnfter{() @bnfopt{parlist} @bnfter{}} block @Rw{end}}
}
```

The following syntactic sugar simplifies function definitions:

```
@Produc{
@producname{stat}@producbody{@Rw{function}
funcname funcbody}
@producname{stat}@producbody{@Rw{local} @Rw{function} @bnfNter{Name} funcbody}
@producname{funcname}@producbody{@bnfNter{Name} @bnfrep{@bnfter{.} @bnfNter{Name}}
@bnfopt{@bnfter{:} @bnfNter{Name}}}
}
```

The statement

```
@verbatim{
function f () @rep{body} end
}
```

translates to

```
@verbatim{
f = function () @rep{body} end
}
```

The statement

```
@verbatim{
function t.a.b.c.f () @rep{body} end
}
```

translates to

```
@verbatim{
t.a.b.c.f = function () @rep{body} end
}
```

The statement

```
@verbatim{
local function f () @rep{body} end
}
```

translates to

```
@verbatim{
local f; f = function () @rep{body} end
}
```

not to

```
@verbatim{
local f = function () @rep{body} end
}
```

(This only makes a difference when the body of the function contains references to @id{f}.)

A function definition is an executable expression, whose value has type @emph{function}. When Lua precompiles a chunk, all its function bodies are precompiled too, but they are not created yet. Then, whenever Lua executes the function definition, the function is @emph{instantiated} (or @emph{closed}). This function instance, or @emphx{closure}, is the final value of the expression.

Parameters act as local variables that are initialized with the argument values:

```
@Produc{
@producname{parlist}@producbody{namelist @bnfopt{@bnfter{,} @bnfter{...}} @Or
@bnfter{...}}
}
```

When a Lua function is called, it adjusts its list of @x{arguments} to the length of its list of parameters @see{multires}, unless the function is a @def{variadic function}, which is indicated by three dots (@Char{...}) at the end of its parameter list.

A variadic function does not adjust its argument list; instead, it collects all extra arguments and supplies them to the function through a @def{vararg expression}, which is also written as three dots.

The value of this expression is a list of all actual extra arguments, similar to a function with multiple results @see{multires}.

As an example, consider the following definitions:

```
@verbatim{
function
f(a, b) end
function g(a, b, ...) end
function r() return 1,2,3 end
}
```

Then, we have the following mapping from arguments to parameters and to the vararg expression:

@verbatim{

CALL            PARAMETERS

f(3)            a=3, b=nil

f(3, 4)        a=3, b=4

f(3, 4, 5)     a=3, b=4

f(r(), 10)     a=1, b=10

f(r())         a=1, b=2

g(3)           a=3, b=nil, ... --> (nothing)

g(3, 4)        a=3, b=4, ... --> (nothing)

g(3, 4, 5, 8)   a=3, b=4, ... --> 5 8

g(5, r())      a=5, b=1, ... --> 2 3

}

Results are returned using the @Rw{return} statement @see{control}.

If control reaches the end of a function

without encountering a @Rw{return} statement,

then the function returns with no results.

@index{multiple return}

There is a system-dependent limit on the number of values that a function may return.

This limit is guaranteed to be greater than 1000.

The @emphx{colon} syntax

is used to emulate @def{methods},

adding an implicit extra parameter @idx{self} to the function.

Thus, the statement

@verbatim{

function t.a.b.c:f (@rep{params}) @rep{body} end

}

is syntactic sugar for

@verbatim{

t.a.b.c.f = function (self, @rep{params}) @rep{body} end

}

}

@sect3{multires| @title{Lists of expressions, multiple results, and adjustment}}

Both function calls and vararg expressions can result in multiple values.

These expressions are called @def{multires expressions}.

When a multires expression is used as the last element of a list of expressions, all results from the expression are added to the list of values produced by the list of expressions. Note that a single expression in a place that expects a list of expressions is the last expression in that (singleton) list.

These are the places where Lua expects a list of expressions:

@description{

@item{A @rw{return} statement,  
for instance @T{return e1, e2, e3} @see{control}.}

@item{A table constructor,  
for instance @T{{e1, e2, e3}} @see{tableconstructor}.}

@item{The arguments of a function call,  
for  
instance @T{foo(e1, e2, e3)} @see{functioncall}.}

@item{A multiple assignment,  
for instance @T{a , b, c = e1, e2, e3} @see{assignment}.}

@item{A local declaration,  
for instance @T{local a , b, c = e1, e2, e3} @see{localvar}.}

@item{The initial values in a generic @rw{for} loop,  
for instance @T{for k in e1, e2, e3 do ... end} @see{for}.}

}

In the last four cases, the list of values from the list of expressions must be @emph{adjusted} to a specific length: the number of parameters in a call to a non-variadic function @see{func-def}, the number of variables in a multiple assignment or a local declaration, and exactly four values for a generic @rw{for} loop. The @def{adjustment} follows these rules: If there are more values than needed, the extra values are thrown away; if there are fewer values than needed, the list is extended with @nil's. When the list of expressions ends with a multires expression, all results from that expression enter the list of values before the adjustment.



When

a multiresult expression is used  
in a list of expressions without being the last element,  
or in a place where the syntax expects a single expression,  
Lua adjusts the result list of that expression to one element.  
As a particular case,  
the syntax expects a single expression inside a parenthesized expression;  
therefore, adding parentheses around a multiresult expression  
forces it to produce exactly one result.

We seldom need to use a variadic expression in a place  
where the syntax expects a single expression.  
(Usually it is simpler to add a regular parameter before  
the variadic part and use that parameter.)  
When there is such a need,  
we recommend assigning the variadic expression  
to a single variable and using that variable  
in its place.

Here are some examples of uses of multiresult expressions.

In all cases, when the construction needs

@Q{the n-th result} and there is no such result,  
it uses a @nil.

```
@verbatim{
print(x, f())    -- prints x and all results from f().
print(x, (f())) -- prints
x and the first result from f().
print(f(), x)    -- prints the first result from f() and x.
print(1 + f())   -- prints 1 added to the first result from f().
local x = ...    -- x gets the first variadic argument.
x,y = ...        -- x gets the first variadic argument,
                -- y gets the second variadic argument.
x,y,z = w, f()   -- x gets w, y gets the first result from f(),
                -- z gets the second result from f().
x,y,z = f()      -- x gets the first result from f(),
                -- y gets the second result from f(),
                -- z gets the third result from f().
x,y,z = f(), g() -- x gets the first result from f(),
                -- y gets the first result from g(),
                -- z gets the second result from g().
x,y,z = (f())    -- x gets the first result from f(), y and z get nil.
return f()       -- returns all results from f().
return x, ...    -- returns x and all received variadic arguments.
return x,y,f()
                -- returns x, y, and all results from f().
{f()}            -- creates a list with all results from f().
{...}           -- creates a list with all variadic arguments.
{f(), 5}        -- creates a list with the first result from f() and 5.
```

}

}

}

@sect2{visibility| @title{Visibility Rules}

@index{visibility}

Lua is a lexically scoped language.

The scope of a local variable begins at the first statement after its declaration and lasts until the last non-void statement of the innermost block that includes the declaration.

(@emph{Void statements} are labels and empty statements.)

Consider the following example:

@verbatim{

```
x = 10          -- global variable
do             -- new block
  local x = x    -- new 'x', with value 10
  print(x)       --> 10
  x = x+1
do             -- another block
  local x = x+1  -- another 'x'
  print(x)       --> 12
end
print(x)        --> 11
end
print(x)        --> 10 (the global one)
}
```

Notice

that, in a declaration like @T{local x = x},  
the new @id{x} being declared is not in scope yet,  
and so the second @id{x} refers to the outside variable.

Because of the @x{lexical scoping} rules,  
local variables can be freely accessed by functions  
defined inside their scope.

A local variable used by an inner function is called an @def{upvalue}  
(or @emphx{external local variable}, or simply @emphx{external variable})  
inside the inner function.

Notice that each execution of a @Rw{local} statement  
defines new local variables.

Consider the following example:

@verbatim{

```
a = {}
local x = 20
```

```

for i = 1, 10 do
  local y = 0
  a[i] = function () y = y + 1; return x + y end
end
}

```

The loop creates ten closures  
(that is, ten instances of the anonymous function).  
Each of these closures uses a different `@id{y}` variable,  
while all of them share the same `@id{x}`.

```

}

}

```

```

@C{-----}
@sect1{API| @title{The Application Program Interface}

```

```

@simplesect{

```

```

@index{C
API}

```

This section describes the `@N{C API}` for Lua, that is,  
the set of `@N{C functions}` available to the host program to communicate  
with Lua.

All API functions and related types and constants  
are declared in the header file `@defid{lua.h}`.

Even when we use the term `@Q{function}`,  
any facility in the API may be provided as a macro instead.  
Except where stated otherwise,  
all such macros use each of their arguments exactly once  
(except for the first argument, which is always a Lua state),  
and so do not generate any hidden side-effects.

As in most `@N{C libraries}`,  
the Lua API functions do not check their arguments  
for validity or consistency.  
However, you can change this behavior by compiling Lua  
with the macro `@defid{LUA_USE_APICHECK}` defined.

The Lua library is fully reentrant:  
it has no global variables.  
It keeps all information it needs in a dynamic structure,  
called the `@def{Lua state}`.

Each Lua state has one or more threads,  
which correspond to independent,

cooperative lines of execution.

The type `@Lid{lua_State}` (despite its name) refers to a thread. (Indirectly, through the thread, it also refers to the Lua state associated to the thread.)

A pointer to a thread must be passed as the first argument to every function in the library, except to `@Lid{lua_newstate}`, which creates a Lua state from scratch and returns a pointer to the `@emph{main thread}` in the new state.

}

@sect2{@title{The Stack}

@simplesect{

Lua uses a `@emph{virtual stack}` to pass values to and from C. Each element in this stack represents a Lua value (`@nil`, number, string, etc.). Functions in the API can access this stack through the Lua state parameter that they receive.

Whenever Lua calls C, the called function gets a new stack, which is independent of previous stacks and of stacks of `@N{C functions}` that are still active. This stack initially contains any arguments to the `@N{C function}` and it is where the `@N{C function}` can store temporary Lua values and must push its results to be returned to the caller `@seeC{lua_CFunction}`.

For convenience, most query operations in the API do not follow a strict stack discipline. Instead, they can refer to any element in the stack by using an `@emph{index}:@index{index (API stack)}`. A positive index represents an absolute stack position, starting `@N{at 1}` as the bottom of the stack; a negative index represents an offset relative to the top of the stack. More specifically, if the stack has `@rep{n}` elements, then `@N{index 1}` represents the first element (that is, the element that was pushed onto the stack first) and `@N{index @rep{n}}` represents the last element; `@N{index @num{-1}}` also represents the last element (that is, the element at `@N{the top}`) and index `@M{-n}` represents the first element.

}

@sect3{stacksize| @title{Stack Size}

When you interact with the Lua API,  
you are responsible for ensuring consistency.

In particular,

@emph{you are responsible for controlling stack overflow}.

When you call any

API function,

you must ensure the stack has enough room to accommodate the results.

There is one exception to the above rule:

When you call a Lua function

without a fixed number of results @seeF{lua\_call},

Lua ensures that the stack has enough space for all results.

However, it does not ensure any extra space.

So, before pushing anything on the stack after such a call

you should use @Lid{lua\_checkstack}.

Whenever Lua calls C,

it ensures that the stack has space for

at least @defid{LUA\_MINSTACK} extra elements;

that is, you can safely push up to @id{LUA\_MINSTACK} values into it.

@id{LUA\_MINSTACK} is defined as 20,

so that usually you do not have to worry about stack space

unless your code has loops pushing elements onto the stack.

Whenever necessary,

you can use the function @Lid{lua\_checkstack}

to ensure that the stack has enough space for pushing new elements.

}

@sect3{@title{Valid and Acceptable Indices}

Any function in the API that receives stack indices

works only with @emphx{valid

indices} or @emphx{acceptable indices}.

A @def{valid index} is an index that refers to a  
position that stores a modifiable Lua value.

It comprises stack indices @N{between 1} and the stack top

(@T{1 @leq abs(index) @leq top})

@index{stack index}

plus @def{pseudo-indices},

which represent some positions that are accessible to @N{C code}

but that are not in the stack.

Pseudo-indices are used to access the registry @see{registry}

and the upvalues of a `@N{C function}` `@see{c-closure}`.

Functions that do not need a specific mutable position, but only a value (e.g., query functions), can be called with acceptable indices.

An `@def{acceptable index}` can be any valid index, but it also can be any positive index after the stack top within the space allocated for the stack, that is, indices up to the stack size.

(Note that 0 is never an acceptable index.)

Indices to upvalues `@see{c-closure}` greater than the real number of upvalues in the current `@N{C function}` are also acceptable (but invalid).

Except

when noted otherwise, functions in the API work with acceptable indices.

Acceptable indices serve to avoid extra tests against the stack top when querying the stack.

For instance, a `@N{C function}` can query its third argument without the need to check whether there is a third argument, that is, without the need to check whether 3 is a valid index.

For functions that can be called with acceptable indices, any non-valid index is treated as if it contains a value of a virtual type `@defid{LUA_TNONE}`, which behaves like a nil value.

}

`@sect3{constchar|@title{Pointers to strings}`

Several functions in the API return pointers (`@T{const char*}`) to Lua strings in the stack.

(See `@Lid{lua_pushfstring}`, `@Lid{lua_pushlstring}`, `@Lid{lua_pushstring}`, and `@Lid{lua_tolstring}`.

See also `@Lid{luaL_checklstring}`, `@Lid{luaL_checkstring}`, and `@Lid{luaL_tolstring}` in the auxiliary library.)

In general,

Lua's garbage collection can free or move internal memory and then invalidate pointers to internal strings.

To allow a safe use of these pointers, the API guarantees that any pointer to a string in a stack index is valid while the string value at that index is not removed from the stack. (It can be moved to another index, though.)

When the index is a pseudo-index (referring to an upvalue), the pointer is valid while the corresponding call is active and

the corresponding upvalue is not modified.

Some functions in the debug interface also return pointers to strings, namely `@Lid{lua_getlocal}`, `@Lid{lua_getupvalue}`, `@Lid{lua_setlocal}`, and `@Lid{lua_setupvalue}`. For these functions, the pointer is guaranteed to be valid while the caller function is active and the given closure (if one was given) is in the stack.

Except for these guarantees, the garbage collector is free to invalidate any pointer to internal strings.

}

}

@sect2{c-closure| @title{C Closures}

When a `@N{C function}` is created, it is possible to associate some values with it, thus creating a `@def{@N{C closure}}` `@seeC{lua_pushcclosure}`; these values are called `@def{upvalues}` and are accessible to the function whenever it is called.

Whenever a `@N{C function}` is called, its upvalues are located at specific pseudo-indices. These pseudo-indices are produced by the macro `@Lid{lua_upvalueindex}`. The first upvalue associated with a function is at index `@T{lua_upvalueindex(1)}`, and so on. Any access to `@T{lua_upvalueindex(@rep{n})}`, where `@rep{n}` is greater than the number of upvalues of the current function (but not greater than 256, which is one plus the maximum number of upvalues in a closure), produces an acceptable but invalid index.

A `@N{C closure}` can also change the values of its corresponding upvalues.

}

@sect2{registry| @title{Registry}

Lua provides a `@def{registry}`,  
a predefined table that can be used by any `@N{C code}` to  
store whatever Lua values it needs to store.  
The registry table is always accessible at pseudo-index  
`@defid{LUA_REGISTRYINDEX}`.  
Any `@N{C library}` can store data into  
this table,  
but it must take care to choose keys  
that are different from those used  
by other libraries, to avoid collisions.  
Typically, you should use as key a string containing your library name,  
or a light userdata with the address of a `@N{C object}` in your code,  
or any Lua object created by your code.  
As with variable names,  
string keys starting with an underscore followed by  
uppercase letters are reserved for Lua.

The integer keys in the registry are used  
by the reference mechanism `@seeC{luaL_ref}`  
and by some predefined values.  
Therefore, integer keys in the registry  
must not be used for other purposes.

When you create a new Lua state,  
its registry comes with some predefined values.  
These predefined values are indexed with integer keys  
defined as constants in `@id{lua.h}`.

The following constants are defined:

```
@description{
@item{@defid{LUA_RIDX_MAINTHREAD}| At this index the registry has
the main thread of the state.
(The main thread is the one created together with the state.)
}
```

```
@item{@defid{LUA_RIDX_GLOBALS}|
At this index the registry has
the @x{global environment}.
}
}
```

`@sect2{C-error|@title{Error Handling in C}`

```
@simplesect{
```

Internally, Lua uses the C `@id{longjmp}` facility to handle errors.  
(Lua will use exceptions if you compile it as C++;



search for @id{LUA\_THROW} in the source code for details.)

When Lua faces any error,  
such as a @x{memory allocation error} or a type error,  
it @emph{raises} an error;  
that is, it does a long jump.  
A @emphx{protected environment} uses @id{setjmp}  
to set a recovery point;  
any error jumps to the most recent active recovery point.

Inside a @N{C function} you can raise an error explicitly  
by calling @Lid{lua\_error}.

Most functions in the API can raise an error,  
for instance due to a @x{memory allocation error}.  
The documentation for each function indicates whether  
it can raise errors.

If an error happens outside any protected environment,  
Lua calls a @def{panic function} (see @Lid{lua\_atpanic})  
and then calls @T{abort},  
thus  
    exiting the host application.  
Your panic function can avoid this exit by  
never returning  
(e.g., doing a long jump to your own recovery point outside Lua).

The panic function,  
as its name implies,  
is a mechanism of last resort.  
Programs should avoid it.  
As a general rule,  
when a @N{C function} is called by Lua with a Lua state,  
it can do whatever it wants on that Lua state,  
as it should be already protected.  
However,  
when C code operates on other Lua states  
(e.g., a Lua-state argument to the function,  
a Lua state stored in the registry, or  
the result of @Lid{lua\_newthread}),  
it should use them only in API calls that cannot raise errors.

The panic function runs as if it were a @x{message handler} @see{error};  
in particular, the error object is on the top of the stack.  
However, there is no guarantee about stack space.  
To push anything on the stack,  
the panic function must first check the available space @see{stacksize}.

}

@sect3{statuscodes|@title{Status Codes}

Several functions

that report errors in the API use the following

status codes to indicate different kinds of errors or other conditions:

@description{

@item{@defid{LUA\_OK} (0)| no errors.}

@item{@defid{LUA\_ERRRUN}| a runtime error.}

@item{@defid{LUA\_ERRMEM}|

@x{memory allocation error}.

For such errors, Lua does not call the @x{message handler}.

}

@item{@defid{LUA\_ERRERR}| error while running the @x{message handler}.

@item{@defid{LUA\_ERRSYNTAX}| syntax error during precompilation.}

@item{@defid{LUA\_YIELD}| the thread (coroutine) yields.}

@item{@defid{LUA\_ERRFILE}| a file-related error;

e.g., it cannot open or read the file.}

}

These constants are defined in the header file @id{lua.h}.

}

}

@sect2{continuations|@title{Handling Yields in C}

Internally, Lua uses the C @id{longjmp} facility to yield a coroutine.

Therefore, if a @N{C function} @id{foo} calls an API function

and this API function yields

(directly or indirectly by calling another function that yields),

Lua cannot return to

@id{foo} any more,

because the @id{longjmp} removes its frame from the @N{C stack}.

To avoid this kind of problem,

Lua raises an error whenever it tries to yield across an API call,

except for three functions:

@Lid{lua\_yieldk}, @Lid{lua\_callk}, and @Lid{lua\_pcallk}.

All those functions receive a `@def{continuation function}`  
(as a parameter named `@id{k}`) to continue execution after a yield.

We need to set some terminology to explain continuations.

We have a `@N{C function}` called from Lua which we will call  
the `@emph{original function}`.

This original function then calls one of those three functions in the C API,  
which we will call the `@emph{callee function}`,  
that then yields the current thread.

This can happen when the callee function is `@Lid{lua_yieldk}`,  
or when the callee function is either `@Lid{lua_callk}` or `@Lid{lua_pcallk}`  
and the function called by them yields.

Suppose the running thread yields while executing the callee function.

After the thread resumes,  
it eventually will finish  
running the callee function.

However,

the callee function cannot return to the original function,  
because its frame in the `@N{C stack}` was destroyed by the yield.

Instead, Lua calls a `@def{continuation function}`,  
which was given as an argument to the callee function.

As the name implies,  
the continuation function should continue the task  
of the original function.

As an illustration, consider the following function:

```
@verbatim{
int original_function(lua_State *L) {
    ... /* code 1 */
    status = lua_pcall(L, n, m, h); /* calls Lua */
    ... /* code 2 */
}
}
```

Now we want to allow  
the Lua code being run by `@Lid{lua_pcall}` to yield.

First, we can rewrite our function like here:

```
@verbatim{
int k(lua_State *L, int status, lua_KContext ctx) {
    ... /* code 2 */
}
}
```

```
int original_function(lua_State *L) {
    ... /* code 1 */
    return k(L, lua_pcall(L, n, m, h), ctx);
}
}
```

In the above code,

the new function `@id{k}` is a  
`@emph{continuation function}` (with type `@Lid{lua_KFunction}`),  
 which  
 should do all the work that the original function  
 was doing after calling `@Lid{lua_pcall}`.  
 Now, we must inform Lua that it must call `@id{k}` if the Lua code  
 being executed by `@Lid{lua_pcall}` gets interrupted in some way  
 (errors or yielding),  
 so we rewrite the code as here,  
 replacing `@Lid{lua_pcall}` by `@Lid{lua_pcallk}`:

```
@verbatim{
int original_function (lua_State *L) {
...    /* code 1 */
return k(L, lua_pcallk(L, n, m, h, ctx2, k), ctx1);
}
}
```

Note the external, explicit call to the continuation:  
 Lua will call the continuation only if needed, that is,  
 in case of errors or resuming after a yield.  
 If the called function returns normally without ever yielding,  
`@Lid{lua_pcallk}` (and `@Lid{lua_callk}`) will also return normally.  
 (Of course, instead of calling the continuation in that case,  
 you can do the equivalent work directly inside the original function.)

Besides the Lua state,  
 the continuation function has two other parameters:  
 the final status of the call and the context value  
 (`@id{ctx}`) that  
 was passed originally to `@Lid{lua_pcallk}`.  
 Lua does not use this context value;  
 it only passes this value from the original function to the  
 continuation function.  
 For `@Lid{lua_pcallk}`,  
 the status is the same value that would be returned by `@Lid{lua_pcallk}`,  
 except that it is `@Lid{LUA_YIELD}` when being executed after a yield  
 (instead of `@Lid{LUA_OK}`).  
 For `@Lid{lua_yieldk}` and `@Lid{lua_callk}`,  
 the status is always `@Lid{LUA_YIELD}` when Lua calls the continuation.  
 (For these two functions,  
 Lua will not call the continuation in case of errors,  
 because they do not handle errors.)  
 Similarly, when using `@Lid{lua_callk}`,  
 you should call the continuation function  
 with `@Lid{LUA_OK}` as the status.  
 (For `@Lid{lua_yieldk}`, there is not much point in calling  
 directly the continuation function,  
 because `@Lid{lua_yieldk}` usually does not return.)

Lua treats the continuation function as if it were the original function.  
 The continuation function receives the same Lua stack  
 from the original  
 function,  
 in the same state it would be if the callee function had returned.  
 (For instance,  
 after a `@Lid{lua_callk}` the function and its arguments are  
 removed from the stack and replaced by the results from the call.)  
 It also has the same upvalues.  
 Whatever it returns is handled by Lua as if it were the return  
 of the original function.

}

@sect2{@title{Functions and Types}}

Here we list all functions and types from the `@N{C API}` in  
 alphabetical order.

Each function has an indicator like this:

`@apii{o,p,x}`

The first field, `@T{o}`,

is how many elements the function pops from the stack.

The second field, `@T{p}`,

is how many elements the function pushes onto the stack.

(Any function always pushes its results after popping its arguments.)

A field in the form `@T{x|y}` means the function can push (or pop)

`@T{x}` or `@T{y}` elements,

depending on the situation;

an interrogation mark `@Char{?}` means that

we cannot know how many elements the function pops/pushes  
 by looking only at its arguments.

(For

instance, they may depend on what is in the stack.)

The third field, `@T{x}`,

tells whether the function may raise errors:

`@Char{-}` means the function never raises any error;

`@Char{m}` means the function may raise only out-of-memory errors;

`@Char{v}` means the function may raise the errors explained in the text;

`@Char{e}` means the function can run arbitrary Lua code,

either directly or through metamethods,

and therefore may raise any errors.

`@APIEntry{int lua_absindex (lua_State *L, int idx);|`

`@apii{0,0,-}`

Converts the `@x{acceptable index}` `@id{idx}`

into an equivalent `@x{absolute index}`  
(that is, one that does not depend on the stack size).

}

```
@APIEntry{
typedef void * (*lua_Alloc) (void *ud,
                             void *ptr,
                             size_t osize,
                             size_t nsize);|
```

The type of the `@x{memory-allocation function}` used by Lua states.

The allocator function must provide a  
functionality similar to `@id{realloc}`,  
but not exactly the  
same.

Its arguments are

`@id{ud}`, an opaque pointer passed to `@Lid{lua_newstate}`;  
`@id{ptr}`, a pointer to the block being allocated/reallocated/freed;  
`@id{osize}`, the original size of the block or some code about what  
is being allocated;  
and `@id{nsize}`, the new size of the block.

When `@id{ptr}` is not `@id{NULL}`,  
`@id{osize}` is the size of the block pointed by `@id{ptr}`,  
that is, the size given when it was allocated or reallocated.

When `@id{ptr}` is `@id{NULL}`,  
`@id{osize}` encodes the kind of object that Lua is allocating.  
`@id{osize}` is any of  
`@Lid{LUA_TSTRING}`, `@Lid{LUA_TTABLE}`, `@Lid{LUA_TFUNCTION}`,  
`@Lid{LUA_TUSERDATA}`, or `@Lid{LUA_TTHREAD}` when (and only when)  
Lua is creating a new object of that type.  
When `@id{osize}` is some other value,  
Lua is allocating memory for something else.

Lua assumes the following behavior from the allocator function:

When `@id{nsize}` is zero,  
the allocator must behave like `@id{free}`  
and then return `@id{NULL}`.

When `@id{nsize}` is not zero,  
the allocator must behave  
like `@id{realloc}`.  
In particular, the allocator returns `@id{NULL}`  
if and only if it cannot fulfill the request.

Here is a simple implementation for the @x{allocator function}.

It is used in the auxiliary library by @Lid{luaL\_newstate}.

```
@verbatim{
static void *l_alloc (void *ud, void *ptr, size_t osize,
                      size_t nsize) {
    (void)ud; (void)osize; /* not used */
    if (nsize == 0) {
        free(ptr);
        return NULL;
    }
    else
        return realloc(ptr, nsize);
}
}
```

Note that @N{ISO C} ensures

that @T{free(NULL)} has no effect and that

@T{realloc(NULL,size)} is equivalent to @T{malloc(size)}.

```
}
```

```
@APIEntry{void lua_arith (lua_State *L, int op);|
```

```
@apii{2|1,1,e}
```

Performs an arithmetic or bitwise operation over the two values  
(or one, in the case of negations)

at the top of the stack,

with the value on the top being the second operand,

pops these values, and pushes the result of the operation.

The function follows the semantics of the corresponding Lua  
operator

(that is, it may call metamethods).

The value of @id{op} must be one of the following constants:

```
@description{
```

```
@item{@defid{LUA_OPADD}| performs addition (@T{+})}
```

```
@item{@defid{LUA_OPSUB}| performs subtraction (@T{-})}
```

```
@item{@defid{LUA_OPMUL}| performs multiplication (@T{*})}
```

```
@item{@defid{LUA_OPDIV}| performs float division (@T{/})}
```

```
@item{@defid{LUA_OPIDIV}| performs floor division (@T{//})}
```

```
@item{@defid{LUA_OPMOD}| performs modulo (@T{%})}
```

```
@item{@defid{LUA_OPPOW}| performs exponentiation (@T{^})}
```

```
@item{@defid{LUA_OPUNM}| performs mathematical negation (unary @T{-})}
```

```
@item{@defid{LUA_OPBNOT}| performs bitwise NOT (@T{~})}
```

```
@item{@defid{LUA_OPBAND}| performs bitwise AND (@T{&})}
```

```
@item{@defid{LUA_OPBOR}| performs bitwise OR (@T{|})}
```

```
@item{@defid{LUA_OPBXOR}| performs bitwise exclusive OR (@T{~})}
```

```

@item{@defid{LUA_OPSHL}| performs left shift (@T{<<})}
@item{@defid{LUA_OPSHR}| performs right shift (@T{>>})}

}

}

```

```

@APIEntry{lua_CFunction lua_atpanic (lua_State *L, lua_CFunction
panicf);|
@apii{0,0,-}

```

Sets a new panic function and returns the old one @see{C-error}.

```

}

```

```

@APIEntry{void lua_call (lua_State *L, int nargs, int nresults);|
@apii{nargs+1,nresults,e}

```

Calls a function.

Like regular Lua calls,

@id{lua\_call} respects the @idx{\_\_call} metamethod.

So, here the word @Q{function}

means any callable value.

To do a call you must use the following protocol:

first, the function to be called is pushed onto the stack;

then, the arguments to the call are pushed

in direct order;

that is, the first argument is pushed first.

Finally you call @Lid{lua\_call};

@id{nargs} is the number of arguments that you pushed onto the stack.

When the function returns,

all arguments and the function value are popped

and the call results are pushed onto the stack.

The number of results is adjusted to @id{nresults},

unless @id{nresults} is @defid{LUA\_MULTRET}.

In this case, all results from the function are pushed;

Lua takes care that the returned values fit into the stack space,

but

it does not ensure any extra space in the stack.

The function results are pushed onto the stack in direct order

(the first result is pushed first),

so that after the call the last result is on the top of the stack.

Any error while calling and running the function is propagated upwards  
(with a @id{longjmp}).

The following example shows how the host program can do the



equivalent to this Lua code:

```
@verbatim{
a = f("how", t.x, 14)
}
```

Here it is @N{in C}:

```
@verbatim{
lua_getglobal(L, "f");           /* function to be called */
lua_pushliteral(L, "how");       /* 1st argument */
lua_getglobal(L, "t");           /* table to be indexed */
lua_getfield(L, -1, "x");        /* push result of t.x (2nd arg) */
lua_remove(L, -2);              /* remove 't' from the stack */
lua_pushinteger(L, 14);          /* 3rd argument */
lua_call(L, 3, 1);              /* call 'f' with 3 arguments and 1 result */
lua_setglobal(L, "a");           /* set global
'a' */
}
```

Note that the code above is @emph{balanced}:

at its end, the stack is back to its original configuration.

This is considered good programming practice.

```
}
```

```
@APIEntry{
void lua_callk (lua_State *L,
               int nargs,
               int nresults,
               lua_KContext ctx,
               lua_KFunction k);|
@apii{nargs + 1,nresults,e}
```

This function behaves exactly like @Lid{lua\_call},  
but allows the called function to yield @see{continuations}.

```
}
```

```
@APIEntry{typedef int (*lua_CFunction) (lua_State *L);|
```

Type for @N{C functions}.

In order to communicate properly with Lua,

a @N{C function} must use the following protocol,

which defines the way parameters and results are passed:

a @N{C function} receives its arguments from Lua in its stack  
in direct order (the first argument is pushed first).

So, when the function starts,

@T{lua\_gettop(L)} returns the number of arguments received by the function.

The first argument (if any) is at index 1

and its last argument

is at index `@T{lua_gettop(L)}`.

To return values to Lua, a `@N{C function}` just pushes them onto the stack, in direct order (the first result is pushed first), and returns in C the number of results.

Any other value in the stack below the results will be properly discarded by Lua.

Like a Lua function, a `@N{C function}` called by Lua can also return many results.

As an example, the following function receives a variable number of numeric arguments and returns their average and their sum:

```
@verbatim{
static int foo (lua_State *L) {
    int n = lua_gettop(L); /* number of arguments */
    lua_Number sum = 0.0;
    int i;
    for (i = 1; i <= n; i++) {
        if (!lua_isnumber(L, i)) {
            lua_pushliteral(L, "incorrect argument");
            lua_error(L);
        }
        sum += lua_tonumber(L, i);
    }
    lua_pushnumber(L, sum/n); /* first result */
    lua_pushnumber(L, sum); /* second result */
    return 2; /* number of results */
}
}
```

```
@APIEntry{int lua_checkstack (lua_State
*L, int n);|
@api{0,0,-}
```

Ensures that the stack has space for at least `@id{n}` extra elements, that is, that you can safely push up to `@id{n}` values into it.

It returns false if it cannot fulfill the request, either because it would cause the stack to be greater than a fixed maximum size (typically at least several thousand elements) or because it cannot allocate memory for the extra space. This function never shrinks the stack; if the stack already has space for the extra elements, it is left unchanged.

```
}
```

```
@APIEntry{void lua_close (lua_State *L);|  
@apii{0,0,-}}
```

Close all active to-be-closed variables in the main thread,  
release all objects in the given Lua state  
(calling the corresponding garbage-collection metamethods, if any),  
and frees all dynamic memory used by this state.

On several platforms, you may not need to call this function,  
because all resources are naturally released when the host program ends.  
On the other hand, long-running programs that create multiple states,  
such  
as daemons or web servers,  
will probably need to close states as soon as they are not needed.

```
}
```

```
@APIEntry{void lua_closeslot (lua_State *L, int index);|  
@apii{0,0,e}}
```

Close the to-be-closed slot at the given index and set its value to `@nil`.  
The index must be the last index previously marked to be closed  
`@see{lua_toclose}` that is still active (that is, not closed yet).

A `@idx{__close}` metamethod cannot yield  
when called through this function.

(This function was introduced in `@N{release 5.4.3}`.)

```
}
```

```
@APIEntry{int lua_closethread (lua_State *L, lua_State *from);|  
@apii{0,?,-}}
```

Resets a thread, cleaning its call stack and closing all pending  
to-be-closed variables.

Returns a status code:

`@Lid{LUA_OK}` for no errors in the thread  
(either the original error that stopped the thread or  
errors in closing methods),  
or an error status otherwise.

In case of error,

leaves the error object on the top of the stack.

The parameter `@id{from}` represents the coroutine that is resetting `@id{L}`.

If  
there is no such coroutine,  
this parameter can be @id{NULL}.

(This function was introduced in @N{release 5.4.6}.)

}

```
@APIEntry{int lua_compare (lua_State *L, int index1, int index2, int op);|
@apii{0,0,e}
```

Compares two Lua values.

Returns 1 if the value at index @id{index1} satisfies @id{op}  
when compared with the value at index @id{index2},  
following the semantics of the corresponding Lua operator  
(that is, it may call metamethods).

Otherwise @N{returns 0}.

Also @N{returns 0} if any of the indices is not valid.

The value of @id{op} must be one of the following constants:

@description{

@item{@defid{LUA\_OPEQ}| compares for equality (@T{==})}

@item{@defid{LUA\_OPLT}| compares for less than (@T{<})}

@item{@defid{LUA\_OPLE}| compares for less or equal (@T{<=})}

}

}

```
@APIEntry{void lua_concat (lua_State *L, int n);|
@apii{n,1,e}
```

Concatenates the @id{n} values at the top of the stack,  
pops them, and leaves the result on the top.

If @N{@T{n} is 1}, the result is the single value on the  
stack

(that is, the function does nothing);

if @id{n} is 0, the result is the empty string.

Concatenation is performed following the usual semantics of Lua  
@see{concat}.

}

```
@APIEntry{void lua_copy (lua_State *L, int fromidx, int toidx);|
@apii{0,0,-}
```

Copies the element at index @id{fromidx}

into the valid index @id{toidx},  
replacing the value at that position.  
Values at other positions are not affected.

}

```
@APIEntry{void lua_createtable (lua_State *L, int narr, int nrec);|
@apii{0,1,m}
```

Creates a new empty table and pushes it onto the stack.  
Parameter @id{narr} is a hint for how many elements the table  
will have as a sequence;  
parameter @id{nrec} is a hint for how many other elements  
the table will have.  
Lua may use these hints to preallocate memory for the new table.  
This preallocation may help performance when you know in advance  
how many elements the table will have.  
Otherwise you can use the function @Lid{lua\_newtable}.

}

```
@APIEntry{int lua_dump (lua_State *L,

    lua_Writer writer,
        void *data,
        int strip);|
@apii{0,0,-}
```

Dumps a function as a binary chunk.  
Receives a Lua function on the top of the stack  
and produces a binary chunk that,  
if loaded again,  
results in a function equivalent to the one dumped.  
As it produces parts of the chunk,  
@Lid{lua\_dump} calls function @id{writer} @seeC{lua\_Writer}  
with the given @id{data}  
to write them.

If @id{strip} is true,  
the binary representation may not include all debug information  
about the function,  
to save space.

The value returned is the error code returned by the last  
call to the writer;  
@N{0 means} no errors.

This function does not pop the Lua function from the stack.

```
}
```

```
@APIEntry{int lua_error (lua_State *L);|  
@apii{1,0,v}
```

Raises a Lua error,  
using the value on the top of the stack as the error object.  
This function does a long jump,  
and therefore never returns  
@seeC{luaL\_error}.

```
}
```

```
@APIEntry{int lua_gc (lua_State *L, int what, ...);|  
@apii{0,0,-}
```

Controls  
the garbage collector.

This function performs several tasks,  
according to the value of the parameter @id{what}.  
For options that need extra arguments,  
they are listed after the option.  
@description{

```
@item{@id{LUA_GCCOLLECT}}|  
Performs a full garbage-collection cycle.  
}
```

```
@item{@id{LUA_GCSTOP}}|  
Stops the garbage collector.  
}
```

```
@item{@id{LUA_GCRESTART}}|  
Restarts the garbage collector.  
}
```

```
@item{@id{LUA_GCCOUNT}}|  
Returns the current amount of memory (in Kbytes) in use by Lua.  
}
```

```
@item{@id{LUA_GCCOUNTB}}|  
Returns the remainder of dividing the current amount of bytes of  
memory in use by Lua by 1024.  
}
```

```
@item{@id{LUA_GCSTEP} @T{(int stepsize)}}|
```

Performs an incremental step of garbage collection,  
corresponding to the allocation of @id{stepsize} Kbytes.

}

@item{@id{LUA\_GCISRUNNING}|

Returns a boolean that tells whether the collector is running  
(i.e., not stopped).

}

@item{@id{LUA\_GCINC} (int pause, int stepmul, stepsize)|

Changes the collector to incremental mode

with the

given parameters @see{incmode}.

Returns the previous mode (@id{LUA\_GCGEN} or @id{LUA\_GCINC}).

}

@item{@id{LUA\_GCGEN} (int minormul, int majormul)|

Changes the collector to generational mode

with the given parameters @see{genmode}.

Returns the previous mode (@id{LUA\_GCGEN} or @id{LUA\_GCINC}).

}

}

For more details about these options,

see @Lid{collectgarbage}.

This function should not be called by a finalizer.

}

@APIEntry{lua\_Alloc lua\_getallocf (lua\_State \*L, void \*\*ud);|

@apii{0,0,-}

Returns the @x{memory-allocation function} of a given state.

If @id{ud} is not @id{NULL}, Lua stores in @T{\*ud} the  
opaque pointer given when the memory-allocator function was set.

}

@APIEntry{int lua\_getfield (lua\_State \*L, int index, const char \*k);|

@apii{0,1,e}

Pushes onto the stack the value @T{t[k]},

where @id{t} is the value at the given index.

As in Lua, this function may trigger a metamethod

for the @Q{index} event @see{metatable}.

Returns the type of the pushed value.

```
}
```

```
@APIEntry{void  
  *lua_getextraspaces (lua_State *L);|  
  @apii{0,0,-}
```

Returns a pointer to a raw memory area associated with the given Lua state.

The application can use this area for any purpose; Lua does not use it for anything.

Each new thread has this area initialized with a copy of the area of the @x{main thread}.

By default, this area has the size of a pointer to void, but you can recompile Lua with a different size for this area. (See @id{LUA\_EXTRASPACE} in @id{luaconf.h}.)

```
}
```

```
@APIEntry{int lua_getglobal (lua_State *L, const char *name);|  
  @apii{0,1,e}
```

Pushes onto the stack the value of the global @id{name}. Returns the type of that value.

```
}
```

```
@APIEntry{int lua_geti (lua_State *L, int index, lua_Integer i);|  
  @apii{0,1,e}
```

Pushes onto the stack the value @T{t[i]}, where @id{t} is the value at the given index. As in Lua, this function may trigger a metamethod for the @Q{index} event @see{metatable}.

Returns the type of the pushed value.

```
}
```

```
@APIEntry{int lua_getmetatable (lua_State *L, int index);|  
  @apii{0,0|1,-}
```

If the value at the given index has a metatable, the function pushes that metatable onto the stack and @N{returns 1}. Otherwise,



the function @N{returns 0} and pushes nothing on the stack.

}

```
@APIEntry{int lua_gettable (lua_State *L, int index);|
@apii{1,1,e}
```

Pushes onto the stack the value @T{t[k]},  
where @id{t} is the value at the given index  
and @id{k} is the value on the top of the stack.

This function pops the key from the stack,  
pushing the resulting value in its place.  
As in Lua, this function may trigger a metamethod  
for the @Q{index} event @see{metatable}.

Returns the type of the pushed value.

}

```
@APIEntry{int lua_gettop (lua_State *L);|
@apii{0,0,-}
```

Returns the index of the top element in the stack.  
Because indices start @N{at 1},  
this result is equal to the number of elements in the stack;  
in particular, @N{0 means} an empty stack.

}

```
@APIEntry{int lua_getiuservalue (lua_State *L, int index, int n);|
@apii{0,1,-}
```

Pushes onto the stack the @id{n}-th  
user value associated with the  
full userdata at the given index and  
returns the type of the pushed value.

If the userdata does not have that value,  
pushes @nil and returns @Lid{LUA\_TNONE}.

}

```
@APIEntry{void lua_insert (lua_State *L, int index);|
@apii{1,1,-}
```

Moves the top element into the given valid index,  
shifting up the elements above this index to open space.

This function cannot be called with a pseudo-index,  
because a pseudo-index is not an actual stack position.

}

@APIEntry{typedef @ldots lua\_Integer;|

The type of integers in Lua.

By default this type is @id{long long},  
(usually a 64-bit two-complement integer),  
but that can be changed to @id{long} or @id{int}  
(usually a 32-bit two-complement integer).  
(See @id{LUA\_INT\_TYPE} in @id{luaconf.h}.)

Lua also defines the constants

@defid{LUA\_MININTEGER} and @defid{LUA\_MAXINTEGER},  
with the minimum and the maximum values that fit in this type.

}

@APIEntry{int lua\_isboolean (lua\_State \*L, int index);|  
@apii{0,0,-}

Returns 1

if the value at the given index is a boolean,  
and @N{0 otherwise}.

}

@APIEntry{int lua\_iscfunction (lua\_State \*L, int index);|  
@apii{0,0,-}

Returns 1 if the value at the given index is a @N{C function},  
and @N{0 otherwise}.

}

@APIEntry{int lua\_isfunction (lua\_State \*L, int index);|  
@apii{0,0,-}

Returns 1 if the value at the given index is a function  
(either C or Lua), and @N{0 otherwise}.

}

@APIEntry{int lua\_isinteger (lua\_State \*L, int index);|  
@apii{0,0,-}

Returns 1 if the value at the given index is an integer  
(that is, the value is a number and is represented as an integer),  
and @N{0 otherwise}.

}

```
@APIEntry{int lua_istouserdata (lua_State *L, int index);|
@apii{0,0,-}
```

Returns 1 if the value at the given index is a light userdata,  
and @N{0 otherwise}.

}

```
@APIEntry{int lua_isnil (lua_State *L, int index);|
@apii{0,0,-}
```

Returns 1 if the value at the given index is @nil,  
and @N{0 otherwise}.

}

```
@APIEntry{int lua_isnone (lua_State *L, int index);|
@apii{0,0,-}
```

Returns  
1 if the given index is not valid,  
and @N{0 otherwise}.

}

```
@APIEntry{int lua_isnoneornil (lua_State *L, int index);|
@apii{0,0,-}
```

Returns 1 if the given index is not valid  
or if the value at this index is @nil,  
and @N{0 otherwise}.

}

```
@APIEntry{int lua_isnumber (lua_State *L, int index);|
@apii{0,0,-}
```

Returns 1 if the value at the given index is a number  
or a string convertible to a number,  
and @N{0 otherwise}.

```
}
```

```
@APIEntry{int lua_isstring (lua_State *L, int index);|  
@apii{0,0,-}}
```

Returns 1 if the value at the given index is a string  
or a number (which is always convertible to a string),  
and @N{0 otherwise}.

```
}
```

```
@APIEntry{int lua_istable (lua_State *L, int index);|  
@apii{0,0,-}}
```

Returns 1 if the value at the given index is a table,  
and @N{0 otherwise}.

```
}
```

```
@APIEntry{int lua_isthread (lua_State *L, int index);|  
@apii{0,0,-}}
```

Returns 1 if the value at the given index is a thread,  
and @N{0 otherwise}.

```
}
```

```
@APIEntry{int lua_isuserdata (lua_State *L, int index);|  
@apii{0,0,-}}
```

Returns  
1 if the value at the given index is a userdata  
(either full or light), and @N{0 otherwise}.

```
}
```

```
@APIEntry{int lua_isyieldable (lua_State *L);|  
@apii{0,0,-}}
```

Returns 1 if the given coroutine can yield,  
and @N{0 otherwise}.

```
}
```

```
@APIEntry{typedef @ldots lua_KContext;|
```

The type for continuation-function contexts.  
It must be a numeric type.

This type is defined as `@id{intptr_t}`  
when `@id{intptr_t}` is available,  
so that it can store pointers too.  
Otherwise, it is defined as `@id{ptrdiff_t}`.

}

```
@APIEntry{
typedef int (*lua_KFunction) (lua_State *L, int status, lua_KContext ctx);|
```

Type for continuation functions `@see{continuations}`.

}

```
@APIEntry{void lua_len (lua_State *L, int index);|
@apii{0,1,e}
```

Returns the length of the value at the given index.  
It is equivalent to the `@Char{#}` operator in Lua `@see{len-op}` and  
may trigger a metamethod for the `@Q{length}` event `@see{metatable}`.  
The result is pushed on the stack.

}

```
@APIEntry{
int lua_load (lua_State *L,
              lua_Reader reader,
              void *data,
              const char *chunkname,
              const char *mode);|
@apii{0,1,-}
```

Loads a Lua chunk without running it.  
If there are no errors,  
`@id{lua_load}` pushes the compiled chunk as a Lua  
function on top of the stack.  
Otherwise, it pushes an error message.

The `@id{lua_load}` function uses a user-supplied `@id{reader}` function  
to read the chunk `@seeC{lua_Reader}`.  
The `@id{data}` argument is an opaque value passed to the reader function.

The `@id{chunkname}` argument gives a name to the chunk,  
which is used for error messages and in debug information `@see{debugI}`.

`@id{lua_load}` automatically detects whether the chunk is text or binary  
and loads it accordingly (see program `@idx{luac}`).  
The string `@id{mode}` works as in function `@Lid{load}`,

with the addition that  
a `@id{NULL}` value is equivalent to the string `@St{bt}`.

`@id{lua_load}` uses the stack internally,  
so the reader function must always leave the stack  
unmodified when returning.

`@id{lua_load}` can return  
`@Lid{LUA_OK}`,  
`@Lid{LUA_ERRSYNTAX}`, or `@Lid{LUA_ERRMEM}`.  
The function may also return other values corresponding to  
errors raised by the read function `@see{statuscodes}`.

If the resulting function has upvalues,  
its first upvalue is set to the value of the `@x{global environment}`  
stored at index `@id{LUA_RIDX_GLOBALS}` in the registry `@see{registry}`.  
When loading main chunks,  
this upvalue will be the `@id{_ENV}` variable `@see{globalenv}`.  
Other upvalues are initialized with `@nil`.

}

```
@APIEntry{lua_State *lua_newstate (lua_Alloc f, void *ud);|
@apii{0,0,-}
```

Creates a new independent state and returns its main thread.  
Returns `@id{NULL}` if it cannot create the state  
(due to lack of memory).  
The argument `@id{f}` is the `@x{allocator function}`;  
Lua will do all memory allocation for this state  
through this function `@seeF{lua_Alloc}`.  
The second argument, `@id{ud}`, is an opaque pointer that Lua  
passes to the allocator in every call.

}

```
@APIEntry{void lua_newtable (lua_State *L);|
@apii{0,1,m}
```

Creates  
a new empty table and pushes it onto the stack.  
It is equivalent to `@T{lua_createtable(L, 0, 0)}`.

}

```
@APIEntry{lua_State *lua_newthread (lua_State *L);|
@apii{0,1,m}
```

Creates a new thread, pushes it on the stack,  
and returns a pointer to a @Lid{lua\_State} that represents this new thread.  
The new thread returned by this function shares with the original thread  
its global environment,  
but has an independent execution stack.

Threads are subject to garbage collection,  
like any Lua object.

}

```
@APIEntry{void *lua_newuserdatauv (lua_State *L, size_t size, int nuvalue);|
@apii{0,1,m}
```

This function creates and pushes on the stack a new full userdata,  
with @id{nuvalue} associated Lua values, called @id{user values},  
plus an associated block of raw memory with @id{size} bytes.  
(The user values can be set and read with the functions  
@Lid{lua\_setiuservalue} and @Lid{lua\_getiuservalue}.)

The function returns the address of the block of memory.  
Lua ensures that this address is valid as long as  
the  
corresponding userdata is alive @see{GC}.  
Moreover, if the userdata is marked for finalization @see{finalizers},  
its address is valid at least until the call to its finalizer.

}

```
@APIEntry{int lua_next (lua_State *L, int index);|
@apii{1,2|0,v}
```

Pops a key from the stack,  
and pushes a key@En{ }value pair from the table at the given index,  
the @Q{next} pair after the given key.  
If there are no more elements in the table,  
then @Lid{lua\_next} @N{returns 0} and pushes nothing.

A typical table traversal looks like this:

```
@verbatim{
/* table is in the stack at index 't' */
lua_pushnil(L); /* first key */
while (lua_next(L, t) != 0) {
/* uses 'key' (at index -2) and 'value' (at index -1) */
printf("%s - %s\n",
    lua_typename(L, lua_type(L, -2)),
    lua_typename(L, lua_type(L, -1)));
/* removes 'value'; keeps 'key' for next iteration */
```

```
lua_pop(L, 1);
}
}
```

While traversing a table,  
avoid calling `@Lid{lua_tolstring}` directly on a key,  
unless you know that the key is  
actually a string.  
Recall that `@Lid{lua_tolstring}` may change  
the value at the given index;  
this confuses the next call to `@Lid{lua_next}`.

This function may raise an error if the given key  
is neither `@nil` nor present in the table.  
See function `@Lid{next}` for the caveats of modifying  
the table during its traversal.

```
}
```

```
@APIEntry{typedef @ldots lua_Number;|
```

The type of floats in Lua.

By default this type is double,  
but that can be changed to a single float or a long double.  
(See `@id{LUA_FLOAT_TYPE}` in `@id{luaconf.h}`.)

```
}
```

```
@APIEntry{int lua_numbertointeger (lua_Number n, lua_Integer *p);|
```

Tries to convert a Lua float to a Lua integer;  
the float `@id{n}` must have an integral value.  
If that value is within the range of Lua integers,  
it is converted to an integer and assigned to `@T{*p}`.  
The macro results in a boolean indicating whether the  
conversion was successful.  
(Note that this range test can be tricky to do  
correctly without this macro, due to rounding.)

This macro may evaluate its  
arguments more than once.

```
}
```

```
@APIEntry{int lua_pcall (lua_State *L, int nargs, int nresults, int msgch);|
@apii{nargs + 1,nresults|1,-}
```



Calls a function (or a callable object) in protected mode.

Both `@id{nargs}` and `@id{nresults}` have the same meaning as in `@Lid{lua_call}`.

If there are no errors during the call,

`@Lid{lua_pcall}` behaves exactly like `@Lid{lua_call}`.

However, if there is any error,

`@Lid{lua_pcall}` catches it,

pushes a single value on the stack (the error object),

and returns an error code.

Like `@Lid{lua_call}`,

`@Lid{lua_pcall}` always removes the function

and its arguments from the stack.

If `@id{msggh}` is 0,

then the error object returned on the stack

is exactly the original error object.

Otherwise, `@id{msggh}` is the stack index of a

`@emph{message handler}`.

(This index cannot be a pseudo-index.)

In case of runtime errors,

this handler will be called with the error object

and its return value will be the object

returned on the stack by `@Lid{lua_pcall}`.

Typically, the message

handler is used to add more debug

information to the error object, such as a stack traceback.

Such information cannot be gathered after the return of `@Lid{lua_pcall}`,

since by then the stack has unwound.

The `@Lid{lua_pcall}` function returns one of the following status codes:

`@Lid{LUA_OK}`, `@Lid{LUA_ERRRUN}`, `@Lid{LUA_ERRMEM}`, or `@Lid{LUA_ERRERR}`.

}

`@APIEntry{`

`int lua_pcallk (lua_State *L,`

`int nargs,`

`int nresults,`

`int msggh,`

`lua_KContext ctx,`

`lua_KFunction k);`

`@apii{nargs + 1,nresults|1,-}`

This function behaves exactly like `@Lid{lua_pcall}`,

except that it allows the called function to yield `@see{continuations}`.

}

```
@APIEntry{void lua_pop (lua_State *L, int n);|
@apii{n,0,e}
```

Pops @id{n} elements from the stack.

It is implemented as a macro over @Lid{lua\_settop}.

}

```
@APIEntry{void lua_pushboolean (lua_State *L, int b);|
@apii{0,1,-}
```

Pushes a boolean value with value @id{b} onto the stack.

}

```
@APIEntry{void
lua_pushcclosure (lua_State *L, lua_CFunction fn, int n);|
@apii{n,1,m}
```

Pushes a new @N{C closure} onto the stack.

This function receives a pointer to a @N{C function}

and pushes onto the stack a Lua value of type @id{function} that,

when called, invokes the corresponding @N{C function}.

The parameter @id{n} tells how many upvalues this function will have

@see{c-closure}.

Any function to be callable by Lua must

follow the correct protocol to receive its parameters

and return its results @seeC{lua\_CFunction}.

When a @N{C function} is created,

it is possible to associate some values with it,

the so called upvalues;

these upvalues are then accessible to the function whenever it is called.

This association is called a @x{@N{C closure}} @see{c-closure}.

To create a @N{C closure},

first the initial values for its upvalues must be pushed onto the stack.

(When there are multiple upvalues, the first value is pushed first.)

Then @Lid{lua\_pushcclosure}

is called to create and push the @N{C

function} onto the stack,

with the argument @id{n} telling how many values will be

associated with the function.

@Lid{lua\_pushcclosure} also pops these values from the stack.

The maximum value for @id{n} is 255.

When @id{n} is zero,  
this function creates a @def{light @N{C function}},  
which is just a pointer to the @N{C function}.  
In that case, it never raises a memory error.

}

```
@APIEntry{void lua_pushcfunction (lua_State *L, lua_CFunction f);|
@apii{0,1,-}}
```

Pushes a @N{C function} onto the stack.  
This function is equivalent to @Lid{lua\_pushcclosure} with no upvalues.

}

```
@APIEntry{const char *lua_pushfstring (lua_State *L, const char *fmt, ...);|
@apii{0,1,v}}
```

Pushes onto the stack a formatted string  
and returns a pointer to this string @see{constchar}.  
It is similar to the @ANSI{sprintf},  
but has two important differences.

First,  
you do not have to allocate space for the result;  
the result is a Lua string and Lua takes care of memory allocation  
(and deallocation, through garbage  
collection).

Second,  
the conversion specifiers are quite restricted.  
There are no flags, widths, or precisions.  
The conversion specifiers can only be  
@Char{%%} (inserts the character @Char{%}),  
@Char{%s} (inserts a zero-terminated string, with no size restrictions),  
@Char{%f} (inserts a @Lid{lua\_Number}),  
@Char{%I} (inserts a @Lid{lua\_Integer}),  
@Char{%p} (inserts a pointer),  
@Char{%d} (inserts an @T{int}),  
@Char{%c} (inserts an @T{int} as a one-byte character), and  
@Char{%U} (inserts a @T{long int} as a @x{UTF-8} byte sequence).

This function may raise errors due to memory overflow  
or an invalid conversion specifier.

}

```
@APIEntry{void lua_pushglobaltable (lua_State *L);|
@apii{0,1,-}}
```

Pushes the @x{global environment} onto the stack.

}

```
@APIEntry{void lua_pushinteger (lua_State *L, lua_Integer n);|
@apii{0,1,-}}
```

Pushes an integer with value @id{n} onto the stack.

}

```
@APIEntry{void lua_pushlightuserdata (lua_State *L, void *p);|
@apii{0,1,-}}
```

Pushes a light userdata onto the stack.

Userdata

represent @N{C values} in Lua.

A @def{light userdata} represents a pointer, a @T{void\*}.

It is a value (like a number):

you do not create it, it has no individual metatable,

and it is not collected (as it was never created).

A light userdata is equal to @Q{any}

light userdata with the same @N{C address}.

}

```
@APIEntry{const char *lua_pushliteral (lua_State *L, const char *s);|
@apii{0,1,m}}
```

This macro is equivalent to @Lid{lua\_pushstring},  
but should be used only when @id{s} is a literal string.  
(Lua may optimize this case.)

}

```
@APIEntry{const char *lua_pushlstring (lua_State *L, const char *s, size_t len);|
@apii{0,1,m}}
```

Pushes the string pointed to by @id{s} with size @id{len}  
onto the stack.

Lua will make or reuse an internal copy of the given string,  
so the memory at @id{s} can be freed or reused immediately after  
the function returns.

The string can contain any binary data,  
including @x{embedded zeros}.

Returns a pointer to the internal copy of the string @see{constchar}.

}

```
@APIEntry{void  
lua_pushnil (lua_State *L);|  
@apii{0,1,-}
```

Pushes a nil value onto the stack.

}

```
@APIEntry{void lua_pushnumber (lua_State *L, lua_Number n);|  
@apii{0,1,-}
```

Pushes a float with value @id{n} onto the stack.

}

```
@APIEntry{const char *lua_pushstring (lua_State *L, const char *s);|  
@apii{0,1,m}
```

Pushes the zero-terminated string pointed to by @id{s}  
onto the stack.

Lua will make or reuse an internal copy of the given string,  
so the memory at @id{s} can be freed or reused immediately after  
the function returns.

Returns a pointer to the internal copy of the string @see{constchar}.

If @id{s} is @id{NULL}, pushes @nil and returns @id{NULL}.

}

```
@APIEntry{int lua_pushthread (lua_State *L);|  
@apii{0,1,-}
```

Pushes the thread represented by @id{L} onto the stack.  
Returns 1 if this thread is the @x{main thread} of its state.

}

```
@APIEntry{void lua_pushvalue (lua_State *L, int index);|  
@apii{0,1,-}
```

Pushes a copy of the element at the given index  
onto the stack.

```
}
```

```
@APIEntry{  
const  
char *lua_pushvfstring (lua_State *L,  
                        const char *fmt,  
                        va_list argp);|  
@apii{0,1,v}
```

Equivalent to `@Lid{lua_pushfstring}`, except that it receives a `@id{va_list}` instead of a variable number of arguments.

```
}
```

```
@APIEntry{int lua_rawequal (lua_State *L, int index1, int index2);|  
@apii{0,0,-}
```

Returns 1 if the two values in indices `@id{index1}` and `@id{index2}` are primitively equal (that is, equal without calling the `@idx{__eq}` metamethod). Otherwise `@N{returns 0}`. Also `@N{returns 0}` if any of the indices are not valid.

```
}
```

```
@APIEntry{int lua_rawget (lua_State *L, int index);|  
@apii{1,1,-}
```

Similar to `@Lid{lua_gettable}`, but does a raw access (i.e., without metamethods). The value at `@id{index}` must be a table.

```
}
```

```
@APIEntry{int lua_rawgeti (lua_State *L, int index, lua_Integer n);|  
@apii{0,1,-}
```

Pushes onto the stack the value `@T{t[n]}`, where `@id{t}` is the table at the given index. The access is raw, that is, it does not use the `@idx{__index}` metavalue.

Returns the type of the pushed value.

```
}
```

```
@APIEntry{int lua_rawgetp (lua_State *L, int index, const void *p);|
```

@apii{0,1,-}

Pushes onto the stack the value @T{t[k]},  
where @id{t} is the table at the given index and  
@id{k} is the pointer @id{p} represented as a light userdata.  
The access is raw;  
that is, it does not use the @idx{\_\_index} metavalue.

Returns the type of the pushed value.

}

@APIEntry{lua\_Unsigned lua\_rawlen (lua\_State \*L, int index);|  
@apii{0,0,-}

Returns the raw @Q{length} of the value at the given index:  
for strings, this is the string length;  
for tables, this is the result of the length operator (@Char{#})  
with no metamethods;  
for userdata, this is the size of the block of memory allocated  
for the userdata.  
For other values, this call @N{returns 0}.

}

@APIEntry{void lua\_rawset (lua\_State \*L, int index);|  
@apii{2,0,m}

Similar to @Lid{lua\_settable}, but does a raw assignment  
(i.e., without metamethods).  
The value at @id{index} must  
be a table.

}

@APIEntry{void lua\_rawseti (lua\_State \*L, int index, lua\_Integer i);|  
@apii{1,0,m}

Does the equivalent of @T{t[i] = v},  
where @id{t} is the table at the given index  
and @id{v} is the value on the top of the stack.

This function pops the value from the stack.  
The assignment is raw,  
that is, it does not use the @idx{\_\_newindex} metavalue.

}

```
@APIEntry{void lua_rawsetp (lua_State *L, int index, const void *p);|
@apii{1,0,m}
```

Does the equivalent of `@T{t[p] = v}`,  
 where `@id{t}` is the table at the given index,  
`@id{p}` is encoded as a light userdata,  
 and `@id{v}` is the value on the top of the stack.

This function pops the value from the stack.  
 The assignment is raw,  
 that is, it does not use the `@idx{__newindex}` metavalue.

```
}
```

```
@APIEntry{
typedef const char * (*lua_Reader) (lua_State *L,
                                   void *data,
                                   size_t *size);|
```

The reader function used by `@Lid{lua_load}`.  
 Every time `@Lid{lua_load}` needs another piece of  
 the chunk,  
 it calls the reader,  
 passing along its `@id{data}` parameter.  
 The reader must return a pointer to a block of memory  
 with a new piece of the chunk  
 and set `@id{size}` to the block size.  
 The block must exist until the reader function is called again.  
 To signal the end of the chunk,  
 the reader must return `@id{NULL}` or set `@id{size}` to zero.  
 The reader function may return pieces of any size greater than zero.

```
}
```

```
@APIEntry{void lua_register (lua_State *L, const char *name, lua_CFunction f);|
@apii{0,0,e}
```

Sets the `@N{C function}` `@id{f}` as the new value of global `@id{name}`.  
 It is defined as a macro:

```
@verbatim{
#define lua_register(L,n,f) \
    (lua_pushcfunction(L, f), lua_setglobal(L, n))
}

}
```

```
@APIEntry{void lua_remove (lua_State *L, int index);|
@apii{1,0,-}
```



Removes the element at the given valid index,  
 shifting down the elements above this index to fill the gap.  
 This function cannot be called with a pseudo-index,  
 because a pseudo-index is not an actual stack position.

```
}
```

```
@APIEntry{void
  lua_replace (lua_State *L, int index);|
@apii{1,0,-}
```

Moves the top element into the given valid index  
 without shifting any element  
 (therefore replacing the value at that given index),  
 and then pops the top element.

```
}
```

```
@APIEntry{int lua_resetthread (lua_State *L);|
@apii{0,?, -}
```

This function is deprecated;  
 it is equivalent to @Lid{lua\_closethread} with  
 @id{from} being @id{NULL}.

```
}
```

```
@APIEntry{int lua_resume (lua_State *L, lua_State *from, int nargs,
                          int *nresults);|
@apii{?,?, -}
```

Starts and resumes a coroutine in the given thread @id{L}.

To start a coroutine,  
 you push the main function plus any arguments  
 onto the empty stack of the thread.  
 then you call @Lid{lua\_resume},  
 with @id{nargs} being the number of arguments.  
 This call returns when the coroutine suspends or finishes its execution.  
 When it returns,  
 @id{\*nresults} is updated and  
 the top of the stack contains  
 the @id{\*nresults} values passed to @Lid{lua\_yield}  
 or returned by the body function.  
 @Lid{lua\_resume}  
 returns  
 @Lid{LUA\_YIELD} if the coroutine yields,

@Lid{LUA\_OK} if the coroutine finishes its execution without errors,  
or an error code in case of errors @see{statuscodes}.  
In case of errors,  
the error object is on the top of the stack.

To resume a coroutine,  
you remove the @id{\*nresults} yielded values from its stack,  
push the values to be passed as results from @id{yield},  
and then call @Lid{lua\_resume}.

The parameter @id{from} represents the coroutine that is resuming @id{L}.  
If there is no such coroutine,  
this parameter can be @id{NULL}.

}

@APIEntry{void lua\_rotate (lua\_State \*L, int idx, int n);|  
@apii{0,0,-}}

Rotates the stack elements between the valid index @id{idx}  
and the top of the stack.  
The elements are rotated @id{n} positions in the direction of the top,  
for a positive @id{n},  
or @T{-n} positions in the direction of the bottom,  
for a negative @id{n}.  
The absolute value of @id{n} must not be greater than the size  
of the slice being rotated.  
This function  
cannot be called with a pseudo-index,  
because a pseudo-index is not an actual stack position.

}

@APIEntry{void lua\_setallocf (lua\_State \*L, lua\_Alloc f, void \*ud);|  
@apii{0,0,-}}

Changes the @x{allocator function} of a given state to @id{f}  
with user data @id{ud}.

}

@APIEntry{void lua\_setfield (lua\_State \*L, int index, const char \*k);|  
@apii{1,0,e}}

Does the equivalent to @T{t[k] = v},  
where @id{t} is the value at the given index  
and @id{v} is the value on the top of the stack.

This function pops the value from the stack.  
As in Lua, this function may trigger a metamethod  
for the @Q{newindex} event @see{metatable}.

```
}
```

```
@APIEntry{void lua_setglobal (lua_State *L, const char *name);|  
@apii{1,0,e}}
```

Pops a value from the stack and  
sets it as the new value of global @id{name}.

```
}
```

```
@APIEntry{void lua_seti (lua_State *L, int index, lua_Integer n);|  
@apii{1,0,e}}
```

Does the equivalent to @T{t[n] = v},  
where @id{t} is the value at the given index  
and @id{v} is the value on the top of  
the stack.

This function pops the value from the stack.  
As in Lua, this function may trigger a metamethod  
for the @Q{newindex} event @see{metatable}.

```
}
```

```
@APIEntry{int lua_setiuservalue (lua_State *L, int index, int n);|  
@apii{1,0,-}}
```

Pops a value from the stack and sets it as  
the new @id{n}-th user value associated to the  
full userdata at the given index.  
Returns 0 if the userdata does not have that value.

```
}
```

```
@APIEntry{int lua_setmetatable (lua_State *L, int index);|  
@apii{1,0,-}}
```

Pops a table or @nil from the stack and  
sets that value as the new metatable for the value at the given index.  
(@nil means no metatable.)

(For historical reasons, this function returns an @id{int},  
which now is always 1.)

```
}
```

```
@APIEntry{void lua_settable (lua_State *L, int index);|
@apii{2,0,e}
```

Does the equivalent to `@T{t[k] = v}`,  
where `@id{t}` is the value at the given index,  
`@id{v}` is the value on the top of the stack,  
and `@id{k}` is the value just below the top.

This function pops both the key and the value  
from the stack.

As in Lua, this function may trigger a metamethod  
for the `@Q{newindex}` event `@see{metatable}`.

```
}
```

```
@APIEntry{void lua_settop (lua_State *L, int index);|
@apii{?,?,e}
```

Accepts any index, `@N{or 0}`,  
and sets the stack top to this index.  
If the new top is greater than the old one,  
then the new elements are filled with `@nil`.  
If `@id{index}` `@N{is 0}`, then all stack elements are removed.

This function can run arbitrary code when removing an index  
marked as to-be-closed from the stack.

```
}
```

```
@APIEntry{void lua_setwarnf (lua_State *L, lua_WarnFunction f, void *ud);|
@apii{0,0,-}
```

Sets the `@x{warning function}` to be used by Lua to emit warnings  
`@see{lua_WarnFunction}`.  
The `@id{ud}` parameter sets the value `@id{ud}` passed to  
the warning function.

```
}
```

```
@APIEntry{typedef struct lua_State lua_State;|
```

An opaque structure that points to a thread and indirectly  
(through the thread) to the whole state of a Lua interpreter.  
The Lua library is fully reentrant:  
it has no global variables.

All

information about a state is accessible through this structure.

A pointer to this structure must be passed as the first argument to every function in the library, except to `@Lid{lua_newstate}`, which creates a Lua state from scratch.

}

```
@APIEntry{int lua_status (lua_State *L);|
@apii{0,0,-}}
```

Returns the status of the thread `@id{L}`.

The status can be `@Lid{LUA_OK}` for a normal thread, an error code if the thread finished the execution of a `@Lid{lua_resume}` with an error, or `@Lid{LUA_YIELD}` if the thread is suspended.

You can call functions only in threads with status `@Lid{LUA_OK}`. You can resume threads with status `@Lid{LUA_OK}` (to start a new coroutine) or `@Lid{LUA_YIELD}` (to resume a coroutine).

}

```
@APIEntry{size_t lua_stringtonumber (lua_State *L, const char *s);|
@apii{0,1,-}}
```

Converts the zero-terminated string `@id{s}` to a number, pushes that number into the stack, and returns the total size of the string, that is, its length plus one.

The conversion can result in an integer or a float,

according to the lexical conventions of Lua `@see{lexical}`.

The string may have leading and trailing whitespaces and a sign.

If the string is not a valid numeral,

returns 0 and pushes nothing.

(Note that the result can be used as a boolean, true if the conversion succeeds.)

}

```
@APIEntry{int lua_toboolean (lua_State *L, int index);|
@apii{0,0,-}}
```

Converts the Lua value at the given index to a `@N{C boolean}`

value (@N{0 or 1}).

Like all tests in Lua,

@Lid{lua\_toboolean} returns true for any Lua value different from @false and @nil; otherwise it returns false.

(If you want to accept only actual boolean values, use @Lid{lua\_isboolean} to test the value's type.)

}

```
@APIEntry{lua_CFunction lua_tocfunction (lua_State *L, int index);|
@apii{0,0,-}
```

Converts a value at the given index to a @N{C function}. That value must be a @N{C function}; otherwise, returns @id{NULL}.

}

```
@APIEntry{void lua_toclose (lua_State *L, int index);|
@apii{0,0,v}
```

Marks the given index in the stack as a to-be-closed

slot @see{to-be-closed}.

Like a to-be-closed variable in Lua, the value at that slot in the stack will be closed when it goes out of scope.

Here, in the context of a C function, to go out of scope means that the running function returns to Lua, or there is an error,

or the slot is removed from the stack through

@Lid{lua\_settop} or @Lid{lua\_pop},

or there is a call to @Lid{lua\_closeslot}.

A slot marked as to-be-closed should not be removed from the stack by any other function in the API except @Lid{lua\_settop} or @Lid{lua\_pop}, unless previously deactivated by @Lid{lua\_closeslot}.

This function raises an error if the value at the given slot neither has a @idx{\_\_close} metamethod nor is a false value.

This function should not be called for an index that is equal to or below an active to-be-closed slot.

Note that, both in case of errors and of a regular return, by the time the @idx{\_\_close} metamethod runs, the @N{C stack} was already unwound, so that any automatic @N{C variable}

declared in the calling function  
(e.g., a buffer) will be out of scope.

}

```
@APIEntry{lua_Integer lua_tointeger (lua_State *L, int index);|  
@apii{0,0,-}
```

Equivalent to @Lid{lua\_tointegerx} with @id{isnum} equal to @id{NULL}.

}

```
@APIEntry{lua_Integer lua_tointegerx (lua_State *L, int index, int *isnum);|  
@apii{0,0,-}
```

Converts the Lua value at the given index  
to the signed integral type @Lid{lua\_Integer}.  
The Lua value must be an integer,  
or a number or string convertible to an integer @see{coercion};  
otherwise, @id{lua\_tointegerx} @N{returns 0}.

If @id{isnum} is not @id{NULL},  
its referent is assigned a boolean value that  
indicates whether the operation succeeded.

}

```
@APIEntry{const char *lua_tolstring (lua_State *L, int index, size_t *len);|  
@apii{0,0,m}
```

Converts the Lua value at the given index to a @N{C string}.  
If @id{len} is not @id{NULL},  
it sets @T{\*len} with the string length.  
The Lua value must be a string or a number;  
otherwise, the function returns @id{NULL}.  
If  
the value is a number,  
then @id{lua\_tolstring} also  
@emph{changes the actual value in the stack to a string}.  
(This change confuses @Lid{lua\_next}  
when @id{lua\_tolstring} is applied to keys during a table traversal.)

@id{lua\_tolstring} returns a pointer  
to a string inside the Lua state @see{constchar}.  
This string always has a zero (@Char{\0})  
after its last character (as @N{in C}),  
but can contain other zeros in its body.

This function can raise memory errors only  
when converting a number to a string  
(as then it may create a new string).

}

```
@APIEntry{lua_Number lua_tonumber (lua_State *L, int index);|  
@apii{0,0,-}}
```

Equivalent to @Lid{lua\_tonumberx} with @id{isnum} equal to @id{NULL}.

}

```
@APIEntry{lua_Number lua_tonumberx (lua_State *L, int index, int *isnum);|  
@apii{0,0,-}}
```

Converts the Lua value at the given index  
to the @N{C type} @Lid{lua\_Number} @seeC{lua\_Number}.  
The Lua value must be a number or a string convertible to a number  
@see{coercion};  
otherwise, @Lid{lua\_tonumberx}  
@N{returns 0}.

If @id{isnum} is not @id{NULL},  
its referent is assigned a boolean value that  
indicates whether the operation succeeded.

}

```
@APIEntry{const void *lua_topointer (lua_State *L, int index);|  
@apii{0,0,-}}
```

Converts the value at the given index to a generic  
@N{C pointer} (@T{void\*}).  
The value can be a userdata, a table, a thread, a string, or a function;  
otherwise, @id{lua\_topointer} returns @id{NULL}.  
Different objects will give different pointers.  
There is no way to convert the pointer back to its original value.

Typically this function is used only for hashing and debug information.

}

```
@APIEntry{const char *lua_tolstring (lua_State *L, int index);|  
@apii{0,0,m}}
```

Equivalent to @Lid{lua\_tolstring} with @id{len} equal to @id{NULL}.



```
}
```

```
@APIEntry{lua_State *lua_tothread (lua_State *L, int index);|  
@apii{0,0,-}}
```

Converts the value at the given index to a Lua thread  
(represented as @T{lua\_State\*}).

This value must be a thread;  
otherwise, the function returns @id{NULL}.

```
}
```

```
@APIEntry{void  
*lua_touserdata (lua_State *L, int index);|  
@apii{0,0,-}}
```

If the value at the given index is a full userdata,  
returns its memory-block address.

If the value is a light userdata,  
returns its value (a pointer).

Otherwise, returns @id{NULL}.

```
}
```

```
@APIEntry{int lua_type (lua_State *L, int index);|  
@apii{0,0,-}}
```

Returns the type of the value in the given valid index,  
or @id{LUA\_TNONE} for a non-valid but acceptable index.

The types returned by @Lid{lua\_type} are coded by the following constants  
defined in @id{lua.h}:

```
@defid{LUA_TNIL},  
@defid{LUA_TNUMBER},  
@defid{LUA_TBOOLEAN},  
@defid{LUA_TSTRING},  
@defid{LUA_TTABLE},  
@defid{LUA_TFUNCTION},  
@defid{LUA_TUSERDATA},  
@defid{LUA_TTHREAD},  
and  
@defid{LUA_TLIGHTUSERDATA}.
```

```
}
```

```
@APIEntry{const char *lua_typename (lua_State *L, int tp);|  
@apii{0,0,-}}
```

Returns the name of the type encoded by the value @id{tp},

which must be one the values returned by @Lid{lua\_type}.

```
}
```

```
@APIEntry{typedef @ldots lua_Unsigned;|
```

The unsigned version of @Lid{lua\_Integer}.

```
}
```

```
@APIEntry{int  
lua_upvalueindex (int i);|  
@apii{0,0,-}
```

Returns the pseudo-index that represents the @id{i}-th upvalue of the running function @see{c-closure}.

@id{i} must be in the range @M{[1,256]}.

```
}
```

```
@APIEntry{lua_Number lua_version (lua_State *L);|  
@apii{0,0,-}
```

Returns the version number of this core.

```
}
```

```
@APIEntry{  
typedef void (*lua_WarnFunction) (void *ud, const char *msg, int tocont);|
```

The type of @x{warning function}s, called by Lua to emit warnings.

The first parameter is an opaque pointer set by @Lid{lua\_setwarnf}.

The second parameter is the warning message.

The third parameter is a boolean that indicates whether the message is to be continued by the message in the next call.

See @Lid{warn} for more details about warnings.

```
}
```

```
@APIEntry{  
void lua_warning (lua_State *L, const char *msg, int tocont);|  
@apii{0,0,-}
```

Emits a warning with the given message.

A message in a call with @id{tocont} true should be

continued in another call to this function.

See

@Lid{warn} for more details about warnings.

}

```
@APIEntry{
typedef int (*lua_Writer) (lua_State *L,
                           const void* p,
                           size_t sz,
                           void* ud);|
```

The type of the writer function used by @Lid{lua\_dump}.  
Every time @Lid{lua\_dump} produces another piece of chunk,  
it calls the writer,  
passing along the buffer to be written (@id{p}),  
its size (@id{sz}),  
and the @id{ud} parameter supplied to @Lid{lua\_dump}.

The writer returns an error code:

@N{0 means} no errors;

any other value means an error and stops @Lid{lua\_dump} from  
calling the writer again.

}

```
@APIEntry{void lua_xmove (lua_State *from, lua_State *to, int n);|
@apii{?,?,-}
```

Exchange values between different threads of the same state.

This function pops @id{n} values from the stack @id{from},  
and pushes them onto the stack @id{to}.

}

```
@APIEntry{int lua_yield (lua_State *L, int nresults);|
@apii{?,?,v}
```

This function is equivalent to @Lid{lua\_yieldk},  
but it has

no continuation @see{continuations}.

Therefore, when the thread resumes,  
it continues the function that called  
the function calling @id{lua\_yield}.

To avoid surprises,  
this function should be called only in a tail call.

```
}
```

```
@APIEntry{  
int lua_yieldk (lua_State *L,  
               int nresults,  
               lua_KContext ctx,  
               lua_KFunction k);  
@apii{?,?,v}
```

Yields a coroutine (thread).

When a @N{C function} calls @Lid{lua\_yieldk},  
the running coroutine suspends its execution,  
and the call to @Lid{lua\_resume} that started this coroutine returns.  
The parameter @id{nresults} is the number of values from the stack  
that will be passed as results to @Lid{lua\_resume}.

When the coroutine is resumed again,  
Lua calls the given @x{continuation function} @id{k} to continue  
the execution of the @N{C function} that yielded @see{continuations}.  
This continuation function receives the same stack  
from the previous function,  
with the @id{n} results removed and  
replaced by the arguments  
passed to @Lid{lua\_resume}.  
Moreover,  
the continuation function receives the value @id{ctx}  
that was passed to @Lid{lua\_yieldk}.

Usually, this function does not return;  
when the coroutine eventually resumes,  
it continues executing the continuation function.  
However, there is one special case,  
which is when this function is called  
from inside a line or a count hook @see{debugI}.  
In that case, @id{lua\_yieldk} should be called with no continuation  
(probably in the form of @Lid{lua\_yield}) and no results,  
and the hook should return immediately after the call.  
Lua will yield and,  
when the coroutine resumes again,  
it will continue the normal execution  
of the (Lua) function that triggered the hook.

This function can raise an error if it is called from a thread  
with a pending C call with no continuation function  
(what is called a @emphx{C-call boundary}),

or it is called from a thread that is not running inside a resume (typically the main thread).

```
}
```

```
}
```

```
@sect2{debugI| @title{The Debug  
Interface}
```

Lua has no built-in debugging facilities.  
Instead, it offers a special interface  
by means of functions and `@emph{hooks}`.  
This interface allows the construction of different  
kinds of debuggers, profilers, and other tools  
that need `@Q{inside information}` from the interpreter.

```
@APIEntry{  
typedef struct lua_Debug {  
    int event;  
    const char *name;      /* (n) */  
    const char *namewhat;  /* (n) */  
    const char *what;      /* (S) */  
    const char *source;    /* (S) */  
    size_t srclen;         /* (S) */  
    int currentline;       /* (l) */  
    int linedefined;       /* (S) */  
    int lastlinedefined;   /* (S) */  
    unsigned char nups;    /* (u) number of upvalues */  
    unsigned char nparams; /* (u) number of parameters */  
    char isvararg;         /* (u) */  
    char istailcall;       /* (t) */  
    unsigned short ftransfer; /* (r) index of first value transferred */  
    unsigned short ntransfer; /* (r) number of transferred values */  
    /*  
    char short_src[LUA_IDSIZE]; /* (S) */  
    /* private part */  
    @rep{other fields}  
} lua_Debug;  
|
```

A structure used to carry different pieces of  
information about a function or an activation record.

`@Lid{lua_getstack}` fills only the private part  
of this structure, for later use.

To fill the other fields of `@Lid{lua_Debug}` with useful information,  
you must call `@Lid{lua_getinfo}` with an appropriate parameter.

(Specifically, to get a field,  
you must add the letter between parentheses in the field's comment  
to the parameter `@id{what}` of `@Lid{lua_getinfo}`.)

The fields of `@Lid{lua_Debug}` have the following meaning:  
`@description{`

`@item{@id{source}|`  
the source of the chunk that created the function.  
If `@T{source}` starts with a `@Char{@At}`,  
it means that the function was defined in a file where  
the file name follows the `@Char{@At}`.  
If `@T{source}` starts with a `@Char{=}`,  
the remainder of its contents describes the source in a user-dependent manner.  
Otherwise,  
the function was defined in a string  
where  
`@T{source}` is that string.  
`}`

`@item{@id{srclen}|`  
The length of the string `@id{source}`.  
`}`

`@item{@id{short_src}|`  
a `@Q{printable}` version of `@T{source}`, to be used in error messages.  
`}`

`@item{@id{linedefined}|`  
the line number where the definition of the function starts.  
`}`

`@item{@id{lastlinedefined}|`  
the line number where the definition of the function ends.  
`}`

`@item{@id{what}|`  
the string `@T{"Lua"}` if the function is a Lua function,  
`@T{"C"}` if it is a `@N{C}` function,  
`@T{"main"}` if it is the main part of a chunk.  
`}`

`@item{@id{currentline}|`  
the current line where the given function is executing.  
When no line information is available,  
`@T{currentline}` is set to `@num{-1}`.  
`}`

`@item{@id{name}}`  
 a reasonable name for the given function.  
 Because functions in Lua are first-class values,  
 they do not have a fixed name:  
 some functions can be the value of multiple global variables,  
 while others can be stored only in a table field.  
 The `@T{lua_getinfo}` function checks how the function was  
 called  
 to find a suitable name.  
 If it cannot find a name,  
 then `@id{name}` is set to `@id{NULL}`.  
}

`@item{@id{namewhat}}`  
 explains the `@T{name}` field.  
 The value of `@T{namewhat}` can be  
`@T{"global"}`, `@T{"local"}`, `@T{"method"}`,  
`@T{"field"}`, `@T{"upvalue"}`, or `@T{""}` (the empty string),  
 according to how the function was called.  
 (Lua uses the empty string when no other option seems to apply.)  
}

`@item{@id{istailcall}}`  
 true if this function invocation was called by a tail call.  
 In this case, the caller of this level is not in the stack.  
}

`@item{@id{nups}}`  
 the number of upvalues of the function.  
}

`@item{@id{nparams}}`  
 the number of parameters of the function  
 (always `@N{0}` for `@N{C}` functions).  
}

`@item{@id{isvararg}}`  
 true if the function is a variadic function  
 (always true for `@N{C}` functions).  
}

`@item{@id{ftransfer}}`  
 the index in the stack of the first value being `@Q{transferred}`,  
 that is, parameters in a call or return values in a return.  
 (The other values are in consecutive indices.)  
 Using this  
 index, you can access and modify these values  
 through `@Lid{lua_getlocal}` and `@Lid{lua_setlocal}`.

This field is only meaningful during a call hook, denoting the first parameter, or a return hook, denoting the first value being returned. (For call hooks, this value is always 1.)

```
}
```

```
@item{@id{ntransfer}|
```

The number of values being transferred (see previous item). (For calls of Lua functions, this value is always equal to @id{nparams}.)

```
}
```

```
}
```

```
}
```

```
@APIEntry{lua_Hook lua_gethook (lua_State *L);|
```

```
@apii{0,0,-}
```

Returns the current hook function.

```
}
```

```
@APIEntry{int lua_gethookcount (lua_State *L);|
```

```
@apii{0,0,-}
```

Returns the current hook count.

```
}
```

```
@APIEntry{int lua_gethookmask (lua_State *L);|
```

```
@apii{0,0,-}
```

Returns the current hook mask.

```
}
```

```
@APIEntry{int lua_getinfo (lua_State *L, const char *what, lua_Debug *ar);|
```

```
@apii{0|1,0|1|2,m}
```

Gets information about a specific function or function invocation.

To get information about a function invocation, the parameter @id{ar} must be a valid activation record that was filled by a previous call to @Lid{lua\_getstack} or given as argument to a hook @seeC{lua\_Hook}.



To get information about a function, you push it onto the stack and start the `@id{what}` string with the character `@Char{>}`.

(In that case,

`@id{lua_getinfo}` pops the function from the top of the stack.)

For instance, to know in which line a function `@id{f}` was defined, you can write the following code:

```
@verbatim{
lua_Debug ar;
lua_getglobal(L, "f"); /* get global 'f' */
lua_getinfo(L, ">S", &ar);
printf("%d\n", ar.linedefined);
}
```

Each character in the string `@id{what}`

selects some fields of the structure `@id{ar}` to be filled or a value to be pushed on the stack.

(These characters are also documented in the declaration of the structure `@Lid{lua_Debug}`,

between parentheses in the comments following each field.)

`@description{`

`@item{@Char{f}|`

pushes onto the stack the function that is running at the given level;

`}`

`@item{@Char{l}|` fills in the field `@id{currentline}`;

`}`

`@item{@Char{n}|`

fills in the fields `@id{name}` and `@id{namewhat}`;

`}`

`@item{@Char{r}|` fills in the fields `@id{ftransfer}` and `@id{ntransfer}`;

`}`

`@item{@Char{S}|`

fills in the fields `@id{source}`, `@id{short_src}`,

`@id{linedefined}`, `@id{lastlinedefined}`, and `@id{what}`;

`}`

`@item{@Char{t}|` fills in the field `@id{istailcall}`;

`}`

`@item{@Char{u}|` fills in the fields

`@id{nups}`, `@id{nparams}`, and `@id{isvararg}`;

`}`

```
@item{@Char{L}|
pushes onto the stack a table whose indices are
the lines on the function with some associated code,
that is, the lines where you can put a break point.
(Lines with no code include empty lines and comments.)
If this option is given together with option @Char{f},
its table is pushed after the function.
This is the only option that can raise a memory error.
}

}
```

This function returns 0 to signal an invalid option in @id{what};  
even then the valid options are handled correctly.

```
}
```

```
@APIEntry{const char *lua_getlocal (lua_State *L, const lua_Debug *ar, int n);|
@apii{0,0|1,-}
```

**Gets**  
information about a local variable or a temporary value  
of a given activation record or a given function.

In the first case,  
the parameter @id{ar} must be a valid activation record that was  
filled by a previous call to @Lid{lua\_getstack} or  
given as argument to a hook @seeC{lua\_Hook}.  
The index @id{n} selects which local variable to inspect;  
see @Lid{debug.getlocal} for details about variable indices  
and names.

@Lid{lua\_getlocal} pushes the variable's value onto the stack  
and returns its name.

In the second case, @id{ar} must be @id{NULL} and the function  
to be inspected must be on the top of the stack.  
In this case, only parameters of Lua functions are visible  
(as there is no information about what variables are active)  
and no values are pushed onto the stack.

Returns @id{NULL} (and pushes nothing)  
when the index is greater than  
the number of active local variables.

```
}
```

```
@APIEntry{int lua_getstack (lua_State *L, int level, lua_Debug *ar);|
```

@apii{0,0,-}

Gets information about the interpreter runtime stack.

This function fills parts of a @Lid{lua\_Debug} structure with an identification of the @emph{activation record} of the function executing at a given level.

@N{Level 0} is the current running function, whereas level @M{n+1} is the function that has called level @M{n} (except for tail calls, which do not count in the stack).

When called with a level greater than the stack depth,

@Lid{lua\_getstack} returns 0; otherwise it returns 1.

}

@APIEntry{const char \*lua\_getupvalue (lua\_State \*L, int funcindex, int n);|  
@apii{0,0|1,-}

Gets information about the @id{n}-th upvalue of the closure at index @id{funcindex}.

It pushes the upvalue's value onto the stack and returns its name.

Returns @id{NULL} (and pushes nothing) when the index @id{n} is greater than the number of upvalues.

See @Lid{debug.getupvalue} for more information about upvalues.

}

@APIEntry{typedef void (\*lua\_Hook) (lua\_State \*L, lua\_Debug \*ar);|

Type for debugging hook functions.

Whenever a hook is called, its @id{ar} argument has its field @id{event} set to the specific event that triggered the hook.

Lua identifies these events with the following constants:

@defid{LUA\_HOOKCALL}, @defid{LUA\_HOOKRET}, @defid{LUA\_HOOKTAILCALL}, @defid{LUA\_HOOKLINE}, and @defid{LUA\_HOOKCOUNT}.

Moreover, for line events, the field @id{currentline} is also set.

To get the value of any other field in @id{ar}, the hook must call @Lid{lua\_getinfo}.

For call events, @id{event} can be @id{LUA\_HOOKCALL}, the normal value, or @id{LUA\_HOOKTAILCALL}, for a tail call;

in this case, there will be no corresponding return event.

While Lua is running a hook, it disables other calls to hooks.

Therefore, if a hook calls back Lua to execute a function or a chunk, this execution occurs without any calls to hooks.

Hook functions cannot have continuations, that is, they cannot call `@Lid{lua_yieldk}`, `@Lid{lua_pcallk}`, or `@Lid{lua_callk}` with a non-null `@id{k}`.

Hook functions can yield under the following conditions:

Only

count and line events can yield;

to yield, a hook function must finish its execution

calling `@Lid{lua_yield}` with `@id{nresults}` equal to zero

(that is, with no values).

}

```
@APIEntry{void lua_sethook (lua_State *L, lua_Hook f, int mask, int count);|
@apii{0,0,-}
```

Sets the debugging hook function.

Argument `@id{f}` is the hook function.

`@id{mask}` specifies on which events the hook will be called:

it is formed by a bitwise OR of the constants

`@defid{LUA_MASKCALL}`,

`@defid{LUA_MASKRET}`,

`@defid{LUA_MASKLINE}`,

and `@defid{LUA_MASKCOUNT}`.

The `@id{count}` argument is only meaningful when the mask includes `@id{LUA_MASKCOUNT}`.

For each event, the hook is called as explained below:

`@description{`

`@item{The call hook|}` is called when the interpreter calls a function.

The hook is called just after Lua enters the new function.

}

`@item{The return hook|}` is called when the interpreter returns from a function.

The hook is called just before Lua leaves the function.

}

`@item{The line hook|}` is called

when the interpreter is about to

start the execution of a new line of code,

or when it jumps back in the code (even to the same line).

This event only happens while Lua is executing a Lua function.

}

@item{The count hook| is called after the interpreter executes every  
@T{count} instructions.

This event only happens while Lua is executing a Lua function.

}

}

Hooks are disabled by setting @id{mask} to zero.

}

@APIEntry{const char \*lua\_setlocal (lua\_State \*L, const lua\_Debug \*ar, int n);|  
@apii{0|1,0,-}}

Sets the value of a local variable of a given activation record.

It assigns the value on the top of the stack  
to the variable and returns its name.

It also pops the value from the stack.

Returns @id{NULL} (and pops nothing)

when the index is greater than  
the number of active local variables.

Parameters @id{ar} and @id{n} are as in the function @Lid{lua\_getlocal}.

}

@APIEntry{const char \*lua\_setupvalue (lua\_State \*L, int funcindex, int n);|  
@apii{0|1,0,-}}

Sets the value of a closure's

upvalue.

It assigns the value on the top of the stack  
to the upvalue and returns its name.

It also pops the value from the stack.

Returns @id{NULL} (and pops nothing)

when the index @id{n} is greater than the number of upvalues.

Parameters @id{funcindex} and @id{n} are as in  
the function @Lid{lua\_getupvalue}.

}

@APIEntry{void \*lua\_upvalueid (lua\_State \*L, int funcindex, int n);|



have a prefix `@id{luaL_}`.

All functions in the auxiliary library are built on top of the basic API, and so they provide nothing that cannot be done with that API. Nevertheless, the use of the auxiliary library ensures more consistency to your code.

Several functions in the auxiliary library use internally some extra stack slots.

When a function in the auxiliary library uses less than five slots, it does not check the stack size; it simply assumes that there are enough slots.

Several functions in the auxiliary library are used to check `@N{C function}` arguments. Because the error message is formatted for arguments (e.g., `@St{bad argument #1}`), you should not use these functions for other stack values.

Functions called `@id{luaL_check*}` always raise an error if the check is not satisfied.

}

`@sect2{@title{Functions and Types}`

Here we list all functions and types from the auxiliary library in alphabetical order.

`@APIEntry{void luaL_addchar (luaL_Buffer *B, char c);|@apii{?,?,m}`

Adds the byte `@id{c}` to the buffer `@id{B}`  
`@seeC{luaL_Buffer}`.

}

`@APIEntry{const void luaL_addgsub (luaL_Buffer *B, const char *s, const char *p, const char *r);|@apii{?,?,m}`

Adds a copy of the string `@id{s}` to the buffer `@id{B}` `@seeC{luaL_Buffer}`,

replacing any  
occurrence of the string @id{p}  
with the string @id{r}.

}

@APIEntry{void luaL\_addlstring (luaL\_Buffer \*B, const char \*s, size\_t l);|  
@apii{?,?,m}

Adds the string pointed to by @id{s} with length @id{l} to  
the buffer @id{B}  
@seeC{luaL\_Buffer}.  
The string can contain @x{embedded zeros}.

}

@APIEntry{void luaL\_addsize (luaL\_Buffer \*B, size\_t n);|  
@apii{?,?,-}

Adds to the buffer @id{B}  
a string of length @id{n} previously copied to the  
buffer area @seeC{luaL\_prepbuffer}.

}

@APIEntry{void luaL\_addstring (luaL\_Buffer \*B, const char \*s);|  
@apii{?,?,m}

Adds the zero-terminated string pointed to by @id{s}  
to the buffer @id{B}  
@seeC{luaL\_Buffer}.

}

@APIEntry{void luaL\_addvalue (luaL\_Buffer \*B);|  
@apii{?,?,m}

Adds the value on the top of the stack  
to the buffer @id{B}  
@seeC{luaL\_Buffer}.  
Pops the value.

This is the only function on string buffers that can (and must)  
be called with an extra element on the stack,  
which is the value to be added to the buffer.

}



```
@APIEntry{
void luaL_argcheck
(lua_State *L,
    int cond,
    int arg,
    const char *extramsg);|
@apii{0,0,v}
```

Checks whether @id{cond} is true.

If it is not, raises an error with a standard message @seeF{luaL\_argerror}.

```
}
```

```
@APIEntry{int luaL_argerror (lua_State *L, int arg, const char *extramsg);|
@apii{0,0,v}
```

Raises an error reporting a problem with argument @id{arg}

of the @N{C function} that called it,

using a standard message

that includes @id{extramsg} as a comment:

```
@verbatim{
bad argument #@rep{arg} to '@rep{funcname}' (@rep{extramsg})
}
```

This function never returns.

```
}
```

```
@APIEntry{
void luaL_argexpected (lua_State *L,
    int cond,
    int arg,
    const char *tname);|
@apii{0,0,v}
```

Checks whether @id{cond} is true.

If it is not, raises an error about the type of the argument @id{arg}

with a standard message @seeF{luaL\_typeerror}.

```
}
```

```
@APIEntry{typedef struct luaL_Buffer luaL_Buffer;|
```

Type for

a @def{string buffer}.

A string buffer allows @N{C code} to build Lua strings piecemeal.

Its pattern of use is as follows:

```
@itemize{
```

@item{First declare a variable @id{b} of type @Lid{luaL\_Buffer}.}

@item{Then initialize it with a call @T{luaL\_buffinit(L, &b)}.

@item{  
Then add string pieces to the buffer calling any of  
the @id{luaL\_add\*} functions.  
}

@item{  
Finish by calling @T{luaL\_pushresult(&b)}.  
This call leaves the final string on the top of the stack.  
}

}

If you know beforehand the maximum size of the resulting string,  
you can use the buffer like this:

@itemize{

@item{First declare a variable @id{b} of type @Lid{luaL\_Buffer}.}

@item{Then initialize it and preallocate a space of  
size @id{sz} with a call @T{luaL\_buffinitsize(L, &b, sz)}.

@item{Then produce the string into that space.}

@item{  
Finish by calling @T{luaL\_pushresultsize(&b, sz)},  
where @id{sz} is the total size of the resulting string  
copied into that space (which may be less than or  
equal to the preallocated  
size).  
}

}

During its normal operation,  
a string buffer uses a variable number of stack slots.  
So, while using a buffer, you cannot assume that you know where  
the top of the stack is.  
You can use the stack between successive calls to buffer operations  
as long as that use is balanced;  
that is,  
when you call a buffer operation,  
the stack is at the same level  
it was immediately after the previous buffer operation.

(The only exception to this rule is @Lid{luaL\_addvalue}.)  
After calling @Lid{luaL\_pushresult},  
the stack is back to its level when the buffer was initialized,  
plus the final string on its top.

}

@APIEntry{char \*luaL\_buffaddr (luaL\_Buffer \*B);|  
@apii{0,0,-}}

Returns the address of the current content of buffer @id{B}  
@seeC{luaL\_Buffer}.  
Note that any addition to the buffer may invalidate this address.

}

@APIEntry{void luaL\_buffinit (lua\_State \*L, luaL\_Buffer \*B);|  
@apii{0,?,-}}

Initializes a buffer @id{B}  
@seeC{luaL\_Buffer}.  
This function does not allocate any space;  
the  
buffer must be declared as a variable.

}

@APIEntry{size\_t luaL\_bufflen (luaL\_Buffer \*B);|  
@apii{0,0,-}}

Returns the length of the current content of buffer @id{B}  
@seeC{luaL\_Buffer}.

}

@APIEntry{char \*luaL\_buffinitsize (lua\_State \*L, luaL\_Buffer \*B, size\_t sz);|  
@apii{?,?,m}}

Equivalent to the sequence  
@Lid{luaL\_buffinit}, @Lid{luaL\_prepbuffsize}.

}

@APIEntry{void luaL\_buffsub (luaL\_Buffer \*B, int n);|  
@apii{?,?,-}}

Removes @id{n} bytes from the buffer @id{B}  
@seeC{luaL\_Buffer}.

The buffer must have at least that many bytes.

```
}
```

```
@APIEntry{int luaL_callmeta (lua_State *L, int obj, const char *e);|
@apii{0,0|1,e}
```

Calls a metamethod.

If the object at index `@id{obj}` has a metatable and this metatable has a field `@id{e}`, this function calls this field passing the object as its only argument. In this case this function returns true and pushes onto the stack the value returned by the call. If there is no metatable or no metamethod, this function returns false without pushing any value on the stack.

```
}
```

```
@APIEntry{void luaL_checkany (lua_State *L, int arg);|
@apii{0,0,v}
```

Checks whether the function has an argument of any type (including `@nil`) at position `@id{arg}`.

```
}
```

```
@APIEntry{lua_Integer luaL_checkinteger (lua_State *L, int arg);|
@apii{0,0,v}
```

Checks whether the function argument `@id{arg}` is an integer (or can be converted to an integer) and returns this integer.

```
}
```

```
@APIEntry{const char *luaL_checklstring (lua_State *L, int arg, size_t *l);|
@apii{0,0,v}
```

Checks whether the function argument `@id{arg}` is a string and returns this string; if `@id{l}` is not `@id{NULL}` fills its referent with the string's length.

This function uses `@Lid{lua_tolstring}` to get its result, so all conversions and caveats of that function apply here.

```
}
```

```
@APIEntry{lua_Number luaL_checknumber (lua_State *L, int arg);|
@apii{0,0,v}
```

Checks whether the function argument @id{arg} is a number and returns this number converted to a @id{lua\_Number}.

```
}
```

```
@APIEntry{
int luaL_checkoption (lua_State
*L,
    int arg,
    const char *def,
    const char *const lst[]);|
@apii{0,0,v}
```

Checks whether the function argument @id{arg} is a string and searches for this string in the array @id{lst} (which must be NULL-terminated).  
Returns the index in the array where the string was found.  
Raises an error if the argument is not a string or if the string cannot be found.

If @id{def} is not @id{NULL},  
the function uses @id{def} as a default value when  
there is no argument @id{arg} or when this argument is @nil.

This is a useful function for mapping strings to @N{C enums}.  
(The usual convention in Lua libraries is  
to use strings instead of numbers to select options.)

```
}
```

```
@APIEntry{void luaL_checkstack (lua_State *L, int sz, const char *msg);|
@apii{0,0,v}
```

Grows the stack size to @T{top + sz} elements,  
raising an error if the stack cannot grow to that size.  
@id{msg} is an additional text to go into the error message  
(or @id{NULL} for no  
additional text).

```
}
```

```
@APIEntry{const char *luaL_checkstring (lua_State *L, int arg);|
@apii{0,0,v}
```

Checks whether the function argument @id{arg} is a string and returns this string.

This function uses @Lid{lua\_tolstring} to get its result, so all conversions and caveats of that function apply here.

}

```
@APIEntry{void luaL_checktype (lua_State *L, int arg, int t);|
@apii{0,0,v}
```

Checks whether the function argument @id{arg} has type @id{t}. See @Lid{lua\_type} for the encoding of types for @id{t}.

}

```
@APIEntry{void *luaL_checkudata (lua_State *L, int arg, const char *tname);|
@apii{0,0,v}
```

Checks whether the function argument @id{arg} is a userdata of the type @id{tname} @seeC{luaL\_newmetatable} and returns the userdata's memory-block address @seeC{lua\_touserdata}.

}

```
@APIEntry{void luaL_checkversion (lua_State *L);|
@apii{0,0,v}
```

Checks whether the code making the call and the Lua library being called are using the same version of Lua and the same numeric types.

}

```
@APIEntry{int
luaL_dofile (lua_State *L, const char *filename);|
@apii{0,?,m}
```

Loads and runs the given file.

It is defined as the following macro:

```
@verbatim{
(luaL_loadfile(L, filename) || lua_pcall(L, 0, LUA_MULTRET, 0))
}
```

It @N{returns 0} (@Lid{LUA\_OK}) if there are no errors, or 1 in case of errors.

}

```
@APIEntry{int luaL_dostring (lua_State *L, const char *str);|
@apii{0,?, -}}
```

Loads and runs the given string.

It is defined as the following macro:

```
@verbatim{
(luaL_loadstring(L, str) || luaL_pcall(L, 0, LUA_MULTRET, 0))
}
```

It @N{returns 0} (@Lid{LUA\_OK}) if there are no errors,  
or 1 in case of errors.

```
}
```

```
@APIEntry{int luaL_error (lua_State *L, const char *fmt, ...);|
@apii{0,0,v}}
```

Raises an error.

The error message format is given by @id{fmt}

plus any extra arguments,

following the same rules of @Lid{lua\_pushfstring}.

It also adds at the beginning of the message the file name and  
the line number where the error occurred,  
if this information is available.

This function never returns,

but it is an

idiom to use it in @N{C functions}

as @T{return luaL\_error(@rep{args})}.

```
}
```

```
@APIEntry{int luaL_execresult (lua_State *L, int stat);|
@apii{0,3,m}}
```

This function produces the return values for  
process-related functions in the standard library  
(@Lid{os.execute} and @Lid{io.close}).

```
}
```

```
@APIEntry{
int luaL_fileresult (lua_State *L, int stat, const char *fname);|
@apii{0,1|3,m}}
```

This function produces the return values for  
file-related functions in the standard library  
(@Lid{io.open}, @Lid{os.rename}, @Lid{file:seek}, etc.).

}

```
@APIEntry{int luaL_getmetafield (lua_State *L, int obj, const char *e);|
@apii{0,0|1,m}
```

Pushes onto the stack the field @id{e} from the metatable of the object at index @id{obj} and returns the type of the pushed value. If the object does not have a metatable, or if the metatable does not have this field, pushes nothing and returns @id{LUA\_TNIL}.

}

```
@APIEntry{int luaL_getmetatable (lua_State *L, const char *tname);|
@apii{0,1,m}
```

Pushes onto the stack the metatable associated with the name @id{tname} in the registry @seeC{luaL\_newmetatable}, or @nil if there is no metatable associated with that name. Returns the type of the pushed value.

}

```
@APIEntry{int luaL_getsubtable (lua_State *L, int idx, const char *fname);|
@apii{0,1,e}
```

Ensures that the value @T{t[fname]}, where @id{t} is the value at index @id{idx}, is a table, and pushes that table onto the stack. Returns true if it finds a previous table there and false if it creates a new table.

}

```
@APIEntry{
const char *luaL_gsub (lua_State *L,
    const char *s,
    const char *p,
    const char *r);|
@apii{0,1,m}
```

Creates a copy of string @id{s}, replacing any occurrence of the string @id{p} with the string @id{r}. Pushes the resulting string on the stack and returns it.



```
}
```

```
@APIEntry{lua_Integer luaL_len (lua_State *L, int index);|
@apii{0,0,e}
```

Returns the @Q{length} of the value at the given index  
as a number;

it is equivalent to the

@Char{#} operator in Lua @see{len-op}.

Raises an error if the result of the operation is not an integer.

(This case can only happen through metamethods.)

```
}
```

```
@APIEntry{
int luaL_loadbuffer (lua_State *L,
    const char *buff,
    size_t sz,
    const char *name);|
@apii{0,1,-}
```

Equivalent to @Lid{luaL\_loadbufferx} with @id{mode} equal to @id{NULL}.

```
}
```

```
@APIEntry{
int luaL_loadbufferx (lua_State *L,
    const char *buff,
    size_t sz,
    const char *name,
    const char *mode);|
@apii{0,1,-}
```

Loads a buffer as a Lua chunk.

This function uses @Lid{lua\_load} to load the chunk in the  
buffer pointed to by @id{buff} with size @id{sz}.

This function returns the same results as @Lid{lua\_load}.

@id{name} is the chunk name,

used for debug information and error messages.

The string @id{mode} works as in the function @Lid{lua\_load}.

```
}
```

```
@APIEntry{int luaL_loadfile (lua_State
```

```
*L, const char *filename);|
@apii{0,1,m}
```

Equivalent to @Lid{luaL\_loadfilex} with @id{mode} equal to @id{NULL}.

```
}
```

```
@APIEntry{int luaL_loadfilex (lua_State *L, const char *filename,
                                const char *mode);|
@apii{0,1,m}
```

Loads a file as a Lua chunk.

This function uses @Lid{lua\_load} to load the chunk in the file named @id{filename}.

If @id{filename} is @id{NULL},

then it loads from the standard input.

The first line in the file is ignored if it starts with a @T{#}.

The string @id{mode} works as in the function @Lid{lua\_load}.

This function returns the same results as @Lid{lua\_load} or @Lid{LUA\_ERRFILE} for file-related errors.

As @Lid{lua\_load}, this function only loads the chunk; it does not run it.

```
}
```

```
@APIEntry{int luaL_loadstring (lua_State *L, const char *s);|
@apii{0,1,-}
```

Loads a string as a Lua chunk.

This function uses @Lid{lua\_load} to load the chunk in the zero-terminated string @id{s}.

This function returns the same results as @Lid{lua\_load}.

Also as @Lid{lua\_load}, this function only loads the chunk; it does not run it.

```
}
```

```
@APIEntry{void luaL_newlib (lua_State *L, const luaL_Reg l[]);|
@apii{0,1,m}
```

Creates a new table and registers there

the functions in the list @id{1}.

It is implemented as the following macro:

```
@verbatim{
(luaL_newlibtable(L,l), luaL_setfuncs(L,l,0))
}
```

The array @id{1} must be the actual array,  
not a pointer to it.

```
}
```

```
@APIEntry{void luaL_newlibtable (lua_State *L, const luaL_Reg l[]);|
@apii{0,1,m}
```

Creates a new table with a size optimized  
to store all entries in the array @id{1}  
(but does not actually store them).

It is intended to be used in conjunction with @Lid{luaL\_setfuncs}  
@seeF{luaL\_newlib}.

It is implemented as a macro.

The array @id{1} must be the actual array,  
not a pointer to it.

```
}
```

```
@APIEntry{int luaL_newmetatable (lua_State *L, const char *tname);|
@apii{0,1,m}
```

If the registry already has the key @id{tname},  
returns 0.

Otherwise,

creates a new table to be used as a

metatable for userdata,

adds to this new table the pair @T{\_\_name = tname},

adds to the registry the pair @T{[tname] = new table},

and returns 1.

In both cases,

the function pushes onto the stack the final value associated  
with @id{tname} in the registry.

```
}
```

```
@APIEntry{lua_State *luaL_newstate (void);|
@apii{0,0,-}
```

Creates a new Lua state.

It calls `@Lid{lua_newstate}` with an allocator based on the `@N{ISO C}` allocation functions and then sets a warning function and a panic function `@see{C-error}` that print messages to the standard error output.

Returns the new state,  
or `@id{NULL}` if there is a `@x{memory allocation error}`.

}

```
@APIEntry{void luaL_openlibs (lua_State *L);|
@apii{0,0,e}
```

Opens all standard Lua libraries into the given state.

}

```
@APIEntry{
T luaL_opt (L, func, arg, dflt);|
@apii{0,0,-}
```

This macro is defined as follows:

```
@verbatim{
(lua_isnoneornil(L,(arg)) ? (dflt) : func(L,(arg)))
}
```

In words, if the argument `@id{arg}` is nil or absent, the macro results in the default

`@id{dflt}`.

Otherwise, it results in the result of calling `@id{func}` with the state `@id{L}` and the argument index `@id{arg}` as arguments.

Note that it evaluates the expression `@id{dflt}` only if needed.

}

```
@APIEntry{
lua_Integer luaL_optinteger (lua_State *L,
                           int arg,
                           lua_Integer d);|
@apii{0,0,v}
```

If the function argument `@id{arg}` is an integer (or it is convertible to an integer), returns this integer.

If this argument is absent or is `@nil`, returns `@id{d}`.

Otherwise, raises an error.

```
}
```

```
@APIEntry{  
const char *luaL_optlstring (lua_State *L,  
                             int arg,  
                             const char *d,  
                             size_t *l);|  
@apii{0,0,v}
```

If the function argument @id{arg} is a string,  
returns this string.

If this argument is absent or is @nil,  
returns @id{d}.

Otherwise, raises an error.

If @id{l} is not @id{NULL},  
fills its referent with the result's length.

If the result is @id{NULL}

(only

possible when returning @id{d} and @T{d == NULL}),  
its length is considered zero.

This function uses @Lid{lua\_tolstring} to get its result,  
so all conversions and caveats of that function apply here.

```
}
```

```
@APIEntry{lua_Number luaL_optnumber (lua_State *L, int arg, lua_Number d);|  
@apii{0,0,v}
```

If the function argument @id{arg} is a number,  
returns this number as a @id{lua\_Number}.

If this argument is absent or is @nil,  
returns @id{d}.

Otherwise, raises an error.

```
}
```

```
@APIEntry{  
const char *luaL_optstring (lua_State *L,  
                             int arg,  
                             const char *d);|  
@apii{0,0,v}
```

If the function argument @id{arg} is a string,  
returns this string.

If this argument is absent or is @nil,  
returns @id{d}.

Otherwise, raises an error.

}

```
@APIEntry{char *luaL_prepbuffer (luaL_Buffer *B);|
@apii{?,?,m}
```

Equivalent to @Lid{luaL\_prepbuffsize}  
with the predefined size @defid{LUAL\_BUFFERSIZE}.

}

```
@APIEntry{char *luaL_prepbuffsize (luaL_Buffer *B, size_t sz);|
@apii{?,?,m}
```

Returns

an address to a space of size @id{sz}  
where you can copy a string to be added to buffer @id{B}  
@seeC{luaL\_Buffer}.  
After copying the string into this space you must call  
@Lid{luaL\_addsize} with the size of the string to actually add  
it to the buffer.

}

```
@APIEntry{void luaL_pushfail (lua_State *L);|
@apii{0,1,-}
```

Pushes the @fail value onto the stack @see{libraries}.

}

```
@APIEntry{void luaL_pushresult (luaL_Buffer *B);|
@apii{?,1,m}
```

Finishes the use of buffer @id{B} leaving the final string on  
the top of the stack.

}

```
@APIEntry{void luaL_pushresults (luaL_Buffer *B, size_t sz);|
@apii{?,1,m}
```

Equivalent to the sequence @Lid{luaL\_addsize}, @Lid{luaL\_pushresult}.

}

```
@APIEntry{int luaL_ref (lua_State *L, int t);|
```

@apii{1,0,m}

Creates and returns a @def{reference},  
in the table at index @id{t},  
for the object on the top of the stack (and pops the object).

A reference is a unique integer key.

As long as you do not manually add integer keys into the table @id{t},

@Lid{luaL\_ref}

ensures the uniqueness of the key it returns.

You can retrieve an object referred by the reference @id{r}

by calling @T{lua\_rawgeti(L, t, r)}.

The function @Lid{luaL\_unref} frees a reference.

If the object on the top of the stack is @nil,

@Lid{luaL\_ref} returns the constant @defid{LUA\_REFNIL}.

The constant @defid{LUA\_NOREF} is guaranteed to be different  
from any reference returned by @Lid{luaL\_ref}.

}

@APIEntry{

typedef struct luaL\_Reg {

const char \*name;

lua\_CFunction func;

} luaL\_Reg;

|

Type for arrays of functions to be registered by

@Lid{luaL\_setfuncs}.

@id{name} is the function name and @id{func} is a pointer to  
the function.

Any array of @Lid{luaL\_Reg} must end with a sentinel entry  
in which both @id{name} and @id{func} are @id{NULL}.

}

@APIEntry{

void luaL\_requiref (lua\_State \*L, const char \*modname,

lua\_CFunction openf, int glb);|

@apii{0,1,e}

If @T{package.loaded[modname]} is not true,

calls the function @id{openf} with the string @id{modname}  
as an argument

and sets the call result to @T{package.loaded[modname]},  
as if that function has been called through @Lid{require}.

If @id{glb} is true,  
also stores the module into the global @id{modname}.

Leaves a copy of the module on the stack.

}

```
@APIEntry{void luaL_setfuncs (lua_State *L, const luaL_Reg *l, int nup);|
@apii{nup,0,m}
```

Registers all functions in the array @id{l}  
@seeC{lual\_Reg} into the table on the top of the stack  
(below optional upvalues, see next).

When @id{nup} is not zero,  
all functions are created with @id{nup} upvalues,  
initialized with copies of the @id{nup} values  
previously pushed on the stack  
on top of the library table.  
These values are popped from the stack after the registration.

A function with a @id{NULL} value represents a placeholder,  
which is filled with @false.

}

```
@APIEntry{void luaL_setmetatable (lua_State *L, const char *tname);|
@apii{0,0,-}
```

Sets the metatable of the object on the top of the stack  
as the metatable associated  
with name @id{tname}  
in the registry @seeC{lual\_newmetatable}.

}

```
@APIEntry{
typedef struct luaL_Stream {
    FILE *f;
    lua_CFunction closef;
} luaL_Stream;
|
```

The standard representation for @x{file handles}  
used by the standard I/O library.

A file handle is implemented as a full userdata,  
with a metatable called @id{LUA\_FILEHANDLE}



(where @id{LUA\_FILEHANDLE} is a macro with the actual metatable's name).

The metatable is created by the I/O library

@seeF{luaL\_newmetatable}.

This userdata must start with the structure @id{luaL\_Stream};

it can contain other data after this initial structure.

The field @id{f} points to the corresponding C stream

(or it can be @id{NULL} to indicate an incompletely created handle).

The field @id{closef} points to a Lua function

that will be called to close the stream

when the handle is closed or collected;

this function receives the file handle as its sole argument and

must return either a true value, in case of success,

or a false value plus an error message,

in case of error.

Once Lua calls this field,

it changes the field value to @id{NULL}

to signal that the handle is closed.

}

@APIEntry{void \*luaL\_testudata (lua\_State \*L, int arg, const char \*tname);|

@apii{0,0,m}

This function works like @Lid{luaL\_checkudata},

except that, when the test fails,

it returns @id{NULL} instead of raising an error.

}

@APIEntry{const char \*luaL\_tolstring (lua\_State \*L, int idx, size\_t \*len);|

@apii{0,1,e}

Converts any Lua value at the given index to a @N{C string}

in a reasonable format.

The resulting string is pushed onto the stack and also

returned by the function @see{constchar}.

If @id{len} is not @id{NULL},

the function also sets @T{\*len} with the string length.

If the value has a metatable with a @idx{\_\_tostring} field,

then @id{luaL\_tolstring} calls the corresponding metamethod

with the value as argument,

and uses the result of the call as its result.

}

@APIEntry{

```
void luaL_traceback (lua_State *L, lua_State *L1, const char *msg,
```

```
    int level);|  
@apii{0,1,m}
```

Creates and pushes a traceback of the stack @id{L1}.

If @id{msg} is not @id{NULL}, it is appended  
at the beginning of the traceback.

The @id{level} parameter tells at which level  
to start the traceback.

```
}
```

```
@APIEntry{int luaL_typeerror (lua_State *L, int arg, const char *tname);|  
@apii{0,0,v}
```

Raises a type error for the argument @id{arg}  
of the @N{C function} that called it,  
using a standard message;  
@id{tname} is a @Q{name} for the expected type.  
This function never returns.

```
}
```

```
@APIEntry{const char *luaL_typename (lua_State *L, int index);|  
@apii{0,0,-}
```

Returns the name of the type of the value at the given index.

```
}
```

```
@APIEntry{void luaL_unref (lua_State *L, int t, int ref);|  
@apii{0,0,-}
```

Releases the reference @id{ref} from the table at index @id{t}  
@seeC{luaL\_ref}.

The entry is removed from the table,  
so that the referred object can be collected.  
The reference @id{ref} is also freed to be used again.

If @id{ref} is @Lid{LUA\_NOREF} or @Lid{LUA\_REFNIL},  
@Lid{luaL\_unref}  
does nothing.

```
}
```

```
@APIEntry{void luaL_where (lua_State *L, int lvl);|  
@apii{0,1,m}
```

Pushes onto the stack a string identifying the current position of the control at level @id{lvl} in the call stack.

Typically this string has the following format:

```
@verbatim{
@rep{chunkname}:@rep{currentline}:
}
@N{Level 0} is the running function,
@N{level 1} is the function that called the running function,
etc.
```

This function is used to build a prefix for error messages.

```
}
```

```
}
```

```
}
```

```
@C{-----}
@sect1{libraries| @title{The Standard Libraries}
```

```
@simplesect{
```

The standard Lua libraries provide useful functions that are implemented @N{in C} through the @N{C API}. Some of these functions provide essential services to the language (e.g., @Lid{type} and @Lid{getmetatable}); others provide access to outside services (e.g., I/O); and others could be implemented in Lua itself, but that for different reasons deserve an implementation in C (e.g., @Lid{table.sort}).

All libraries are implemented through the official @N{C API} and are provided as separate @N{C modules}. Unless otherwise noted, these library functions do not adjust its number of arguments to its expected parameters. For instance, a function documented as @T{foo(arg)} should not be called without an argument.

The notation @fail means a false value representing some kind of failure. (Currently, @fail is equal to @nil, but that may change in future versions. The recommendation is to always test the success of these functions

with `@T{(not status)}`, instead of `@T{(status == nil)}`.)

Currently, Lua has the following standard libraries:

`@itemize{`

`@item{@link{predefined|basic library};}`

`@item{@link{corolib|coroutine library};}`

`@item{@link{packlib|package library};}`

`@item{@link{strlib|string manipulation};}`

`@item{@link{utf8|basic UTF-8 support};}`

`@item{@link{tablib|table manipulation};}`

`@item{@link{mathlib|mathematical functions}`  
`(sin, log, etc.);}`

`@item{@link{iolib|input and output};}`

`@item{@link{oslib|operating system facilities};}`

`@item{@link{debuglib|debug facilities}.}`

`}`

Except for the basic and the package libraries,  
each library provides all its functions as fields of a global table  
or as methods of its objects.

To have access to these libraries,  
the `@N{C host}` program should call the `@Lid{luaL_openlibs}` function,  
which opens all standard libraries.

Alternatively,

the host program can open them individually by using

`@Lid{luaL_requiref}` to call

`@defid{luaopen_base}` (for the basic library),

`@defid{luaopen_package}` (for the package library),

`@defid{luaopen_coroutine}` (for the coroutine library),

`@defid{luaopen_string}` (for the string library),

`@defid{luaopen_utf8}` (for the UTF-8 library),

`@defid{luaopen_table}` (for the table library),

`@defid{luaopen_math}` (for the mathematical library),

`@defid{luaopen_io}` (for the I/O library),

`@defid{luaopen_os}` (for the operating system library),

and `@defid{luaopen_debug}`

(for the debug library).

These functions are declared in @defid{lualib.h}.

}

@sect2{predefined| @title{Basic Functions}}

The basic library provides core functions to Lua.

If you do not include this library in your application,  
you should check carefully whether you need to provide  
implementations for some of its facilities.

@LibEntry{assert (v [, message])|

Raises an error if

the value of its argument @id{v} is false (i.e., @nil or @false);  
otherwise, returns all its arguments.

In case of error,

@id{message} is the error object;

when absent, it defaults to @St{assertion failed!}

}

@LibEntry{collectgarbage ([opt [, arg]])|

This function is a generic interface to the garbage collector.

It performs different functions according to its first argument, @id{opt}:  
@description{

@item{@St{collect}|

Performs a full garbage-collection cycle.

This is the default option.

}

@item{@St{stop}|

Stops automatic execution of the garbage collector.

The collector will run only when explicitly  
invoked,

until a call to restart it.

}

@item{@St{restart}|

Restarts automatic execution of the garbage collector.

}

@item{@St{count}|

Returns the total memory in use by Lua in Kbytes.  
The value has a fractional part,  
so that it multiplied by 1024  
gives the exact number of bytes in use by Lua.  
}

@item{@St{step}|  
Performs a garbage-collection step.  
The step @Q{size} is controlled by @id{arg}.  
With a zero value,  
the collector will perform one basic (indivisible) step.  
For non-zero values,  
the collector will perform as if that amount of memory  
(in Kbytes) had been allocated by Lua.  
Returns @true if the step finished a collection cycle.  
}

@item{@St{isrunning}|  
Returns a boolean that tells whether the collector is running  
(i.e., not stopped).  
}

@item{@St{incremental}|  
Change the collector mode to incremental.  
This option can be followed by three numbers:  
the garbage-collector pause,  
the step multiplier,  
and the step size @see{incmode}.  
A zero means to not change that value.  
}

@item{@St{generational}|  
Change  
the collector mode to generational.  
This option can be followed by two numbers:  
the garbage-collector minor multiplier  
and the major multiplier @see{genmode}.  
A zero means to not change that value.  
}

}  
See @See{GC} for more details about garbage collection  
and some of these options.

This function should not be called by a finalizer.

}

@LibEntry{dofile ([filename])|

Opens the named file and executes its content as a Lua chunk.

When called without arguments,

@id{dofile} executes the content of the standard input (@id{stdin}).

Returns all values returned by the chunk.

In case of errors, @id{dofile} propagates the error to its caller.

(That is, @id{dofile} does not run in protected mode.)

}

@LibEntry{error (message [, level])|

Raises an error @see{error} with @id{message} as the error object.

This function never returns.

Usually, @id{error} adds some information about the error position at the beginning of the message, if the message is a string.

The @id{level}

argument specifies how to get the error position.

With @N{level 1} (the default), the error position is where the

@id{error} function was called.

@N{Level 2} points the error to where the function

that called @id{error} was called; and so on.

Passing a @N{level 0} avoids the addition of error position information to the message.

}

@LibEntry{\_G|

A global variable (not a function) that

holds the @x{global environment} @see{globalenv}.

Lua itself does not use this variable;

changing its value does not affect any environment,

nor vice versa.

}

@LibEntry{getmetatable (object)|

If @id{object} does not have a metatable, returns @nil.

Otherwise,

if the object's metatable has a @idx{\_\_metatable} field,

returns the associated value.

Otherwise, returns the metatable of the given object.

}

@LibEntry{ipairs (t)|

Returns three values (an iterator function, the table `@id{t}`, and 0)

so that the construction

```
@verbatim{
for i,v in ipairs(t) do @rep{body} end
}
will iterate over the key@En{ }value
pairs
(@T{1,t[1]}), (@T{2,t[2]}), @ldots,
up to the first absent index.

}
```

`@LibEntry{load (chunk [, chunkname [, mode [, env]]])}`

Loads a chunk.

If `@id{chunk}` is a string, the chunk is this string.

If `@id{chunk}` is a function,

`@id{load}` calls it repeatedly to get the chunk pieces.

Each call to `@id{chunk}` must return a string that concatenates with previous results.

A return of an empty string, `@nil`, or no value signals the end of the chunk.

If there are no syntactic errors,

`@id{load}` returns the compiled chunk as a function;

otherwise, it returns `@fail` plus the error message.

When you load a main chunk,

the resulting function will always have exactly one upvalue,

the `@id{_ENV}` variable `@see{globalenv}`.

However,

when you load a binary chunk created from a function `@seeF{string.dump}`,

the resulting function can have an arbitrary number of upvalues,

and there is no guarantee that its first upvalue will be

the `@id{_ENV}` variable.

(A non-main function may not even have an `@id{_ENV}` upvalue.)

Regardless, if the resulting function has any upvalues,

its first upvalue is set to the value of `@id{env}`,

if that parameter is given,

or to the value of the `@x{global environment}`.

Other upvalues are initialized with `@nil`.

All upvalues are fresh, that is,

they are not shared with any other function.

`@id{chunkname}` is used as the name of the chunk for error messages



and debug information @see{debugI}.

When absent,

it defaults to @id{chunk}, if @id{chunk} is a string,

or to @St{=(load)} otherwise.

The string @id{mode} controls whether the chunk can be text or binary (that is, a precompiled chunk).

It may be the string @St{b} (only @x{binary chunk}s),

@St{t} (only text chunks),

or @St{bt} (both binary and text).

The default is @St{bt}.

It is safe to load malformed binary chunks;

@id{load} signals an appropriate error.

However,

Lua does not check the consistency of the code inside binary chunks;

running maliciously crafted bytecode can crash the interpreter.

}

@LibEntry{loadfile

([filename [, mode [, env]]])

Similar to @Lid{load},

but gets the chunk from file @id{filename}

or from the standard input,

if no file name is given.

}

@LibEntry{next (table [, index])}

Allows a program to traverse all fields of a table.

Its first argument is a table and its second argument

is an index in this table.

A call to @id{next} returns the next index of the table

and its associated value.

When called with @nil as its second argument,

@id{next} returns an initial index

and its associated value.

When called with the last index,

or with @nil in an empty table,

@id{next} returns @nil.

If the second argument is absent, then it is interpreted as @nil.

In particular,

you can use @T{next(t)} to check whether a table is empty.

The order in which the indices are enumerated is not specified,

@emph{even for numeric indices}.  
(To traverse a table in numerical order,  
use a numerical @Rw{for}.)

You should not assign any value to a non-existent field in a table  
during its traversal.

You

may however modify existing fields.

In particular, you may set existing fields to nil.

}

@LibEntry{pairs (t)|

If @id{t} has a metamethod @idx{\_\_pairs},  
calls it with @id{t} as argument and returns the first three  
results from the call.

Otherwise,

returns three values: the @Lid{next} function, the table @id{t}, and @nil,  
so that the construction

@verbatim{

for k,v in pairs(t) do @rep{body} end

}

will iterate over all key@En{ }value pairs of table @id{t}.

See function @Lid{next} for the caveats of modifying  
the table during its traversal.

}

@LibEntry{pcall (f [, arg1, @Cdots])|

Calls the function @id{f} with

the given arguments in @emphx{protected mode}.

This means that any error @N{inside @T{f}} is not propagated;

instead, @id{pcall} catches the error

and returns a status code.

Its first result is the status code (a boolean),

which is @true if the call succeeds without errors.

In such case, @id{pcall} also returns all results from the call,

after this first result.

In

case of any error, @id{pcall} returns @false plus the error object.

Note that errors caught by @id{pcall} do not call a message handler.

}

@LibEntry{print (@Cdots)|

Receives any number of arguments  
and prints their values to @id{stdout},  
converting each argument to a string  
following the same rules of @Lid{tostring}.

The function @id{print} is not intended for formatted output,  
but only as a quick way to show a value,  
for instance for debugging.  
For complete control over the output,  
use @Lid{string.format} and @Lid{io.write}.

}

@LibEntry{rawequal (v1, v2)|

Checks whether @id{v1} is equal to @id{v2},  
without invoking the @idx{\_\_eq} metamethod.  
Returns a boolean.

}

@LibEntry{rawget (table, index)|

Gets the real value of @T{table[index]},  
without using the @idx{\_\_index} metavalue.  
@id{table} must be a table;  
@id{index} may be any value.

}

@LibEntry{rawlen (v)|

Returns the length of the object @id{v},  
which must be a table or a string,  
without invoking the @idx{\_\_len} metamethod.  
Returns  
an integer.

}

@LibEntry{rawset (table, index, value)|

Sets the real value of @T{table[index]} to @id{value},  
without using the @idx{\_\_newindex} metavalue.  
@id{table} must be a table,  
@id{index} any value different from @nil and @x{NaN},  
and @id{value} any Lua value.

This function returns @id{table}.

}

@LibEntry{select (index, @Cdots)|

If @id{index} is a number,  
returns all arguments after argument number @id{index};  
a negative number indexes from the end (@num{-1} is the last argument).  
Otherwise, @id{index} must be the string @T{"#"},  
and @id{select} returns the total number of extra arguments it received.

}

@LibEntry{setmetatable (table, metatable)|

Sets the metatable for the given table.  
If @id{metatable} is @nil,  
removes the metatable of the given table.  
If the original metatable has a @idx{\_\_metatable} field,  
raises an error.

This function returns @id{table}.

To change the metatable of other types from Lua code,  
you must use the @link{debuglib|debug library}.

}

@LibEntry{tonumber  
(e [, base])|

When called with no @id{base},  
@id{tonumber} tries to convert its argument to a number.  
If the argument is already a number or  
a string convertible to a number,  
then @id{tonumber} returns this number;  
otherwise, it returns @fail.

The conversion of strings can result in integers or floats,  
according to the lexical conventions of Lua @see{lexical}.  
The string may have leading and trailing spaces and a sign.

When called with @id{base},  
then @id{e} must be a string to be interpreted as  
an integer numeral in that base.  
The base may be any integer between 2 and 36, inclusive.  
In bases @N{above 10}, the letter @Char{A} (in either upper or lower case)  
@N{represents 10}, @Char{B} @N{represents 11}, and so forth,  
with @Char{Z} representing 35.  
If the string @id{e} is not a valid numeral in the given base,

the function returns `@fail`.

```
}
```

`@LibEntry{tostring (v)|`

Receives a value of any type and  
converts it to a string in a human-readable format.

If the metatable

of `@id{v}` has a `@idx{__tostring}` field,

then `@id{tostring}` calls the corresponding value

with `@id{v}` as argument,

and uses the result of the call as its result.

Otherwise, if the metatable of `@id{v}` has a `@idx{__name}` field

with a string value,

`@id{tostring}` may use that string in its final result.

For complete control of how numbers are converted,  
use `@Lid{string.format}`.

```
}
```

`@LibEntry{type (v)|`

Returns the type of its only argument, coded as a string.

The possible results of this function are

`@St{nil}` (a string, not the value `@nil`),

`@St{number}`,

`@St{string}`,

`@St{boolean}`,

`@St{table}`,

`@St{function}`,

`@St{thread}`,

and `@St{userdata}`.

```
}
```

`@LibEntry{_VERSION|`

A global variable (not a function) that

holds a string containing the running Lua version.

The current value of this variable is `@St{Lua 5.4}`.

```
}
```

`@LibEntry{warn (msg1, @Cdots)|`

Emits a warning with a message composed by the concatenation of all its arguments (which should be strings).

By convention,  
a one-piece message starting  
with `@Char{@At}`  
is intended to be a `@emph{control message}`,  
which is a message to the warning system itself.  
In particular, the standard warning function in Lua  
recognizes the control messages `@St{@At}{off}`,  
to stop the emission of warnings,  
and `@St{@At}{on}`, to (re)start the emission;  
it ignores unknown control messages.

}

`@LibEntry{xpcall (f, msg [, arg1, @Cdots)]|`

This function is similar to `@Lid{pcall}`,  
except that it sets a new `@x{message handler}` `@id{msg}`.

}

}

`@sect2{corolib| @title{Coroutine Manipulation}`

This library comprises the operations to manipulate coroutines,  
which come inside the table `@defid{coroutine}`.  
See `@See{coroutine}` for a general description of coroutines.

`@LibEntry{coroutine.close (co)|`

Closes coroutine `@id{co}`,  
that is,  
closes all its pending to-be-closed variables  
and puts the coroutine in a dead state.  
The given coroutine must be dead or suspended.  
In case of error  
(either the original error that stopped the coroutine or  
errors in closing  
methods),  
returns `@false` plus the error object;  
otherwise returns `@true`.

}

@LibEntry{coroutine.create (f)|

Creates a new coroutine, with body @id{f}.

@id{f} must be a function.

Returns this new coroutine,  
an object with type @T{"thread"}.

}

@LibEntry{coroutine.isyieldable ([co])|

Returns @true when the coroutine @id{co} can yield.

The default for @id{co} is the running coroutine.

A coroutine is yieldable if it is not the main thread and  
it is not inside a non-yieldable @N{C function}.

}

@LibEntry{coroutine.resume (co [, val1, @Cdots])|

Starts or continues the execution of coroutine @id{co}.

The first time you resume a coroutine,  
it starts running its body.

The values @id{val1}, @ldots are passed  
as the arguments to the body function.

If the coroutine has yielded,

@id{resume} restarts it;

the values @id{val1}, @ldots are passed  
as the results from the yield.

If the coroutine runs without any errors,

@id{resume} returns @true plus any values passed to @id{yield}

(when the coroutine

yields) or any values returned by the body function

(when the coroutine terminates).

If there is any error,

@id{resume} returns @false plus the error message.

}

@LibEntry{coroutine.running ()|

Returns the running coroutine plus a boolean,

@true when the running coroutine is the main one.

}

@LibEntry{coroutine.status (co)|

Returns the status of the coroutine @id{co}, as a string:

@T{"running"},

if the coroutine is running

(that is, it is the one that called @id{status});

@T{"suspended"}, if the coroutine is suspended in a call to @id{yield},

or if it has not started running yet;

@T{"normal"} if the coroutine is active but not running

(that is, it has resumed another coroutine);

and @T{"dead"} if the coroutine has finished its body function,

or if it has stopped with an error.

}

@LibEntry{coroutine.wrap (f)|

Creates a new coroutine, with body @id{f};

@id{f} must be a function.

Returns a function that resumes the coroutine each time it is called.

Any arguments passed to this

function behave as the

extra arguments to @id{resume}.

The function returns the same values returned by @id{resume},

except the first boolean.

In case of error,

the function closes the coroutine and propagates the error.

}

@LibEntry{coroutine.yield (@Cdots)|

Suspends the execution of the calling coroutine.

Any arguments to @id{yield} are passed as extra results to @id{resume}.

}

}

@sect2{packlib| @title{Modules}}

The package library provides basic

facilities for loading modules in Lua.

It exports one function directly in the global environment:

@Lid{require}.

Everything else is exported in the table @defid{package}.



@LibEntry{require (modname)}

Loads the given module.

The function starts by looking into the @Lid{package.loaded} table to determine whether @id{modname} is already loaded.

If it is, then @id{require} returns the value stored at @T{package.loaded[modname]}.

(The absence of a second result in this case signals that this call did not have to load the module.)

Otherwise,

it tries to find a @emph{loader} for the module.

To find a loader,

@id{require} is guided by the table @Lid{package.searchers}.

Each item in this table is a search function, that searches for the module in a particular way.

By changing this table,

we can change how @id{require} looks for a module.

The following explanation is based on the default configuration for @Lid{package.searchers}.

First @id{require} queries @T{package.preload[modname]}.

If it has a value,

this value (which must be a function) is the loader.

Otherwise @id{require} searches for a Lua loader using the path stored in @Lid{package.path}.

If that also fails, it searches for a @N{C loader} using the path stored in @Lid{package.cpath}.

If that also fails,

it tries an @emph{all-in-one} loader @seeF{package.searchers}.

Once a loader is found,

@id{require} calls the loader with two arguments:

@id{modname} and an extra value,

a @emph{loader data},

also returned by the searcher.

The loader data can be any value useful to the module;

for the default searchers,

it indicates where the loader was found.

(For instance, if the loader came from a file, this extra value is the file path.)

If the loader returns any non-nil value,

@id{require} assigns the returned value to @T{package.loaded[modname]}.

If the loader does not return a non-nil value and

has not assigned any value to @T{package.loaded[modname]},

then @id{require} assigns @true to this entry.

In any case, @id{require} returns the

final value of `@T{package.loaded[modname]}`.  
Besides that value, `@id{require}` also returns as a second result  
the loader data returned by the searcher,  
which indicates how `@id{require}` found the module.

If there is any error loading or running the module,  
or if it cannot find any loader for the module,  
then `@id{require}` raises an error.

}

`@LibEntry{package.config|`

A string describing some compile-time configurations for packages.  
This string is a sequence of lines:

`@itemize{`

`@item{The first line is the @x{directory  
separator} string.`

Default is `@Char{\}` for `@x{Windows}` and `@Char{/}` for all other systems.}

`@item{The second line is the character that separates templates in a path.  
Default is @Char{;}.}`

`@item{The third line is the string that marks the  
substitution points in a template.  
Default is @Char{?}.}`

`@item{The fourth line is a string that, in a path in @x{Windows},  
is replaced by the executable's directory.  
Default is @Char{!}.}`

`@item{The fifth line is a mark to ignore all text after it  
when building the @id{luaopen_} function name.  
Default is @Char{-}.}`

}

}

`@LibEntry{package.cpath|`

A string with the path used by `@Lid{require}`  
to search for a `@N{C loader}`.

Lua initializes the `@N{C path}` `@Lid{package.cpath}` in the same way  
it initializes the Lua path `@Lid{package.path}`,  
using the environment variable `@defid{LUA_CPATH_5_4}`,

or the environment variable @defid{LUA\_CPATH},  
or a default path defined in @id{luaconf.h}.

}

@LibEntry{package.loaded|

A table used by @Lid{require} to control  
which  
modules are already loaded.

When you require a module @id{modname} and  
@T{package.loaded[modname]} is not false,  
@Lid{require} simply returns the value stored there.

This variable is only a reference to the real table;  
assignments to this variable do not change the  
table used by @Lid{require}.  
The real table is stored in the C registry @see{registry},  
indexed by the key @defid{LUA\_LOADED\_TABLE}, a string.

}

@LibEntry{package.loadlib (libname, funcname)|

Dynamically links the host program with the @N{C library} @id{libname}.

If @id{funcname} is @St{\*},  
then it only links with the library,  
making the symbols exported by the library  
available to other dynamically linked libraries.  
Otherwise,  
it looks for a function @id{funcname} inside the library  
and returns this function as a @N{C function}.  
So, @id{funcname} must follow the @Lid{lua\_CFunction} prototype  
@seeC{lua\_CFunction}.

This is a low-level function.  
It completely bypasses the package and module system.  
Unlike @Lid{require},  
it  
does not perform any path searching and  
does not automatically adds extensions.  
@id{libname} must be the complete file name of the @N{C library},  
including if necessary a path and an extension.  
@id{funcname} must be the exact name exported by the @N{C library}  
(which may depend on the @N{C compiler} and linker used).

This functionality is not supported by @N{ISO C}.

As such, it is only available on some platforms  
(Windows, Linux, Mac OS X, Solaris, BSD,  
plus other Unix systems that support the `@id{dlfcn}` standard).

This function is inherently insecure,  
as it allows Lua to call any function in any readable dynamic  
library in the system.

(Lua calls any function assuming the function  
has a proper prototype and respects a proper protocol  
`@see{lua_CFunction}`).

Therefore,  
calling an arbitrary function in an arbitrary dynamic library  
more often than not results in an access violation.)

}

`@LibEntry{package.path|`

A string with the path used by `@Lid{require}`  
to search for a Lua  
loader.

At start-up, Lua initializes this variable with  
the value of the environment variable `@defid{LUA_PATH_5_4}` or  
the environment variable `@defid{LUA_PATH}` or  
with a default path defined in `@id{luaconf.h}`,  
if those environment variables are not defined.  
A `@St{;;}` in the value of the environment variable  
is replaced by the default path.

}

`@LibEntry{package.preload|`

A table to store loaders for specific modules  
`@seeF{require}`.

This variable is only a reference to the real table;  
assignments to this variable do not change the  
table used by `@Lid{require}`.

The real table is stored in the C registry `@see{registry}`,  
indexed by the key `@defid{LUA_PRELOAD_TABLE}`, a string.

}

`@LibEntry{package.searchers|`

A table used by `@Lid{require}` to control how to find modules.

Each entry in this table is a `@def{searcher function}`.  
When looking for a module,  
`@Lid{require}` calls each of these searchers in ascending order,  
with the module name (the argument given to `@Lid{require}`) as its  
sole argument.

If  
the searcher finds the module,  
it returns another function, the module `@def{loader}`,  
plus an extra value, a `@emph{loader data}`,  
that will be passed to that loader and  
returned as a second result by `@Lid{require}`.  
If it cannot find the module,  
it returns a string explaining why  
(or `@nil` if it has nothing to say).

Lua initializes this table with four searcher functions.

The first searcher simply looks for a loader in the  
`@Lid{package.preload}` table.

The second searcher looks for a loader as a Lua library,  
using the path stored at `@Lid{package.path}`.  
The search is done as described in function `@Lid{package.searchpath}`.

The third searcher looks for a loader as a `@N{C library}`,  
using the path given by the variable `@Lid{package.cpath}`.  
Again,  
the search is done as described in function `@Lid{package.searchpath}`.

For instance,  
if the `@N{C path}` is the string  
`@verbatim{  
"./?.so;./?.dll;/usr/local/?/init.so"  
}`  
the searcher for module `@id{foo}`  
will try to open the files `@T{./foo.so}`,  
`@T{./foo.dll}`,  
and `@T{/usr/local/foo/init.so}`, in that order.

Once it finds a `@N{C library}`,  
this searcher first uses a dynamic link facility to link the  
application with the library.  
Then it tries to find a `@N{C function}` inside the library to  
be used as the loader.

The name of this `@N{C function}` is the string `@St{luaopen_}`  
concatenated with a copy of the module name where each dot  
is replaced by an underscore.

Moreover, if the module name has a hyphen,  
its suffix after (and including) the first hyphen is removed.

For instance, if the module name is `@id{a.b.c-v2.1}`,  
the function name will be `@id{luaopen_a_b_c}`.

The fourth searcher tries an `@def{all-in-one loader}`.

It searches the `@N{C path}` for a library for  
the root name of the given module.

For instance, when requiring `@id{a.b.c}`,  
it will search for a `@N{C library}` for `@id{a}`.

If found, it looks into it for an open function for  
the submodule;

in our example, that would be `@id{luaopen_a_b_c}`.

With this facility, a package can pack  
several `@N{C submodules}`

into one single library,  
with each submodule keeping its original open function.

All searchers except the first one (preload) return as the extra value  
the file path where the module was found,  
as returned by `@Lid{package.searchpath}`.

The first searcher always returns the string `@St{:preload:}`.

Searchers should raise no errors and have no side effects in Lua.  
(They may have side effects in C,  
for instance by linking the application with a library.)

}

`@LibEntry{package.searchpath (name, path [, sep [, rep]])|`

Searches for the given `@id{name}` in the given `@id{path}`.

A path is a string containing a sequence of  
`@emph{templates}` separated by semicolons.

For each template,  
the function replaces each interrogation mark (if any)  
in the template with a copy of `@id{name}`  
wherein all occurrences of `@id{sep}`  
(a dot, by default)  
were replaced by `@id{rep}`  
(the system's directory separator, by default),  
and then tries to open the resulting file name.

For instance, if  
the path is the string  
`@verbatim{  
"./?.lua;./?.lc;/usr/local/?/init.lua"  
}`  
the search for the name `@id{foo.a}`

will try to open the files  
@T{./foo/a.lua}, @T{./foo/a.lc}, and  
@T{/usr/local/foo/a/init.lua}, in that order.

Returns the resulting name of the first file that it can  
open in read mode (after closing the file),  
or @fail plus an error message if none succeeds.  
(This error message lists all file names it tried to open.)

}

}

@sect2{strlib| @title{String Manipulation}

@simplesect{

This library provides generic functions for string manipulation,  
such as finding and extracting substrings, and pattern matching.  
When indexing a string in Lua, the first character is at @N{position 1}  
(not @N{at 0}, as in C).  
Indices are allowed to be negative and are interpreted as indexing backwards,  
from the end of the string.  
Thus, the last character is at position @num{-1}, and so on.

The string library provides all its functions inside the table  
@defid{string}.  
It also sets a @x{metatable for  
strings}  
where the @idx{\_\_index} field points to the @id{string} table.  
Therefore, you can use the string functions in object-oriented style.  
For instance, @T{string.byte(s,i)}  
can be written as @T{s:byte(i)}.

The string library assumes one-byte character encodings.

@LibEntry{string.byte (s [, i [, j]])|  
Returns the internal numeric codes of the characters @T{s[i]},  
@T{s[i+1]}, @ldots, @T{s[j]}.  
The default value for @id{i} @N{is 1};  
the default value for @id{j} @N{is @id{i}}.  
These indices are corrected  
following the same rules of function @Lid{string.sub}.

Numeric codes are not necessarily portable across platforms.

}

@LibEntry{string.char (@Cdots)|

Receives zero or more integers.

Returns a string with length equal to the number of arguments,  
in which each character has the internal numeric code equal  
to its corresponding argument.

Numeric codes are not necessarily portable across platforms.

}

@LibEntry{string.dump (function [, strip])|

Returns a string containing a binary  
representation

(a *@emph{binary chunk}*)

of the given function,

so that a later @Lid{load} on this string returns

a copy of the function (but with new upvalues).

If @id{strip} is a true value,

the binary representation may not include all debug information  
about the function,

to save space.

Functions with upvalues have only their number of upvalues saved.

When (re)loaded,

those upvalues receive fresh instances.

(See the @Lid{load} function for details about

how these upvalues are initialized.

You can use the debug library to serialize

and reload the upvalues of a function

in a way adequate to your needs.)

}

@LibEntry{string.find (s, pattern [, init [, plain]])|

Looks for the first match of

@id{pattern} @see{pm} in the string @id{s}.

If it finds a match, then @id{find} returns the indices @N{of @T{s}}

where this occurrence starts and ends;

otherwise, it returns @fail.

A third, optional numeric argument @id{init} specifies

where to start the search;

its default value @N{is 1} and can

be negative.

A @true as a fourth, optional argument @id{plain}

turns off the pattern matching facilities,



so the function does a plain `@Q{find substring}` operation,  
with no characters in `@id{pattern}` being considered magic.

If the pattern has captures,  
then in a successful match  
the captured values are also returned,  
after the two indices.

}

`@LibEntry{string.format (formatstring, @Cdots)}`

Returns a formatted version of its variable number of arguments  
following the description given in its first argument,  
which must be a string.

The format string follows the same rules as the `@ANSI{sprintf}`.

The only differences are that the conversion specifiers and modifiers  
`@id{F}`, `@id{n}`, `@T{*}`, `@id{h}`, `@id{L}`, and `@id{l}` are not supported  
and that there is an extra specifier, `@id{q}`.

Both width and precision, when present,  
are limited to two digits.

The specifier `@id{q}` formats booleans, nil, numbers, and strings  
in a way that the result is a valid constant in Lua source code.

Booleans and nil

are written in the obvious way

(`@id{true}`, `@id{false}`, `@id{nil}`).

Floats are written in hexadecimal,  
to preserve full precision.

A string is written between double quotes,  
using escape sequences when necessary to ensure that  
it can safely be read back by the Lua interpreter.

For instance, the call

```
@verbatim{
string.format("%q", 'a string with "quotes" and \n new line')
}
```

may produce the string:

```
@verbatim{
"a string with \"quotes\" and \
new line"
}
```

This specifier does not support modifiers (flags, width, precision).

The conversion specifiers

`@id{A}`, `@id{a}`, `@id{E}`, `@id{e}`, `@id{f}`,  
`@id{G}`, and `@id{g}` all expect a number as argument.

The specifiers `@id{c}`, `@id{d}`,

`@id{i}`, `@id{o}`, `@id{u}`, `@id{X}`, and `@id{x}`

expect an integer.

When Lua is compiled with a C89 compiler,  
the specifiers `@id{A}` and `@id{a}` (hexadecimal floats)  
do not support modifiers.

The specifier `@id{s}` expects a string;

if its argument is not a string,

it is converted to one following the same rules of `@Lid{tostring}`.

If

the specifier has any modifier,

the corresponding string argument should not contain `@x{embedded zeros}`.

The specifier `@id{p}` formats the pointer

returned by `@Lid{lua_topointer}`.

That gives a unique string identifier for tables, userdata,  
threads, strings, and functions.

For other values (numbers, nil, booleans),  
this specifier results in a string representing  
the pointer `@id{NULL}`.

}

`@LibEntry{string.gmatch (s, pattern [, init])}`

Returns an iterator function that,

each time it is called,

returns the next captures from `@id{pattern}` `@see{pm}`  
over the string `@id{s}`.

If `@id{pattern}` specifies no captures,

then the whole match is produced in each call.

A third, optional numeric argument `@id{init}` specifies  
where to start the search;

its default value `@N{is 1}` and can be negative.

As an example, the following loop

will iterate over all the words from string `@id{s}`,

printing one per line:

```
@verbatim{
s = "hello world from Lua"
for w in string.gmatch(s, "%a+") do
  print(w)
end
}
```

The next

example collects all pairs `@T{key=value}` from the  
given string into a table:

```
@verbatim{
t = {}
s = "from=world, to=Lua"
```

```

for k, v in string.gmatch(s, "(%w+)=(%w+)") do
  t[k] = v
end
}

```

For this function, a caret `@Char{^}` at the start of a pattern does not work as an anchor, as this would prevent the iteration.

```

}

```

`@LibEntry{string.gsub (s, pattern, repl [, n])}`

Returns a copy of `@id{s}`

in which all (or the first `@id{n}`, if given)

occurrences of the `@id{pattern}` `@see{pm}` have been

replaced by a replacement string specified by `@id{repl}`,

which can be a string, a table, or a function.

`@id{gsub}` also returns, as its second value,

the total number of matches that occurred.

The name `@id{gsub}` comes from `@emph{Global SUBstitution}`.

If `@id{repl}` is a string, then its value is used for replacement.

The `@N{character @T{%}}` works as an escape character:

any sequence in `@id{repl}` of the form `@T{%@rep{d}}`,

with `@rep{d}` between 1 and 9,

stands for the value of the `@rep{d}`-th captured substring;

the

sequence `@T{%0}` stands for the whole match;

the sequence `@T{%}%` stands for a `@N{single @T{%}}`.

If `@id{repl}` is a table, then the table is queried for every match, using the first capture as the key.

If `@id{repl}` is a function, then this function is called every time a match occurs, with all captured substrings passed as arguments, in order.

In any case,

if the pattern specifies no captures,

then it behaves as if the whole pattern was inside a capture.

If the value returned by the table query or by the function call is a string or a number,

then it is used as the replacement string;

otherwise, if it is `@Rw{false}` or `@nil`,

then there is no replacement

(that is, the original match is kept in the string).

Here are some examples:

```

@verbatim{
x = string.gsub("hello world", "(%w+)", "%1 %1")
--> x="hello hello world world"

x = string.gsub("hello world", "%w+", "%0 %0", 1)
--> x="hello hello world"

x = string.gsub("hello world from Lua", "(%w+)%s*(%w+)", "%2 %1")
--> x="world hello Lua
from"

x = string.gsub("home = $HOME, user = $USER", "%$(%w+)", os.getenv)
--> x="home = /home/roberto, user = roberto"

x = string.gsub("4+5 = $return 4+5$", "%$(.)%$", function (s)
    return load(s)()
end)
--> x="4+5 = 9"

local t = {name="lua", version="5.4"}
x = string.gsub("$name-$version.tar.gz", "%$(%w+)", t)
--> x="lua-5.4.tar.gz"
}
}

```

@LibEntry{string.len (s)|

Receives a string and returns its length.  
The empty string @T{""} has length 0.  
Embedded zeros are counted,  
so @T{"a\000bc\000"} has length 5.

}

@LibEntry{string.lower (s)|

Receives a string and returns a copy of this string with all  
uppercase letters changed to lowercase.  
All other characters are left unchanged.  
The definition of what an uppercase letter is depends on the current locale.

}

@LibEntry{string.match (s, pattern [, init])|

Looks for the first @emph{match} of  
the @id{pattern} @see{pm} in the string @id{s}.

If it finds one, then `@id{match}` returns the captures from the pattern; otherwise it returns `@fail`.  
 If `@id{pattern}` specifies no captures, then the whole match is returned.  
 A third, optional numeric argument `@id{init}` specifies where to start the search; its default value `@N{is 1}` and can be negative.

}

`@LibEntry{string.pack (fmt, v1, v2, @Cdots)|`

Returns a binary string containing the values `@id{v1}`, `@id{v2}`, etc. serialized in binary form (packed) according to the format string `@id{fmt}` `@see{pack}`.

}

`@LibEntry{string.packsize (fmt)|`

Returns the length of a string resulting from `@Lid{string.pack}` with the given format.  
 The format string cannot have the variable-length options `@Char{s}` or `@Char{z}` `@see{pack}`.

}

`@LibEntry{string.rep (s, n [, sep])|`

Returns a string that is the concatenation of `@id{n}` copies of the string `@id{s}` separated by the string `@id{sep}`.  
 The default value for `@id{sep}` is the empty string (that is, no separator).  
 Returns the empty string if `@id{n}` is not positive.

(Note that it is very easy to exhaust the memory of your machine with a single call to this function.)

}

`@LibEntry{string.reverse (s)|`

Returns a string that is the string `@id{s}` reversed.

}

@LibEntry{string.sub (s, i [, j])|

Returns the substring of @id{s} that starts at @id{i} and continues until @id{j};  
@id{i} and @id{j} can be negative.  
If @id{j} is absent, then it is assumed to be equal to @num{-1} (which is the same as the string length).  
In particular,  
the call @T{string.sub(s,1,j)} returns a prefix of @id{s} with length @id{j},  
and @T{string.sub(s, -i)} (for a positive @id{i}) returns a suffix of @id{s} with length @id{i}.

If, after the translation of negative indices,  
@id{i} is less than 1,  
it is corrected to 1.  
If @id{j} is greater than the string length,  
it is corrected to that length.  
If, after these corrections,  
@id{i} is greater than @id{j},  
the function returns the empty string.

}

@LibEntry{string.unpack (fmt, s [, pos])|

Returns the values packed in string @id{s} @seeF{string.pack} according to the format string @id{fmt} @see{pack}.  
An  
optional @id{pos} marks where  
to start reading in @id{s} (default is 1).  
After the read values,  
this function also returns the index of the first unread byte in @id{s}.

}

@LibEntry{string.upper (s)|

Receives a string and returns a copy of this string with all lowercase letters changed to uppercase.  
All other characters are left unchanged.  
The definition of what a lowercase letter is depends on the current locale.

}

}

@sect3{pm| @title{Patterns}

@simplesect{

Patterns in Lua are described by regular strings,  
which are interpreted as patterns by the pattern-matching functions

@Lid{string.find},

@Lid{string.gmatch},

@Lid{string.gsub},

and @Lid{string.match}.

This section describes the syntax and the meaning  
(that is, what they match) of these strings.

}

@sect4{@title{Character Class:}}

A @def{character class} is used to represent a set of characters.

The following combinations are allowed in describing a character class:

@description{

@item{@rep{x}|

(where @rep{x} is not one

of the @emphx{magic characters}

@T{^\$()%.[]\*+-.?})

represents the character @emph{x} itself.

}

@item{@T{.}| (a dot) represents all characters.}

@item{@T{%a}| represents all letters.}

@item{@T{%c}| represents all control characters.}

@item{@T{%d}| represents all digits.}

@item{@T{%g}| represents all printable characters except space.}

@item{@T{%l}| represents all lowercase letters.}

@item{@T{%p}| represents all punctuation characters.}

@item{@T{%s}| represents all space characters.}

@item{@T{%u}| represents all uppercase letters.}

@item{@T{%w}| represents all alphanumeric characters.}

@item{@T{%x}| represents all hexadecimal digits.}

@item{@T{%@rep{x}}| (where @rep{x} is any non-alphanumeric character)  
represents the character @rep{x}.

This is the standard way to escape the magic characters.

Any non-alphanumeric character

(including all punctuation characters, even the non-magical)  
can be preceded by a @Char{%} to represent itself in a pattern.  
}

@item{@T{[@rep{set}]|

represents

the class which is the union of all  
characters in @rep{set}.

A range of characters can be specified by  
separating the end characters of the range,  
in ascending order, with a @Char{-}.

All classes @T{%}@emph{x} described above can also be used as  
components in @rep{set}.

All other characters in @rep{set} represent themselves.

For example, @T{[%w\_]} (or @T{[\_%w]})

represents all alphanumeric characters plus the underscore,

@T{[0-7]} represents the octal digits,

and @T{[0-7%l%-]} represents the octal digits plus  
the lowercase letters plus the @Char{-} character.

You can put a closing square bracket in a set  
by positioning it as the first character in the set.

You can put a hyphen in a set

by positioning it as the first or the last character in the set.

(You can also use an escape for both cases.)

The interaction between ranges and classes is not defined.

Therefore, patterns like @T{[%a-z]} or @T{[a-%%]}  
have no meaning.

}

@item{@T{^[@rep{set}]|

represents the complement of @rep{set},

where

@rep{set} is interpreted as above.

}

}

For all classes represented by single letters (@T{%a}, @T{%c}, etc.),  
the corresponding uppercase letter represents the complement of the class.

For instance, @T{%S} represents all non-space characters.



The definitions of letter, space, and other character groups depend on the current locale.

In particular, the class `@T{[a-z]}` may not be equivalent to `@T{%l}`.

}

@sect4{@title{Pattern Item:}

A `@def{pattern item}` can be

`@itemize{`

`@item{`

a single character class,

which matches any single character in the class;

}

`@item{`

a single character class followed by `@Char{*}`,

which matches sequences of zero or more characters in the class.

These repetition items will always match the longest possible sequence;

}

`@item{`

a single character class followed by `@Char{+}`,

which matches sequences of one or more characters in the class.

These repetition items will always match the longest possible sequence;

}

`@item{`

a single character class followed

by `@Char{-}`,

which also matches sequences of zero or more characters in the class.

Unlike `@Char{*}`,

these repetition items will always match the shortest possible sequence;

}

`@item{`

a single character class followed by `@Char{?}`,

which matches zero or one occurrence of a character in the class.

It always matches one occurrence if possible;

}

`@item{`

`@T{%@rep{n}}`, for `@rep{n}` between 1 and 9;

such item matches a substring equal to the `@rep{n}`-th captured string (see below);

}

```
@item{
@T{%b@rep{xy}}, where @rep{x} and @rep{y} are two distinct characters;
such item matches strings that start @N{with @rep{x}}, end @N{with @rep{y}},
and where the @rep{x} and @rep{y} are @emph{balanced}.
This means that, if one reads the string from left to right,
counting @M{+1} for an @rep{x} and @M{-1} for a @rep{y},
the ending @rep{y} is the first @rep{y} where the count reaches 0.
For instance, the item @T{%b()} matches expressions with
balanced parentheses.
}
```

```
@item{
@T{%f[@rep{set}]}, a @def{frontier
pattern};
such item matches an empty string at any position such that
the next character belongs to @rep{set}
and the previous character does not belong to @rep{set}.
The set @rep{set} is interpreted as previously described.
The beginning and the end of the subject are handled as if
they were the character @Char{\0}.
}

}

}
```

```
@sect4{@title{Pattern:}
A @def{pattern} is a sequence of pattern items.
A caret @Char{^} at the beginning of a pattern anchors the match at the
beginning of the subject string.
A @Char{$} at the end of a pattern anchors the match at the
end of the subject string.
At other positions,
@Char{^} and @Char{$} have no special meaning and represent themselves.
}
```

```
@sect4{@title{Captures:}
A pattern can contain sub-patterns enclosed in parentheses;
they describe @def{captures}.
When a match succeeds, the substrings of the subject string
that match captures are stored (@emph{captured}) for future use.
Captures are numbered according to their left parentheses.
For instance,
in the pattern @T{"a*(.)%w(%s*)"},
the part of the string matching @T{"a*(.)%w(%s*)"} is
stored as the first capture, and therefore has @N{number 1};
the character matching @St{.} is captured with @N{number 2},
```

and the part matching `@St{%s*}` has `@N{number 3}`.

As a special case, the capture `@T{()}` captures the current string position (a number).

For instance, if we apply the pattern `@T{"()aa()}"` on the string `@T{"flaaap"}`, there will be two captures: `@N{3 and 5}`.

}

`@sect4{@title{Multiple matches:}`

The function `@Lid{string.gsub}` and the iterator `@Lid{string.gmatch}` match multiple occurrences of the given pattern in the subject.

For these functions,

a new match is considered valid only

if it ends at least one byte after the end of the previous match.

In other words, the pattern machine never accepts the empty string as a match immediately after another match.

As an example,

consider the results of the following code:

`@verbatim{`

`> string.gsub("abc", "()a*()", print);`

`--> 1 2`

`--> 3`

`3`

`--> 4 4`

`}`

The second and third results come from Lua matching an empty string after `@Char{b}` and another one after `@Char{c}`.

Lua does not match an empty string after `@Char{a}`, because it would end at the same position of the previous match.

}

}

`@sect3{pack| @title{Format Strings for Pack and Unpack}`

The first argument to `@Lid{string.pack}`,

`@Lid{string.packsize}`, and `@Lid{string.unpack}`

is a format string,

which describes the layout of the structure being created or read.

A format string is a sequence of conversion options.

The conversion options are as follows:

`@description{`

`@item{@T{<}|sets little endian}`

`@item{@T{>}|sets big endian}`

`@item{@T{=}|sets native endian}`

`@item{@T{![@rep{n}]}` sets maximum alignment to `@id{n}`  
 (default is native alignment)  
`@item{@T{b}|a` signed byte (`@id{char}`)  
`@item{@T{B}|a` unsigned byte (`@id{char}`)  
`@item{@T{h}|a` signed `@id{short}` (native size)  
`@item{@T{H}|a` unsigned `@id{short}` (native size)  
`@item{@T{l}|a` signed `@id{long}` (native size)  
`@item{@T{L}|a` unsigned `@id{long}` (native size)  
`@item{@T{j}|a` `@id{lua_Integer}`  
`@item{@T{J}|a` `@id{lua_Unsigned}`  
`@item{@T{T}|a` `@id{size_t}` (native size)  
`@item{@T{i[@rep{n}]}` a signed `@id{int}` with `@id{n}` bytes  
 (default is native size)  
`@item{@T{I[@rep{n}]}` an unsigned `@id{int}` with `@id{n}` bytes  
 (default is native size)  
`@item{@T{f}|a` `@id{float}` (native size)  
`@item{@T{d}|a` `@id{double}` (native size)  
`@item{@T{n}|a` `@id{lua_Number}`  
`@item{@T{c@rep{n}}` a fixed-sized string with `@id{n}` bytes  
`@item{@T{z}|a` zero-terminated string  
`@item{@T{s[@emph{n}]}` a string preceded by its length  
 coded as an unsigned integer with `@id{n}` bytes  
 (default is a `@id{size_t}`)  
`@item{@T{x}|` one byte of padding  
`@item{@T{X@rep{op}}` an empty item that aligns  
 according to option `@id{op}`  
 (which is otherwise ignored)  
`@item{@Char{ }|` (space) ignored  
`}`

(A `@St{![@rep{n}]}` means an optional integral numeral.)

Except for padding, spaces, and configurations

(options `@St{XX <=>!}`),

each option corresponds to an argument in `@Lid{string.pack}`

or

a result in `@Lid{string.unpack}`.

For options `@St{!@rep{n]}`, `@St{s@rep{n]}`, `@St{i@rep{n]}`, and `@St{I@rep{n]}`,

`@id{n}` can be any integer between 1 and 16.

All integral options check overflows;

`@Lid{string.pack}` checks whether the given value fits in the given size;

`@Lid{string.unpack}` checks whether the read value fits in a Lua integer.

For the unsigned options,

Lua integers are treated as unsigned values too.

Any format string starts as if prefixed by `@St{!1=}`,

that is,

with maximum alignment of 1 (no alignment)

and native endianness.

Native endianness assumes that the whole system is either big or little endian.

The packing functions will not emulate correctly the behavior of mixed-endian formats.

Alignment works as follows:

For each option,

the format gets extra padding until the data starts at an offset that is a multiple of the minimum between the option size and the maximum alignment; this minimum must be a power of 2.

Options `@St{c}` and `@St{z}` are not aligned; option

`@St{s}` follows the alignment of its starting integer.

All padding is filled with zeros by `@Lid{string.pack}` and ignored by `@Lid{string.unpack}`.

}

}

`@sect2{utf8| @title{UTF-8 Support}`

This library provides basic support for `@x{UTF-8}` encoding.

It provides all its functions inside the table `@defid{utf8}`.

This library does not provide any support for `@x{Unicode}` other than the handling of the encoding.

Any operation that needs the meaning of a character, such as character classification, is outside its scope.

Unless stated otherwise,

all functions that expect a byte position as a parameter assume that the given position is either the start of a byte sequence or one plus the length of the subject string.

As in the string library,

negative indices count from the end of the string.

Functions that create byte sequences

accept all values up to `@T{0x7FFFFFFF}`,

as defined in the original UTF-8 specification;

that implies byte sequences of up to six bytes.

Functions that interpret

byte sequences only accept valid sequences (well formed and not overlong).  
By default, they only accept byte sequences that result in valid Unicode code points, rejecting values greater than `@T{10FFFF}` and surrogates.  
A boolean argument `@id{lax}`, when available, lifts these checks, so that all values up to `@T{0x7FFFFFFF}` are accepted.  
(Not well formed and overlong sequences are still rejected.)

```
@LibEntry{utf8.char (@Cdots)|
```

Receives zero or more integers, converts each one to its corresponding UTF-8 byte sequence and returns a string with the concatenation of all these sequences.

```
}
```

```
@LibEntry{utf8.charpattern|
```

The pattern (a string, not a function) `@St{[\0-\x7F\xC2-\xFD][\x80-\xBF]*}`  
`@see{pm}`,  
which matches exactly one UTF-8 byte sequence, assuming that the subject is a valid UTF-8 string.

```
}
```

```
@LibEntry{utf8.codes (s [, lax])|
```

Returns values so that the construction  
`@verbatim{  
for p, c in utf8.codes(s) do @rep{body} end  
}`  
will iterate over all UTF-8 characters in string `@id{s}`,  
with  
`@id{p}` being the position (in bytes) and `@id{c}` the code point of each character.  
It raises an error if it meets any invalid byte sequence.

```
}
```

```
@LibEntry{utf8.codepoint (s [, i [, j [, lax]]])|
```

Returns the code points (as integers) from all characters in `@id{s}` that start between byte position `@id{i}` and `@id{j}` (both included).  
The default for `@id{i}` is 1 and for `@id{j}` is `@id{i}`.  
It raises an error if it meets any invalid byte sequence.

}

@LibEntry{utf8.len (s [, i [, j [, lax]])]|

Returns the number of UTF-8 characters in string @id{s} that start between positions @id{i} and @id{j} (both inclusive). The default for @id{i} is @num{1} and for @id{j} is @num{-1}. If it finds any invalid byte sequence, returns @fail plus the position of the first invalid byte.

}

@LibEntry{utf8.offset (s, n [, i)]|

Returns the position (in bytes) where the encoding of the @id{n}-th character of @id{s} (counting from position @id{i}) starts. A negative @id{n} gets characters before position @id{i}. The default for @id{i} is 1 when @id{n} is non-negative and @T{#s + 1} otherwise, so that @T{utf8.offset(s, -n)} gets the offset of the @id{n}-th character from the end of the string. If the specified character is neither in the subject nor right after its end, the function returns @fail.

As a special case, when @id{n} is 0 the function returns the start of the encoding of the character that contains the @id{i}-th byte of @id{s}.

This function assumes that @id{s} is a valid UTF-8 string.

}

}

@sect2{tablib| @title{Table Manipulation}}

This library provides generic functions for table manipulation. It provides all its functions inside the table @defid{table}.

Remember that, whenever an operation needs the length of a table, all caveats about the length operator apply @see{len-op}. All functions ignore non-numeric keys in the tables given as arguments.

@LibEntry{table.concat (list [, sep [, i [, j]])]}

Given a list where all elements are strings or numbers,  
returns the string

@T{list[i]..sep..list[i+1] @Cdots sep..list[j]}.

The default value for @id{sep} is the empty string,

the default for @id{i} is 1,

and the default for @id{j} is @T{#list}.

If @id{i} is greater than @id{j}, returns the empty string.

}

@LibEntry{table.insert (list, [pos,] value)}

Inserts element @id{value} at position @id{pos} in @id{list},  
shifting up the elements

@T{list[pos], list[pos+1], @Cdots, list[#list]}.

The default value for @id{pos} is @T{#list+1},

so that a call @T{table.insert(t,x)} inserts @id{x} at the end  
of the list @id{t}.

}

@LibEntry{table.move (a1, f, e, t [,a2])}

Moves elements from the table @id{a1} to the table @id{a2},  
performing the equivalent to the following  
multiple assignment:

@T{a2[t],@Cdots = a1[f],@Cdots,a1[e]}.

The default for @id{a2} is @id{a1}.

The destination range can overlap with the source range.

The number of elements to be moved must fit in a Lua integer.

Returns the destination table @id{a2}.

}

@LibEntry{table.pack (@Cdots)}

Returns

a new table with all arguments stored into keys 1, 2, etc.

and with a field @T{n} with the total number of arguments.

Note that the resulting table may not be a sequence,

if some arguments are @nil.

}



@LibEntry{table.remove (list [, pos])|

Removes from @id{list} the element at position @id{pos},  
returning the value of the removed element.

When @id{pos} is an integer between 1 and @T{#list},  
it shifts down the elements

@T{list[pos+1], list[pos+2], @Cdots, list[#list]}

and erases element @T{list[#list]};

The index @id{pos} can also be 0 when @T{#list} is 0,  
or @T{#list + 1}.

The default value for @id{pos} is @T{#list},  
so that a call @T{table.remove(l)} removes the last element  
of the list @id{l}.

}

@LibEntry{table.sort (list [, comp])|

Sorts the list elements in a given order, @emph{in-place},  
from @T{list[1]} to @T{list[#list]}.

If @id{comp} is given,

then it must be a function that receives two list elements  
and returns true when the first element must come  
before the second in

the final order,

so that, after the sort,

@T{i <= j} implies @T{not comp(list[j],list[i])}.

If @id{comp} is not given,

then the standard Lua operator @T{<} is used instead.

The @id{comp} function must define a consistent order;  
more formally, the function must define a strict weak order.  
(A weak order is similar to a total order,  
but it can equate different elements for comparison purposes.)

The sort algorithm is not stable:

Different elements considered equal by the given order  
may have their relative positions changed by the sort.

}

@LibEntry{table.unpack (list [, i [, j]])|

Returns the elements from the given list.

This function is equivalent to

@verbatim{

return list[i], list[i+1], @Cdots, list[j]

}

By default, `@id{i}` `@N{is 1}` and `@id{j}` is `@T{#list}`.

}

}

`@sect2{mathlib| @title{Mathematical Functions}}`

This library provides basic mathematical functions.

It provides all its functions and constants inside the table `@defid{math}`.

Functions with the annotation `@St{integer/float}`

give

integer results for integer arguments

and float results for non-integer arguments.

The rounding functions

`@Lid{math.ceil}`, `@Lid{math.floor}`, and `@Lid{math.modf}`

return an integer when the result fits in the range of an integer,

or a float otherwise.

`@LibEntry{math.abs (x)|`

Returns the maximum value between `@id{x}` and `@id{-x}`. (integer/float)

}

`@LibEntry{math.acos (x)|`

Returns the arc cosine of `@id{x}` (in radians).

}

`@LibEntry{math.asin (x)|`

Returns the arc sine of `@id{x}` (in radians).

}

`@LibEntry{math.atan (y [, x])|`

`@index{atan}` `@index{atan2}`

Returns the arc tangent of `@T{y/x}` (in radians),

using the signs of both arguments to find the

quadrant of the result.

It also handles correctly the case of `@id{x}` being zero.

The default value for `@id{x}` is 1,

so that the call `@T{math.atan(y)}`

returns the arc tangent of @id{y}.

}

@LibEntry{math.ceil (x)|

Returns the smallest integral value greater than or equal to @id{x}.

}

@LibEntry{math.cos (x)|

Returns the cosine of  
@id{x} (assumed to be in radians).

}

@LibEntry{math.deg (x)|

Converts the angle @id{x} from radians to degrees.

}

@LibEntry{math.exp (x)|

Returns the value @M{e@sp{x}}  
(where @id{e} is the base of natural logarithms).

}

@LibEntry{math.floor (x)|

Returns the largest integral value less than or equal to @id{x}.

}

@LibEntry{math.fmod (x, y)|

Returns the remainder of the division of @id{x} by @id{y}  
that rounds the quotient towards zero. (integer/float)

}

@LibEntry{math.huge|

The float value @idx{HUGE\_VAL},  
a value greater than any other numeric value.

}

@LibEntry{math.log (x [, base])|

Returns the logarithm of @id{x} in the given base.  
The default for @id{base} is @M{e}  
(so that the function returns the natural logarithm of @id{x}).

}

@LibEntry{math.max (x, @Cdots)|

Returns the argument with the maximum value,  
according to the Lua operator @T{<}.

}

@LibEntry{math.maxinteger|

An integer with the maximum value for an integer.

}

@LibEntry{math.min (x, @Cdots)|

Returns  
the argument with the minimum value,  
according to the Lua operator @T{<}.

}

@LibEntry{math.mininteger|

An integer with the minimum value for an integer.

}

@LibEntry{math.modf (x)|

Returns the integral part of @id{x} and the fractional part of @id{x}.  
Its second result is always a float.

}

@LibEntry{math.pi|

The value of @M{@pi}.

}

@LibEntry{math.rad (x)|

Converts the angle @id{x} from degrees to radians.

}

@LibEntry{math.random ([m [, n]])|

When called without arguments,  
returns a pseudo-random float with uniform distribution  
in the range @C{() @M{[0,1)}. @C{}}

When called with two integers @id{m} and @id{n},  
@id{math.random} returns a pseudo-random integer  
with uniform distribution in the range @M{[m, n]}.

The call @T{math.random(n)}, for a positive @id{n},  
is equivalent to @T{math.random(1,n)}.

The call @T{math.random(0)} produces an integer with  
all bits (pseudo)random.

This function uses the @idx{xoshiro256\*\*} algorithm to produce  
pseudo-random 64-bit integers,  
which

are the results of calls with @N{argument 0}.

Other results (ranges and floats)  
are unbiased extracted from these integers.

Lua initializes its pseudo-random generator with the equivalent of  
a call to @Lid{math.randomseed} with no arguments,  
so that @id{math.random} should generate  
different sequences of results each time the program runs.

}

@LibEntry{math.randomseed ([x [, y]])|

When called with at least one argument,  
the integer parameters @id{x} and @id{y} are  
joined into a 128-bit @emph{x}{seed} that  
is used to reinitialize the pseudo-random generator;  
equal seeds produce equal sequences of numbers.  
The default for @id{y} is zero.

When called with no arguments,  
Lua generates a seed with  
a weak attempt for randomness.

This function returns the two seed components  
that were effectively used,

so that setting them again repeats the sequence.

To ensure a required level of randomness to the initial state  
(or contrarily, to have a deterministic sequence,  
for instance when debugging  
a program),  
you should call `@LibEntry{math.randomseed}` with explicit arguments.

}

`@LibEntry{math.sin (x)|`

Returns the sine of `@id{x}` (assumed to be in radians).

}

`@LibEntry{math.sqrt (x)|`

Returns the square root of `@id{x}`.  
(You can also use the expression `@T{x^0.5}` to compute this value.)

}

`@LibEntry{math.tan (x)|`

Returns the tangent of `@id{x}` (assumed to be in radians).

}

`@LibEntry{math.tointeger (x)|`

If the value `@id{x}` is convertible to an integer,  
returns that integer.  
Otherwise, returns `@fail`.

}

`@LibEntry{math.type (x)|`

Returns `@St{integer}` if `@id{x}` is an integer,  
`@St{float}` if it is a float,  
or `@fail` if `@id{x}` is not a number.

}

`@LibEntry{math.ult (m, n)|`

Returns a boolean,

@true if and only if integer @id{m} is below integer @id{n} when they are compared as @x{unsigned integers}.

}

}

@sect2{iolib| @title{Input and Output Facilities}}

The I/O library provides two different styles for file manipulation.

The first one uses implicit file handles;

that is, there

are operations to set a default input file and a

default output file,

and all input/output operations are done over these default files.

The second style uses explicit file handles.

When using implicit file handles,

all operations are supplied by table @defid{io}.

When using explicit file handles,

the operation @Lid{io.open} returns a file handle

and then all operations are supplied as methods of the file handle.

The metatable for file handles provides metamethods

for @idx{\_\_gc} and @idx{\_\_close} that try

to close the file when called.

The table @id{io} also provides

three predefined file handles with their usual meanings from C:

@defid{io.stdin}, @defid{io.stdout}, and @defid{io.stderr}.

The I/O library never closes these files.

Unless otherwise stated,

all I/O functions return @fail on failure,

plus an error message as a second result and

a system-dependent error code as a third result,

and some non-false value on success.

On non-POSIX systems,

the computation of the error message

and error code

in case of errors

may be not @x{thread safe},

because they rely on the global C variable @id{errno}.

@LibEntry{io.close ([file])|

Equivalent to @T{file:close()}.

Without a @id{file}, closes the default output file.

```
}
```

```
@LibEntry{io.flush ()|
```

Equivalent to `@T{io.output():flush()}.flush()`.

```
}
```

```
@LibEntry{io.input ([file])|
```

When called with a file name, it opens the named file (in text mode), and sets its handle as the default input file.

When called with a file handle,

it simply sets this file handle as the default input file.

When called without arguments,

it returns the current default input file.

In case of errors this function raises the error,  
instead of returning an error code.

```
}
```

```
@LibEntry{io.lines ([filename, @Cdots])|
```

Opens the given file name in read mode  
and returns an iterator function that  
works like `@T{file:lines(@Cdots)}` over the opened file.

When the iterator function fails to read any value,  
it automatically closes the file.

Besides the iterator function,

```
@id{io.lines}
```

returns three other values:

two `@nil` values as placeholders,

plus the created file handle.

Therefore, when used in a generic `@Rw{for}` loop,  
the file is closed also if the loop is interrupted by an  
error or a `@Rw{break}`.

The call `@T{io.lines()}` (with no file name) is equivalent  
to `@T{io.input():lines("I")}`;  
that is, it iterates over the lines of the default input file.  
In this case, the iterator does not close the file when the loop ends.

In case of errors opening the file,  
this function raises the error,  
instead of returning an error code.



}

@LibEntry{io.open (filename [, mode])|

This function opens a file,  
in the mode specified in the string @id{mode}.  
In case of success,  
it returns a new file handle.

The @id{mode} string can be any of the following:

```
@description{
@item{@St{r}| read mode (the default);}
@item{@St{w}| write mode;}
@item{@St{a}| append mode;}
@item{@St{r+}| update mode, all previous data is preserved;}
@item{@St{w+}| update mode, all previous data is
erased;}
@item{@St{a+}| append update mode, previous data is preserved,
writing is only allowed at the end of file.}
}
```

The @id{mode} string can also have a @Char{b} at the end,  
which is needed in some systems to open the file in binary mode.

}

@LibEntry{io.output ([file])|

Similar to @Lid{io.input}, but operates over the default output file.

}

@LibEntry{io.popen (prog [, mode])|

This function is system dependent and is not available  
on all platforms.

Starts the program @id{prog} in a separated process and returns  
a file handle that you can use to read data from this program  
(if @id{mode} is @T{"r"}, the default)  
or to write data to this program  
(if @id{mode} is @T{"w"}).

}

@LibEntry{io.read (@Cdots)|

Equivalent to @T{io.input().read(@Cdots)}.

}

@LibEntry{io.tmpfile ()|

In case of success,  
returns a handle for a temporary file.  
This file is opened in update mode  
and it is automatically removed when the program ends.

}

@LibEntry{io.type (obj)|

Checks whether @id{obj}  
is a valid file handle.  
Returns the string @T{"file"} if @id{obj} is an open file handle,  
@T{"closed file"} if @id{obj} is a closed file handle,  
or @fail if @id{obj} is not a file handle.

}

@LibEntry{io.write (@Cdots)|

Equivalent to @T{io.output():write(@Cdots)}.

}

@LibEntry{file:close ()|

Closes @id{file}.  
Note that files are automatically closed when  
their handles are garbage collected,  
but that takes an unpredictable amount of time to happen.

When closing a file handle created with @Lid{io.popen},  
@Lid{file:close} returns the same values  
returned by @Lid{os.execute}.

}

@LibEntry{file:flush ()|

Saves any written data to @id{file}.

}

@LibEntry{file:lines (@Cdots)|

Returns an iterator function that,  
each time it is called,  
reads the file according to the given formats.  
When no format is given,  
uses `@St{1}` as a default.  
As an example, the construction

```
@verbatim{
for c in file:lines(1) do @rep{body} end
}
```

will iterate over all characters of the file,  
starting at the current  
position.  
Unlike `@Lid{io.lines}`, this function does not close the file  
when the loop ends.

```
}
```

```
@LibEntry{file:read (@Cdots)|
```

Reads the file `@id{file}`,  
according to the given formats, which specify what to read.  
For each format,  
the function returns a string or a number with the characters read,  
or `@fail` if it cannot read data with the specified format.  
(In this latter case,  
the function does not read subsequent formats.)  
When called without arguments,  
it uses a default format that reads the next line  
(see below).

The available formats are

```
@description{
```

```
@item{@St{n}|
```

reads a numeral and returns it as a float or an integer,  
following the lexical conventions of Lua.  
(The numeral may have leading whitespaces and a sign.)  
This format always reads the longest input sequence that  
is a valid prefix for a numeral;  
if that prefix does not form a valid numeral  
(e.g., an empty string, `@St{0x}`, or `@St{3.4e-}`)  
or it is too long (more than 200 characters),  
it is discarded and the format returns `@fail`.

```
}
```

```
@item{@St{a}|
```

```
reads
```

the whole file, starting at the current position.  
On end of file, it returns the empty string;  
this format never fails.  
}

@item{@St{1}|  
reads the next line skipping the end of line,  
returning @fail on end of file.  
This is the default format.  
}

@item{@St{L}|  
reads the next line keeping the end-of-line character (if present),  
returning @fail on end of file.  
}

@item{@emph{number}|  
reads a string with up to this number of bytes,  
returning @fail on end of file.  
If @id{number} is zero,  
it reads nothing and returns an empty string,  
or @fail on end of file.  
}

}  
The formats @St{1} and @St{L} should be used only for text files.  
}

@LibEntry{file:seek ([whence [, offset]])}

Sets and gets the file position,  
measured from the beginning of the file,  
to the position given by @id{offset} plus a base  
specified by the string @id{whence}, as follows:  
@description{  
@item{@St{set}| base is position 0 (beginning of the file);}  
@item{@St{cur}| base is current position;}  
@item{@St{end}|  
base is end of file;}  
}

In case of success, @id{seek} returns the final file position,  
measured in bytes from the beginning of the file.  
If @id{seek} fails, it returns @fail,  
plus a string describing the error.

The default value for @id{whence} is @T{"cur"},  
and for @id{offset} is 0.

Therefore, the call `@T{file:seek()}` returns the current file position, without changing it;  
the call `@T{file:seek("set")}` sets the position to the beginning of the file (and returns 0);  
and the call `@T{file:seek("end")}` sets the position to the end of the file, and returns its size.

}

`@LibEntry{file:setvbuf (mode [, size])|`

Sets the buffering mode for a file.

There are three available modes:

```
@description{
@item{@St{no}| no buffering.}
@item{@St{full}| full buffering.}
@item{@St{line}| line buffering.}
}
```

For the last two cases,

`@id{size}` is a hint for the size of the buffer, in bytes.

The default is an appropriate size.

The specific behavior of each mode is non portable;  
check the underlying

`@ANSI{setvbuf}` in your platform for  
more details.

}

`@LibEntry{file:write (@Cdots)|`

Writes the value of each of its arguments to `@id{file}`.

The arguments must be strings or numbers.

In case of success, this function returns `@id{file}`.

}

}

`@sect2{oslib| @title{Operating System Facilities}`

This library is implemented through table `@defid{os}`.

`@LibEntry{os.clock ()|`

Returns an approximation of the amount in seconds of CPU time used by the program,  
as returned by the underlying `@ANSI{clock}`.

}

`@LibEntry{os.date ([format [, time]])|`

Returns a string or a table containing date and time,  
formatted according to the given string `@id{format}`.

If the `@id{time}` argument is present,  
this is the time to be formatted  
(see the `@Lid{os.time}` function for a description of this value).  
Otherwise, `@id{date}` formats the current time.

If `@id{format}` starts with `@Char{!}`,  
then the date is formatted in Coordinated Universal Time.  
After this optional character,  
if `@id{format}` is the string `@St{*t}`,  
then

`@id{date}` returns a table with the following fields:  
`@id{year}`, `@id{month}` (1@En{ }12), `@id{day}` (1@En{ }31),  
`@id{hour}` (0@En{ }23), `@id{min}` (0@En{ }59),  
`@id{sec}` (0@En{ }61, due to leap seconds),  
`@id{yday}` (weekday, 1@En{ }7, Sunday @N{is 1}),  
`@id{yday}` (day of the year, 1@En{ }366),  
and `@id{isdst}` (daylight saving flag, a boolean).  
This last field may be absent  
if the information is not available.

If `@id{format}` is not `@St{*t}`,  
then `@id{date}` returns the date as a string,  
formatted according to the same rules as the `@ANSI{strftime}`.

If `@id{format}` is absent, it defaults to `@St{%c}`,  
which gives a human-readable date and time representation  
using the current locale.

On non-POSIX systems,  
this function may be not `@x{thread safe}`  
because of its reliance on `@CId{gmtime}` and `@CId{localtime}`.

}

`@LibEntry{os.difftime (t2, t1)|`

Returns the difference, in seconds,

from time @id{t1} to time @id{t2}  
 (where the times are values returned by @Lid{os.time}).  
 In @x{POSIX}, @x{Windows}, and  
 some other systems,  
 this value is exactly @id{t2}@M{-}@id{t1}.

}

@LibEntry{os.execute ([command])|

This function is equivalent to the @ANSI{system}.  
 It passes @id{command} to be executed by an operating system shell.  
 Its first result is @true  
 if the command terminated successfully,  
 or @fail otherwise.  
 After this first result  
 the function returns a string plus a number,  
 as follows:  
 @description{

@item{@St{exit}|  
 the command terminated normally;  
 the following number is the exit status of the command.  
 }

@item{@St{signal}|  
 the command was terminated by a signal;  
 the following number is the signal that terminated the command.  
 }

}

When called without a @id{command},  
 @id{os.execute} returns a boolean that is true if a shell is available.

}

@LibEntry{os.exit ([code [, close]])|

Calls the @ANSI{exit} to terminate the host program.  
 If @id{code} is @true,  
 the returned status is @idx{EXIT\_SUCCESS};  
 if @id{code} is @false,  
 the returned status is @idx{EXIT\_FAILURE};  
 if @id{code} is a number,  
 the  
 returned status is this number.  
 The default value for @id{code} is @true.

If the optional second argument `@id{close}` is true,  
the function closes the Lua state before exiting `@seeF{lua_close}`.

}

`@LibEntry{os.getenv (varname)|`

Returns the value of the process environment variable `@id{varname}`  
or `@fail` if the variable is not defined.

}

`@LibEntry{os.remove (filename)|`

Deletes the file (or empty directory, on `@x{POSIX}` systems)  
with the given name.

If this function fails, it returns `@fail`  
plus a string describing the error and the error code.  
Otherwise, it returns true.

}

`@LibEntry{os.rename (oldname, newname)|`

Renames the file or directory named `@id{oldname}` to `@id{newname}`.  
If this function fails, it returns `@fail`,  
plus a string describing the error and the error code.  
Otherwise, it returns true.

}

`@LibEntry{os.setlocale (locale [, category])|`

Sets the current locale of the program.  
`@id{locale}` is a system-dependent string specifying a locale;  
`@id{category}` is an optional  
string describing which category to change:  
`@T{"all"}`, `@T{"collate"}`, `@T{"ctype"}`,  
`@T{"monetary"}`, `@T{"numeric"}`, or `@T{"time"}`;  
the default category is `@T{"all"}`.  
The function returns the name of the new locale,  
or `@fail` if the request cannot be honored.

If `@id{locale}` is the empty string,  
the current locale is set to an implementation-defined native locale.  
If `@id{locale}` is the string `@St{C}`,  
the current locale is set to the standard C locale.



When called with `@nil` as the first argument,  
this function only returns the name of the current locale  
for the given category.

This function may be not `@x{thread safe}`  
because of its reliance on `@Cid{setlocale}`.

}

`@LibEntry{os.time ([table])}`

Returns the current time when called without arguments,  
or a time representing the local date and time specified by the given table.  
This table must have fields `@id{year}`, `@id{month}`, and `@id{day}`,  
and may have fields  
`@id{hour}` (default is 12),  
`@id{min}` (default is 0),  
`@id{sec}` (default is 0),  
and  
`@id{isdst}` (default is `@nil`).  
Other fields are ignored.  
For a description of these fields, see the `@Lid{os.date}` function.

When the function is called,  
the values in these fields do not need to be inside their valid ranges.  
For instance, if `@id{sec}` is -10,  
it means 10 seconds before the time specified by the other fields;  
if `@id{hour}` is 1000,  
it means 1000 hours after the time specified by the other fields.

The returned value is a number, whose meaning depends on your system.  
In `@x{POSIX}`, `@x{Windows}`, and some other systems,  
this number counts the number  
of seconds since some given start time (the `@Q{epoch}`).  
In other systems, the meaning is not specified,  
and the number returned by `@id{time}` can be used only as an argument to  
`@Lid{os.date}` and `@Lid{os.difftime}`.

When called with a table,  
`@id{os.time}` also normalizes all the fields  
documented in the `@Lid{os.date}` function,  
so that they represent the same time as before the call  
but with values inside their valid ranges.

}

`@LibEntry{os.tmpname}`

()

Returns a string with a file name that can be used for a temporary file.  
The file must be explicitly opened before its use and explicitly removed when no longer needed.

In @x{POSIX} systems,  
this function also creates a file with that name, to avoid security risks.  
(Someone else might create the file with wrong permissions in the time between getting the name and creating the file.)  
You still have to open the file to use it and to remove it (even if you do not use it).

When possible,  
you may prefer to use @Lid{io.tmpfile},  
which automatically removes the file when the program ends.

}

}

@sect2{debuglib| @title{The Debug Library}}

This library provides  
the functionality of the @link{debugI|debug interface} to Lua programs.  
You should exert care when using this library.  
Several of its functions  
violate basic assumptions about Lua code  
(e.g., that variables local to a function  
cannot be accessed from outside;  
that userdata metatables cannot be changed by Lua  
code;  
that Lua programs do not crash)  
and therefore can compromise otherwise secure code.  
Moreover, some functions in this library may be slow.

All functions in this library are provided  
inside the @defid{debug} table.  
All functions that operate over a thread  
have an optional first argument which is the  
thread to operate over.  
The default is always the current thread.

@LibEntry{debug.debug ()}

Enters an interactive mode with the user,  
 running each string that the user enters.  
 Using simple commands and other debug facilities,  
 the user can inspect global and local variables,  
 change their values, evaluate expressions, and so on.  
 A line containing only the word `@id{cont}` finishes this function,  
 so that the caller continues its execution.

Note that commands for `@id{debug.debug}` are not lexically nested  
 within any function and so have no direct access to local variables.

}

`@LibEntry{debug.gethook ([thread])|`

Returns the current hook settings of the thread, as three values:  
 the current  
 hook function, the current hook mask,  
 and the current hook count,  
 as set by the `@Lid{debug.sethook}` function.

Returns `@fail` if there is no active hook.

}

`@LibEntry{debug.getinfo ([thread,] f [, what])|`

Returns a table with information about a function.  
 You can give the function directly  
 or you can give a number as the value of `@id{f}`,  
 which means the function running at level `@id{f}` of the call stack  
 of the given thread:  
`@N{level 0}` is the current function (`@id{getinfo}` itself);  
`@N{level 1}` is the function that called `@id{getinfo}`  
 (except for tail calls, which do not count in the stack);  
 and so on.  
 If `@id{f}` is a number greater than the number of active functions,  
 then `@id{getinfo}` returns `@fail`.

The returned table can contain all the fields returned by `@Lid{lua_getinfo}`,  
 with the string `@id{what}` describing which fields to fill in.  
 The default for `@id{what}` is to get all information available,  
 except the table of valid lines.  
 The option `@Char{f}`  
 adds a field named `@id{func}` with  
 the function itself.  
 The option `@Char{L}` adds a field named `@id{activelines}`  
 with the table of valid lines,

provided the function is a Lua function.  
If the function has no debug information,  
the table is empty.

For instance, the expression `@T{debug.getinfo(1,"n").name}` returns  
a name for the current function,  
if a reasonable name can be found,  
and the expression `@T{debug.getinfo(print)}`  
returns a table with all available information  
about the `@Lid{print}` function.

}

`@LibEntry{debug.getlocal ([thread,] f, local)|`

This function returns the name and the value of the local variable  
with index `@id{local}` of the function at level `@id{f}` of the stack.  
This function accesses not only explicit local variables,  
but also parameters and temporary values.

The first parameter or local variable has `@N{index 1}`, and so on,  
following the order that they are declared in the code,  
counting only the variables that are active  
in the current scope of the function.  
Compile-time constants may not appear  
in this listing,  
if they were optimized away by the compiler.  
Negative indices refer to vararg arguments;  
`@num{-1}` is the first vararg argument.  
The function returns `@fail`  
if there is no variable with the given index,  
and raises an error when called with a level out of range.  
(You can call `@Lid{debug.getinfo}` to check whether the level is valid.)

Variable names starting with `@Char{() (open parenthesis) @C{}}`  
represent variables with no known names  
(internal variables such as loop control variables,  
and variables from chunks saved without debug information).

The parameter `@id{f}` may also be a function.  
In that case, `@id{getlocal}` returns only the name of function parameters.

}

`@LibEntry{debug.getmetatable (value)|`

Returns the metatable of the given `@id{value}`  
or `@nil` if it does not have a metatable.

}

@LibEntry{debug.getregistry ()|

Returns the registry table @see{registry}.

}

@LibEntry{debug.getupvalue (f, up)|

This function returns the name and the value of the upvalue with

index @id{up} of the function @id{f}.

The function returns @fail

if there is no upvalue with the given index.

(For Lua functions,

upvalues are the external local variables that the function uses, and that are consequently included in its closure.)

For @N{C functions}, this function uses the empty string @T{""} as a name for all upvalues.

Variable name @Char{?} (interrogation mark)

represents variables with no known names

(variables from chunks saved without debug information).

}

@LibEntry{debug.getuservalue (u, n)|

Returns the @id{n}-th user value associated

to the userdata @id{u} plus a boolean,

@false if the userdata does not have that value.

}

@LibEntry{debug.sethook ([thread,] hook, mask [, count])|

Sets the given function as the debug hook.

The string @id{mask} and the number @id{count} describe when the hook will be called.

The string mask may have any combination of the following characters, with the given meaning:

@description{

@item{@Char{c}| the hook is called every

```

time Lua calls a function;}
@item{@Char{r}| the hook is called every time Lua returns from a function;}
@item{@Char{l}| the hook is called every time Lua enters a new line of code.}
}

```

Moreover,

with a @id{count} different from zero,  
the hook is called also after every @id{count} instructions.

When called without arguments,

@Lid{debug.sethook} turns off the hook.

When the hook is called, its first parameter is a string  
describing the event that has triggered its call:

```

@T{"call"}, @T{"tail call"}, @T{"return"},
@T{"line"}, and @T{"count"}.

```

For line events,

the hook also gets the new line number as its second parameter.

Inside a hook,

you can call @id{getinfo} with @N{level 2} to get more information about  
the running function.

(@N{Level 0} is the @id{getinfo} function,  
and @N{level 1} is the hook function.)

```

}

```

```

@LibEntry{debug.setlocal ([thread,] level, local, value)|

```

This function assigns the value @id{value} to the local variable  
with index @id{local} of the function at level @id{level}  
of the stack.

The function returns @fail if there is no local  
variable with the given index,

and raises an error when called with a @id{level} out of range.

(You can call @id{getinfo} to check whether the level is valid.)

Otherwise, it returns the name of the local variable.

See @Lid{debug.getlocal} for more information about  
variable indices and names.

```

}

```

```

@LibEntry{debug.setmetatable (value, table)|

```

Sets the metatable for the given @id{value} to the given @id{table}  
(which can be @nil).

Returns @id{value}.

```

}

```

@LibEntry{debug.setupvalue (f, up, value)|

This function assigns the value @id{value} to the upvalue with index @id{up} of the function @id{f}.

The function returns @fail if there is no upvalue with the given index.

Otherwise, it returns the name of the upvalue.

See @Lid{debug.getupvalue} for more information about upvalues.

}

@LibEntry{debug.setuservalue (udata, value, n)|

Sets the given @id{value} as the @id{n}-th user value associated to the given @id{udata}.

@id{udata} must be a full userdata.

Returns @id{udata}, or @fail if the userdata does not have that value.

}

@LibEntry{debug.traceback ([thread,] [message [, level]])|

If @id{message} is present but is neither a string nor @nil, this function returns @id{message} without further processing.

Otherwise,

it returns a string with a traceback of the call stack.

The optional @id{message} string is appended at the beginning of the traceback.

An optional @id{level} number tells at which level to start the traceback

(default is 1, the function calling @id{traceback}).

}

@LibEntry{debug.upvalueid (f, n)|

Returns a unique identifier (as a light userdata) for the upvalue numbered @id{n} from the given function.

These unique identifiers allow a program to check whether different closures share upvalues.

Lua closures that share an upvalue

(that is, that access a same external local variable)  
will return identical ids for those upvalue indices.

}

@LibEntry{debug.upvaluejoin (f1, n1, f2, n2)|

Make

the @id{n1}-th upvalue of the Lua closure @id{f1}  
refer to the @id{n2}-th upvalue of the Lua closure @id{f2}.

}

}

}

@C{-----}

@sect1{lua-sa| @title{Lua Standalone}

Although Lua has been designed as an extension language,  
to be embedded in a host @N{C program},  
it is also frequently used as a standalone language.

An interpreter for Lua as a standalone language,  
called simply @id{lua},  
is provided with the standard distribution.

The @x{standalone interpreter} includes  
all standard libraries.

Its usage is:

@verbatim{

lua [options] [script [args]]

}

The options are:

@description{

@item{@T{-e @rep{stat}}| execute string @rep{stat};}

@item{@T{-i}| enter interactive mode after running @rep{script};}

@item{@T{-l @rep{mod}}| @Q{require} @rep{mod} and assign the  
result to global @rep{mod};}

@item{@T{-l @rep{g=mod}}| @Q{require} @rep{mod} and assign the  
result to global @rep{g};}

@item{@T{-v}| print version information;}

@item{@T{-E}|

ignore environment variables;}

@item{@T{-W}| turn warnings on;}

@item{@T{--}| stop handling options;}

@item{@T{-}| execute @id{stdin} as a file and stop handling options.}

}



(The form `@T{-l @rep{g=mod}}` was introduced in `@N{release 5.4.4}`.)

After handling its options, `@id{lua}` runs the given `@emph{script}`.

When called without arguments,

`@id{lua}` behaves as `@T{lua -v -i}`

when the standard input (`@id{stdin}`) is a terminal,

and as `@T{lua -}` otherwise.

When called without the option `@T{-E}`,

the interpreter checks for an environment variable `@defid{LUA_INIT_5_4}`

(or `@defid{LUA_INIT}` if the versioned name is not defined)

before running any argument.

If the variable content has the format `@T{@At@rep{filename}}`,

then `@id{lua}` executes the file.

Otherwise, `@id{lua}` executes the string itself.

When called with the option `@T{-E}`,

Lua does not consult any environment variables.

In particular,

the values of `@Lid{package.path}` and `@Lid{package.cpath}`

are set with the default

paths defined in `@id{luaconf.h}`.

To signal to the libraries that this option is on,

the stand-alone interpreter sets the field

`@idx{"LUA_NOENV"}` in the registry to a true value.

Other libraries may consult this field for the same purpose.

The options `@T{-e}`, `@T{-l}`, and `@T{-W}` are handled in the order they appear.

For instance, an invocation like

```
@verbatim{
```

```
$ lua -e 'a=1' -llib1 script.lua
```

```
}
```

will first set `@id{a}` to 1, then require the library `@id{lib1}`,

and finally run the file `@id{script.lua}` with no arguments.

(Here `@T{$}` is the shell prompt. Your prompt may be different.)

Before running any code,

`@id{lua}` collects all command-line arguments

in a global table called `@id{arg}`.

The script name goes to index 0,

the first argument after the script name goes to index 1,

and so on.

Any arguments before the script name

(that is, the interpreter name plus its options)

go to negative indices.

For instance, in the call

```
@verbatim{
```

```
$ lua -la b.lua t1 t2
```

```
}
```

the table is like this:

```
@verbatim{
```

```
arg
```

```
= { [-2] = "lua", [-1] = "-la",
```

```
    [0] = "b.lua",
```

```
    [1] = "t1", [2] = "t2" }
```

```
}
```

If there is no script in the call,

the interpreter name goes to index 0,

followed by the other arguments.

For instance, the call

```
@verbatim{
```

```
$ lua -e "print(arg[1])"
```

```
}
```

will print @St{-e}.

If there is a script,

the script is called with arguments

```
@T{arg[1]}, @Cdots, @T{arg[#arg]}.
```

Like all chunks in Lua,

the script is compiled as a variadic function.

In interactive mode,

Lua repeatedly prompts and waits for a line.

After reading a line,

Lua first try to interpret the line as an expression.

If it succeeds, it prints its value.

Otherwise, it interprets the line as a statement.

If you write an incomplete statement,

the interpreter waits for its completion

by issuing a different prompt.

If the global variable @defid{\_PROMPT} contains a string,

then its value is used as the prompt.

Similarly, if the global variable @defid{\_PROMPT2} contains a string,

its value is used as the secondary prompt

(issued

during incomplete statements).

In case of unprotected errors in the script,

the interpreter reports the error to the standard error stream.

If the error object is not a string but

has a metamethod @idx{\_\_tostring},

the interpreter calls this metamethod to produce the final message.

Otherwise, the interpreter converts the error object to a string

and adds a stack traceback to it.

When warnings are on,

they are simply printed in the standard error output.

When finishing normally,  
the interpreter closes its main Lua state  
@seeF{lua\_close}.  
The script can avoid this step by  
calling @Lid{os.exit} to terminate.

To allow the use of Lua as a  
script interpreter in Unix systems,  
Lua skips the first line of a file chunk if it starts with @T{#}.  
Therefore, Lua scripts can be made into executable programs  
by using @T{chmod +x} and @N{the @T{#!}} form,  
as in

```
@verbatim{
#!/usr/local/bin/lua
}
```

Of course,  
the location of the Lua interpreter may be different in your machine.  
If @id{lua} is in your

@id{PATH},  
then

```
@verbatim{
#!/usr/bin/env lua
}
```

is a more portable solution.

```
}
```

@sect1{incompat| @title{Incompatibilities with the Previous Version}}

@simplesect{

Here we list the incompatibilities that you may find when moving a program  
from @N{Lua 5.3} to @N{Lua 5.4}.

You can avoid some incompatibilities by compiling Lua with  
appropriate options (see file @id{luaconf.h}).

However,  
all these compatibility options will be removed in the future.  
More often than not,  
compatibility issues arise when these compatibility options  
are removed.

So, whenever you have the chance,  
you should try to test your code with a version of Lua compiled  
with all compatibility options turned off.

That will ease transitions to newer versions of Lua.

Lua versions can always change the C API in ways that do not imply source-code changes in a program, such as the numeric values for constants or the implementation of functions as macros. Therefore, you should never assume that binaries are compatible between different Lua versions. Always recompile clients of the Lua API when using a new version.

Similarly, Lua versions can always change the internal representation of precompiled chunks; precompiled chunks are not compatible between different Lua versions.

The standard paths in the official distribution may change between versions.

}

@sect2{@title{Incompatibilities in the Language}  
@itemize{

@item{  
The coercion of strings to numbers in arithmetic and bitwise operations has been removed from the core language. The string library does a similar job for arithmetic (but not for bitwise) operations using the string metamethods. However, unlike in previous versions, the new implementation preserves the implicit type of the numeral in the string. For instance, the result of @T{"1" + "2"} now is an integer, not a float.  
}

@item{  
Literal decimal integer constants that overflow are read as floats, instead of wrapping around. You can use hexadecimal notation for such constants if you want the old behavior (reading them as integers with wrap around).  
}

@item{

The use of the `@idx{__lt}` metamethod to emulate `@idx{__le}` has been removed.

When needed, this metamethod must be explicitly defined.

}

@item{

The semantics of the numerical `@Rw{for}` loop over integers changed in some details.

In particular, the control variable never wraps around.

}

@item{

A label for a `@Rw{goto}` cannot be declared where a label with the same name is visible, even if this other label is declared in an enclosing block.

}

@item{

When finalizing an object,

Lua does not ignore `@idx{__gc}` metamethods that are not functions.

Any value will be called, if present.

(Non-callable values will generate a warning, like any other error when calling a finalizer.)

}

}

}

@sect2{@title{Incompatibilities in the Libraries}

@itemize{

@item{

The function `@Lid{print}` does not call `@Lid{tostring}` to format its arguments;

instead, it has this functionality hardwired.

You should use `@idx{__tostring}` to modify how values are printed.

}

@item{

The pseudo-random number generator used by the function `@Lid{math.random}` now starts with a somewhat random seed.

Moreover, it uses a different algorithm.

}

@item{

By default, the decoding functions in the `@Lid{utf8}` library

do not accept surrogates as valid code points.  
An extra parameter in these functions makes them more permissive.  
}

@item{  
The options @St{setpause} and @St{setstepmul}  
of the function @Lid{collectgarbage} are deprecated.  
You should use the new option @St{incremental} to set them.  
}

@item{  
The function @Lid{io.lines} now returns four values,  
instead of just one.  
That can be a problem when it is used as the sole  
argument to another function that has optional parameters,  
such as in @T{load(io.lines(filename, "L"))}.  
To fix that issue,  
you can wrap the call into parentheses,  
to adjust its number of results to one.  
}

}

}

@sect2{@title{Incompatibilities in the API}}

@itemize{

@item{  
Full userdata now has an arbitrary number of associated  
user values.  
Therefore, the functions @id{lua\_newuserdata},  
@id{lua\_setuservalue}, and @id{lua\_getuservalue} were  
replaced by @Lid{lua\_newuserdatauv},  
@Lid{lua\_setiuservalue}, and @Lid{lua\_getiuservalue},  
which have an extra argument.

For compatibility, the old names still work as macros assuming  
one single user value.

Note, however, that userdata with zero user values  
are more efficient memory-wise.

}

@item{  
The function @Lid{lua\_resume} has an extra parameter.  
This out parameter returns the number of values on  
the top of the stack that were yielded or returned by the coroutine.

(In previous versions,  
those values were the entire stack.)  
}

@item{  
The function @Lid{lua\_version} returns the version number,  
instead of an address of the version number.  
The Lua core should work correctly with libraries using their  
own static copies of the same core,  
so there is no need to check whether they are using the same  
address space.  
}

@item{  
The constant @id{LUA\_ERRGCMM} was removed.  
Errors in  
finalizers are never propagated;  
instead, they generate a warning.  
}

@item{  
The options @idx{LUA\_GCSETPAUSE} and @idx{LUA\_GCSETSTEPMUL}  
of the function @Lid{lua\_gc} are deprecated.  
You should use the new option @id{LUA\_GCINC} to set them.  
}  
  
}  
  
}  
  
}

@C{[=====]}

@sect1{BNF| @title{The Complete Syntax of Lua}

Here is the complete syntax of Lua in extended BNF.  
As usual in extended BNF,  
@bnfNter{ {A} } means 0 or more @bnfNter{A}s,  
and @bnfNter{[A]} means an optional @bnfNter{A}.  
(For operator precedences, see @See{prec};  
for a description of the terminals  
@bnfNter{Name}, @bnfNter{Numeral},  
and @bnfNter{LiteralString}, see @See{lexical}.)  
@index{grammar}

@Produc{

```

@producname{chunk}@producbody{block}

@producname{block}@producbody{@bnfrep{stat} @bnfopt{retstat}}

@producname{stat}@producbody{
  @bnfter{;}
  @OrNL varlist @bnfter{=} explist
  @OrNL functioncall
  @OrNL label
  @OrNL @Rw{break}
  @OrNL @Rw{goto} Name
  @OrNL @Rw{do} block
  @Rw{end}
  @OrNL @Rw{while} exp @Rw{do} block @Rw{end}
  @OrNL @Rw{repeat} block @Rw{until} exp
  @OrNL @Rw{if} exp @Rw{then} block
  @bnfrep{@Rw{elseif} exp @Rw{then} block}
  @bnfopt{@Rw{else} block} @Rw{end}
  @OrNL @Rw{for} @bnfNter{Name} @bnfter{=} exp @bnfter{,} exp @bnfopt{@bnfter{,} exp}
  @Rw{do} block @Rw{end}
  @OrNL @Rw{for} namelist @Rw{in} explist @Rw{do} block @Rw{end}
  @OrNL @Rw{function} funcname funcbody
  @OrNL @Rw{local} @Rw{function} @bnfNter{Name} funcbody
  @OrNL @Rw{local} attnamelist @bnfopt{@bnfter{=} explist}
}

@producname{attnamelist}@producbody{
  @bnfNter{Name} attrib @bnfrep{@bnfter{,} @bnfNter{Name} attrib}}

@producname{attrib}@producbody{@bnfopt{@bnfter{<} @bnfNter{Name} @bnfter{>}}}}

@producname{retstat}@producbody{@Rw{return}
  @bnfopt{explist} @bnfopt{@bnfter{;}}}}

@producname{label}@producbody{@bnfter{::} Name @bnfter{::}}

@producname{funcname}@producbody{@bnfNter{Name} @bnfrep{@bnfter{.} @bnfNter{Name}}}

  @bnfopt{@bnfter{:} @bnfNter{Name}}}}

@producname{varlist}@producbody{var @bnfrep{@bnfter{,} var}}

@producname{var}@producbody{
  @bnfNter{Name}
  @Or prefixexp @bnfter{[] exp @bnfter{[]}}
  @Or prefixexp @bnfter{.} @bnfNter{Name}
}

```



@producname{namelist}@producbody{@bnfNter{Name} @bnfrep{@bnfter{,} @bnfNter{Name}}}

@producname{explist}@producbody{exp @bnfrep{@bnfter{,} exp}}

@producname{exp}@producbody{  
@Rw{nil}  
@Or @Rw{false}  
@Or @Rw{true}  
@Or @bnfNter{Numeral}  
@Or @bnfNter{LiteralString}  
@Or @bnfter{...}  
@Or functiondef  
@OrNL prefixexp  
@Or tableconstructor  
@Or exp binop exp  
@Or unop exp  
}

@producname{prefixexp}@producbody{var @Or functioncall @Or @bnfter{() exp @bnfter{}}}

@producname{functioncall}@producbody{  
prefixexp args  
@Or prefixexp @bnfter{:} @bnfNter{Name} args  
}

@producname{args}@producbody{  
@bnfter{() @bnfopt{explist} @bnfter{}}  
@Or tableconstructor  
@Or @bnfNter{LiteralString}  
}

@producname{functiondef}@producbody{@Rw{function} funcbody}

@producname{funcbody}@producbody{@bnfter{(  
@bnfopt{parlist} @bnfter{)} block @Rw{end}}

@producname{parlist}@producbody{namelist @bnfopt{@bnfter{,} @bnfter{...}}  
@Or @bnfter{...}}

@producname{tableconstructor}@producbody{@bnfter{@Open} @bnfopt{fieldlist} @bnfter{@Close}}

@producname{fieldlist}@producbody{field @bnfrep{fieldsep field} @bnfopt{fieldsep}}

@producname{field}@producbody{@bnfter{[] exp @bnfter{[] @bnfter{=} exp @Or @bnfNter{Name}  
@bnfter{=} exp @Or exp}

```

@producname{fieldsep}@producbody{@bnfter{,} @Or @bnfter{;}}

@producname{binop}@producbody{
@bnfter{+} @Or @bnfter{-} @Or @bnfter{*} @Or @bnfter{/} @Or @bnfter{//}
@Or @bnfter{^} @Or @bnfter{%}
@OrNL
@bnfter{&} @Or @bnfter{~} @Or @bnfter{|} @Or @bnfter{>>} @Or @bnfter{<<}
@Or @bnfter{..}
@OrNL
@bnfter{<} @Or @bnfter{<=} @Or @bnfter{>} @Or @bnfter{>=}
@Or @bnfter{==} @Or @bnfter{~=}
@OrNL
@Rw{and} @Or @Rw{or}}

@producname{unop}@producbody{@bnfter{-} @Or @Rw{not} @Or @bnfter{#} @Or
@bnfter{~}}

}

}

@C{ }=====}

}
@C{ }-----}

```

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*****
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```

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```

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```
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```

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```
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This is free software, and you are welcome to redistribute
```

it

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<signature of Ty Coon>, 1 April 1989  
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```
{
  "testfiles": [
    "test/*.uts",
    "test/scapy/layers/*.uts",
    "test/contrib/automotive/*.uts",
    "test/contrib/automotive/obd/*.uts",
    "test/contrib/automotive/scanner/*.uts",
    "test/contrib/automotive/gm/*.uts",
    "test/contrib/automotive/bmw/*.uts",
    "test/contrib/automotive/xcp/*.uts",
    "test/contrib/automotive/autosar/*.uts",
    "test/contrib/*.uts"
  ],
  "remove_testfiles": [
    "test/linux.uts",
    "test/windows.uts",
    "test/contrib/automotive/ecu_am.uts",
    "test/contrib/automotive/gm/gmlanutils.uts",
    "test/contrib/isotp_packet.uts",
    "test/contrib/isotpscan.uts",
    "test/contrib/isotp_soft_socket.uts"
  ],
  "onlyfailed": true,
  "preexec": {
```

```

"test/contrib/*.uts": "load_contrib(\"%name%\")",
"test/cert.uts": "load_layer(\"tls\")",
"test/sslv2.uts": "load_layer(\"tls\")",
"test/tls*.uts": "load_layer(\"tls\")"
},
"kw_ko": [
  "linux",
  "windows",
  "ipv6",
  "vcan_socket",
  "tun",
  "tap"
]
}

```

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# 1.30 clang18-libs 18.1.8-r2

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## 1.31 net-snmp-lib 5.9.4-r1

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A. HISTORY OF THE SOFTWARE

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Python was created in the early 1990s by Guido van Rossum at Stichting Mathematisch Centrum (CWI, see <https://www.cwi.nl>) in the Netherlands as a successor of a language called ABC. Guido remains Python's principal author, although it includes many contributions from others.

In 1995, Guido continued his work on Python at the Corporation for National Research Initiatives (CNRI, see <https://www.cnri.reston.va.us>) in Reston, Virginia where he released several versions of the software.

In May 2000, Guido and the Python core development team moved to BeOpen.com to form the BeOpen PythonLabs team. In October of the same year, the PythonLabs team moved to Digital Creations, which became Zope Corporation. In 2001, the Python Software Foundation (PSF, see <https://www.python.org/psf/>) was formed, a non-profit organization created specifically to own Python-related Intellectual Property. Zope Corporation was a sponsoring member of the PSF.

All

Python releases are Open Source (see <https://opensource.org> for the Open Source Definition). Historically, most, but not all, Python releases have also been GPL-compatible; the table below summarizes the various releases.

| Release        | Derived from | Year      | Owner      | GPL-compatible? (1) |
|----------------|--------------|-----------|------------|---------------------|
| 0.9.0 thru 1.2 |              | 1991-1995 | CWI        | yes                 |
| 1.3 thru 1.5.2 | 1.2          | 1995-1999 | CNRI       | yes                 |
| 1.6            | 1.5.2        | 2000      | CNRI       | no                  |
| 2.0            | 1.6          | 2000      | BeOpen.com | no                  |
| 1.6.1          | 1.6          | 2001      | CNRI       | yes (2)             |
| 2.1            | 2.0+1.6.1    | 2001      | PSF        | no                  |
| 2.0.1          | 2.0+1.6.1    | 2001      | PSF        | yes                 |
| 2.1.1          | 2.1+2.0.1    | 2001      | PSF        | yes                 |
| 2.1.2          | 2.1.1        | 2002      | PSF        | yes                 |
| 2.1.3          | 2.1.2        | 2002      | PSF        | yes                 |
| 2.2 and above  | 2.1.1        | 2001-now  |            |                     |
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- Chris McDonough, 2011/02/16
- Wichert Akkerman, 2012/02/02

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#### A. HISTORY OF THE SOFTWARE

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Python was created in the early 1990s by Guido van Rossum at Stichting Mathematisch Centrum (CWI, see <http://www.cwi.nl>) in the Netherlands as a successor of a language called ABC. Guido remains Python's principal author, although it includes many contributions from others.

In 1995, Guido continued his work on Python at the Corporation for National Research Initiatives (CNRI, see <http://www.cnri.reston.va.us>) in Reston, Virginia where he released several versions of the software.

In May 2000, Guido and the Python core development team moved to BeOpen.com to form the BeOpen PythonLabs team. In October of the same year, the PythonLabs team moved to Digital Creations (now Zope Corporation, see <http://www.zope.com>). In 2001, the Python Software Foundation (PSF, see <http://www.python.org/psf/>) was formed, a non-profit organization created specifically to own Python-related Intellectual Property. Zope Corporation is a sponsoring member of the PSF.

All Python releases are Open Source (see <http://www.opensource.org> for the Open Source Definition). Historically, most, but not all, Python releases have also been GPL-compatible; the table below summarizes the various releases.

| Release        | Derived from | Year      | Owner      | GPL-compatible? (1) |
|----------------|--------------|-----------|------------|---------------------|
| 0.9.0 thru 1.2 |              | 1991-1995 | CWI        | yes                 |
| 1.3 thru 1.5.2 | 1.2          | 1995-1999 | CNRI       | yes                 |
| 1.6            | 1.5.2        | 2000      | CNRI       | no                  |
| 2.0            | 1.6          | 2000      | BeOpen.com | no                  |
| 1.6.1          | 1.6          | 2001      | CNRI       | yes (2)             |
| 2.1            | 2.0+1.6.1    | 2001      | PSF        | no                  |
| 2.0.1          | 2.0+1.6.1    | 2001      | PSF        | yes                 |
| 2.1.1          | 2.1+2.0.1    | 2001      | PSF        | yes                 |
| 2.2            | 2.1.1        | 2001      | PSF        | yes                 |
| 2.1.2          | 2.1.1        | 2002      | PSF        | yes                 |
| 2.1.3          |              |           |            |                     |
| 2.1.2          | 2002         | PSF       | yes        |                     |
| 2.2.1          | 2.2          | 2002      | PSF        | yes                 |
| 2.2.2          | 2.2.1        | 2002      | PSF        | yes                 |
| 2.2.3          | 2.2.2        | 2003      | PSF        | yes                 |
| 2.3            | 2.2.2        | 2002-2003 | PSF        | yes                 |
| 2.3.1          | 2.3          | 2002-2003 | PSF        | yes                 |
| 2.3.2          | 2.3.1        | 2002-2003 | PSF        | yes                 |
| 2.3.3          | 2.3.2        | 2002-2003 | PSF        | yes                 |
| 2.3.4          | 2.3.3        | 2004      | PSF        | yes                 |
| 2.3.5          | 2.3.4        | 2005      | PSF        | yes                 |
| 2.4            | 2.3          | 2004      | PSF        | yes                 |
| 2.4.1          | 2.4          | 2005      | PSF        | yes                 |
| 2.4.2          | 2.4.1        | 2005      | PSF        | yes                 |
| 2.4.3          | 2.4.2        | 2006      | PSF        | yes                 |
| 2.4.4          | 2.4.3        | 2006      | PSF        | yes                 |
| 2.5            | 2.4          | 2006      | PSF        | yes                 |
| 2.5.1          | 2.5          | 2007      | PSF        | yes                 |
| 2.5.2          | 2.5.1        | 2008      | PSF        | yes                 |
| 2.5.3          | 2.5.2        | 2008      | PSF        | yes                 |

|       |       |      |     |     |
|-------|-------|------|-----|-----|
| 2.6   | 2.5   | 2008 | PSF | yes |
| 2.6.1 | 2.6   | 2008 | PSF | yes |
| 2.6.2 | 2.6.1 | 2009 | PSF | yes |
| 2.6.3 | 2.6.2 | 2009 | PSF | yes |
| 2.6.4 | 2.6.3 | 2009 | PSF | yes |
| 2.6.5 | 2.6.4 | 2010 | PSF | yes |
| 2.7   | 2.6   | 2010 | PSF | yes |

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(2) According to Richard Stallman, 1.6.1 is not GPL-compatible, because its license has a choice of law clause. According to CNRI, however, Stallman's lawyer has told CNRI's lawyer that 1.6.1 is "not incompatible" with the GPL.

Thanks to the many outside volunteers who have worked under Guido's direction to make these releases possible.

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#### A. HISTORY OF THE SOFTWARE

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Python was created in the early 1990s by Guido van Rossum at Stichting Mathematisch Centrum (CWI, see <http://www.cwi.nl>) in the Netherlands as a successor of a language called ABC. Guido remains Python's principal author, although it includes many contributions from others.

In 1995, Guido continued his work on Python at the Corporation for National Research Initiatives (CNRI, see <http://www.cnri.reston.va.us>) in Reston, Virginia where he released several versions of the software.

In May 2000, Guido and the Python core development team moved to BeOpen.com to form the BeOpen PythonLabs team. In October of the same year, the PythonLabs team moved to Digital Creations (now Zope Corporation, see <http://www.zope.com>). In 2001, the Python Software Foundation (PSF, see <http://www.python.org/psf/>) was formed, a non-profit organization created specifically to own Python-related Intellectual Property. Zope Corporation is a sponsoring member of the PSF.

All Python releases are Open Source (see <http://www.opensource.org> for the Open Source Definition). Historically, most, but not all, Python releases have also been GPL-compatible; the table below summarizes the various releases.

| Release        | Derived from | Year      | Owner      | GPL-compatible? (1) |
|----------------|--------------|-----------|------------|---------------------|
| 0.9.0 thru 1.2 |              | 1991-1995 | CWI        | yes                 |
| 1.3 thru 1.5.2 | 1.2          | 1995-1999 | CNRI       | yes                 |
| 1.6            | 1.5.2        | 2000      | CNRI       | no                  |
| 2.0            | 1.6          | 2000      | BeOpen.com | no                  |
| 1.6.1          | 1.6          | 2001      | CNRI       | yes (2)             |
| 2.1            | 2.0+1.6.1    | 2001      | PSF        | no                  |
| 2.0.1          | 2.0+1.6.1    | 2001      | PSF        | yes                 |



|       |           |           |     |     |
|-------|-----------|-----------|-----|-----|
| 2.1.1 | 2.1+2.0.1 | 2001      | PSF | yes |
| 2.2   | 2.1.1     | 2001      | PSF | yes |
| 2.1.2 | 2.1.1     | 2002      | PSF | yes |
| 2.1.3 |           |           |     |     |
| 2.1.2 | 2002      | PSF       | yes |     |
| 2.2.1 | 2.2       | 2002      | PSF | yes |
| 2.2.2 | 2.2.1     | 2002      | PSF | yes |
| 2.2.3 | 2.2.2     | 2003      | PSF | yes |
| 2.3   | 2.2.2     | 2002-2003 | PSF | yes |
| 2.3.1 | 2.3       | 2002-2003 | PSF | yes |
| 2.3.2 | 2.3.1     | 2002-2003 | PSF | yes |
| 2.3.3 | 2.3.2     | 2002-2003 | PSF | yes |
| 2.3.4 | 2.3.3     | 2004      | PSF | yes |
| 2.3.5 | 2.3.4     | 2005      | PSF | yes |
| 2.4   | 2.3       | 2004      | PSF | yes |
| 2.4.1 | 2.4       | 2005      | PSF | yes |
| 2.4.2 | 2.4.1     | 2005      | PSF | yes |
| 2.4.3 | 2.4.2     | 2006      | PSF | yes |
| 2.4.4 | 2.4.3     | 2006      | PSF | yes |
| 2.5   | 2.4       | 2006      | PSF | yes |
| 2.5.1 | 2.5       | 2007      | PSF | yes |
| 2.5.2 | 2.5.1     | 2008      | PSF | yes |
| 2.5.3 | 2.5.2     | 2008      | PSF | yes |
| 2.6   | 2.5       | 2008      | PSF | yes |
| 2.6.1 | 2.6       | 2008      | PSF | yes |
| 2.6.2 | 2.6.1     | 2009      | PSF | yes |
| 2.6.3 | 2.6.2     | 2009      | PSF | yes |
| 2.6.4 | 2.6.3     | 2009      | PSF | yes |
| 2.6.5 | 2.6.4     | 2010      | PSF | yes |
| 3.0   | 2.6       | 2008      | PSF | yes |
| 3.0.1 | 3.0       | 2009      | PSF | yes |
| 3.1   | 3.0.1     | 2009      | PSF | yes |
| 3.1.1 | 3.1       | 2009      | PSF | yes |
| 3.1.2 | 3.1       | 2010      | PSF | yes |
| 3.2   | 3.1       | 2010      | PSF | yes |

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(2) According to Richard Stallman, 1.6.1 is not GPL-compatible, because its license has a choice of law clause. According to CNRI, however, Stallman's lawyer has told CNRI's lawyer that 1.6.1

is "not incompatible" with the GPL.

Thanks to the many outside volunteers who have worked under Guido's direction to make these releases possible.

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## 1.35 tmux-zsh-completion 5.9-r4

### 1.35.1 Available under license :

```
#autoload

# Options:
#
# -0      include jid 0 as a match for the host system
# -o param jail parameter to complete instead of jid -
#         e.g. name, path, ip4.addr, host.hostname

local addhost host param desc=1
local -a jails args expl
zparseopts -D -K -E 0=addhost o:=param
param=${param[2]:-name}

jails=( ${$(f) "$(_call_program jails jls $param name)"/ /:} )
case $param in
  jid) host=0 ;;
  name)
    host=0
    desc=0
    ;;
  path)
    host=/
    args=( -M 'r:/=* r:|=*' )
    ;;
  ip4.addr) args=( -M 'r:|.* r:|=*' ) ;;
esac
[[ -n $addhost && -n $host ]] && jails+=( "$host:$HOST" )

if (( desc )); then
  _describe -t jails jail jails "$@" "$args[@]"
else
  _wanted jails expl jail compadd "$@" "$args[@]" - ${jails%:*}
fi
#autoload

local points=(
  'c[trace system calls]
```



```

'i[trace I/O]'
'n[trace namei translations]'
's[trace signal processing]'
'u[trace user data]'
'+[trace the default points]'
)

case $OSTYPE in
dragonfly*|freebsd*|netbsd*)
    points+=(
        'w[context switches]'
    )
    ;|
freebsd*|openbsd*)
    points+=(
        't[trace various structures]'
    )
    ;|
freebsd*)
    points+=(
        'f[trace page faults]'
        'p[trace capability check failures]'
        'y[trace sysctl(3) requests]'
    )
    ;;
netbsd*)
    points+=(
        'A[trace all tracepoints]'
        'a[trace exec arguments]'
        'e[trace emulation changes]'
        'f[trace open file descriptors after exec]'
        'S[trace MIB access (sysctl)]'
        'v[trace exec environment]'
        '-[do not trace following trace points]'
    )
    ;;
openbsd*)
    points+=(
        'p[trace violation of pledge(2) restrictions]'
        'x[trace argument vector in execve(2)]'
        'X[trace environment in execve(2)]'
    )
    ;;
esac

_values -s " 'ktrace point' $points
#autoload
#

```

```

# device types on FreeBSD/DragonFly
# (for commands using devstat_buildmatch(), such as iostat and vmstat)
#
local -a d i types

d=( da sa printer proc worm cd scanner optical changer
    comm array enclosure floppy)
i=( IDE SCSI other )
types=(
    "($d)da[direct access devices]"
    "($d)sa[sequential access devices]"
    "($d)printer[printers]"
    "($d)proc[processor devices]"
    "($d)worm[write once read multiple devices]"
    "($d)cd[CD devices]"
    "($d)scanner[scanner devices]"
    "($d)optical[optical memory devices]"
    "($d)changer[medium changer devices]"
    "($d)comm[communication devices]"
    "($d)array[storage array devices]"
    "($d)enclosure[enclosure services devices]"
    "($d)floppy[floppy devices]"
    "($i)IDE[Integrated Drive Electronics devices]"
    "($i)SCSI[Small Computer System Interface devices]"
    "($i)other[any other device interface]"
    'pass[passthrough devices]'
)

_values -s , 'device type' $types
#autoload

local expl

_description architectures expl 'architecture'
compadd "$@" "$expl[@]" amd64 arm arm64 i386 mips powerpc riscv sparc64
#autoload

local expl

_description routing-domains expl 'routing domain'
compadd "$@" "$expl[@]" - ${$(M)${(f)}$_call_program routing-domains netstat -R)}:#Rdomain *}#Rdomain
}
#autoload

# Provides completion for file flags (formerly part of _chflags)

local curcontext=$curcontext su=$(( ! EUID || $_comp_priv_prefix ))
local -a context line state state_descr copts=( "${@}" ) flags flag_descs

```

```

local -A val_args

flag_descs+=(
  nodump nodump
  uappnd 'user append-only'
  uchg 'user immutable'
)

if (( su )); then
  flag_descs+=(
    arch archived
    sappnd 'system append-only'
    schg 'system immutable'
  )
fi

if [[ $OSTYPE = (darwin|dragonfly|freebsd|netbsd)* ]]; then
  flag_descs+=(opaque opaque)

  if [[ $OSTYPE = darwin* ]]; then
    flag_descs+=(hidden hidden)
  fi

  if [[ $OSTYPE = (dragonfly|freebsd)* ]]; then
    flag_descs+=(uunlnk 'user undeletable')

    (( su )) &&
    flag_descs+=(sunlnk 'system undeletable')
  fi

  if [[ $OSTYPE = dragonfly* ]]; then
    flag_descs+=(
      cache cache
      nouhistory 'user nohistory'
    )

    (( su )) && flag_descs+=(
      noscache noscache
      noshistory 'system nohistory'
    )
  fi

  [[ $OSTYPE =
  freebsd* ]] && flag_descs+=(
    uarch archive
    uhidden hidden
    uoffline offline
    urdonly 'DOS, Windows and CIFS readonly'

```

```

    ureparse 'Windows reparse point'
    usparse 'sparse file'
    usystem 'DOS, Windows and CIFS system'
)
fi

for 1 2 in $flag_descs; do
    if [[ $1 = no* ]]; then
        flags+=("${1#no}$1[set the $2 flag]"
            "$1${1#no}[unset the $2 flag]")
    else
        flags+=("(no$1)$1[set the $2 flag]"
            "$1no$1[unset the $2 flag]")
    fi
done

_values -O copts -s , 'file flags' $flags
#autoload
# disk device names on BSDs
local -a disks

case $OSTYPE in
    freebsd*)
        disks=( ${$(M){(f)"$(geom disk list)"}\:#Geom name\:.*}#*\: } )
        ;;
    dragonfly*)
        disks=( $(sysctl -n kern.disks) )
        ;;
    openbsd*)
        disks=( ${$(s,,)"$(sysctl -n hw.disknames)"}%\:.* } )
        ;;
    netbsd*)
        disks=( $(sysctl -n hw.disknames) )
        ;;
esac

if (( $#disks )); then
    local expl
    _wanted disk-devices expl 'disk device' compadd "$@" $disks
    return
fi

```

return 1

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#### ZSH CONTRIBUTORS

-----

Zsh was originally written by Paul Falstad. Zsh is now maintained by the members of the zsh-workers mailing list <zsh-workers@zsh.org>. The development is currently coordinated by Peter Stephenson <pws@zsh.org>.

This file credits only the major contributors to the current release. See the ChangeLog files for a complete list of people who have submitted patches. Note that email addresses below and in the ChangeLog file are included for disambiguation purposes only, and are not guaranteed to be currently accurate. If you feel that you or someone else have been unfairly omitted from this list please mail the list

<zsh-workers@zsh.org>.

#### Version 4.3

-----

Contributors to the main shell include Clint Adams, Rocky Bernstein, Andrey Borzenkov, Dan Bullok, Marc Chantreux, Thorsten Dahlheimer, Wayne Davison, Lionel Flandrin, Michael Hwang, Oliver Kiddle, Greg Klanderma, Matthias Kopferman, Mikael Magnusson, Dan Nelson, Phil Pennock, Toby Peterson, R. Ramkumar, Franois Revol, Bart Schaefer, Tom Smetana, Joerg Sonnenberger, Peter Stephenson, Jon Strait, Takimoto Jun, River Tarnell, Frank Terbeck, Philippe Troin, Geoff Wing, Matt Wozniski.

The VCS\_Info function system was written by Frank Terbeck with contributions from Julien Langer.

Contributors to documentation and to completion and other shell functions include those above plus Nuno Alexandre, Ralph Amissah, Micah Anderson, arno, Frank Benkstein, Jay Berkenbilt, Frank Blending, Zack Cerza, Brendan Cully, Baptiste Daroussin, Danek Duvall, Ryan F, Sean Finney, Daniel Friesel, Alexey I. Froloff, Tobias Gruetzmacher, Pierre Habouzit, Richard Hartmann, Benjamin R. Haskell, Ag. D. Hatzimanikas, Pete Hollobon, Erik Johansson, Kohsuke Kawaguchi, Dough Kearns, Hannu Koivisto, Henryk Konsek, Chris Lamb, Vincent Lefevre, Roger Leigh, Eric Mangold, Max Mikhanosha, Arkadiusz Miskiewicz, Matthieu Moy, Scott Murray, Alexander Myodov, tpm Nmec, Kalle Olavi Niemitalo, Kazuhiro NISHIYAMA, Omari Norman, Mustafa Oezkan, Tomasz Pala, Peter Palfrader, Carlos Phillips, Daniel Qarras, Jean-Baptiste Quenot, David Riebenbauer, Haakon Riiser, Ingo Rohlf, Felix Rosencrantz, Simon Ruderich, Stephen Rger, William Scott, Kris Shannon, Jrg Sommer, Travis Spencer, Vincent Steman, Mrten Svantesson, Evgenii Terechkov, Magnus Therning, Bernhard Tittelbach, Ingmar Vanhassel, Markus Waldeck, Motoi Washida, Nikolai Weibull, Jesse Weinstein.

#### Version 4.2

-----

The contributor list is similar to that for 4.1.1.

#### Version 4.1.1

-----

Clint Adams <clint@zsh.org>: termcap/terminfo, completion, configuration, various modules, networking, prompts

Andrey Borzenkov <bor@zsh.org>: configuration, completion functions, cygwin

support

Chmouel Boudjnah <chmouel@mandrakesoft.com>: Linux completion support

Wayne Davison <wayned@users.sourceforge.net>: shell history mechanism,  
arithmetic

Zvi Har'El <rl@math.technion.ac.il>: completion functions

Doug Kearns <djkea2@mugca.its.monash.edu.au>:  
completion functions

Oliver Kiddle <opk@zsh.org>: builtins, completion, parameters, prompts,  
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Andrew Main <zefram@zsh.org>: zle keymaps, games

Akinori Musha: BSD completion support

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Bart Schaefer <schaefer@zsh.org>: configuration, parameters, prompts,  
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Adam Spiers <adam@spiers.net>: completion and other functions

Peter Stephenson <pws@zsh.org>: configuration, zle, networking, syntax,  
completion

Tanaka Akira <akr@zsh.org>: completion functions

Philippe Troin <phil@fifi.org>: signals, process groups.

Geoff Wing <gcw@zsh.org>: archiving and distribution network, line editor  
display, configuration

Sven Wischnowsky <wischnow@zsh.org>: internal completion mechanism and  
low-level functions, line editor internals, syntax, wordcode mechanism,

Version 4.0.1

-----

Clint Adams <schizo@debian.org>: Completion functions, general  
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and module issues.

Andrej Borsenkow <bor@zsh.org>: Cygwin support,

configuration, completion functions.

Chmouel Boudjnah <chmouel@mandrakesoft.com>: configuration support.

Wayne Davison <wayned@users.sourceforge.net>: History code.

Alexandre Duret-Lutz: completion functions and substitution code.

Oliver Kiddle <opk@zsh.org>: Modules and completion functions, AIX support.

Andrew Main <zefram@zsh.org>: Parameters and arithmetic, configuration.

Felix Rosencrantz <f\_rosencrantz@yahoo.com>: Test code and shell functions.

Bart Schaefer <schaefer@zsh.org>: bits of everything in all parts of code;  
general sanity control.

Adam Spiers <adam@spiers.net>: Completion and other functions, completion  
caching.

Peter Stephenson <pws@zsh.org>: configuration and installation, parameters,  
completion functions and configuration.

Tanaka Akira <akr@zsh.org>: Completion and test functions.

Geoff Wing <gcw@zsh.org>: FTP and mailing list archive

Sven Wischnowsky <wischnow@zsh.org>:

Most of the completion code, zpty,  
signal queueing, parameters, builtins, builtouts, built-here-and-theres;  
mend garden shed, rewire electricity, reinstall shutters, fix TV aerial in  
howling gale...

Other patches from E. Jay Birkenbilt, Jan Fedak, Ulrik Haugen, Paul  
Johnson, Fr. Br. George (George V Kouryachy).

Versions 3.1.7 to 3.1.9

-----

\* Clint Adams <schizo@debian.org>: configuration, various fixes esp. in  
completion

\* Andrej Borsenkow <Andrej.Borsenkow@mow.siemens.ru>: design, testing and  
patches for completion system, documentation, various other fixes

\* Chmouel Boudjnah <chmouel@mandrakesoft.com>: design, testing and patches  
for completion system, documentation, various other fixes



- \* Wayne Davison <wayne@clari.net>: History code
- \* Alexandre Duret-Lutz <duret\_g@epita.fr>: design, testing and patches for completion system, documentation, various other fixes
- \* Oliver Kiddle <opk@zsh.org>: AIX dynamic library support, various completion functions, web page maintenance, documentation fixes
- \* Andrew Main <zefram@zsh.org>: configuration and module/DLL code, IPv6 support, various other bits
- \* Felix Rosencrantz <f\_rosencrantz@yahoo.com>: design, testing and patches for completion system, documentation, various other fixes
- \* Bart Schaefer <schaefer@zsh.org>: documentation and many other bits, archive maintenance
- \* Adam Spiers <adam@spiers.net>: various completion functions, source code archive maintenance, documentation fixes, prompt themes
- \* Peter Stephenson <pws@zsh.org>: pattern matching code rewrite and enhancements, typeset and local variables, zftp maintenance, general configuration, floating point support
- \* Tanaka Akira <akr@zsh.org>: CVS archive, numerous completion functions for common commands, regex shell function state machine
- \* Geoff Wing <gcw@zsh.org>: mailing list and FTP archive, various other bits
- \* Sven Wischnowsky <wischnow@zsh.org>: almost all completion code including all comp\* libraries, all core functions in completion function system; styles; job control code; rewrite of internal shell code structures and parsing and execution code to use word code; parameter code; repair roof, fix guttering, put up shelves in study, recarpet hall, ...

Other patches were submitted by Will Day, Irving Wolfe, John Williams, Vin Shelton, Akim Demaille, Helmut Jarausch, Gene Cohler, Johan Sundstrm.

Version 3.1.6

-----

- \* Sven Wischnowsky <wischnow@informatik.hu-berlin.de>: completion code, major rewrite and enhancements, including matching control, completion widgets and function system, complist module; zle code additions; job control code changes; parameters code changes; parameter module;

additional autoloading code; general code changes for extra efficiency; subscripting and ordering of globbing lists.

\* Peter Stephenson <pws@zsh.org>: zftp and mapfile modules and zf\* functions; local parameters and typeset changes; changes in autoconf system; case-independent and approximate pattern matching; various options; a few completion modules; some zle changes; FAQ.

\* Bart Schaefer <schaefer@zsh.org>: associative array implementation; other parameter changes; keeping track of missing patches; function autoloading changes.

\* Wayne Davison <wayne@clari.net>: History code novelties and improvements with new options.

\* Geoff Wing <gcw@zsh.org>: Zle display code fixes, mailing list and patch archive.

\* Zoltn Hidvgy <hzoli@cs.elte.hu>: AIX dynamic loading code.

\* Matt Armstrong: cygwin configuration changes.

Other improvements, bug fixes and design suggestions from all the above plus Andrej Borsenkow, Oliver Kiddle, Tanaka Akira, Naoki Wakamatsu, Tatuso Furukawa, Ville Herva, Will Day, Lehti Rahmi, Larry P. Schrof, Helmut Jarausch, Phil Pennock, Wilfredo Sanchez, Bruce Stephens, Gene Cohler, Ollivier Robert, Felix Rosencrantz.

Previous versions of zsh 3 were maintained by Zoltn Hidvgy and Andrew Main (Zefram).

Version 3.0

-----

\*

Richard Coleman <coleman@math.gatech.edu> maintained the code till the release of zsh-2.6-beta16. Converted zsh to use autoconf thus greatly improving the portability. Rewrote signal handling code. Reorganized internal hash tables and rewrote the related builtins (enable, disable, hash, unhash). Made some cleanups in exec.c.

\* Zoltn Hidvgy <hzoli@cs.elte.hu> maintained zsh from version 2.6-beta16. Rewrote most of the lexer and substitution and the related completion code. Improved sh/ksh/POSIX compatibility. Fixed lots of bugs in completion, parameter and history code. Made zsh fully 8-bit clean. Made some reorganizations in exec.c. Fixed signal handling bugs. Fixed lots of bugs in various places.

\* Peter W. Stephenson <pws@zsh.org> the maintainer of the zsh FAQ. Reorganizations in exec.c. Rewrote and reorganized the history code. Rewrote the zshcompctl manual page. Fixed several bugs related to programmable completion. Fixed several signal handling bugs. Rewrote test and read builtins. Lots of other bugfixes.

\* Andrew Main (Zefram) <zefram@zsh.org> reorganized builtin.c. Rewrote large parts of the zle vi mode. Redirection fixes. Reorganized parts of the completion code, added some enhancements and fixed lots of bugs. Made zle fully 8-bit clean. Fixed several zle bugs. Reorganized zsh option handling. Lots of other bugfixes.

\* Sven Wischnowsky <wischnow@informatik.hu-berlin.de> wrote most of the programmable completion code in zsh-2.5.0. Several bugfixes in exec.c and jobs.c. Lots of completion bugfixes and enhancements.

\* Geoff Wing <gcw@zsh.org> rewrote most of zle\_refresh.c. Some other bugfixes.

\* Clive Messer <clive@epos.demon.co.uk> brought the texinfo documentation up-to-date.

\* Mark Borges <mdb@cdc.noaa.gov> contributed several documentation fixes including further texinfo documentation updates and maintained the zsh web pages during their tenure at www.mal.com.

\* Wayne Davison <wayne@clari.net> improved the zle search functions and made them 8-bit clean. Some other little bugfixes.

\* Bart Schaefer <schaefer@zsh.org> submitted several bugfixes, reported lots of bugs and gave many very useful suggestions.

Version 2.5

-----

Bas de Bakker maintained zsh till the release of zsh-2.5.0. People who have contributed to zsh-2.5.0 are (in lexical order):

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Harald.Eikrem@delab.sintef.no  
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wacren@cis10.ens-cachan.fr (Laurent Wacrenier)
#autoload
```

```
local expl
```

```
_description architectures expl 'architecture'
compadd "$@" "$expl[@]" alpha amd64 arm64 armv7 hppa i386 landisk loongson luna88k macppc octeon sparc64
#autoload
```

```
local expl
```

```
_description architectures expl 'architecture'
compadd "$@" "$expl[@]" amd64 evbarm evbmips evbppc hpcarm i386 sparc64 xen \
acorn32 algor alpha amiga amigappc arc atari bebox cats cesfic cobalt dreamcast \
emips epoc32 evbsh3 ews4800mips hp300 hppa hpcmips hpcsh ia64 ibmnws iyonix \
landisk luna68k mac68k macppc mipsco mmeye mvme68k mvmeppc netwinder news68k \
newsmips next68k ofppc pmax prep rs6000 sandpoint sbmips sgimips shark sparc \
sun2 sun3 vax x68k zaurus
#autoload
```

```
local expl
```

```
_description routing-tables expl 'routing table'
compadd "$@" "$expl[@]" - ${s: }${(M)${(f)"$_call_program routing-tables netstat -R")}:# Routing tables#:
*}#*: } }
#autoload
```

```
local expl login_classes
```

```
login_classes=(${(M)${(f)"$(</etc/login.conf)"}:#[^[:blank:]]*}%%[:]*})
if [[ $OSTYPE = openbsd* ]]; then
    login_classes+=(/etc/login.conf.d/*(N:t))
fi
```

```
_description login-classes expl 'login class'
compadd "$@" "$expl[@]" - $login_classes
```

## 1.36 wget 1.25.0-r0

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Upstream-Name: bcc

Source: <https://github.com/iovisor/bcc>

Files: \*

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## 1.38 py3-bcc-pyc 0.32.0-r0

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Upstream-Name: bcc

Source: <https://github.com/iovisor/bcc>

Files: \*

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## 1.39 bcc-doc 0.32.0-r0

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Source: <https://github.com/iovisor/bcc>

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## 1.42 ssl-client 1.37.0-r12

### 1.42.1 Available under license :

```
# Automatically generated by apkbuild-cpan, template 4
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maintainer="Celeste <cielesti@protonmail.com>"
pkgname=perl-bsd-resource
pkgver=1.2911
pkgrel=10
#_pkgreal is used by apkbuild-cpan to find modules at MetaCpan
_pkgreal=BSD-Resource
pkgdesc="Perl extension implements the BSD process resource limit functions"
url="https://metacpan.org/release/BSD-Resource/"
arch="all"
license="Artistic-2.0 OR LGPL-2.0"
depends="perl"
makedepends="perl-dev"
subpackages="$pkgname-doc"
source="https://cpan.metacpan.org/authors/id/J/JH/JHI/BSD-Resource-$pkgver.tar.gz"
builddir="$srcdir/${_pkgreal}-${pkgver}"

build() {
    export CFLAGS=$(perl -MConfig -E 'say $Config{ccflags}')
    PERL_MM_USE_DEFAULT=1 perl -I. Makefile.PL \
        INSTALLDIRS=vendor \
        NO_PACKLIST=1 \
        NO_PERLLOCAL=1
    make
}

check() {
    export CFLAGS=$(perl -MConfig -E 'say $Config{ccflags}')
    make test
}

package() {
    make DESTDIR="$pkgdir" install
}
```

```
sha512sums="
d0032d41c7c0468ed1c6d8f57b885f6cb97a5039d754c8cb60b2067daedaf53bd15fb6561a3d0f828df16dfa5417f663b
8065ba65f4fea16dc9262728b3b6b85
  BSD-Resource-1.2911.tar.gz
"
```

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bzip2/libbzip2 version 1.0.4 of 20 December 2006

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like this

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<signature of Ty Coon>, 1 April 1989

Ty Coon, President of

Vice

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# Contributor: Maxim Karasev <begs@disroot.org>

# Maintainer: mio <miyopan@e.email>

pkgname=bsd-games

pkgver=3.3

pkgrel=2

pkgdesc="traditional text mode games from BSD"

url="https://bsd-games.sourceforge.io/"

arch="all"

license="BSD-3-Clause"

install="\$pkgname.post-install"

makedepends="ncurses-dev coreutils" # configure causes busybox expr error

subpackages="\$pkgname-doc"

source="https://sourceforge.net/projects/bsd-games/files/bsd-games-\$pkgver.tar.gz

0001-bsd-games-scores-dir.patch

"

options="!check" # no tests

build() {

```

# some GNU autoconf options are ignored, but it works
./configure \
--build=$CBUILD \
--host=$CHOST \
--prefix=/usr \
--sysconfdir=/etc \
--mandir=/usr/share/man \
--sourcedir=/usr/share/$pkgname
make
}

package() {
make DESTDIR="$pkgdir" install
install -Dm644 LICENSE "$pkgdir"/usr/share/licenses/bsd-games/LICENSE
}

sha512sums="
aaf36d09d4fe68514a5c279063d7e77a9a9a84c447037cba974b29faa07eb80c2aab2379d0699c196b5c27ffe1b2bb2c6
8d3390143e0e62d5e3d210ccfb61294
bsd-games-3.3.tar.gz
e1def0d4835a877242c4173fae862e278a7858738e0bacacbb045a42bcabec2aa7c72d000bbd2421ce35fe66cdc1f52c0
577b7e278029ca5ed50f7aab22319f6 0001-bsd-games-scores-dir.patch
"

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```

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Any feedback, contact Ian Wilson.

[vintagedreamworks@hotmail.com](mailto:vintagedreamworks@hotmail.com)

<http://www.geocities.com/SiliconValley/Campus/8645/index.html>

<http://members.nbc.com/silicon39/>

<http://www.mp3.com/silicon39>

<https://analoguesque.x10host.com/>

# Maintainer: Natanael Copa <[ncopa@alpinelinux.org](mailto:ncopa@alpinelinux.org)>

pkgname=libart-lgpl

pkgver=2.3.21

pkgrel=8

pkgdesc="A library for high-performance 2D graphics"

url="https://www.levien.com/libart/"

arch="all"

options="!check" # No test suite.

license="LGPL-2.0-or-later"

subpackages="\$pkgname-dev"

source="https://download.gnome.org/sources/libart-lgpl/2.3/libart-lgpl-\$pkgver.tar.bz2"

"

builddir="\$srcdir"/libart-lgpl-\$pkgver

```
prepare() {  
    update_config_sub  
    default_prepare  
}
```

```
build() {  
    ./configure \  
        --build=$CBUILD \  
        --host=$CHOST \  
        --prefix=/usr  
    make  
}
```

```
package() {  
    make DESTDIR="$pkgdir" install
```



```
}
```

```
sha512sums="8a632a6a4da59e5e8c02ec2f5a57e36d182b325b46513765425e5f171ff9ae326af1b133725beba28f7e7
6654309e001aee9bace727b5b4c8589405256a3c020 libart_lgpl-2.3.21.tar.bz2"
mini_sendmail - accept email on behalf of real sendmail
```

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```
# Contributor: Carlo Landmeter <clandmeter@alpinelinux.org>
```

```
# Maintainer: Kevin Daudt <kdaudt@alpinelinux.org>
```

```
pkgname=spdx-licenses
```

```
pkgver=3.26.0
```

```
pkgrel=0
```

```
pkgdesc="Various data formats for the SPDX License List"
```

```
url="https://spdx.org/"
```

```
arch="noarch"
```

```
options="!check" # no test suite
```

```
license="CC-BY-3.0"
```

```
source="license-list-data-$pkgver.tar.gz::https://github.com/spdx/license-list-data/archive/v$pkgver.tar.gz"
```

```
builddir="$srcdir/license-list-data-$pkgver"
```

```
subpackages="$pkgname-list"
```

```
_types="html json rdfa rdfnt rdfturtle rdfxml template text"
```

```
for type in $_types; do
```

```
subpackages="$subpackages $pkgname-$type:_subpkg"
```

done

```
package() {  
  mkdir -p "$pkgdir"  
}
```

```
_subpkg() {  
  local type=${subpkgname/$pkgname-/  
  pkgdesc="$pkgdesc ($type)"  
  install_if="$pkgname=$pkgver-r$pkgrel"  
  mkdir -p "$subpkgdir"/usr/share/spdx  
  cp -r "$builddir"/$type "$subpkgdir"/usr/share/spdx/  
}
```

```
list() {  
  pkgdesc="$pkgdesc (licence list)"  
  mkdir -p "$subpkgdir"/usr/share/spdx  
  local i; for i in "$builddir"/text/*.txt;  
  do  
    local license=${i##*/}  
    echo ${license%.*} >> "$subpkgdir"/usr/share/spdx/license.lst  
  done  
}
```

```
sha512sums="  
67e618d4642dfe4f366935d9514d6f7941d3711e77c49bc1b340ac572d36015981b8f10c72a9f80f1d83e132ae7e5093c  
0155e0c0e786e4777ee16d1cb7b885a license-list-data-3.26.0.tar.gz  
"
```

```
# Contributor: Patrycja Rosa <alpine@ptrcnull.me>  
# Maintainer: Patrycja Rosa <alpine@ptrcnull.me>  
pkgname=bsd-compat-headers  
pkgver=0.7.2  
pkgrel=6  
pkgdesc="BSD compatibility headers (cdefs, queue, tree)"  
url="https://gitlab.alpinelinux.org/alpine/aports"  
arch="noarch"  
license="BSD-2-Clause AND BSD-3-Clause"  
source="  
cdefs.h  
queue.h  
tree.h  
"
```

```
builddir="$srcdir"  
options="!check" # just headers
```

```
package() {  
  mkdir -p "$pkgdir"  
  install -Dm644 -t "$pkgdir"/usr/include/sys \
```

```

cdefs.h queue.h tree.h
}
sha512sums="
37c8fc73c7aea7b490f7850927e2bb91d12137c9e59e22c084146d515696dbc7973b5de92f4c987ba080dd2502ba8312
7006442c3f019b6447a620c0cae73178 cdefs.h
2f0d5e6e4dc3350285cf17009265dddcbe12431c111868eea39bc8cb038ab7c1f2acacbb21735c4e9d4a1fd106a8fc0f86
11ea33987d4faba37dde5ce6da0750 queue.h
d9ac210d81feb8ad2655bc80fb065d3fe20ae4417b32b4a1711e6738a4870140005c13373b5d1846ef3ce5ae6da45f2da
cef2092881eded0a2e94f6a07752ef3 tree.h
"

```

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The text rotation code in w\_rottext.c was written by Alan Richardson.

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The Kohonen neural network code for color optimization was written by Anthony Dekker.

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The X-Spline code was written Carole Blanc (blanc@labri.u-bordeaux.fr) and Christophe Schlick (schlick@labri.u-bordeaux.fr) starting from an initial implementation done by C. Feuille, S. Grosbois, L. Maziere and L. Minihot as a student practice (Universite Bordeaux, France). For additional information about X-splines, see:

"X-Splines: A Spline Model Designed for the End User" by C. Blanc and C. Schlick, Proceedings of SIGGRAPH'95  
<http://dept-info.labri.u-bordeaux.fr/~schlick/DOC/sig1.html>

# Contributor: Dhruvin Gandhi <contact@dhruvin>

# Maintainer: Patrycja Rosa <alpine@ptrcnull.me>

pkgname=py3-license-expression

\_pkgname=license\_expression

pkgver=30.4.1

pkgrel=0

pkgdesc="Library to parse, compare, simplify and normalize license expressions"

url="https://github.com/nexB/license-expression"

arch="noarch"

```

license="Apache-2.0"
depends="python3 py3-boolean.py"
makedepends="py3-setuptools py3-setuptools_scm py3-gpep517 py3-wheel"
checkdepends="py3-pytest py3-pytest-xdist"
subpackages="$pkgname-pyc"
source="https://files.pythonhosted.org/packages/source/l/${_pkgname}/${_pkgname}-${pkgver}.tar.gz"
builddir="$srcdir/${_pkgname}-${pkgver}"

build() {
    gpep517 build-wheel \
        --wheel-dir .dist \
        --output-fd 3 3>&1 >&2
}

check() {
    python3 -m venv --clear --without-pip --system-site-packages .testenv
    .testenv/bin/python3 -m installer .dist/*.whl
    .testenv/bin/python3 -m pytest
}

package() {
    python3 -m installer -d "$pkgdir" \
        .dist/*.whl
}

sha512sums="
114c630f098939757e49187e35b4e54883266a2ee9ca283724992420ef4c860f9606a8342da0ab74d93627c10805f312
fda3f699cbc7c4fbd47a71e220440fb0
    license_expression-30.4.1.tar.gz
"

# Contributor: Fabian Affolter <fabian@affolter-engineering.ch>
# Maintainer: Fabian Affolter <fabian@affolter-engineering.ch>
pkgname=py3-flake8-copyright
_pkgname=flake8-copyright
pkgver=0.2.4
pkgrel=3
pkgdesc="Extension for flake8 which checks for copyrights"
options="!check" # No testsuite
url="https://github.com/savoirfairelinux/flake8-copyright"
arch="noarch"
license="MIT"
depends="py3-flake8 py3-setuptools"
makedepends="py3-gpep517 py3-wheel"
subpackages="$pkgname-pyc"
source="https://files.pythonhosted.org/packages/source/${_pkgname:0:1}/${_pkgname}/${_pkgname}-${pkgver}.tar.gz"
builddir="$srcdir"/${_pkgname}-${pkgver}

replaces="py-flake8-copyright" # Backwards compatibility

```

```

provides="py-flake8-copyright=$pkgver-r$pkgrel" # Backwards compatibility

build() {
    gpep517 build-wheel \
        --wheel-dir .dist \
        --output-fd 3 3>&1 >&2
}

package() {
    gpep517 install-wheel --destdir "$pkgdir" \
        .dist/*.whl
}

sha512sums="
a6ab47e1bb715618f075c51f398e18180404871b3b0faf1c2d30701d5203db6bc23771bf22ffb5bafcd8ee856b9b64237
b316bd503ae7dceed6ca284ccd5a74d
flake8-copyright-0.2.4.tar.gz
"

# Maintainer: fossdd <fossdd@pwned.life>
pkgname=cargo-license
pkgver=0.6.1
pkgrel=1
pkgdesc="Cargo subcommand to see license of dependencies"
url="https://github.com/onur/cargo-license"
arch="all"
license="MIT"
makedepends="cargo cargo-auditable"
source="$pkgname-$pkgver.tar.gz::https://crates.io/api/v1/crates/cargo-license/$pkgver/download"

prepare() {
    default_prepare

    cargo fetch --target="$CTARGET" --locked
}

build() {
    cargo auditable build --release --frozen
}

check() {
    cargo test --frozen
}

package() {
    install -Dm755 target/release/cargo-license -t "$pkgdir"/usr/bin
}

sha512sums="

```

36215145e79965be090ae2f5ce6f5eb208465eb67a94c26bed1fe70a131c46c6dc35695e30852759b7366883fbc3caf00  
272d796ac634f0a5e1d49232b6b29d5 cargo-license-0.6.1.tar.gz  
"

## 1.43 ca-certificates-bundle 20241121-r1

### 1.43.1 Available under license :

```
# Contributor: Patrycja Rosa <alpine@ptrcnull.me>
# Maintainer: Patrycja Rosa <alpine@ptrcnull.me>
pkgname=bsd-compat-headers
pkgver=0.7.2
pkgrel=6
pkgdesc="BSD compatibility headers (cdefs, queue, tree)"
url="https://gitlab.alpinelinux.org/alpine/aports"
arch="noarch"
license="BSD-2-Clause AND BSD-3-Clause"
source="
cdefs.h
queue.h
tree.h
"

builddir="$srcdir"
options="!check" # just headers

package() {
    mkdir -p "$pkgdir"
    install -Dm644 -t "$pkgdir"/usr/include/sys \
        cdefs.h queue.h tree.h
}

sha512sums="
37c8fc73c7aea7b490f7850927e2bb91d12137c9e59e22c084146d515696dbc7973b5de92f4c987ba080dd2502ba8312
7006442c3f019b6447a620c0cae73178 cdefs.h
2f0d5e6e4dc3350285cf17009265dddcbe12431c111868eea39bc8cb038ab7c1f2acacbb21735c4e9d4a1fd106a8fc0f86
11ea33987d4faba37dde5ce6da0750 queue.h
d9ac210d81feb8ad2655bc80fb065d3fe20ae4417b32b4a1711e6738a4870140005c13373b5d1846ef3ce5ae6da45f2da
cef2092881eded0a2e94f6a07752ef3 tree.h
"

# Maintainer: Natanael Copa <ncopa@alpinelinux.org>
pkgname=libart-lgpl
pkgver=2.3.21
pkgrel=8
pkgdesc="A library for high-performance 2D graphics"
url="https://www.levien.com/libart/"
arch="all"
options="!check" # No test suite.
license="LGPL-2.0-or-later"
subpackages="$pkgname-dev"
```

```

source="https://download.gnome.org/sources/libart_lgpl/2.3/libart_lgpl-$pkgver.tar.bz2
"

builddir="$srcdir"/libart_lgpl-$pkgver

prepare() {
    update_config_sub
    default_prepare
}

build() {
    ./configure \
        --build=$CBUILD \
        --host=$CHOST \
        --prefix=/usr
    make
}

package() {
    make DESTDIR="$pkgdir" install
}

sha512sums="8a632a6a4da59e5e8c02ec2f5a57e36d182b325b46513765425e5f171ff9ae326af1b133725beba28f7e7
6654309e001aee9bace727b5b4c8589405256a3c020 libart_lgpl-2.3.21.tar.bz2"

```

## 1.44 alpine-baselayout-data 3.6.8-r1

### 1.44.1 Available under license :

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## 1.45 tshark 4.4.2-r0

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Installing Wireshark on FreeBSD/OpenBSD/NetBSD/DragonFly BSD

=====

1. Berkeley Packet Filter (BPF) requirement
2. Running Wireshark as a non-root user

For general installation instructions, see the INSTALL file, along with the Developer's Guide located at <https://www.wireshark.org/docs/> and in the doc/ directory. Additional BSD specific notes and requirements follow.

1. Berkeley Packet Filter (BPF) requirement

-----

In order to capture packets (with Wireshark/TShark, tcpdump, or any other packet capture program) on a BSD system, your kernel must have the Berkeley Packet Filter mechanism enabled. The default kernel configurations in recent versions of BSD systems have this enabled already. To verify the bpf device is present, look in the /dev directory:

```
ls -l /dev/bpf*
```

You should see one or more bpf devices listed similar to this:

```
crw----- 1 root wheel
0, 90 Aug 10 21:05 /dev/bpf0
crw----- 1 root wheel 0, 91 Aug 10 21:05 /dev/bpf1
```

Packet-capturing programs will pick the first bpf device that's not in use. Recent versions of most BSDs will create bpf devices as needed, so you don't have to configure the number of devices that will be available.

2. Running wireshark as a non-root user

-----

Since the bpf devices are read-only by the owner (root), you normally have to run packet capturing programs such as Wireshark as root. It is safer to run programs as a non-root user if possible. To run Wireshark as a non-root user, you must change the permissions on the bpf device(s). If you are the only user that needs to use Wireshark, the easiest way is to change the owner of each bpf device to your username. You can also add the read/write ability to the group (typically wheel) and add users that need to use Wireshark to the wheel group. Check your operating system's documentation on how to make permanent these changes as they are often reset upon reboot; if /dev is implemented with devfs, it might be possible to configure devfs to create all bpf devices owned by a

particular user and/or group and with particular permissions. In FreeBSD 6.0 and later this can be done by creating an `/etc/devfs.rules` file with content such as

```
[localrules=10]
add path 'bpf*' {mode and permissions}
```

where "mode and permissions" can include clauses such as

```
mode {octal permissions}
```

to set the permissions on the device (e.g., "mode 0660" to set the permissions to `rw-rw-r--`),

```
user {user}
```

to set the user who owns the device, or

```
group {group}
```

to set the group that owns the device and adding a line such as

```
devfs_system_ruleset=localrules
```

to `/etc/rc.conf`. For example, an `/etc/devfs.rules` file with

```
[localrules=10]
add path 'bpf*' mode 0660 group wheel
```

will grant read and write permissions on all BPF devices to all users in the "wheel" group.

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```

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wiretap/erf.h

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## 1.48 wireshark-common 4.4.2-r0

### 1.48.1 Available under license :

Installing Wireshark on FreeBSD/OpenBSD/NetBSD/DragonFly BSD

=====

1. Berkeley Packet Filter (BPF) requirement
2. Running Wireshark as a non-root user

For general installation instructions, see the INSTALL file, along with the Developer's Guide located at <https://www.wireshark.org/docs/> and in the doc/ directory. Additional BSD specific notes and requirements follow.

1. Berkeley Packet Filter (BPF) requirement

-----

In order to capture packets (with Wireshark/TShark, tcpdump, or any other packet capture program) on a BSD system, your kernel must have the Berkeley Packet Filter mechanism enabled. The default kernel configurations in recent versions of BSD systems have this enabled already. To verify the bpf device is present, look in the /dev directory:

```
ls -l /dev/bpf*
```

You should see one or more bpf devices listed similar to this:

```
crw----- 1 root wheel
0, 90 Aug 10 21:05 /dev/bpf0
crw----- 1 root wheel 0, 91 Aug 10 21:05 /dev/bpf1
```

Packet-capturing programs will pick the first bpf device that's not in use. Recent versions of most BSDs will create bpf devices as needed, so you don't have to configure the number of devices that will be available.

## 2. Running wireshark as a non-root user

-----

Since the bpf devices are read-only by the owner (root), you normally have to run packet capturing programs such as Wireshark as root. It is safer to run programs as a non-root user if possible. To run Wireshark as a non-root user, you must change the permissions on the bpf device(s). If you are the only user that needs to use Wireshark, the easiest way is to change the owner of each bpf device to your username. You can also add the read/write ability to the group (typically wheel) and add users that need to use Wireshark to the wheel group. Check your operating system's documentation on how to make permanent these changes as they are often reset upon reboot; if /dev is implemented with devfs, it might be possible to configure devfs to create all bpf devices owned by a particular user and/or group and with particular permissions. In FreeBSD 6.0 and later this can be done by creating an /etc/devfs.rules file with content such as

```
[localrules=10]
add path 'bpf*' {mode and permissions}
```

where "mode and permissions" can include clauses such as

```
mode {octal permissions}
```

to set the permissions on the device (e.g., "mode 0660" to set the permissions to rw-rw-r--),

```
user {user}
```

to set the user who owns the device, or

```
group {group}
```

to set the group that owns the device and adding a line such as

devfs\_system\_ruleset=localrules

to /etc/rc.conf. For example, an /etc/devfs.rules file with

```
[localrules=10]
add path 'bpf*' mode 0660 group wheel
```

will grant read and write permissions on all BPF devices to all users in the "wheel" group.

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```
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```

```
*
```

```
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```

```
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```

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*
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Solar Designer  
Stefan Kristiansson  
Stefan O'Rear  
Szabolcs Nagy  
Timo Ters  
Trutz Behn  
Valentin Ochs  
Will Dietz  
William Haddon  
William Pitcock

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The mips64 port was contributed by Imagination Technologies and is licensed under the standard MIT terms.

The powerpc port was also originally written by Richard Pennington, and later supplemented and integrated by John Spencer. It is licensed under the standard MIT terms.

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John Spencer  
Nicholas J. Kain  
Rich Felker  
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Stefan Kristiansson  
Szabolcs Nagy

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## 1.53 alpine-release 3.21.3-r0

### 1.53.1 Available under license :

```
# Automatically generated by apkbuild-cpan, template 4
# Contributor: Valery Kartel <valery.kartel@gmail.com>
# Maintainer: Celeste <cielesti@protonmail.com>
maintainer="Celeste <cielesti@protonmail.com>"
pkgname=perl-bsd-resource
pkgver=1.2911
pkgrel=10
#_pkgreal is used by apkbuild-cpan to find modules at MetaCpan
_pkgreal=BSD-Resource
pkgdesc="Perl extension implements the BSD process resource limit functions"
url="https://metacpan.org/release/BSD-Resource/"
arch="all"
license="Artistic-2.0 OR LGPL-2.0"
depends="perl"
makedepends="perl-dev"
subpackages="$pkgname-doc"
source="https://cpan.metacpan.org/authors/id/J/JH/JHI/BSD-Resource-$pkgver.tar.gz"
buildid="$srcdir/${_pkgreal}-$pkgver"

build() {
    export CFLAGS=$(perl -MConfig -E 'say $Config{ccflags}')
    PERL_MM_USE_DEFAULT=1 perl -I. Makefile.PL \
        INSTALLDIRS=vendor \
        NO_PACKLIST=1 \
        NO_PERLLOCAL=1
```

```

make
}

check() {
export CFLAGS=$(perl -MConfig -E 'say $Config{ccflags}')
make test
}

package() {
make DESTDIR="$pkgdir" install
}

sha512sums="
d0032d41c7c0468ed1c6d8f57b885f6cb97a5039d754c8cb60b2067daedaf53bd15fb6561a3d0f828df16dfa5417f663b
8065ba65f4fea16dc9262728b3b6b85
  BSD-Resource-1.2911.tar.gz
"

# Maintainer: fossdd <fossdd@pwned.life>
pkgname=cargo-license
pkgver=0.6.1
pkgrel=1
pkgdesc="Cargo subcommand to see license of dependencies"
url="https://github.com/onur/cargo-license"
arch="all"
license="MIT"
makedepends="cargo cargo-auditable"
source="$pkgname-$pkgver.tar.gz::https://crates.io/api/v1/crates/cargo-license/$pkgver/download"

prepare() {
default_prepare

cargo fetch --target="$CTARGET" --locked
}

build() {
cargo auditable build --release --frozen
}

check() {
cargo test --frozen
}

package() {
install -Dm755 target/release/cargo-license -t "$pkgdir"/usr/bin
}

sha512sums="
36215145e79965be090ae2f5ce6f5eb208465eb67a94c26bed1fe70a131c46c6dc35695e30852759b7366883fbc3caf00

```

272d796ac634f0a5e1d49232b6b29d5 cargo-license-0.6.1.tar.gz

"

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OF OR IN CONNECTION WITH THE SOFTWARE OR THE USE OR OTHER DEALINGS IN THE SOFTWARE.

# Contributor: Dhruvin Gandhi <contact@dhruvin>

# Maintainer: Patrycja Rosa <alpine@ptrcnull.me>

pkgname=py3-license-expression

\_pkgname=license\_expression

pkgver=30.4.0

pkgrel=0

pkgdesc="Library to parse, compare, simplify and normalize license expressions"

url="https://github.com/nexB/license-expression"

arch="noarch"

license="Apache-2.0"

depends="python3 py3-boolean.py"

makedepends="py3-setuptools py3-setuptools\_scm py3-gpep517 py3-wheel"

checkdepends="py3-pytest py3-pytest-xdist"

subpackages="\$pkgname-pyc"

source="https://files.pythonhosted.org/packages/source/l/\_pkgname/\_pkgname-\$pkgver.tar.gz"

builddir="\$srcdir/\$\_pkgname-\$pkgver"

build() {

gpep517 build-wheel \

--wheel-dir .dist \

--output-fd 3 3>&1 >&2

}

```
check() {
python3 -m venv --clear --without-pip --system-site-packages .testenv
.testenv/bin/python3 -m installer .dist/*.whl
.testenv/bin/python3 -m pytest
}
```

```
package() {
python3 -m installer -d "$pkgdir" \
.dist/*.whl
}
```

```
sha512sums="
cc7cd6b5bd8ea4c99b66f074871ffd7cc78b3e8b1b0d3afd9b95efdb7147c8293db2fac977d684fc34d3d60bd79066a06
dc2bff0a38b130d9d83c63538502db1
license_expression-30.4.0.tar.gz
"
```

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Any feedback, contact Ian Wilson.

[vintagedreamworks@hotmail.com](mailto:vintagedreamworks@hotmail.com)

<http://www.geocities.com/SiliconValley/Campus/8645/index.html>

<http://members.nbc.com/silicon39/>

<http://www.mp3.com/silicon39>

<https://analoguesque.x10host.com/>

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mini\_sendmail - accept email on behalf of real sendmail

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# Maintainer: Natanael Copa <ncopa@alpinelinux.org>

pkgname=libart-lgpl

pkgver=2.3.21

pkgrel=8

pkgdesc="A library for high-performance 2D graphics"

url="https://www.levien.com/libart/"

arch="all"

options="!check" # No test suite.

license="LGPL-2.0-or-later"

subpackages="\$pkgname-dev"

source="https://download.gnome.org/sources/libart-lgpl/2.3/libart-lgpl-\$pkgver.tar.bz2"



```

"

builddir="$srcdir"/libart_lgpl-$pkgver

prepare() {
    update_config_sub
    default_prepare
}

build() {
    ./configure \
        --build=$CBUILD \
        --host=$CHOST \
        --prefix=/usr
    make
}

package() {
    make DESTDIR="$pkgdir" install
}

sha512sums="8a632a6a4da59e5e8c02ec2f5a57e36d182b325b46513765425e5f171ff9ae326af1b133725beba28f7e7
6654309e001aee9bace727b5b4c8589405256a3c020 libart_lgpl-2.3.21.tar.bz2"

```

## 1.54 openssl-client-common 9.9\_p2-r0

### 1.54.1 Notifications :

This product includes software developed by the OpenSSL Project for use in the OpenSSL Toolkit  
(<http://www.openssl.org/>)

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This product includes software written by Tim Hudson (tjh@cryptsoft.com).

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The Kohonen neural network code for color optimization was written by Anthony Dekker.

Parts Copyright (c) 1995 by C. Blanc and C. Schlick

The X-Spline code was written Carole Blanc (blanc@labri.u-bordeaux.fr) and Christophe Schlick (schlick@labri.u-bordeaux.fr) starting from an initial implementation done by C. Feuille, S. Grosbois, L. Maziere and L. Minihot as a student practice (Universite Bordeaux, France). For additional information about X-splines, see:

"X-Splines: A Spline Model Designed for the End User" by C. Blanc and C. Schlick, Proceedings of SIGGRAPH'95

<http://dept-info.labri.u-bordeaux.fr/~schlick/DOC/sig1.html>

# Automatically generated by apkbuild-cpan, template 4

# Contributor: Valery Kartel <valery.kartel@gmail.com>

# Maintainer: Celeste <cielesti@protonmail.com>

maintainer="Celeste <cielesti@protonmail.com>"

pkgname=perl-bsd-resource

pkgver=1.2911

pkgrel=10

#\_pkgreal is used by apkbuild-cpan to find modules at MetaCpan

\_pkgreal=BSD-Resource

pkgdesc="Perl extension implements the BSD process resource limit functions"

url="https://metacpan.org/release/BSD-Resource/"

arch="all"

license="Artistic-2.0 OR LGPL-2.0"

depends="perl"

makedepends="perl-dev"

subpackages="\$pkgname-doc"

source="https://cpan.metacpan.org/authors/id/J/JH/JHI/BSD-Resource-\$pkgver.tar.gz"

builddir="\$srcdir/\${\_pkgreal}-\$pkgver"

build() {

export CFLAGS=\$(perl -MConfig -E 'say \$Config{ccflags}')

PERL\_MM\_USE\_DEFAULT=1 perl -I. Makefile.PL \

INSTALLDIRS=vendor \

NO\_PACKLIST=1 \

NO\_PERLLOCAL=1

make

}

check() {

export CFLAGS=\$(perl -MConfig -E 'say \$Config{ccflags}')

make test

}

package() {

```

make DESTDIR="$pkgdir" install
}

sha512sums="
d0032d41c7c0468ed1c6d8f57b885f6cb97a5039d754c8cb60b2067daedaf53bd15fb6561a3d0f828df16dfa5417f663b
8065ba65f4fea16dc9262728b3b6b85
  BSD-Resource-1.2911.tar.gz
"

# Contributor: Fabian Affolter <fabian@affolter-engineering.ch>
# Maintainer: Fabian Affolter <fabian@affolter-engineering.ch>
pkgname=py3-flake8-copyright
_pkgname=flake8-copyright
pkgver=0.2.4
pkgrel=3
pkgdesc="Extension for flake8 which checks for copyrights"
options="!check" # No testsuite
url="https://github.com/savoirfairelinux/flake8-copyright"
arch="noarch"
license="MIT"
depends="py3-flake8 py3-setuptools"
makedepends="py3-gpep517 py3-wheel"
subpackages="$pkgname-pyc"
source="https://files.pythonhosted.org/packages/source/${_pkgname:0:1}/${_pkgname}/${_pkgname}-${pkgver}.tar.gz"
builddir="$srcdir"/$_pkgname-$pkgver

replaces="py-flake8-copyright"          # Backwards compatibility
provides="py-flake8-copyright=${pkgver}-r${pkgrel}" # Backwards compatibility

build() {
  gpep517 build-wheel \
    --wheel-dir .dist \
    --output-fd 3 3>&1 >&2
}

package() {
  gpep517 install-wheel --destdir "$pkgdir" \
    .dist/*.whl
}

sha512sums="
a6ab47e1bb715618f075c51f398e18180404871b3b0faf1c2d30701d5203db6bc23771bf22ffb5bafcd8ee856b9b64237
b316bd503ae7dceed6ca284ccd5a74d
  flake8-copyright-0.2.4.tar.gz
"

# Maintainer: fossdd <fossdd@pwned.life>
pkgname=cargo-license
pkgver=0.6.1
pkgrel=1

```

```

pkgdesc="Cargo subcommand to see license of dependencies"
url="https://github.com/onur/cargo-license"
arch="all"
license="MIT"
makedepends="cargo cargo-auditable"
source="$pkgname-$pkgver.tar.gz::https://crates.io/api/v1/crates/cargo-license/$pkgver/download"

prepare() {
    default_prepare

    cargo fetch --target="$CTARGET" --locked
}

build() {
    cargo auditable build --release --frozen
}

check() {
    cargo test --frozen
}

package() {
    install -Dm755 target/release/cargo-license -t "$pkgdir"/usr/bin
}

sha512sums="
36215145e79965be090ae2f5ce6f5eb208465eb67a94c26bed1fe70a131c46c6dc35695e30852759b7366883fbc3caf00
272d796ac634f0a5e1d49232b6b29d5  cargo-license-0.6.1.tar.gz
"

# Contributor: Dhruvin Gandhi <contact@dhruvin>
# Maintainer: Patrycja Rosa <alpine@ptrcnull.me>
pkgname=py3-license-expression
_pkgname=license_expression
pkgver=30.4.0
pkgrel=0
pkgdesc="Library to parse, compare, simplify and normalize license expressions"
url="https://github.com/nexB/license-expression"
arch="noarch"
license="Apache-2.0"
depends="python3 py3-boolean.py"
makedepends="py3-setuptools py3-setuptools_scm py3-gpep517 py3-wheel"
checkdepends="py3-pytest py3-pytest-xdist"
subpackages="$pkgname-pyc"
source="https://files.pythonhosted.org/packages/source/l/${_pkgname}/${_pkgname}-${pkgver}.tar.gz"
builddir="$srcdir/${_pkgname}-${pkgver}"

build() {
    gpep517 build-wheel \

```

```

--wheel-dir .dist \
--output-fd 3 3>&1 >&2
}

check() {
python3 -m venv --clear --without-pip --system-site-packages .testenv
.testenv/bin/python3 -m installer .dist/*.whl
.testenv/bin/python3 -m pytest
}

package() {
python3 -m installer -d "$pkgdir" \
.dist/*.whl
}

sha512sums="
cc7cd6b5bd8ea4c99b66f074871ffd7cc78b3e8b1b0d3afd9b95efdb7147c8293db2fac977d684fc34d3d60bd79066a06
dc2bff0a38b130d9d83c63538502db1
license_expression-30.4.0.tar.gz
"
MIT License

```

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# Contributor: Carlo Landmeter <clandmeter@alpinelinux.org>

# Maintainer: Kevin Daudt <kdaudt@alpinelinux.org>

pkgname=spdx-licenses

pkgver=3.24.0

pkgrel=0

pkgdesc="Various data formats for the SPDX License List"

```

url="https://spdx.org/"
arch="noarch"
options="!check" # no test suite
license="CC-BY-3.0"
source="license-list-data-$pkgver.tar.gz::https://github.com/spdx/license-list-data/archive/v$pkgver.tar.gz"
buildddir="$srcdir/license-list-data-$pkgver"
subpackages="$pkgname-list"

_types="html json rdfa rdft rdfturtle rdfxml template text"

for type in $_types; do
    subpackages="$subpackages $pkgname-$type:_subpkg"
done

package() {
    mkdir -p "$pkgdir"
}

_subpkg() {
    local type=${subpkgname/$pkgname-/}
    pkgdesc="$pkgdesc ($type)"
    install_if="$pkgname=$pkgver-r$pkgrel"
    mkdir -p "$subpkgdir"/usr/share/spdx
    cp -r "$builddir"/$type "$subpkgdir"/usr/share/spdx/
}

list() {
    pkgdesc="$pkgdesc (licence list)"
    mkdir -p "$subpkgdir"/usr/share/spdx
    local i; for i in "$builddir"/text/*.txt;
    do
        local license=${i##*/}
        echo ${license%.*} >> "$subpkgdir"/usr/share/spdx/license.lst
    done
}

sha512sums="
6eb81424e1b3173dbd8e17859b2e15dfe1c2af8f4da59b7dad0729c038a4cbdba95c34c2c546285fcdbbd41562e39575e
6a6ebb9463b70121e0a12b99d1307e7  license-list-data-3.24.0.tar.gz
"

```

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[Tatu continues]

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- IDEA is no longer included, its use is deprecated

- DES is now external, in the OpenSSL library

- GMP is no longer used, and instead we call BN code from OpenSSL

- Zlib is now external, in a library

- The make-ssh-known-hosts script is no longer included

- TSS has been removed

- MD5 is now external, in the OpenSSL library

- RC4 support has been replaced with ARC4 support from OpenSSL

- Blowfish is now external, in the OpenSSL library

[The licence continues]

Note that any information and cryptographic algorithms used in this

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4)

The Rijndael implementation by Vincent Rijmen, Antoon Bosselaers and Paulo Barreto is in the public domain and distributed with the following license:

\* @version 3.0 (December 2000)

\*

\* Optimised ANSI C code for the Rijndael cipher (now AES)

\*

\* @author Vincent Rijmen <vincent.rijmen@esat.kuleuven.ac.be>

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## 1.55 openssh-client-default 9.9\_p2-r0

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```
# Contributor: Patrycja Rosa <alpine@ptrcnull.me>
# Maintainer: Patrycja Rosa <alpine@ptrcnull.me>
pkgname=bsd-compat-headers
pkgver=0.7.2
pkgrel=6
pkgdesc="BSD compatibility headers (cdefs, queue, tree)"
url="https://gitlab.alpinelinux.org/alpine/aports"
arch="noarch"
license="BSD-2-Clause AND BSD-3-Clause"
source="
cdefs.h
queue.h
tree.h
"
buildddir="$srcdir"
options="!check" # just headers

package() {
    mkdir -p "$pkgdir"
    install -Dm644 -t "$pkgdir"/usr/include/sys \
        cdefs.h queue.h tree.h
}
sha512sums="
37c8fc73c7aea7b490f7850927e2bb91d12137c9e59e22c084146d515696dbc7973b5de92f4c987ba080dd2502ba8312
7006442c3f019b6447a620c0cae73178 cdefs.h
2f0d5e6e4dc3350285cf17009265dddcbe12431c111868eea39bc8cb038ab7c1f2acacbb21735c4e9d4a1fd106a8fc0f86
11ea33987d4faba37dde5ce6da0750 queue.h
d9ac210d81feb8ad2655bc80fb065d3fe20ae4417b32b4a1711e6738a4870140005c13373b5d1846ef3ce5ae6da45f2da
cef2092881eded0a2e94f6a07752ef3 tree.h
"

# Contributor: Fabian Affolter <fabian@affolter-engineering.ch>
# Maintainer: Fabian Affolter <fabian@affolter-engineering.ch>
pkgname=py3-flake8-copyright
_pkgname=flake8-copyright
pkgver=0.2.4
pkgrel=3
pkgdesc="Extension for flake8 which checks for copyrights"
options="!check" # No testsuite
url="https://github.com/savoirfairelinux/flake8-copyright"
arch="noarch"
license="MIT"
```



```

depends="py3-flake8 py3-setuptools"
makedepends="py3-gpep517 py3-wheel"
subpackages="$pkgname-pyc"
source="https://files.pythonhosted.org/packages/source/${_pkgname:0:1}/${_pkgname}/${_pkgname}-${pkgver}.tar.gz"
builddir="$srcdir"/$_pkgname-$pkgver

replaces="py-flake8-copyright"          # Backwards compatibility
provides="py-flake8-copyright=$pkgver-r$pkgrel" # Backwards compatibility

build() {
    gpep517 build-wheel \
        --wheel-dir .dist \
        --output-fd 3 3>&1 >&2
}

package() {
    gpep517 install-wheel --destdir "$pkgdir" \
        .dist/*.whl
}

sha512sums="
a6ab47e1bb715618f075c51f398e18180404871b3b0faf1c2d30701d5203db6bc23771bf22ffb5bafcd8ee856b9b64237
b316bd503ae7dceed6ca284ccd5a74d
    flake8-copyright-0.2.4.tar.gz
"

# Maintainer: fossdd <fossdd@pwned.life>
pkgname=cargo-license
pkgver=0.6.1
pkgrel=1
pkgdesc="Cargo subcommand to see license of dependencies"
url="https://github.com/onur/cargo-license"
arch="all"
license="MIT"
makedepends="cargo cargo-auditable"
source="$pkgname-$pkgver.tar.gz::https://crates.io/api/v1/crates/cargo-license/$pkgver/download"

prepare() {
    default_prepare

    cargo fetch --target="$CTARGET" --locked
}

build() {
    cargo auditable build --release --frozen
}

check() {
    cargo test --frozen
}

```

```

}

package() {
    install -Dm755 target/release/cargo-license -t "$pkgdir"/usr/bin
}

sha512sums="
36215145e79965be090ae2f5ce6f5eb208465eb67a94c26bed1fe70a131c46c6dc35695e30852759b7366883fbc3caf00
272d796ac634f0a5e1d49232b6b29d5 cargo-license-0.6.1.tar.gz
"

# Contributor: Maxim Karasev <begs@disroot.org>
# Maintainer: mio <miyopan@e.email>
pkgname=bsd-games
pkgver=3.3
pkgrel=2
pkgdesc="traditional text mode games from BSD"
url="https://bsd-games.sourceforge.io/"
arch="all"
license="BSD-3-Clause"
install="$pkgname.post-install"
makedepends="ncurses-dev coreutils" # configure causes busybox expr error
subpackages="$pkgname-doc"
source="https://sourceforge.net/projects/bsd-games/files/bsd-games-$pkgver.tar.gz
0001-bsd-games-scores-dir.patch
"

options="!check" # no tests

build() {
    # some GNU autoconf options are ignored, but it works
    ./configure \
        --build=$CBUILD \
        --host=$CHOST \
        --prefix=/usr \
        --sysconfdir=/etc \
        --mandir=/usr/share/man \
        --sourcedir=/usr/share/$pkgname
    make
}

package() {
    make DESTDIR="$pkgdir" install
    install -Dm644 LICENSE "$pkgdir"/usr/share/licenses/bsd-games/LICENSE
}

sha512sums="
aaf36d09d4fe68514a5c279063d7e77a9a9a84c447037cba974b29faa07eb80c2aab2379d0699c196b5c27ffe1b2bb2c6
8d3390143e0e62d5e3d210ccfb61294

```

bsd-games-3.3.tar.gz  
e1def0d4835a877242c4173fae862e278a7858738e0bacacbb045a42bcabec2aa7c72d000bbd2421ce35fe66cdc1f52c0  
577b7e278029ca5ed50f7aab22319f6 0001-bsd-games-scores-dir.patch  
"

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pkgname=libart-lgpl

pkgver=2.3.21

pkgrel=8

pkgdesc="A library for high-performance 2D graphics"

url="https://www.levien.com/libart/"

arch="all"

options="!check" # No test suite.

license="LGPL-2.0-or-later"

subpackages="\$pkgname-dev"

source="https://download.gnome.org/sources/libart-lgpl/2.3/libart-lgpl-\$pkgver.tar.bz2"

"

builddir="\$srcdir"/libart-lgpl-\$pkgver

```
prepare() {  
    update_config_sub  
    default_prepare  
}
```

```
build() {  
    ./configure \  
        --build=$CBUILD \  
        --host=$CHOST \  
        --prefix=/usr  
    make  
}
```

```
package() {  
    make DESTDIR="$pkgdir" install  
}
```

sha512sums="8a632a6a4da59e5e8c02ec2f5a57e36d182b325b46513765425e5f171ff9ae326af1b133725beba28f7e76654309e001aee9bace727b5b4c8589405256a3c020 libart-lgpl-2.3.21.tar.bz2"

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- Zlib is now external, in a library
- The make-ssh-known-hosts script is no longer included
- TSS has been removed
- MD5 is now external, in the OpenSSL library
- RC4 support has been replaced with ARC4 support from OpenSSL
- Blowfish is now external, in the OpenSSL library

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\*

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\* @author Antoon Bosselaers <antoon.bosselaers@esat.kuleuven.ac.be>

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"X-Splines: A Spline Model Designed for the End User" by C. Blanc and C. Schlick, Proceedings of SIGGRAPH'95

<http://dept-info.labri.u-bordeaux.fr/~schlick/DOC/sig1.html>

# Automatically generated by apkbuidl-cpan, template 4

# Contributor: Valery Kartel <valery.kartel@gmail.com>

# Maintainer: Celeste <cielesti@protonmail.com>

maintainer="Celeste <cielesti@protonmail.com>"

pkgname=perl-bdd-resource

pkgver=1.2911

pkgrel=10

#\_pkgreal is used by apkbuidl-cpan to find modules at MetaCpan

\_pkgreal=BDD-Resource

pkgdesc="Perl extension implements the BDD process resource limit functions"

url="https://metacpan.org/release/BDD-Resource/"

arch="all"

```

license="Artistic-2.0 OR LGPL-2.0"
depends="perl"
makedepends="perl-dev"
subpackages="$pkgname-doc"
source="https://cpan.metacpan.org/authors/id/J/JH/JHI/BSD-Resource-$pkgver.tar.gz"
builddir="$srcdir/$_pkgreal-$pkgver"

build() {
    export CFLAGS=$(perl -MConfig -E 'say $Config{ccflags}')
    PERL_MM_USE_DEFAULT=1 perl -I. Makefile.PL \
        INSTALLDIRS=vendor \
        NO_PACKLIST=1 \
        NO_PERLLOCAL=1
    make
}

check() {
    export CFLAGS=$(perl -MConfig -E 'say $Config{ccflags}')
    make test
}

package() {
    make DESTDIR="$pkgdir" install
}

sha512sums="
d0032d41c7c0468ed1c6d8f57b885f6cb97a5039d754c8cb60b2067daedaf53bd15fb6561a3d0f828df16dfa5417f663b
8065ba65f4fea16dc9262728b3b6b85
    BSD-Resource-1.2911.tar.gz
"

# Contributor: Dhruvin Gandhi <contact@dhruvin>
# Maintainer: Patrycja Rosa <alpine@ptrcnull.me>
pkgname=py3-license-expression
_pkgname=license_expression
pkgver=30.4.0
pkgrel=0
pkgdesc="Library to parse, compare, simplify and normalize license expressions"
url="https://github.com/nexB/license-expression"
arch="noarch"
license="Apache-2.0"
depends="python3 py3-boolean.py"
makedepends="py3-setuptools py3-setuptools_scm py3-gpep517 py3-wheel"
checkdepends="py3-pytest py3-pytest-xdist"
subpackages="$pkgname-pyc"
source="https://files.pythonhosted.org/packages/source/l/${_pkgname}/${_pkgname}-${pkgver}.tar.gz"
builddir="$srcdir/${_pkgname}-${pkgver}"

build() {

```

```

gpep517 build-wheel \
--wheel-dir .dist \
--output-fd 3 3>&1 >&2
}

check() {
python3 -m venv --clear --without-pip --system-site-packages .testenv
.testenv/bin/python3 -m installer .dist/*.whl
.testenv/bin/python3 -m pytest
}

package() {
python3 -m installer -d "$pkgdir" \
.dist/*.whl
}

sha512sums="
cc7cd6b5bd8ea4c99b66f074871ffd7cc78b3e8b1b0d3afd9b95efdb7147c8293db2fac977d684fc34d3d60bd79066a06
dc2bff0a38b130d9d83c63538502db1
license_expression-30.4.0.tar.gz
"
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```

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<http://www.geocities.com/SiliconValley/Campus/8645/index.html>

<http://members.nbc.com/silicon39/>

<http://www.mp3.com/silicon39>

<https://analoguesque.x10host.com/>

# Contributor: Carlo Landmeter <[clandmeter@alpinelinux.org](mailto:clandmeter@alpinelinux.org)>

# Maintainer: Kevin Daudt <[kdaudt@alpinelinux.org](mailto:kdaudt@alpinelinux.org)>

pkgname=spdx-licenses

pkgver=3.24.0

pkgrel=0

pkgdesc="Various data formats for the SPDX License List"

url="https://spdx.org/"

arch="noarch"

options="!check" # no test suite

license="CC-BY-3.0"

source="license-list-data-\$pkgver.tar.gz::https://github.com/spdx/license-list-data/archive/v\$pkgver.tar.gz"

builddir="\$srcdir/license-list-data-\$pkgver"

subpackages="\$pkgname-list"

\_types="html json rdfa rdfturtle rdfxml template text"

for type in \$\_types; do

subpackages="\$subpackages \$pkgname-\$type:\_subpkg"

done

package() {

mkdir -p "\$pkgdir"

}

\_subpkg() {

local type=\${subpkgname/\$pkgname-/}

pkgdesc="\$pkgdesc (\$type)"

install\_if="\$pkgname=\$pkgver-r\$pkgrel"

mkdir -p "\$subpkgdir"/usr/share/spdx

cp -r "\$builddir"/\$type "\$subpkgdir"/usr/share/spdx/

}

```

list() {
    pkgdesc="$pkgdesc (licence list)"
    mkdir -p "$subpkgdir"/usr/share/spdx
    local i; for i in "$builddir"/text/*.txt;
    do
        local license=${i##*/}
        echo ${license%.*} >> "$subpkgdir"/usr/share/spdx/license.lst
    done
}

sha512sums="
6eb81424e1b3173dbd8e17859b2e15dfe1c2af8f4da59b7dad0729c038a4cbdba95c34c2c546285fcdbbd41562e39575e
6a6ebb9463b70121e0a12b99d1307e7  license-list-data-3.24.0.tar.gz
"

# Maintainer: Natanael Copa <ncopa@alpinelinux.org>
pkgname=libart-lgpl
pkgver=2.3.21
pkgrel=8
pkgdesc="A library for high-performance 2D graphics"
url="https://www.levien.com/libart/"
arch="all"
options="!check" # No test suite.
license="LGPL-2.0-or-later"
subpackages="$pkgname-dev"
source="https://download.gnome.org/sources/libart-lgpl/2.3/libart-lgpl-$pkgver.tar.bz2
"

builddir="$srcdir"/libart-lgpl-$pkgver

prepare() {
    update_config_sub
    default_prepare
}

build() {
    ./configure \
        --build=$CBUILD \
        --host=$CHOST \
        --prefix=/usr
    make
}

package() {
    make DESTDIR="$pkgdir" install
}

sha512sums="8a632a6a4da59e5e8c02ec2f5a57e36d182b325b46513765425e5f171ff9ae326af1b133725beba28f7e7
6654309e001aee9bace727b5b4c8589405256a3c020  libart-lgpl-2.3.21.tar.bz2"

```

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- Zlib is now external, in a library

- The make-ssh-known-hosts script is no longer included

- TSS has been removed

- MD5 is now external, in the OpenSSL library

- RC4 support has been replaced with ARC4 support from OpenSSL

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- \*
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# 1.57 simple launcher 1.1.0.14

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### A. HISTORY OF THE SOFTWARE

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In 1995, Guido continued his work on Python at the Corporation for National Research Initiatives (CNRI, see <http://www.cnri.reston.va.us>) in Reston, Virginia where he released several versions of the software.

In May 2000, Guido and the Python core development team moved to BeOpen.com to form the BeOpen PythonLabs team. In October of the same year, the PythonLabs team moved to Digital Creations (now Zope Corporation, see <http://www.zope.com>). In 2001, the Python Software Foundation (PSF, see <http://www.python.org/psf/>) was formed, a non-profit organization created specifically to own Python-related Intellectual Property. Zope Corporation is a sponsoring member of the PSF.

All Python releases are Open Source (see <http://www.opensource.org> for the Open Source Definition). Historically, most, but not all, Python releases have also been GPL-compatible; the table below summarizes the various releases.

| Release        | Derived from | Year      | Owner      | GPL-compatible? (1) |
|----------------|--------------|-----------|------------|---------------------|
| 0.9.0 thru 1.2 |              | 1991-1995 | CWI        | yes                 |
| 1.3 thru 1.5.2 | 1.2          | 1995-1999 | CNRI       | yes                 |
| 1.6            | 1.5.2        | 2000      | CNRI       | no                  |
| 2.0            | 1.6          | 2000      | BeOpen.com | no                  |
| 1.6.1          | 1.6          | 2001      | CNRI       | yes (2)             |
| 2.1            | 2.0+1.6.1    | 2001      | PSF        | no                  |
| 2.0.1          | 2.0+1.6.1    | 2001      | PSF        | yes                 |
| 2.1.1          | 2.1+2.0.1    | 2001      | PSF        | yes                 |
| 2.2            | 2.1.1        | 2001      | PSF        | yes                 |
| 2.1.2          | 2.1.1        | 2002      | PSF        | yes                 |
| 2.1.3          |              |           |            |                     |

|       |       |           |     |     |
|-------|-------|-----------|-----|-----|
| 2.1.2 | 2002  | PSF       | yes |     |
| 2.2.1 | 2.2   | 2002      | PSF | yes |
| 2.2.2 | 2.2.1 | 2002      | PSF | yes |
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| 2.3   | 2.2.2 | 2002-2003 | PSF | yes |
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| 2.3.3 | 2.3.2 | 2002-2003 | PSF | yes |
| 2.3.4 | 2.3.3 | 2004      | PSF | yes |
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| 3.0.1 | 3.0   | 2009      | PSF | yes |
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- Arc Riley
- C. Anthony Risinger
- Elson Rodriguez
- Luis Rojas
- Erik Rose

- Brian Rosner
- Vinay Sajip
- Victor Stinner
- Alexandre Vassalotti
- Nadeem Vawda

Metadata-Version: 1.0

Name: setuptools

Version: 0.6c9

Summary: Download, build, install, upgrade, and uninstall Python packages -- easily!

Home-page: <http://pypi.org/pypi/setuptools>

Author: Phillip J. Eby

Author-email: [distutils-sig@python.org](mailto:distutils-sig@python.org)

License: PSF or ZPL

Description: =====

Installing and Using Setuptools

=====

.. contents:: \*\*Table of Contents\*\*

-----  
Installation Instructions  
-----

Windows  
=====

Install setuptools using the provided ``.exe`` installer. If you've previously installed older versions of setuptools, please delete all ``setuptools\*.egg`` and ``setuptools.pth`` files from your system's ``site-packages`` directory (and any other ``sys.path`` directories) FIRST.

If you are upgrading a previous version of setuptools that was installed using an ``.exe`` installer, please be sure to also *\*uninstall that older version\** via your system's "Add/Remove Programs" feature, BEFORE installing the newer version.

Once installation is complete, you will find an ``easy\_install.exe`` program in your Python ``Scripts`` subdirectory. Be sure to add this directory to your ``PATH`` environment variable, if you haven't already done so.

RPM-Based Systems  
=====

Install setuptools using the provided source RPM. The included ``.spec`` file assumes you are installing using the default ``python`` executable, and is not

specific to a particular Python version. The ``easy\_install`` executable will be installed to a system ``bin`` directory such as ``/usr/bin``.

If you wish to install to a location other than the default Python installation's default ``site-packages`` directory (and ``\$prefix/bin`` for scripts), please use the ``.egg``-based installation approach described in the following section.

Cygwin, Mac OS X, Linux, Other

=====

1. Download the appropriate egg for your version of Python (e.g. ``setuptools-0.6c9-py2.4.egg``). Do NOT rename it.
2. Run it as if it were a shell script, e.g. ``sh setuptools-0.6c9-py2.4.egg``. Setuptools will install itself using the matching version of Python (e.g. ``python2.4``), and will place the ``easy\_install`` executable in the default location for installing Python scripts (as determined by the standard distutils configuration files, or by the Python installation).

If you want to install setuptools to somewhere other than ``site-packages`` or your default distutils installation locations for libraries and scripts, you may include EasyInstall command-line options such as ``--prefix``, ``--install-dir``, and so on, following the ``.egg`` filename on the same command line. For example::

```
sh setuptools-0.6c9-py2.4.egg --prefix=~
```

You can use ``--help`` to get a full options list, but we recommend consulting the `EasyInstall manual`\_ for detailed instructions, especially the section on custom installation locations`\_.

.. \_EasyInstall manual: <http://peak.telecommunity.com/DevCenter/EasyInstall>  
.. \_the section on custom installation locations: <http://peak.telecommunity.com/DevCenter/EasyInstall#custom-installation-locations>

Cygwin Note

-----

If you are trying to install setuptools for the **Windows** version of Python (as opposed to the Cygwin version that lives in ``/usr/bin``), you must make sure that an appropriate executable (``python2.3``, ``python2.4``, or ``python2.5``) is on your **Cygwin** ``PATH`` when invoking the egg. For example, doing the following at a Cygwin bash prompt will install setuptools

for the **\*\*Windows\*\*** Python found at ``C:\Python24``:

```
ln -s /cygdrive/c/Python24/python.exe python2.4
PATH=.:$PATH sh setuptools-0.6c9-py2.4.egg
rm python2.4
```

## Downloads

=====

All setuptools downloads can be found at the project's home page in the Python Package Index`. Scroll to the very bottom of the page to find the links.

.. the project's home page in the Python Package Index: <http://pypi.org/pypi/setuptools>

In addition to the PyPI downloads, the development version of ``setuptools`` is available from the `Python SVN sandbox`, and in-development versions of the `0.6 branch` are available as well.

.. 0.6 branch: <http://svn.python.org/projects/sandbox/branches/setuptools-0.6/#egg=setuptools-dev06>

.. Python SVN sandbox: <http://svn.python.org/projects/sandbox/trunk/setuptools/#egg=setuptools-dev>

-----

## Using

### Setuptools and EasyInstall

-----

Here are some of the available manuals, tutorials, and other resources for learning about Setuptools, Python Eggs, and EasyInstall:

- \* `The EasyInstall user's guide and reference manual`\_
- \* `The setuptools Developer's Guide`\_
- \* `The pkg\_resources API reference`\_
- \* `Package Compatibility Notes`\_ (user-maintained)
- \* `The Internal Structure of Python Eggs`\_

Questions, comments, and bug reports should be directed to the `distutils-sig mailing list`. If you have written (or know of) any tutorials, documentation, plug-ins, or other resources for setuptools users, please let us know about them there, so this reference list can be updated. If you have working, \*tested\* patches to correct problems or add features, you may submit them to the `setuptools bug tracker`\_.

.. setuptools bug tracker: <http://bugs.python.org/setuptools/>

.. Package Compatibility Notes: <http://peak.telecommunity.com/DevCenter/PackageNotes>

.. The Internal Structure of Python Eggs: <http://peak.telecommunity.com/DevCenter/EggFormats>

.. The setuptools Developer's Guide: <http://peak.telecommunity.com/DevCenter/setuptools>

.. \_The pkg\_resources API reference: <http://peak.telecommunity.com/DevCenter/PkgResources>  
.. \_The EasyInstall user's guide and reference manual: <http://peak.telecommunity.com/DevCenter/EasyInstall>  
.. \_distutils-sig mailing list: <http://mail.python.org/pipermail/distutils-sig/>

-----  
Credits  
-----

\* The original design for the ``.egg`` format and the ``pkg\_resources`` API was co-created by Phillip Eby and Bob Ippolito. Bob also implemented the first version of ``pkg\_resources``, and supplied the OS X operating system version compatibility algorithm.

\* Ian Bicking implemented many early "creature comfort" features of easy\_install, including support for downloading via Sourceforge and Subversion repositories. Ian's comments on the Web-SIG about WSGI application deployment also inspired the concept of "entry points" in eggs, and he has given talks at PyCon and elsewhere to inform and educate the community about eggs and setuptools.

\* Jim Fulton contributed time and effort to build automated tests of various aspects of ``easy\_install``, and supplied the doctests for the command-line ``.exe`` wrappers on Windows.

\* Phillip J. Eby is the principal author and maintainer of setuptools, and first proposed the idea of an importable binary distribution format for Python application plug-ins.

\* Significant parts of the implementation of setuptools were funded by the Open Source Applications Foundation, to provide a plug-in infrastructure for the Chandler PIM application.

In addition, many OSAF staffers (such as Mike "Code Bear" Taylor) contributed their time and stress as guinea pigs for the use of eggs and setuptools, even before eggs were "cool". (Thanks, guys!)

Keywords: CPAN PyPI distutils eggs package management

Platform: UNKNOWN

Classifier: Development Status :: 3 - Alpha

Classifier: Intended Audience :: Developers

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Classifier: Programming Language :: Python

Classifier: Topic :: Software Development :: Libraries :: Python Modules

Classifier: Topic :: System :: Archiving :: Packaging

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## 1.58 openssh-sftp-server 9.9\_p2-r0

### 1.58.1 Notifications :

This product includes software developed by the OpenSSL Project for use in the OpenSSL Toolkit (<http://www.openssl.org/>)

This product includes cryptographic software written by Eric Young ([eyay@cryptsoft.com](mailto:eyay@cryptsoft.com)).

This product includes software written by Tim Hudson ([tjh@cryptsoft.com](mailto:tjh@cryptsoft.com)).

### 1.58.2 Available under license :

```
# Contributor: Patrycja Rosa <alpine@ptrcnll.me>
# Maintainer: Patrycja Rosa <alpine@ptrcnll.me>
pkgname=bsd-compat-headers
pkgver=0.7.2
pkgrel=6
pkgdesc="BSD compatibility headers (cdefs, queue, tree)"
url="https://gitlab.alpinelinux.org/alpine/aports"
arch="noarch"
license="BSD-2-Clause AND BSD-3-Clause"
source="
cdefs.h
queue.h
tree.h
"
```



```

builddir="$srcdir"
options="!check" # just headers

package() {
    mkdir -p "$pkgdir"
    install -Dm644 -t "$pkgdir"/usr/include/sys \
        cdefs.h queue.h tree.h
}
sha512sums="
37c8fc73c7aea7b490f7850927e2bb91d12137c9e59e22c084146d515696dbc7973b5de92f4c987ba080dd2502ba8312
7006442c3f019b6447a620c0cae73178 cdefs.h
2f0d5e6e4dc3350285cf17009265dddcbe12431c111868eea39bc8cb038ab7c1f2acacbb21735c4e9d4a1fd106a8fc0f86
11ea33987d4faba37dde5ce6da0750 queue.h
d9ac210d81feb8ad2655bc80fb065d3fe20ae4417b32b4a1711e6738a4870140005c13373b5d1846ef3ce5ae6da45f2da
cef2092881eded0a2e94f6a07752ef3 tree.h
"

```

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 The X-Spline code was written Carole Blanc (blanc@labri.u-bordeaux.fr) and Christophe Schlick (schlick@labri.u-bordeaux.fr) starting from an initial implementation done by C. Feuille, S. Grosbois, L. Maziere and L. Minihot as a student practice (Universite Bordeaux, France). For additional information about X-splines, see:  
 "X-Splines: A Spline Model Designed for the End User" by C. Blanc and C. Schlick, Proceedings of SIGGRAPH'95  
<http://dept-info.labri.u-bordeaux.fr/~schlick/DOC/sig1.html>  
 # Automatically generated by apkbuild-cpan, template 4  
 # Contributor: Valery Kartel <valery.kartel@gmail.com>  
 # Maintainer: Celeste <cielesti@protonmail.com>

```

maintainer="Celeste <cielesti@protonmail.com>"
pkgname=perl-bsd-resource
pkgver=1.2911
pkgrel=10
#_pkgreal is used by apkbuild-cpan to find modules at MetaCpan
_pkgreal=BSD-Resource
pkgdesc="Perl extension implements the BSD process resource limit functions"
url="https://metacpan.org/release/BSD-Resource/"
arch="all"
license="Artistic-2.0 OR LGPL-2.0"
depends="perl"
makedepends="perl-dev"
subpackages="$pkgname-doc"
source="https://cpan.metacpan.org/authors/id/J/JH/JHI/BSD-Resource-$pkgver.tar.gz"
builddir="$srcdir/${_pkgreal}-${pkgver}"

build() {
    export CFLAGS=$(perl -MConfig -E 'say $Config{ccflags}')
    PERL_MM_USE_DEFAULT=1 perl -I. Makefile.PL \
        INSTALLDIRS=vendor \
        NO_PACKLIST=1 \
        NO_PERLLOCAL=1
    make
}

check() {
    export CFLAGS=$(perl -MConfig -E 'say $Config{ccflags}')
    make test
}

package() {
    make DESTDIR="$pkgdir" install
}

sha512sums="
d0032d41c7c0468ed1c6d8f57b885f6cb97a5039d754c8cb60b2067daedaf53bd15fb6561a3d0f828df16dfa5417f663b
8065ba65f4fea16dc9262728b3b6b85
    BSD-Resource-1.2911.tar.gz
"

# Contributor: Fabian Affolter <fabian@affolter-engineering.ch>
# Maintainer: Fabian Affolter <fabian@affolter-engineering.ch>
pkgname=py3-flake8-copyright
_pkgname=flake8-copyright
pkgver=0.2.4
pkgrel=3
pkgdesc="Extension for flake8 which checks for copyrights"
options="!check" # No testsuite
url="https://github.com/savoirfairelinux/flake8-copyright"

```

```

arch="noarch"
license="MIT"
depends="py3-flake8 py3-setuptools"
makedepends="py3-gpep517 py3-wheel"
subpackages="$pkgname-pyc"
source="https://files.pythonhosted.org/packages/source/${_pkgname:0:1}/${_pkgname}/${_pkgname}-${pkgver}.tar.gz"
builddir="$srcdir"/$_pkgname-$pkgver

replaces="py-flake8-copyright"          # Backwards compatibility
provides="py-flake8-copyright=$pkgver-r$pkgrel" # Backwards compatibility

build() {
    gpep517 build-wheel \
        --wheel-dir .dist \
        --output-fd 3 3>&1 >&2
}

package() {
    gpep517 install-wheel --destdir "$pkgdir" \
        .dist/*.whl
}

sha512sums="
a6ab47e1bb715618f075c51f398e18180404871b3b0faf1c2d30701d5203db6bc23771bf22ffb5bafcd8ee856b9b64237
b316bd503ae7dceed6ca284ccd5a74d
    flake8-copyright-0.2.4.tar.gz
"

# Contributor: Dhruvin Gandhi <contact@dhruvin>
# Maintainer: Patrycja Rosa <alpine@ptrcnull.me>
pkgname=py3-license-expression
_pkgname=license_expression
pkgver=30.4.0
pkgrel=0
pkgdesc="Library to parse, compare, simplify and normalize license expressions"
url="https://github.com/nexB/license-expression"
arch="noarch"
license="Apache-2.0"
depends="python3 py3-boolean.py"
makedepends="py3-setuptools py3-setuptools_scm py3-gpep517 py3-wheel"
checkdepends="py3-pytest py3-pytest-xdist"
subpackages="$pkgname-pyc"
source="https://files.pythonhosted.org/packages/source/l/${_pkgname}/${_pkgname}-${pkgver}.tar.gz"
builddir="$srcdir"/$_pkgname-$pkgver

build() {
    gpep517 build-wheel \
        --wheel-dir .dist \
        --output-fd 3 3>&1 >&2
}

```

```

}

check() {
python3 -m venv --clear --without-pip --system-site-packages .testenv
.testenv/bin/python3 -m installer .dist/*.whl
.testenv/bin/python3 -m pytest
}

package() {
python3 -m installer -d "$pkgdir" \
.dists/*.whl
}

sha512sums="
cc7cd6b5bd8ea4c99b66f074871ffd7cc78b3e8b1b0d3afd9b95efdb7147c8293db2fac977d684fc34d3d60bd79066a06
dc2bff0a38b130d9d83c63538502db1
license_expression-30.4.0.tar.gz
"

Vintage Dreams Waves v 2.0. for Creative Labs' AWE Soundcards
(EMU Soundfont 2 Format)

```

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[vintagedreamworks@hotmail.com](mailto:vintagedreamworks@hotmail.com)

<http://www.geocities.com/SiliconValley/Campus/8645/index.html>

<http://members.nbci.com/silicon39/>

<http://www.mp3.com/silicon39>

<https://analoguesque.x10host.com/>

# Contributor: Carlo Landmeter <[clandmeter@alpinelinux.org](mailto:clandmeter@alpinelinux.org)>

# Maintainer: Kevin Daudt <[kdaudt@alpinelinux.org](mailto:kdaudt@alpinelinux.org)>

pkgname=spdx-licenses

pkgver=3.24.0

pkgrel=0

pkgdesc="Various data formats for the SPDX License List"

url="https://spdx.org/"

arch="noarch"

options="!check" # no test suite

```

license="CC-BY-3.0"
source="license-list-data-$pkgver.tar.gz::https://github.com/spdx/license-list-data/archive/v$pkgver.tar.gz"
builddir="$srcdir/license-list-data-$pkgver"
subpackages="$pkgname-list"

_types="html json rdfa rdft rdfturtle rdFXML template text"

for type in $_types; do
    subpackages="$subpackages $pkgname-$type:_subpkg"
done

package() {
    mkdir -p "$pkgdir"
}

_subpkg() {
    local type=${subpkgname/$pkgname-/}
    pkgdesc="$pkgdesc ($type)"
    install_if="$pkgname=$pkgver-r$pkgrel"
    mkdir -p "$subpkgdir"/usr/share/spdx
    cp -r "$builddir"/$type "$subpkgdir"/usr/share/spdx/
}

list() {
    pkgdesc="$pkgdesc (licence list)"
    mkdir -p "$subpkgdir"/usr/share/spdx
    local i; for i in "$builddir"/text/*.txt;
    do
        local license=${i##*/}
        echo ${license%.*} >> "$subpkgdir"/usr/share/spdx/license.lst
    done
}

sha512sums="
6eb81424e1b3173dbd8e17859b2e15dfe1c2af8f4da59b7dad0729c038a4cbdba95c34c2c546285fcdbbd41562e39575e
6a6ebb9463b70121e0a12b99d1307e7  license-list-data-3.24.0.tar.gz
"

```

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- DES is now external, in the OpenSSL library
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- Zlib is now external, in a library
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\* @version 3.0 (December 2000)

\*

\* Optimised ANSI C code for the Rijndael cipher (now AES)

\*

\* @author Vincent Rijmen <vincent.rijmen@esat.kuleuven.ac.be>

\* @author Antoon Bosselaers <antoon.bosselaers@esat.kuleuven.ac.be>

\* @author Paulo Barreto <paulo.barreto@terra.com.br>

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## 1.59 openssl-server-common 9.9\_p2-r0

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```
# Contributor: Patrycja Rosa <alpine@ptrcnull.me>
# Maintainer: Patrycja Rosa <alpine@ptrcnull.me>
pkgname=bsd-compat-headers
pkgver=0.7.2
pkgrel=6
pkgdesc="BSD compatibility headers (cdefs, queue, tree)"
url="https://gitlab.alpinelinux.org/alpine/aports"
arch="noarch"
license="BSD-2-Clause AND BSD-3-Clause"
source=""
cdefs.h
queue.h
tree.h
"

builddir="$srcdir"
options="!check" # just headers

package() {
    mkdir -p "$pkgdir"
    install -Dm644 -t "$pkgdir"/usr/include/sys \
        cdefs.h queue.h tree.h
}
sha512sums="
37c8fc73c7aea7b490f7850927e2bb91d12137c9e59e22c084146d515696dbc7973b5de92f4c987ba080dd2502ba8312
7006442c3f019b6447a620c0cae73178 cdefs.h
2f0d5e6e4dc3350285cf17009265dddcbe12431c111868eea39bc8cb038ab7c1f2acacbb21735c4e9d4a1fd106a8fc0f86
11ea33987d4faba37dde5ce6da0750 queue.h
d9ac210d81feb8ad2655bc80fb065d3fe20ae4417b32b4a1711e6738a4870140005c13373b5d1846ef3ce5ae6da45f2da
cef2092881eded0a2e94f6a07752ef3 tree.h
"

# Contributor: Fabian Affolter <fabian@affolter-engineering.ch>
# Maintainer: Fabian Affolter <fabian@affolter-engineering.ch>
pkgname=py3-flake8-copyright
_pkgname=flake8-copyright
pkgver=0.2.4
pkgrel=3
pkgdesc="Extension for flake8 which checks for copyrights"
options="!check" # No testsuite
url="https://github.com/savoirfairelinux/flake8-copyright"
arch="noarch"
license="MIT"
depends="py3-flake8 py3-setuptools"
makedepends="py3-gpep517 py3-wheel"
subpackages="$pkgname-pyc"
source="https://files.pythonhosted.org/packages/source/${_pkgname:0:1}/${_pkgname}/${_pkgname}-${pkgver}.tar.gz"
builddir="$srcdir"/$_pkgname-$pkgver
```

```

replaces="py-flake8-copyright"          # Backwards compatibility
provides="py-flake8-copyright=$pkgver-r$pkgrel" # Backwards compatibility

build() {
    gpep517 build-wheel \
        --wheel-dir .dist \
        --output-fd 3 3>&1 >&2
}

package() {
    gpep517 install-wheel --destdir "$pkgdir" \
        .dist/*.whl
}

sha512sums="
a6ab47e1bb715618f075c51f398e18180404871b3b0faf1c2d30701d5203db6bc23771bf22ffb5bafcd8ee856b9b64237
b316bd503ae7dceed6ca284ccd5a74d
    flake8-copyright-0.2.4.tar.gz
"

# Maintainer: fossdd <fossdd@pwned.life>
pkgname=cargo-license
pkgver=0.6.1
pkgrel=1
pkgdesc="Cargo subcommand to see license of dependencies"
url="https://github.com/onur/cargo-license"
arch="all"
license="MIT"
makedepends="cargo cargo-auditable"
source="$pkgname-$pkgver.tar.gz::https://crates.io/api/v1/crates/cargo-license/$pkgver/download"

prepare() {
    default_prepare

    cargo fetch --target="$CTARGET" --locked
}

build() {
    cargo auditable build --release --frozen
}

check() {
    cargo test --frozen
}

package() {
    install -Dm755 target/release/cargo-license -t "$pkgdir"/usr/bin
}

```



```

sha512sums="
36215145e79965be090ae2f5ce6f5eb208465eb67a94c26bed1fe70a131c46c6dc35695e30852759b7366883fbc3caf00
272d796ac634f0a5e1d49232b6b29d5 cargo-license-0.6.1.tar.gz
"

# Contributor: Maxim Karasev <begs@disroot.org>
# Maintainer: mio <miyopan@e.email>
pkgname=bsd-games
pkgver=3.3
pkgrel=2
pkgdesc="traditional text mode games from BSD"
url="https://bsd-games.sourceforge.io/"
arch="all"
license="BSD-3-Clause"
install="$pkgname.post-install"
makedepends="ncurses-dev coreutils" # configure causes busybox expr error
subpackages="$pkgname-doc"
source="https://sourceforge.net/projects/bsd-games/files/bsd-games-$pkgver.tar.gz
0001-bsd-games-scores-dir.patch
"

options="!check" # no tests

build() {
# some GNU autoconf options are ignored, but it works
./configure \
--build=$CBUILD \
--host=$CHOST \
--prefix=/usr \
--sysconfdir=/etc \
--mandir=/usr/share/man \
--scoredir=/usr/share/$pkgname
make
}

package() {
make DESTDIR="$pkgdir" install
install -Dm644 LICENSE "$pkgdir"/usr/share/licenses/bsd-games/LICENSE
}

sha512sums="
aaf36d09d4fe68514a5c279063d7e77a9a9a84c447037cba974b29faa07eb80c2aab2379d0699c196b5c27ffe1b2bb2c6
8d3390143e0e62d5e3d210ccfb61294
bsd-games-3.3.tar.gz
e1def0d4835a877242c4173fae862e278a7858738e0bacacbb045a42bcabec2aa7c72d000bbd2421ce35fe66cdc1f52c0
577b7e278029ca5ed50f7aab22319f6 0001-bsd-games-scores-dir.patch
"

Vintage Dreams Waves v 2.0. for Creative Labs' AWE Soundcards
(EMU Soundfont 2 Format)

```

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[vintagedreamworks@hotmail.com](mailto:vintagedreamworks@hotmail.com)

<http://www.geocities.com/SiliconValley/Campus/8645/index.html>

<http://members.nbc.com/silicon39/>

<http://www.mp3.com/silicon39>

<https://analoguesque.x10host.com/>

mini\_sendmail - accept email on behalf of real sendmail

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# Maintainer: Natanael Copa <ncopa@alpinelinux.org>

pkgname=libart-lgpl

pkgver=2.3.21

pkgrel=8

```

pkgdesc="A library for high-performance 2D graphics"
url="https://www.levien.com/libart/"
arch="all"
options="!check" # No test suite.
license="LGPL-2.0-or-later"
subpackages="$pkgname-dev"
source="https://download.gnome.org/sources/libart_lgpl/2.3/libart_lgpl-$pkgver.tar.bz2"
"

```

```

builddir="$srcdir"/libart_lgpl-$pkgver

```

```

prepare() {
    update_config_sub
    default_prepare
}

```

```

build() {
    ./configure \
        --build=$CBUILD \
        --host=$CHOST \
        --prefix=/usr
    make
}

```

```

package() {
    make DESTDIR="$pkgdir" install
}

```

```

sha512sums="8a632a6a4da59e5e8c02ec2f5a57e36d182b325b46513765425e5f171ff9ae326af1b133725beba28f7e7
6654309e001aee9bace727b5b4c8589405256a3c020 libart_lgpl-2.3.21.tar.bz2"

```

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```
<one line to give the program's name and a brief idea of what it does.>  
Copyright (C) <year> <name of author>
```

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```
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This is free software, and you are welcome to redistribute  
it  
under certain conditions; type `show c' for details.
```

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<signature of Ty Coon>, 1 April 1989

Ty Coon, President of Vice

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The

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## 1.62 fdisk 2.40.4-r1

### 1.62.1 Available under license :

|   | NR    | START | END  | SECTORS | SIZE        | NAME | UUID |
|---|-------|-------|------|---------|-------------|------|------|
| 1 | 32    | 7679  | 7648 | 3.7M    | 8f8378c0-01 |      |      |
| 2 | 7680  | 16383 | 8704 | 4.3M    | 8f8378c0-02 |      |      |
| 5 | 7936  | 12799 | 4864 | 2.4M    |             |      |      |
| 6 | 12544 | 16127 | 3584 | 1.8M    |             |      |      |

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Version 2.1, February 1999

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| 1 | 32    | 7679  | 7648 | 3.7M    |      | 8f8378c0-01 |      |
| 2 | 7680  | 16383 | 8704 | 4.3M    |      | 8f8378c0-02 |      |
| 5 | 7936  | 12799 | 4864 | 2.4M    |      |             |      |
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```

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## 1.64 findmnt 2.40.4-r1

### 1.64.1 Available under license :

```
NR START  END SECTORS SIZE NAME UUID
1  32 7679  7648 3.7M   8f8378c0-01
2 7680 16383  8704 4.3M   8f8378c0-02
5 7936 12799  4864 2.4M
6 12544 16127  3584 1.8M
```

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To do so, attach the following notices to the program. It is safest to attach them to the start of each source file to most effectively convey the exclusion of warranty; and each file should have at least the "copyright" line and a pointer to where the full notice is found.

```
<one line to give the program's name and a brief idea of what it does.>  
Copyright (C) <year> <name of author>
```

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```
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Gnomovision comes with ABSOLUTELY NO WARRANTY; for details type `show w'.  
This is free software, and you are welcome to redistribute  
it  
under certain conditions; type `show c' for details.
```

The hypothetical commands `show w' and `show c' should show the appropriate parts of the General Public License. Of course, the commands you use may



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<signature of Ty Coon>, 1 April 1989

Ty Coon, President of Vice

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Version 2.1, February 1999

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the work with the complete corresponding

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## 1.65 partx 2.40.4-r1

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|---|-------|-------|------|---------|------|-------------|------|
| 1 | 32    | 7679  | 7648 | 3.7M    |      | 8f8378c0-01 |      |
| 2 | 7680  | 16383 | 8704 | 4.3M    |      | 8f8378c0-02 |      |
| 5 | 7936  | 12799 | 4864 | 2.4M    |      |             |      |
| 6 | 12544 | 16127 | 3584 | 1.8M    |      |             |      |

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Version 3, 29 June 2007

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Finally, every program is threatened constantly by software patents. States should not allow patents to restrict development and use of software on general-purpose computers, but in those that do, we wish to avoid the special danger that patents applied to a free program could make it effectively proprietary. To prevent this, the GPL assures that patents cannot be used to render the program non-free.

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#### 1. Source Code.

The "source code" for a work means the preferred form of the work for making modifications to it. "Object code" means any non-source form of a work.

A "Standard Interface" means an interface that either is an official standard defined by a recognized standards body, or, in the case of interfaces specified for a particular programming language, one that

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```
Gnomovision version 69, Copyright (C) year name of author
Gnomovision comes with ABSOLUTELY NO WARRANTY; for details type `show w'.
This is free software, and you are welcome to redistribute
it
under certain conditions; type `show c' for details.
```

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```
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`Gnomovision' (which makes passes at compilers) written by James Hacker.
```

```
<signature of Ty Coon>, 1 April 1989
Ty Coon, President of Vice
```

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## 1.66 agetty 2.40.4-r1

### 1.66.1 Available under license :

|   | NR    | START | END  | SECTORS | SIZE | NAME | UUID        |
|---|-------|-------|------|---------|------|------|-------------|
| 1 | 32    | 7679  | 7648 | 3.7M    |      |      | 8f8378c0-01 |
| 2 | 7680  | 16383 | 8704 | 4.3M    |      |      | 8f8378c0-02 |
| 5 | 7936  | 12799 | 4864 | 2.4M    |      |      |             |
| 6 | 12544 | 16127 | 3584 | 1.8M    |      |      |             |

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Version 3, 29 June 2007

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| 2 | 7680  | 16383 | 8704 | 4.3M    |      | 8f8378c0-02 |      |
| 5 | 7936  | 12799 | 4864 | 2.4M    |      |             |      |
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# 1.68 sfdisk 2.40.4-r1

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```
NR START  END SECTORS SIZE NAME UUID
1  32 7679   7648 3.7M   8f8378c0-01
2 7680 16383  8704 4.3M   8f8378c0-02
5 7936 12799  4864 2.4M
6 12544 16127 3584 1.8M
```

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|   | NR    | START | END  | SECTORS | SIZE | NAME        | UUID |
|---|-------|-------|------|---------|------|-------------|------|
| 1 | 32    | 7679  | 7648 | 3.7M    |      | 8f8378c0-01 |      |
| 2 | 7680  | 16383 | 8704 | 4.3M    |      | 8f8378c0-02 |      |
| 5 | 7936  | 12799 | 4864 | 2.4M    |      |             |      |
| 6 | 12544 | 16127 | 3584 | 1.8M    |      |             |      |

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| 1  | 32    | 7679  | 7648    | 3.7M |      | 8f8378c0-01 |
| 2  | 7680  | 16383 | 8704    | 4.3M |      | 8f8378c0-02 |
| 5  | 7936  | 12799 | 4864    | 2.4M |      |             |
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# 1.71 runuser 2.40.4-r1

## 1.71.1 Available under license :

|   | NR    | START | END  | SECTORS | SIZE | NAME        | UUID |
|---|-------|-------|------|---------|------|-------------|------|
| 1 | 32    | 7679  | 7648 | 3.7M    |      | 8f8378c0-01 |      |
| 2 | 7680  | 16383 | 8704 | 4.3M    |      | 8f8378c0-02 |      |
| 5 | 7936  | 12799 | 4864 | 2.4M    |      |             |      |
| 6 | 12544 | 16127 | 3584 | 1.8M    |      |             |      |

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### 1.72.1 Available under license :

```
NR START  END SECTORS SIZE NAME UUID
1  32 7679  7648 3.7M   8f8378c0-01
2 7680 16383  8704 4.3M   8f8378c0-02
5 7936 12799  4864 2.4M
6 12544 16127  3584 1.8M
```

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```
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```

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## 1.73 libmount 2.40.4-r1

### 1.73.1 Available under license :

```
NR START  END SECTORS SIZE NAME UUID
1  32 7679  7648 3.7M   8f8378c0-01
2 7680 16383  8704 4.3M   8f8378c0-02
5 7936 12799  4864 2.4M
6 12544 16127  3584 1.8M
```

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```
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## 1.74 setarch 2.40.4-r1

### 1.74.1 Available under license :

|   | NR    | START | END  | SECTORS | SIZE | NAME | UUID        |
|---|-------|-------|------|---------|------|------|-------------|
| 1 | 32    | 7679  | 7648 | 3.7M    |      |      | 8f8378c0-01 |
| 2 | 7680  | 16383 | 8704 | 4.3M    |      |      | 8f8378c0-02 |
| 5 | 7936  | 12799 | 4864 | 2.4M    |      |      |             |
| 6 | 12544 | 16127 | 3584 | 1.8M    |      |      |             |

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```
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2 7680 16383  8704 4.3M   8f8378c0-02
5 7936 12799  4864 2.4M
6 12544 16127 3584 1.8M
```

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```
NR START  END SECTORS SIZE NAME UUID
1  32 7679   7648 3.7M   8f8378c0-01
2 7680 16383  8704 4.3M   8f8378c0-02
5 7936 12799  4864 2.4M
6 12544 16127 3584 1.8M
```

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```
NR START  END SECTORS SIZE NAME UUID
1  32 7679  7648 3.7M   8f8378c0-01
2 7680 16383  8704 4.3M   8f8378c0-02
5 7936 12799  4864 2.4M
6 12544 16127  3584 1.8M
```

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## 1.78 liblastlog2 2.40.4-r1

### 1.78.1 Available under license :

|   | NR    | START | END  | SECTORS | SIZE | NAME        | UUID |
|---|-------|-------|------|---------|------|-------------|------|
| 1 | 32    | 7679  | 7648 | 3.7M    |      | 8f8378c0-01 |      |
| 2 | 7680  | 16383 | 8704 | 4.3M    |      | 8f8378c0-02 |      |
| 5 | 7936  | 12799 | 4864 | 2.4M    |      |             |      |
| 6 | 12544 | 16127 | 3584 | 1.8M    |      |             |      |

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```
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1  32 7679   7648 3.7M   8f8378c0-01
2 7680 16383  8704 4.3M   8f8378c0-02
5 7936 12799  4864 2.4M
6 12544 16127 3584 1.8M
```

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## 1.80 blkid 2.40.4-r1

### 1.80.1 Available under license :

|   | NR    | START | END  | SECTORS | SIZE | NAME        | UUID |
|---|-------|-------|------|---------|------|-------------|------|
| 1 | 32    | 7679  | 7648 | 3.7M    |      | 8f8378c0-01 |      |
| 2 | 7680  | 16383 | 8704 | 4.3M    |      | 8f8378c0-02 |      |
| 5 | 7936  | 12799 | 4864 | 2.4M    |      |             |      |
| 6 | 12544 | 16127 | 3584 | 1.8M    |      |             |      |

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```

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## 1.81 setpriv 2.40.4-r1

### 1.81.1 Available under license :

```
NR START  END SECTORS SIZE NAME UUID
1  32 7679   7648 3.7M   8f8378c0-01
2 7680 16383  8704 4.3M   8f8378c0-02
5 7936 12799  4864 2.4M
6 12544 16127 3584 1.8M
```

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## 1.82 hexdump 2.40.4-r1

### 1.82.1 Available under license :

|   | NR    | START | END  | SECTORS | SIZE | NAME        | UUID |
|---|-------|-------|------|---------|------|-------------|------|
| 1 | 32    | 7679  | 7648 | 3.7M    |      | 8f8378c0-01 |      |
| 2 | 7680  | 16383 | 8704 | 4.3M    |      | 8f8378c0-02 |      |
| 5 | 7936  | 12799 | 4864 | 2.4M    |      |             |      |
| 6 | 12544 | 16127 | 3584 | 1.8M    |      |             |      |

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Version 3, 29 June 2007

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| 2 | 7680  | 16383 | 8704 | 4.3M    |      | 8f8378c0-02 |      |
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Version 2.1, February 1999

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```

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```
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NR START END SECTORS SIZE NAME UUID

|   |       |       |      |      |             |
|---|-------|-------|------|------|-------------|
| 1 | 32    | 7679  | 7648 | 3.7M | 8f8378c0-01 |
| 2 | 7680  | 16383 | 8704 | 4.3M | 8f8378c0-02 |
| 5 | 7936  | 12799 | 4864 | 2.4M |             |
| 6 | 12544 | 16127 | 3584 | 1.8M |             |

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it
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```

```
<signature of Ty Coon>, 1 April 1989
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# 1.85 mount 2.40.4-r1

## 1.85.1 Available under license :

```
NR START  END SECTORS SIZE NAME UUID
1  32 7679  7648 3.7M   8f8378c0-01
2 7680 16383  8704 4.3M   8f8378c0-02
5 7936 12799  4864 2.4M
6 12544 16127  3584 1.8M
```

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```
NR START  END SECTORS SIZE NAME UUID
1  32 7679  7648 3.7M   8f8378c0-01
2 7680 16383 8704 4.3M   8f8378c0-02
5 7936 12799 4864 2.4M
6 12544 16127 3584 1.8M
```

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# 1.87 umount 2.40.4-r1

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|---|-------|-------|------|---------|------|-------------|------|
| 1 | 32    | 7679  | 7648 | 3.7M    |      | 8f8378c0-01 |      |
| 2 | 7680  | 16383 | 8704 | 4.3M    |      | 8f8378c0-02 |      |
| 5 | 7936  | 12799 | 4864 | 2.4M    |      |             |      |
| 6 | 12544 | 16127 | 3584 | 1.8M    |      |             |      |

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it
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```
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```

```
<signature of Ty Coon>, 1 April 1989
Ty Coon, President of Vice
```

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## 1.88 llvm18-libs 18.1.8-r2

### 1.88.1 Available under license :

```
; NOTE: Assertions have been autogenerated by utils/update_llc_test_checks.py  
; RUN: llc < %s -mtriple=aarch64-- | FileCheck %s
```

```
; A shuffle mask with all undef elements is always legal.
```

```
define <4 x i32> @PR41535(<2 x i32> %p1, <2 x i32> %p2) {  
; CHECK-LABEL: PR41535:  
; CHECK:      // %bb.0:  
; CHECK-NEXT:  ext v0.8b, v0.8b, v1.8b, #4  
; CHECK-NEXT:  mov v0.d[1], v0.d[0]  
; CHECK-NEXT:  ret  
%cat1 = shufflevector <2 x i32> %p1, <2 x i32> undef, <4 x i32> <i32 undef, i32 1, i32 undef, i32 undef>  
%cat2 = shufflevector <2 x i32> %p2, <2 x i32> undef, <4 x i32> <i32 0, i32 undef, i32 undef, i32 undef>  
%r = shufflevector <4 x i32> %cat1, <4 x i32> %cat2, <4 x i32> <i32 undef, i32 undef, i32 1, i32 4>  
ret <4 x i32> %r
```

```

}
# RUN: llc -O0 -mtriple=m68k -start-after=prologuepillog -verify-machineinstrs %s -o - | FileCheck %s

name: is-pcrel-register-operand-legal
body:      |
bb.0.entry:
    ; CHECK: move.l (0,%pc,%a0), (%a1)
    ; CHECK: move.l (%a0), (0,%pc,%a1)

    MOV32jk $a1, 0, $a0, implicit-def $ccr
    MOV32kj 0, $a1, $a0, implicit-def $ccr
; NOTE: Assertions have been autogenerated by utils/update_llc_test_checks.py
; RUN: llc -mtriple=amdgcn -mcpu=fiji < %s | FileCheck -enable-var-scope --check-prefixes=GCN,GCN-
SAFE,VI,VI-SAFE %s
; RUN: llc -enable-no-signed-zeros-fp-math -mtriple=amdgcn -mcpu=fiji < %s | FileCheck -enable-var-scope --
check-prefixes=GCN,GCN-NSZ,VI,VI-NSZ %s

; -----
; rcp tests
; -----

define half @v_fneg_rcp_f16(half %a) #0 {
; GCN-LABEL: v_fneg_rcp_f16:
; GCN:      ; %bb.0:
; GCN-NEXT:  s_waitcnt vmcnt(0) expcnt(0) lgkmcnt(0)
; GCN-NEXT:  v_rcp_f16_e64 v0, -v0
; GCN-NEXT:  s_setpc_b64 s[30:31]
    %rcp = call half @llvm.amdgcn.rcp.f16(half %a)
    %fneg = fneg half %rcp
    ret half %fneg
}

define half @v_fneg_rcp_fneg_f16(half %a) #0 {
; GCN-LABEL: v_fneg_rcp_fneg_f16:
; GCN:      ; %bb.0:
; GCN-NEXT:  s_waitcnt vmcnt(0) expcnt(0) lgkmcnt(0)
; GCN-NEXT:
    v_rcp_f16_e32 v0, v0
; GCN-NEXT:  s_setpc_b64 s[30:31]
    %fneg.a = fneg half %a
    %rcp = call half @llvm.amdgcn.rcp.f16(half %fneg.a)
    %fneg = fneg half %rcp
    ret half %fneg
}

define { half, half } @v_fneg_rcp_store_use_fneg_f16(half %a) #0 {
; GCN-LABEL: v_fneg_rcp_store_use_fneg_f16:
; GCN:      ; %bb.0:

```



```

; GCN-NEXT:  s_waitcnt vmcnt(0) expcnt(0) lgkmcnt(0)
; GCN-NEXT:  v_rcp_f16_e32 v2, v0
; GCN-NEXT:  v_xor_b32_e32 v1, 0x8000, v0
; GCN-NEXT:  v_mov_b32_e32 v0, v2
; GCN-NEXT:  s_setpc_b64 s[30:31]
%fneg.a = fneg half %a
%rcp = call half @llvm.amdgcn.rcp.f16(half %fneg.a)
%fneg = fneg half %rcp
%insert.0 = insertvalue { half, half } poison, half %fneg, 0
%insert.1 = insertvalue { half, half } %insert.0, half %fneg.a, 1
ret { half, half } %insert.1
}

define { half, half } @v_fneg_rcp_multi_use_fneg_f16(half %a, half %c) #0 {
; GCN-LABEL: v_fneg_rcp_multi_use_fneg_f16:
; GCN:      ; %bb.0:
; GCN-NEXT:  s_waitcnt vmcnt(0) expcnt(0) lgkmcnt(0)
; GCN-NEXT:
    v_rcp_f16_e32 v2, v0
; GCN-NEXT:  v_mul_f16_e64 v1, -v0, v1
; GCN-NEXT:  v_mov_b32_e32 v0, v2
; GCN-NEXT:  s_setpc_b64 s[30:31]
%fneg.a = fneg half %a
%rcp = call half @llvm.amdgcn.rcp.f16(half %fneg.a)
%fneg = fneg half %rcp
%use1 = fmul half %fneg.a, %c
%insert.0 = insertvalue { half, half } poison, half %fneg, 0
%insert.1 = insertvalue { half, half } %insert.0, half %use1, 1
ret { half, half } %insert.1
}

; -----
; sin tests
; -----

define half @v_fneg_amdgcn_sin_f16(half %a) #0 {
; GCN-LABEL: v_fneg_amdgcn_sin_f16:
; GCN:      ; %bb.0:
; GCN-NEXT:  s_waitcnt vmcnt(0) expcnt(0) lgkmcnt(0)
; GCN-NEXT:  v_sin_f16_e64 v0, -v0
; GCN-NEXT:  s_setpc_b64 s[30:31]
%sin = call half @llvm.amdgcn.sin.f16(half %a)
%fneg = fneg half %sin
ret half %fneg
}

; -----
;

```

vintrp tests

; -----

```
define { float, float } @v_fneg_interp_p1_f16(float %a, float %b) #0 {
; GCN-LABEL: v_fneg_interp_p1_f16:
; GCN:      ; %bb.0:
; GCN-NEXT: s_waitcnt vmcnt(0) expcnt(0) lgkmcnt(0)
; GCN-NEXT: v_mul_f32_e64 v1, v0, -v1
; GCN-NEXT: s_mov_b32 m0, 0
; GCN-NEXT: s_setreg_imm32_b32 hwreg(HW_REG_MODE, 2, 2), 3
; GCN-NEXT: v_interp_p1ll_f16 v0, v1, attr0.x
; GCN-NEXT: v_interp_p1ll_f16 v1, v1, attr0.y
; GCN-NEXT: s_setpc_b64 s[30:31]
%mul = fmul float %a, %b
%fneg = fneg float %mul
%intrp0 = call float @llvm.amdgcn.interp.p1.f16(float %fneg, i32 0, i32 0, i1 false, i32 0)
%intrp1 = call float @llvm.amdgcn.interp.p1.f16(float %fneg, i32 1, i32 0, i1 false, i32 0)
%insert.0 = insertvalue { float, float } poison, float %intrp0, 0
%insert.1 = insertvalue { float, float } %insert.0, float %intrp1, 1
ret { float, float } %insert.1
}
```

```
define
{ half, half } @v_fneg_interp_p2_f16(float %a, float %b) #0 {
; GCN-LABEL: v_fneg_interp_p2_f16:
; GCN:      ; %bb.0:
; GCN-NEXT: s_waitcnt vmcnt(0) expcnt(0) lgkmcnt(0)
; GCN-NEXT: v_mul_f32_e64 v1, v0, -v1
; GCN-NEXT: v_mov_b32_e32 v2, 4.0
; GCN-NEXT: s_mov_b32 m0, 0
; GCN-NEXT: s_setreg_imm32_b32 hwreg(HW_REG_MODE, 2, 2), 3
; GCN-NEXT: v_interp_p2_f16 v0, v1, attr0.x, v2
; GCN-NEXT: v_interp_p2_f16 v1, v1, attr0.y, v2
; GCN-NEXT: s_setpc_b64 s[30:31]
%mul = fmul float %a, %b
%fneg = fneg float %mul
%intrp0 = call half @llvm.amdgcn.interp.p2.f16(float 4.0, float %fneg, i32 0, i32 0, i1 false, i32 0)
%intrp1 = call half @llvm.amdgcn.interp.p2.f16(float 4.0, float %fneg, i32 1, i32 0, i1 false, i32 0)
%insert.0 = insertvalue { half, half } poison, half %intrp0, 0
%insert.1 = insertvalue { half, half } %insert.0, half %intrp1, 1
ret { half, half } %insert.1
}
```

; -----

;

arithmetic.fence tests

; -----

```

; FIXME: Legalization/promote is broken
define half @v_fneg_arithmetic_fence_f16(half %a) #0 {
; GCN-LABEL: v_fneg_arithmetic_fence_f16:
; GCN:      ; %bb.0:
; GCN-NEXT:  ; ARITH_FENCE
; GCN-NEXT:  s_waitcnt vmcnt(0) expcnt(0) lgkmcnt(0)
; GCN-NEXT:  v_xor_b32_e32 v0, 0x8000, v0
; GCN-NEXT:  s_setpc_b64 s[30:31]
    %fence = call half @llvm.amdgcn.fence.f16(half %a)
    %fneg = fneg half %fence
    ret half %fneg
}

define half @v_fneg_arithmetic_fence_fmul_f16(half %a, half %b) #0 {
; GCN-LABEL: v_fneg_arithmetic_fence_fmul_f16:
; GCN:      ; %bb.0:
; GCN-NEXT:  s_waitcnt vmcnt(0) expcnt(0) lgkmcnt(0)
; GCN-NEXT:  v_mul_f16_e32 v0, v0, v1
; GCN-NEXT:  ; ARITH_FENCE
; GCN-NEXT:  v_xor_b32_e32 v0, 0x8000, v0
; GCN-NEXT:  s_setpc_b64 s[30:31]
    %mul = fmul half %a, %b
    %fence = call half @llvm.amdgcn.fence.f16(half %mul)
    %fneg = fneg half %fence
    ret half
    %fneg
}

declare half @llvm.amdgcn.rcp.f16(half) #1
declare half @llvm.amdgcn.sin.f16(half) #1
declare half @llvm.amdgcn.fence.f16(half) #1
declare float @llvm.amdgcn.interp.p1.f16(float, i32, i32, i1, i32) #0
declare half @llvm.amdgcn.interp.p2.f16(float, float, i32, i32, i1, i32) #0

attributes #0 = { nounwind "denormal-fp-math-f32"="preserve-sign,preserve-sign" }
attributes #1 = { nounwind readnone }
attributes #2 = { nounwind "unsafe-fp-math"="true" }
attributes #3 = { nounwind "no-signed-zeros-fp-math"="true" }
attributes #4 = { nounwind "amdgpu-ieee"="false" "denormal-fp-math-f32"="preserve-sign,preserve-sign" }
;; NOTE: These prefixes are unused and the list is autogenerated. Do not add tests below this line:
; GCN-NSZ: {{.*}}
; GCN-SAFE: {{.*}}
; VI: {{.*}}
; VI-NSZ: {{.*}}
; VI-SAFE: {{.*}}
; NOTE: Assertions have been autogenerated by utils/update_test_checks.py UTC_ARGS: --function-signature --
check-attributes --check-globals
; RUN: opt -aa-pipeline=basic-aa -passes=attributor -attributor-manifest-internal -attributor-annotate-decl-cs -S <

```

```
%s | FileCheck %s --check-prefixes=CHECK,TUNIT
; RUN: opt -aa-pipeline=basic-aa -passes=attributor-cgsccl-attributor-manifest-internal -attributor-annotate-decl-cs -
S < %s | FileCheck %s --check-prefixes=CHECK,CGSCC
; Test that we only promote arguments when the caller/callee have compatible
; function attributes.
```

```
target triple = "x86_64-unknown-linux-gnu"
```

```
; This should promote
define internal fastcc void @callee_avx512_legal512_prefer512_call_avx512_legal512_prefer512(ptr %arg, ptr
readonly %arg1) #0 {
;
; CHECK: Function Attrs: inlinehint mustprogress norecurse nosync nounwind willreturn memory(argmem:
readwrite) uwtable
; CHECK-LABEL: define {{[^\n]+}}@callee_avx512_legal512_prefer512_call_avx512_legal512_prefer512
; CHECK-SAME:
(ptr noalias nocapture norecurse noundef nonnull writeonly align 64 dereferenceable(64) [[ARG:%.*]], <8 x i64>
[[TMP0:%.*]]) #[[ATTR0:[0-9]+]] {
; CHECK-NEXT: bb:
; CHECK-NEXT: [[ARG1_PRIV:%.*]] = alloca <8 x i64>, align 64
; CHECK-NEXT: store <8 x i64> [[TMP0]], ptr [[ARG1_PRIV]], align 64
; CHECK-NEXT: [[TMP:%.*]] = load <8 x i64>, ptr [[ARG1_PRIV]], align 64
; CHECK-NEXT: store <8 x i64> [[TMP]], ptr [[ARG]], align 64
; CHECK-NEXT: ret void
;
bb:
%tmp = load <8 x i64>, ptr %arg1
store <8 x i64> %tmp, ptr %arg
ret void
}
```

```
define void @avx512_legal512_prefer512_call_avx512_legal512_prefer512(ptr %arg) #0 {
;
; TUNIT: Function Attrs: inlinehint mustprogress norecurse nosync nounwind willreturn memory(argmem:
readwrite) uwtable
; TUNIT-LABEL: define {{[^\n]+}}@avx512_legal512_prefer512_call_avx512_legal512_prefer512
; TUNIT-SAME: (ptr nocapture norecurse writeonly [[ARG:%.*]]) #[[ATTR0]] {
; TUNIT-NEXT: bb:
; TUNIT-NEXT: [[TMP:%.*]] = alloca <8 x i64>, align
32
; TUNIT-NEXT: [[TRUETMP2:%.*]] = alloca <8 x i64>, align 32
; TUNIT-NEXT: call void @llvm.memset.p0.i64(ptr noalias nocapture norecurse noundef nonnull writeonly align 32
dereferenceable(64) [[TMP]], i8 noundef 0, i64 noundef 32, i1 noundef false) #[[ATTR5:[0-9]+]]
; TUNIT-NEXT: [[TMP0:%.*]] = load <8 x i64>, ptr [[TMP]], align 64
; TUNIT-NEXT: call fastcc void @callee_avx512_legal512_prefer512_call_avx512_legal512_prefer512(ptr
noalias nocapture norecurse noundef nonnull writeonly align 64 dereferenceable(64) [[TRUETMP2]], <8 x i64>
[[TMP0]]) #[[ATTR6:[0-9]+]]
; TUNIT-NEXT: [[TRUETMP4:%.*]] = load <8 x i64>, ptr [[TRUETMP2]], align 64
```

```

; TUNIT-NEXT: store <8 x i64> [[TRUETMP4]], ptr [[ARG]], align 2
; TUNIT-NEXT: ret void
;
; CGSCC: Function Attrs: inlinehint mustprogress nofree norecurse nosync nounwind willreturn memory(argmem:
readwrite) uwtable
; CGSCC-LABEL: define {{{^@}+}}@avx512_legal512_prefer512_call_avx512_legal512_prefer512
; CGSCC-SAME: (ptr nocapture
nofree noundef nonnull writeonly align 2 dereferenceable(64) [[ARG:%.*]]) #[[ATTR0]] {
; CGSCC-NEXT: bb:
; CGSCC-NEXT: [[TMP:%.*]] = alloca <8 x i64>, align 32
; CGSCC-NEXT: [[TRUETMP2:%.*]] = alloca <8 x i64>, align 32
; CGSCC-NEXT: call void @llvm.memset.p0.i64(ptr noalias nocapture nofree noundef nonnull writeonly align 64
dereferenceable(64) [[TMP]], i8 noundef 0, i64 noundef 32, i1 noundef false) #[[ATTR5:[0-9]+]]
; CGSCC-NEXT: [[TMP0:%.*]] = load <8 x i64>, ptr [[TMP]], align 64
; CGSCC-NEXT: call fastcc void @callee_avx512_legal512_prefer512_call_avx512_legal512_prefer512(ptr
noalias nocapture nofree noundef nonnull writeonly align 64 dereferenceable(64) [[TRUETMP2]], <8 x i64>
[[TMP0]]) #[[ATTR6:[0-9]+]]
; CGSCC-NEXT: [[TRUETMP4:%.*]] = load <8 x i64>, ptr [[TRUETMP2]], align 64
; CGSCC-NEXT: store <8 x i64> [[TRUETMP4]], ptr [[ARG]], align 2
; CGSCC-NEXT: ret void
;
bb:
%tmp = alloca <8 x i64>, align 32
%tmp2 = alloca <8 x i64>, align 32
call void
@llvm.memset.p0.i64(ptr align 32 %tmp, i8 0, i64 32, i1 false)
call fastcc void @callee_avx512_legal512_prefer512_call_avx512_legal512_prefer512(ptr %tmp2, ptr %tmp)
%tmp4 = load <8 x i64>, ptr %tmp2, align 32
store <8 x i64> %tmp4, ptr %arg, align 2
ret void
}

; This should promote
define internal fastcc void @callee_avx512_legal512_prefer256_call_avx512_legal512_prefer256(ptr %arg, ptr
readonly %arg1) #1 {
;
; CHECK: Function Attrs: inlinehint mustprogress nofree norecurse nosync nounwind willreturn memory(argmem:
readwrite) uwtable
; CHECK-LABEL: define {{{^@}+}}@callee_avx512_legal512_prefer256_call_avx512_legal512_prefer256
; CHECK-SAME: (ptr noalias nocapture nofree noundef nonnull writeonly align 64 dereferenceable(64)
[[ARG:%.*]], <8 x i64> [[TMP0:%.*]]) #[[ATTR1:[0-9]+]] {
; CHECK-NEXT: bb:
; CHECK-NEXT: [[ARG1_PRIV:%.*]] = alloca <8 x i64>, align 64
; CHECK-NEXT: store <8 x i64> [[TMP0]], ptr [[ARG1_PRIV]], align 64
; CHECK-NEXT: [[TMP:%.*]] = load <8 x
i64>, ptr [[ARG1_PRIV]], align 64
; CHECK-NEXT: store <8 x i64> [[TMP]], ptr [[ARG]], align 64
; CHECK-NEXT: ret void

```

```

;
bb:
    %tmp = load <8 x i64>, ptr %arg1
    store <8 x i64> %tmp, ptr %arg
    ret void
}

define void @avx512_legal512_prefer256_call_avx512_legal512_prefer256(ptr %arg) #1 {
;
; TUNIT: Function Attrs: inlinehint mustprogress norecurse nosync nounwind willreturn memory(argmem:
readwrite) uwtable
; TUNIT-LABEL: define { {[^@]+} } @avx512_legal512_prefer256_call_avx512_legal512_prefer256
; TUNIT-SAME: (ptr nocapture norecurse writeonly [[ARG:%.*]]) #[[ATTR1]] {
; TUNIT-NEXT: bb:
; TUNIT-NEXT:    [[TMP:%.*]] = alloca <8 x i64>, align 32
; TUNIT-NEXT:    [[TRUETMP2:%.*]] = alloca <8 x i64>, align 32
; TUNIT-NEXT:    call void @llvm.memset.p0.i64(ptr noalias nocapture norecurse noundef nonnull writeonly align 32
dereferenceable(64) [[TMP]], i8 noundef 0, i64 noundef 32, i1 noundef false) #[[ATTR5]]
; TUNIT-NEXT:    [[TMP0:%.*]] = load <8 x i64>, ptr [[TMP]], align 64
; TUNIT-NEXT:
    call fastcc void @callee_avx512_legal512_prefer256_call_avx512_legal512_prefer256(ptr noalias nocapture
norecurse noundef nonnull writeonly align 64 dereferenceable(64) [[TRUETMP2]], <8 x i64> [[TMP0]]) #[[ATTR6]]
; TUNIT-NEXT:    [[TRUETMP4:%.*]] = load <8 x i64>, ptr [[TRUETMP2]], align 64
; TUNIT-NEXT:    store <8 x i64> [[TRUETMP4]], ptr [[ARG]], align 2
; TUNIT-NEXT:    ret void
;
; CGSCC: Function Attrs: inlinehint mustprogress norecurse nosync nounwind willreturn memory(argmem:
readwrite) uwtable
; CGSCC-LABEL: define { {[^@]+} } @avx512_legal512_prefer256_call_avx512_legal512_prefer256
; CGSCC-SAME: (ptr nocapture norecurse noundef nonnull writeonly align 2 dereferenceable(64) [[ARG:%.*]])
#[[ATTR1]] {
; CGSCC-NEXT: bb:
; CGSCC-NEXT:    [[TMP:%.*]] = alloca <8 x i64>, align 32
; CGSCC-NEXT:    [[TRUETMP2:%.*]] = alloca <8 x i64>, align 32
; CGSCC-NEXT:    call void @llvm.memset.p0.i64(ptr noalias nocapture norecurse noundef nonnull writeonly align 64
dereferenceable(64)
[[TMP]], i8 noundef 0, i64 noundef 32, i1 noundef false) #[[ATTR5]]
; CGSCC-NEXT:    [[TMP0:%.*]] = load <8 x i64>, ptr [[TMP]], align 64
; CGSCC-NEXT:    call fastcc void @callee_avx512_legal512_prefer256_call_avx512_legal512_prefer256(ptr
noalias nocapture norecurse noundef nonnull writeonly align 64 dereferenceable(64) [[TRUETMP2]], <8 x i64>
[[TMP0]]) #[[ATTR6]]
; CGSCC-NEXT:    [[TRUETMP4:%.*]] = load <8 x i64>, ptr [[TRUETMP2]], align 64
; CGSCC-NEXT:    store <8 x i64> [[TRUETMP4]], ptr [[ARG]], align 2
; CGSCC-NEXT:    ret void
;
bb:
    %tmp = alloca <8 x i64>, align 32
    %tmp2 = alloca <8 x i64>, align 32

```

```

call void @llvm.memset.p0.i64(ptr align 32 %tmp, i8 0, i64 32, i1 false)
call fastcc void @callee_avx512_legal512_prefer256_call_avx512_legal512_prefer256(ptr %tmp2, ptr %tmp)
%tmp4 = load <8 x i64>, ptr %tmp2, align 32
store <8 x i64> %tmp4, ptr %arg, align 2
ret void
}

; This should promote
define internal fastcc void @callee_avx512_legal512_prefer512_call_avx512_legal512_prefer256(ptr
%arg, ptr readonly %arg1) #1 {
;
; CHECK: Function Attrs: inlinehint mustprogress nofree norecurse nosync nounwind willreturn memory(argmem:
readwrite) uwtable
; CHECK-LABEL: define {{^[^@]+}}@callee_avx512_legal512_prefer512_call_avx512_legal512_prefer256
; CHECK-SAME: (ptr noalias nocapture nofree noundef nonnull writeonly align 64 dereferenceable(64)
[[ARG:%.*]], <8 x i64> [[TMP0:%.*]]) #[[ATTR1]] {
; CHECK-NEXT: bb:
; CHECK-NEXT: [[ARG1_PRIV:%.*]] = alloca <8 x i64>, align 64
; CHECK-NEXT: store <8 x i64> [[TMP0]], ptr [[ARG1_PRIV]], align 64
; CHECK-NEXT: [[TMP:%.*]] = load <8 x i64>, ptr [[ARG1_PRIV]], align 64
; CHECK-NEXT: store <8 x i64> [[TMP]], ptr [[ARG]], align 64
; CHECK-NEXT: ret void
;
bb:
%tmp = load <8 x i64>, ptr %arg1
store <8 x i64> %tmp, ptr %arg
ret void
}

define void @avx512_legal512_prefer512_call_avx512_legal512_prefer256(ptr %arg) #0 {
;
; TUNIT: Function Attrs: inlinehint mustprogress nofree norecurse nosync nounwind
willreturn memory(argmem: readwrite) uwtable
; TUNIT-LABEL: define {{^[^@]+}}@avx512_legal512_prefer512_call_avx512_legal512_prefer256
; TUNIT-SAME: (ptr nocapture nofree writeonly [[ARG:%.*]]) #[[ATTR0]] {
; TUNIT-NEXT: bb:
; TUNIT-NEXT: [[TMP:%.*]] = alloca <8 x i64>, align 32
; TUNIT-NEXT: [[TRUETMP2:%.*]] = alloca <8 x i64>, align 32
; TUNIT-NEXT: call void @llvm.memset.p0.i64(ptr noalias nocapture nofree noundef nonnull writeonly align 32
dereferenceable(64) [[TMP]], i8 noundef 0, i64 noundef 32, i1 noundef false) #[[ATTR5]]
; TUNIT-NEXT: [[TMP0:%.*]] = load <8 x i64>, ptr [[TMP]], align 64
; TUNIT-NEXT: call fastcc void @callee_avx512_legal512_prefer512_call_avx512_legal512_prefer256(ptr
noalias nocapture nofree noundef nonnull writeonly align 64 dereferenceable(64) [[TRUETMP2]], <8 x i64>
[[TMP0]]) #[[ATTR6]]
; TUNIT-NEXT: [[TRUETMP4:%.*]] = load <8 x i64>, ptr [[TRUETMP2]], align 64
; TUNIT-NEXT: store <8 x i64> [[TRUETMP4]], ptr [[ARG]], align 2
; TUNIT-NEXT:

```

```

    ret void
;
; CGSCC: Function Attrs: inlinehint mustprogress nofree norecurse nosync nounwind willreturn memory(argmem:
readwrite) uwtable
; CGSCC-LABEL: define {{^@}+}@avx512_legal512_prefer512_call_avx512_legal512_prefer256
; CGSCC-SAME: (ptr nocapture nofree noundef nonnull writeonly align 2 dereferenceable(64) [[ARG:%.*]])
#[[ATTR0]] {
; CGSCC-NEXT: bb:
; CGSCC-NEXT: [[TMP:%.*]] = alloca <8 x i64>, align 32
; CGSCC-NEXT: [[TRUETMP2:%.*]] = alloca <8 x i64>, align 32
; CGSCC-NEXT: call void @llvm.memset.p0.i64(ptr noalias nocapture nofree noundef nonnull writeonly align 64
dereferenceable(64) [[TMP]], i8 noundef 0, i64 noundef 32, i1 noundef false) #[[ATTR5]]
; CGSCC-NEXT: [[TMP0:%.*]] = load <8 x i64>, ptr [[TMP]], align 64
; CGSCC-NEXT: call fastcc void @callee_avx512_legal512_prefer512_call_avx512_legal512_prefer256(ptr
noalias nocapture nofree noundef nonnull writeonly align 64 dereferenceable(64) [[TRUETMP2]], <8 x i64>
[[TMP0]]) #[[ATTR6]]
; CGSCC-NEXT:
    [[TRUETMP4:%.*]] = load <8 x i64>, ptr [[TRUETMP2]], align 64
; CGSCC-NEXT: store <8 x i64> [[TRUETMP4]], ptr [[ARG]], align 2
; CGSCC-NEXT: ret void
;
bb:
    %tmp = alloca <8 x i64>, align 32
    %tmp2 = alloca <8 x i64>, align 32
    call void @llvm.memset.p0.i64(ptr align 32 %tmp, i8 0, i64 32, i1 false)
    call fastcc void @callee_avx512_legal512_prefer512_call_avx512_legal512_prefer256(ptr %tmp2, ptr %tmp)
    %tmp4 = load <8 x i64>, ptr %tmp2, align 32
    store <8 x i64> %tmp4, ptr %arg, align 2
    ret void
}

```

; This should promote

```

define internal fastcc void @callee_avx512_legal512_prefer256_call_avx512_legal512_prefer512(ptr %arg, ptr
readonly %arg1) #0 {
;

```

```

; CHECK: Function Attrs: inlinehint mustprogress nofree norecurse nosync nounwind willreturn memory(argmem:
readwrite) uwtable

```

```

; CHECK-LABEL: define {{^@}+}@callee_avx512_legal512_prefer256_call_avx512_legal512_prefer512

```

```

; CHECK-SAME: (ptr noalias nocapture nofree noundef nonnull writeonly align 64 dereferenceable(64)
[[ARG:%.*]],
<8 x i64> [[TMP0:%.*]]) #[[ATTR0]] {

```

```

; CHECK-NEXT: bb:

```

```

; CHECK-NEXT: [[ARG1_PRIV:%.*]] = alloca <8 x i64>, align 64

```

```

; CHECK-NEXT: store <8 x i64> [[TMP0]], ptr [[ARG1_PRIV]], align 64

```

```

; CHECK-NEXT: [[TMP:%.*]] = load <8 x i64>, ptr [[ARG1_PRIV]], align 64

```

```

; CHECK-NEXT: store <8 x i64> [[TMP]], ptr [[ARG]], align 64

```

```

; CHECK-NEXT: ret void
;

```



```

bb:
%tmp = load <8 x i64>, ptr %arg1
store <8 x i64> %tmp, ptr %arg
ret void
}

define void @avx512_legal512_prefer256_call_avx512_legal512_prefer512(ptr %arg) #1 {
;
; TUNIT: Function Attrs: inlinehint mustprogress norecurse nosync nounwind willreturn memory(argmem:
readwrite) uwtable
; TUNIT-LABEL: define { { (^@)+ } } @avx512_legal512_prefer256_call_avx512_legal512_prefer512
; TUNIT-SAME: (ptr nocapture norecurse writeonly [[ARG:%.*]]) # [[ATTR1]] {
; TUNIT-NEXT: bb:
; TUNIT-NEXT: [[TMP:%.*]] = alloca <8 x i64>, align 32
; TUNIT-NEXT: [[TRUETMP2:%.*]] = alloca <8 x i64>, align 32
; TUNIT-NEXT: call void @llvm.memset.p0.i64(ptr
noalias nocapture norecurse noundef nonnull writeonly align 32 dereferenceable(64) [[TMP]], i8 noundef 0, i64
noundef 32, i1 noundef false) # [[ATTR5]]
; TUNIT-NEXT: [[TMP0:%.*]] = load <8 x i64>, ptr [[TMP]], align 64
; TUNIT-NEXT: call fastcc void @callee_avx512_legal512_prefer256_call_avx512_legal512_prefer512(ptr
noalias nocapture norecurse noundef nonnull writeonly align 64 dereferenceable(64) [[TRUETMP2]], <8 x i64>
[[TMP0]]) # [[ATTR6]]
; TUNIT-NEXT: [[TRUETMP4:%.*]] = load <8 x i64>, ptr [[TRUETMP2]], align 64
; TUNIT-NEXT: store <8 x i64> [[TRUETMP4]], ptr [[ARG]], align 2
; TUNIT-NEXT: ret void
;
; CGSCC: Function Attrs: inlinehint mustprogress norecurse nosync nounwind willreturn memory(argmem:
readwrite) uwtable
; CGSCC-LABEL: define { { (^@)+ } } @avx512_legal512_prefer256_call_avx512_legal512_prefer512
; CGSCC-SAME: (ptr nocapture norecurse noundef nonnull writeonly align 2 dereferenceable(64) [[ARG:%.*]])
# [[ATTR1]] {
; CGSCC-NEXT: bb:
; CGSCC-NEXT:
[[TMP:%.*]] = alloca <8 x i64>, align 32
; CGSCC-NEXT: [[TRUETMP2:%.*]] = alloca <8 x i64>, align 32
; CGSCC-NEXT: call void @llvm.memset.p0.i64(ptr noalias nocapture norecurse noundef nonnull writeonly align 64
dereferenceable(64) [[TMP]], i8 noundef 0, i64 noundef 32, i1 noundef false) # [[ATTR5]]
; CGSCC-NEXT: [[TMP0:%.*]] = load <8 x i64>, ptr [[TMP]], align 64
; CGSCC-NEXT: call fastcc void @callee_avx512_legal512_prefer256_call_avx512_legal512_prefer512(ptr
noalias nocapture norecurse noundef nonnull writeonly align 64 dereferenceable(64) [[TRUETMP2]], <8 x i64>
[[TMP0]]) # [[ATTR6]]
; CGSCC-NEXT: [[TRUETMP4:%.*]] = load <8 x i64>, ptr [[TRUETMP2]], align 64
; CGSCC-NEXT: store <8 x i64> [[TRUETMP4]], ptr [[ARG]], align 2
; CGSCC-NEXT: ret void
;
bb:
%tmp = alloca <8 x i64>, align 32
%tmp2 = alloca <8 x i64>, align 32

```

```

call void @llvm.memset.p0.i64(ptr align 32 %tmp, i8 0, i64 32, i1 false)
call fastcc void @callee_avx512_legal512_prefer256_call_avx512_legal512_prefer512(ptr
%tmp2, ptr %tmp)
%tmp4 = load <8 x i64>, ptr %tmp2, align 32
store <8 x i64> %tmp4, ptr %arg, align 2
ret void
}

; This should not promote
define internal fastcc void @callee_avx512_legal256_prefer256_call_avx512_legal512_prefer256(ptr %arg, ptr
readonly %arg1) #1 {
;
; CHECK: Function Attrs: inlinehint mustprogress nofree norecurse nosync nounwind willreturn memory(argmem:
readwrite) uwtable
; CHECK-LABEL: define {{[^@]+}}@callee_avx512_legal256_prefer256_call_avx512_legal512_prefer256
; CHECK-SAME: (ptr noalias nocapture nofree noundef nonnull writeonly align 64 dereferenceable(64)
[[ARG:%.*]], ptr noalias nocapture nofree noundef nonnull readonly align 64 dereferenceable(64) [[ARG1:%.*]])
#[[ATTR1]] {
; CHECK-NEXT: bb:
; CHECK-NEXT: [[TMP:%.*]] = load <8 x i64>, ptr [[ARG1]], align 64
; CHECK-NEXT: store <8 x i64> [[TMP]], ptr [[ARG]], align 64
; CHECK-NEXT: ret void
;
bb:
%tmp = load <8 x i64>, ptr %arg1
store <8 x i64> %tmp, ptr %arg
ret void
}

define void @avx512_legal256_prefer256_call_avx512_legal512_prefer256(ptr %arg) #2 {
;
; TUNIT: Function Attrs: inlinehint mustprogress nofree norecurse nosync nounwind willreturn memory(argmem:
readwrite) uwtable
; TUNIT-LABEL: define {{[^@]+}}@avx512_legal256_prefer256_call_avx512_legal512_prefer256
; TUNIT-SAME: (ptr nocapture nofree writeonly [[ARG:%.*]]) #[[ATTR2:[0-9]+]] {
; TUNIT-NEXT: bb:
; TUNIT-NEXT: [[TMP:%.*]] = alloca <8 x i64>, align 32
; TUNIT-NEXT: [[TRUETMP2:%.*]] = alloca <8 x i64>, align 32
; TUNIT-NEXT: call void @llvm.memset.p0.i64(ptr noalias nocapture nofree noundef nonnull writeonly align 32
dereferenceable(64) [[TMP]], i8 noundef 0, i64 noundef 32, i1 noundef false) #[[ATTR5]]
; TUNIT-NEXT: call fastcc void @callee_avx512_legal256_prefer256_call_avx512_legal512_prefer256(ptr
noalias nocapture nofree noundef nonnull writeonly align 64 dereferenceable(64) [[TRUETMP2]], ptr noalias
nocapture nofree noundef nonnull readonly align 64 dereferenceable(64)
[[TMP]]) #[[ATTR6]]
; TUNIT-NEXT: [[TRUETMP4:%.*]] = load <8 x i64>, ptr [[TRUETMP2]], align 64
; TUNIT-NEXT: store <8 x i64> [[TRUETMP4]], ptr [[ARG]], align 2
; TUNIT-NEXT: ret void
;

```

```

; CGSCC: Function Attrs: inlinehint mustprogress norecurse nosync nounwind willreturn memory(argmem:
readwrite) uwtable
; CGSCC-LABEL: define {{^@+}}@avx512_legal256_prefer256_call_avx512_legal512_prefer256
; CGSCC-SAME: (ptr nocapture norecurse noundef nonnull writeonly align 2 dereferenceable(64) [[ARG:%.*]])
#[[ATTR2:[0-9]+]] {
; CGSCC-NEXT: bb:
; CGSCC-NEXT: [[TMP:%.*]] = alloca <8 x i64>, align 32
; CGSCC-NEXT: [[TRUETMP2:%.*]] = alloca <8 x i64>, align 32
; CGSCC-NEXT: call void @llvm.memset.p0.i64(ptr noalias nocapture norecurse noundef nonnull writeonly align 64
dereferenceable(64) [[TMP]], i8 noundef 0, i64 noundef 32, i1 noundef false) #[[ATTR5]]
; CGSCC-NEXT: call fastcc void @callee_avx512_legal256_prefer256_call_avx512_legal512_prefer256(ptr
noalias
nocapture norecurse noundef nonnull writeonly align 64 dereferenceable(64) [[TRUETMP2]], ptr noalias nocapture
norecurse noundef nonnull readonly align 64 dereferenceable(64) [[TMP]]) #[[ATTR6]]
; CGSCC-NEXT: [[TRUETMP4:%.*]] = load <8 x i64>, ptr [[TRUETMP2]], align 64
; CGSCC-NEXT: store <8 x i64> [[TRUETMP4]], ptr [[ARG]], align 2
; CGSCC-NEXT: ret void
;
bb:
%tmp = alloca <8 x i64>, align 32
%tmp2 = alloca <8 x i64>, align 32
call void @llvm.memset.p0.i64(ptr align 32 %tmp, i8 0, i64 32, i1 false)
call fastcc void @callee_avx512_legal256_prefer256_call_avx512_legal512_prefer256(ptr %tmp2, ptr %tmp)
%tmp4 = load <8 x i64>, ptr %tmp2, align 32
store <8 x i64> %tmp4, ptr %arg, align 2
ret void
}

; This should not promote
define internal fastcc void @callee_avx512_legal512_prefer256_call_avx512_legal256_prefer256(ptr %arg, ptr
readonly %arg1) #2 {
;
; CHECK: Function Attrs: inlinehint mustprogress norecurse nosync nounwind willreturn memory(argmem:
readwrite) uwtable
;
CHECK-LABEL: define {{^@+}}@callee_avx512_legal512_prefer256_call_avx512_legal256_prefer256
; CHECK-SAME: (ptr noalias nocapture norecurse noundef nonnull writeonly align 64 dereferenceable(64)
[[ARG:%.*]], ptr noalias nocapture norecurse noundef nonnull readonly align 64 dereferenceable(64) [[ARG1:%.*]])
#[[ATTR2:[0-9]+]] {
; CHECK-NEXT: bb:
; CHECK-NEXT: [[TMP:%.*]] = load <8 x i64>, ptr [[ARG1]], align 64
; CHECK-NEXT: store <8 x i64> [[TMP]], ptr [[ARG]], align 64
; CHECK-NEXT: ret void
;
bb:
%tmp = load <8 x i64>, ptr %arg1
store <8 x i64> %tmp, ptr %arg
ret void

```

```

}

define void @avx512_legal512_prefer256_call_avx512_legal256_prefer256(ptr %arg) #1 {
;
; TUNIT: Function Attrs: inlinehint mustprogress norecurse nosync nounwind willreturn memory(argmem:
readwrite) uwtable
; TUNIT-LABEL: define {{{^@+}}} @avx512_legal512_prefer256_call_avx512_legal256_prefer256
; TUNIT-SAME: (ptr nocapture norecurse writeonly [[ARG:%.*]]) #[[ATTR1]] {
; TUNIT-NEXT: bb:
; TUNIT-NEXT:
    [[TMP:%.*]] = alloca <8 x i64>, align 32
; TUNIT-NEXT:  [[TRUETMP2:%.*]] = alloca <8 x i64>, align 32
; TUNIT-NEXT:  call void @llvm.memset.p0.i64(ptr noalias nocapture norecurse noundef nonnull writeonly align 32
dereferenceable(64) [[TMP]], i8 noundef 0, i64 noundef 32, i1 noundef false) #[[ATTR5]]
; TUNIT-NEXT:  call fastcc void @callee_avx512_legal512_prefer256_call_avx512_legal256_prefer256(ptr
noalias nocapture norecurse noundef nonnull writeonly align 64 dereferenceable(64) [[TRUETMP2]], ptr noalias
nocapture norecurse noundef nonnull readonly align 64 dereferenceable(64) [[TMP]]) #[[ATTR6]]
; TUNIT-NEXT:  [[TRUETMP4:%.*]] = load <8 x i64>, ptr [[TRUETMP2]], align 64
; TUNIT-NEXT:  store <8 x i64> [[TRUETMP4]], ptr [[ARG]], align 2
; TUNIT-NEXT:  ret void
;
; CGSCC: Function Attrs: inlinehint mustprogress norecurse nosync nounwind willreturn memory(argmem:
readwrite) uwtable
; CGSCC-LABEL: define {{{^@+}}} @avx512_legal512_prefer256_call_avx512_legal256_prefer256
;
    CGSCC-SAME: (ptr nocapture norecurse noundef nonnull writeonly align 2 dereferenceable(64) [[ARG:%.*]])
#[[ATTR1]] {
; CGSCC-NEXT: bb:
; CGSCC-NEXT:  [[TMP:%.*]] = alloca <8 x i64>, align 32
; CGSCC-NEXT:  [[TRUETMP2:%.*]] = alloca <8 x i64>, align 32
; CGSCC-NEXT:  call void @llvm.memset.p0.i64(ptr noalias nocapture norecurse noundef nonnull writeonly align 64
dereferenceable(64) [[TMP]], i8 noundef 0, i64 noundef 32, i1 noundef false) #[[ATTR5]]
; CGSCC-NEXT:  call fastcc void @callee_avx512_legal512_prefer256_call_avx512_legal256_prefer256(ptr
noalias nocapture norecurse noundef nonnull writeonly align 64 dereferenceable(64) [[TRUETMP2]], ptr noalias
nocapture norecurse noundef nonnull readonly align 64 dereferenceable(64) [[TMP]]) #[[ATTR6]]
; CGSCC-NEXT:  [[TRUETMP4:%.*]] = load <8 x i64>, ptr [[TRUETMP2]], align 64
; CGSCC-NEXT:  store <8 x i64> [[TRUETMP4]], ptr [[ARG]], align 2
; CGSCC-NEXT:  ret void
;
bb:
    %tmp = alloca <8 x i64>, align 32
    %tmp2 = alloca <8 x i64>,
    align 32
    call void @llvm.memset.p0.i64(ptr align 32 %tmp, i8 0, i64 32, i1 false)
    call fastcc void @callee_avx512_legal512_prefer256_call_avx512_legal256_prefer256(ptr %tmp2, ptr %tmp)
    %tmp4 = load <8 x i64>, ptr %tmp2, align 32
    store <8 x i64> %tmp4, ptr %arg, align 2
    ret void

```

```

}

; This should promote
define internal fastcc void @callee_avx2_legal256_prefer256_call_avx2_legal512_prefer256(ptr %arg, ptr readonly
%arg1) #3 {
;
; CHECK: Function Attrs: inlinehint mustprogress norecurse nosync nounwind willreturn memory(argmem:
readwrite) uwtable
; CHECK-LABEL: define {{^[^@]+}}@callee_avx2_legal256_prefer256_call_avx2_legal512_prefer256
; CHECK-SAME: (ptr noalias nocapture norecurse noundef nonnull writeonly align 64 dereferenceable(64)
[[ARG:%.*]], <8 x i64> [[TMP0:%.*]]) #[[ATTR3:[0-9]+]] {
; CHECK-NEXT: bb:
; CHECK-NEXT: [[ARG1_PRIV:%.*]] = alloca <8 x i64>, align 64
; CHECK-NEXT: store <8 x i64> [[TMP0]], ptr [[ARG1_PRIV]], align 64
; CHECK-NEXT: [[TMP:%.*]]
= load <8 x i64>, ptr [[ARG1_PRIV]], align 64
; CHECK-NEXT: store <8 x i64> [[TMP]], ptr [[ARG]], align 64
; CHECK-NEXT: ret void
;
bb:
%tmp = load <8 x i64>, ptr %arg1
store <8 x i64> %tmp, ptr %arg
ret void
}

define void @avx2_legal256_prefer256_call_avx2_legal512_prefer256(ptr %arg) #4 {
;
; TUNIT: Function Attrs: inlinehint mustprogress norecurse nosync nounwind willreturn memory(argmem:
readwrite) uwtable
; TUNIT-LABEL: define {{^[^@]+}}@avx2_legal256_prefer256_call_avx2_legal512_prefer256
; TUNIT-SAME: (ptr nocapture norecurse writeonly [[ARG:%.*]]) #[[ATTR3]] {
; TUNIT-NEXT: bb:
; TUNIT-NEXT: [[TMP:%.*]] = alloca <8 x i64>, align 32
; TUNIT-NEXT: [[TRUETMP2:%.*]] = alloca <8 x i64>, align 32
; TUNIT-NEXT: call void @llvm.memset.p0.i64(ptr noalias nocapture norecurse noundef nonnull writeonly align 32
dereferenceable(64) [[TMP]], i8 noundef 0, i64 noundef 32, i1 noundef false) #[[ATTR5]]
; TUNIT-NEXT: [[TMP0:%.*]] = load <8 x i64>, ptr [[TMP]], align 64
;
TUNIT-NEXT: call fastcc void @callee_avx2_legal256_prefer256_call_avx2_legal512_prefer256(ptr noalias
nocapture norecurse noundef nonnull writeonly align 64 dereferenceable(64) [[TRUETMP2]], <8 x i64> [[TMP0]])
#[[ATTR6]]
; TUNIT-NEXT: [[TRUETMP4:%.*]] = load <8 x i64>, ptr [[TRUETMP2]], align 64
; TUNIT-NEXT: store <8 x i64> [[TRUETMP4]], ptr [[ARG]], align 2
; TUNIT-NEXT: ret void
;
; CGSCC: Function Attrs: inlinehint mustprogress norecurse nosync nounwind willreturn memory(argmem:
readwrite) uwtable
; CGSCC-LABEL: define {{^[^@]+}}@avx2_legal256_prefer256_call_avx2_legal512_prefer256

```

```

; CGSCC-SAME: (ptr norecapture norefree noundef nonnull writeonly align 2 dereferenceable(64) [[ARG:%.*]])
#[[ATTR3]] {
; CGSCC-NEXT: bb:
; CGSCC-NEXT: [[TMP:%.*]] = alloca <8 x i64>, align 32
; CGSCC-NEXT: [[TRUETMP2:%.*]] = alloca <8 x i64>, align 32
; CGSCC-NEXT: call void @llvm.memset.p0.i64(ptr noalias norecapture norefree noundef nonnull writeonly align 64
dereferenceable(64) [[TMP]],
i8 noundef 0, i64 noundef 32, i1 noundef false) #[[ATTR5]]
; CGSCC-NEXT: [[TMP0:%.*]] = load <8 x i64>, ptr [[TMP]], align 64
; CGSCC-NEXT: call fastcc void @callee_avx2_legal256_prefer256_call_avx2_legal512_prefer256(ptr noalias
norecapture norefree noundef nonnull writeonly align 64 dereferenceable(64) [[TRUETMP2]], <8 x i64> [[TMP0]])
#[[ATTR6]]
; CGSCC-NEXT: [[TRUETMP4:%.*]] = load <8 x i64>, ptr [[TRUETMP2]], align 64
; CGSCC-NEXT: store <8 x i64> [[TRUETMP4]], ptr [[ARG]], align 2
; CGSCC-NEXT: ret void
;
bb:
%tmp = alloca <8 x i64>, align 32
%tmp2 = alloca <8 x i64>, align 32
call void @llvm.memset.p0.i64(ptr align 32 %tmp, i8 0, i64 32, i1 false)
call fastcc void @callee_avx2_legal256_prefer256_call_avx2_legal512_prefer256(ptr %tmp2, ptr %tmp)
%tmp4 = load <8 x i64>, ptr %tmp2, align 32
store <8 x i64> %tmp4, ptr %arg, align 2
ret void
}

; This should promote
define internal fastcc void @callee_avx2_legal512_prefer256_call_avx2_legal256_prefer256(ptr
%arg, ptr readonly %arg1) #4 {
;
; CHECK: Function Attrs: inlinehint mustprogress norefree norecurse nosync nounwind willreturn memory(argmem:
readwrite) uwtable
; CHECK-LABEL: define {{{^@}+}}@callee_avx2_legal512_prefer256_call_avx2_legal256_prefer256
; CHECK-SAME: (ptr noalias norecapture norefree noundef nonnull writeonly align 64 dereferenceable(64)
[[ARG:%.*]], <8 x i64> [[TMP0:%.*]]) #[[ATTR3]] {
; CHECK-NEXT: bb:
; CHECK-NEXT: [[ARG1_PRIV:%.*]] = alloca <8 x i64>, align 64
; CHECK-NEXT: store <8 x i64> [[TMP0]], ptr [[ARG1_PRIV]], align 64
; CHECK-NEXT: [[TMP:%.*]] = load <8 x i64>, ptr [[ARG1_PRIV]], align 64
; CHECK-NEXT: store <8 x i64> [[TMP]], ptr [[ARG]], align 64
; CHECK-NEXT: ret void
;
bb:
%tmp = load <8 x i64>, ptr %arg1
store <8 x i64> %tmp, ptr %arg
ret void
}

```

```

define void @avx2_legal512_prefer256_call_avx2_legal256_prefer256(ptr %arg) #3 {
;
; TUNIT: Function Attrs: inlinehint mustprogress norecurse nosync nounwind willreturn memory(argmem:
readwrite) uwtable
; TUNIT-LABEL: define {{^[^@]+}}@avx2_legal512_prefer256_call_avx2_legal256_prefer256
; TUNIT-SAME: (ptr nocapture norecurse writeonly [[ARG:%.*]]) #[[ATTR3]] {
; TUNIT-NEXT: bb:
; TUNIT-NEXT: [[TMP:%.*]] = alloca <8 x i64>, align 32
; TUNIT-NEXT: [[TRUETMP2:%.*]] = alloca <8 x i64>, align 32
; TUNIT-NEXT: call void @llvm.memset.p0.i64(ptr noalias nocapture norecurse noundef nonnull writeonly align 32
dereferenceable(64) [[TMP]], i8 noundef 0, i64 noundef 32, i1 noundef false) #[[ATTR5]]
; TUNIT-NEXT: [[TMP0:%.*]] = load <8 x i64>, ptr [[TMP]], align 64
; TUNIT-NEXT: call fastcc void @callee_avx2_legal512_prefer256_call_avx2_legal256_prefer256(ptr noalias
nocapture norecurse noundef nonnull writeonly align 64 dereferenceable(64) [[TRUETMP2]], <8 x i64> [[TMP0]])
#[[ATTR6]]
; TUNIT-NEXT: [[TRUETMP4:%.*]] = load <8 x i64>, ptr [[TRUETMP2]], align 64
; TUNIT-NEXT: store <8 x i64> [[TRUETMP4]], ptr [[ARG]], align 2
; TUNIT-NEXT: ret void
;
; CGSCC: Function
Attrs: inlinehint mustprogress norecurse nosync nounwind willreturn memory(argmem: readwrite) uwtable
; CGSCC-LABEL: define {{^[^@]+}}@avx2_legal512_prefer256_call_avx2_legal256_prefer256
; CGSCC-SAME: (ptr nocapture norecurse noundef nonnull writeonly align 2 dereferenceable(64) [[ARG:%.*]])
#[[ATTR3]] {
; CGSCC-NEXT: bb:
; CGSCC-NEXT: [[TMP:%.*]] = alloca <8 x i64>, align 32
; CGSCC-NEXT: [[TRUETMP2:%.*]] = alloca <8 x i64>, align 32
; CGSCC-NEXT: call void @llvm.memset.p0.i64(ptr noalias nocapture norecurse noundef nonnull writeonly align 64
dereferenceable(64) [[TMP]], i8 noundef 0, i64 noundef 32, i1 noundef false) #[[ATTR5]]
; CGSCC-NEXT: [[TMP0:%.*]] = load <8 x i64>, ptr [[TMP]], align 64
; CGSCC-NEXT: call fastcc void @callee_avx2_legal512_prefer256_call_avx2_legal256_prefer256(ptr noalias
nocapture norecurse noundef nonnull writeonly align 64 dereferenceable(64) [[TRUETMP2]], <8 x i64> [[TMP0]])
#[[ATTR6]]
; CGSCC-NEXT: [[TRUETMP4:%.*]] = load <8 x i64>,
ptr [[TRUETMP2]], align 64
; CGSCC-NEXT: store <8 x i64> [[TRUETMP4]], ptr [[ARG]], align 2
; CGSCC-NEXT: ret void
;
bb:
%tmp = alloca <8 x i64>, align 32
%tmp2 = alloca <8 x i64>, align 32
call void @llvm.memset.p0.i64(ptr align 32 %tmp, i8 0, i64 32, i1 false)
call fastcc void @callee_avx2_legal512_prefer256_call_avx2_legal256_prefer256(ptr %tmp2, ptr %tmp)
%tmp4 = load <8 x i64>, ptr %tmp2, align 32
store <8 x i64> %tmp4, ptr %arg, align 2
ret void
}

```

```

; Function Attrs: argmemonly nounwind
declare void @llvm.memset.p0.i64(ptr nocapture writeonly, i8, i64, i1) #5

attributes #0 = { inlinehint norecurse nounwind uwtable "target-features"="+avx512vl" "min-legal-vector-width"="512" "prefer-vector-width"="512" }
attributes #1 = { inlinehint norecurse nounwind uwtable "target-features"="+avx512vl" "min-legal-vector-width"="512" "prefer-vector-width"="256" }
attributes #2 = { inlinehint norecurse nounwind uwtable "target-features"="+avx512vl" "min-legal-vector-width"="256"
"prefer-vector-width"="256" }
attributes #3 = { inlinehint norecurse nounwind uwtable "target-features"="+avx2" "min-legal-vector-width"="512"
"prefer-vector-width"="256" }
attributes #4 = { inlinehint norecurse nounwind uwtable "target-features"="+avx2" "min-legal-vector-width"="256"
"prefer-vector-width"="256" }
attributes #5 = { argmemonly nounwind }
;
; TUNIT: attributes #[[ATTR0]] = { inlinehint mustprogress norecurse nosync nounwind willreturn
memory(argmem: readwrite) uwtable "min-legal-vector-width"="512" "prefer-vector-width"="512" "target-features"="+avx512vl" }
; TUNIT: attributes #[[ATTR1]] = { inlinehint mustprogress norecurse nosync nounwind willreturn
memory(argmem: readwrite) uwtable "min-legal-vector-width"="512" "prefer-vector-width"="256" "target-features"="+avx512vl" }
; TUNIT: attributes #[[ATTR2]] = { inlinehint mustprogress norecurse nosync nounwind willreturn
memory(argmem: readwrite) uwtable "min-legal-vector-width"="256" "prefer-vector-width"="256"
"target-features"="+avx512vl" }
; TUNIT: attributes #[[ATTR3]] = { inlinehint mustprogress norecurse nosync nounwind willreturn
memory(argmem: readwrite) uwtable "min-legal-vector-width"="512" "prefer-vector-width"="256" "target-features"="+avx2" }
; TUNIT: attributes #[[ATTR4:[0-9]+]] = { norecurse nosync nounwind willreturn memory(argmem: write) }
; TUNIT: attributes #[[ATTR5]] = { norecurse willreturn memory(write) }
; TUNIT: attributes #[[ATTR6]] = { norecurse nosync nounwind willreturn }
;
; CGSCC: attributes #[[ATTR0]] = { inlinehint mustprogress norecurse nosync nounwind willreturn
memory(argmem: readwrite) uwtable "min-legal-vector-width"="512" "prefer-vector-width"="512" "target-features"="+avx512vl" }
; CGSCC: attributes #[[ATTR1]] = { inlinehint mustprogress norecurse nosync nounwind willreturn
memory(argmem: readwrite) uwtable "min-legal-vector-width"="512" "prefer-vector-width"="256" "target-features"="+avx512vl" }
; CGSCC: attributes #[[ATTR2]]
= { inlinehint mustprogress norecurse nosync nounwind willreturn memory(argmem: readwrite) uwtable
"min-legal-vector-width"="256" "prefer-vector-width"="256" "target-features"="+avx512vl" }
; CGSCC: attributes #[[ATTR3]] = { inlinehint mustprogress norecurse nosync nounwind willreturn
memory(argmem: readwrite) uwtable "min-legal-vector-width"="512" "prefer-vector-width"="256" "target-features"="+avx2" }
; CGSCC: attributes #[[ATTR4:[0-9]+]] = { norecurse nosync nounwind willreturn memory(argmem: write) }
; CGSCC: attributes #[[ATTR5]] = { norecurse willreturn memory(write) }
; CGSCC: attributes #[[ATTR6]] = { norecurse nounwind willreturn }
;

```



```
; NOTE: Assertions have been autogenerated by utils/update_llc_test_checks.py
; RUN: llc -mtriple=riscv64 -verify-machineinstrs < %s \
; RUN: -riscv-experimental-rv64-legal-i32 | FileCheck %s -check-prefix=RV64I
; RUN: llc -mtriple=riscv64 -mattr=+zbb -verify-machineinstrs < %s \
; RUN: -riscv-experimental-rv64-legal-i32 | FileCheck %s -check-prefix=RV64ZBB
```

```
declare i32 @llvm.ctlz.i32(i32, i1)
```

```
define signext i32 @ctlz_i32(i32 signext %a) nounwind {
```

```
; RV64I-LABEL: ctlz_i32:
```

```
; RV64I:    # %bb.0:
```

```
; RV64I-NEXT: beqz a0, .LBB0_2
```

```
; RV64I-NEXT: # %bb.1: # %cond.false
```

```
; RV64I-NEXT: addi sp, sp, -16
```

```
; RV64I-NEXT: sd ra, 8(sp) # 8-byte Folded Spill
```

```
; RV64I-NEXT: srliw a1, a0, 1
```

```
; RV64I-NEXT: or a0, a0, a1
```

```
; RV64I-NEXT: srliw a1, a0, 2
```

```
; RV64I-NEXT: or a0, a0, a1
```

```
; RV64I-NEXT: srliw a1, a0, 4
```

```
; RV64I-NEXT: or a0, a0, a1
```

```
; RV64I-NEXT: srliw a1, a0, 8
```

```
; RV64I-NEXT: or a0, a0, a1
```

```
; RV64I-NEXT: srliw a1, a0, 16
```

```
; RV64I-NEXT: or a0, a0, a1
```

```
; RV64I-NEXT:
```

```
    not a0, a0
```

```
; RV64I-NEXT: srliw a1, a0, 1
```

```
; RV64I-NEXT: lui a2, 349525
```

```
; RV64I-NEXT: addi a2, a2, 1365
```

```
; RV64I-NEXT: and a1, a1, a2
```

```
; RV64I-NEXT: subw a0, a0, a1
```

```
; RV64I-NEXT: lui a1, 209715
```

```
; RV64I-NEXT: addi a1, a1, 819
```

```
; RV64I-NEXT: and a2, a0, a1
```

```
; RV64I-NEXT: srliw a0, a0, 2
```

```
; RV64I-NEXT: and a0, a0, a1
```

```
; RV64I-NEXT: add a0, a2, a0
```

```
; RV64I-NEXT: srliw a1, a0, 4
```

```
; RV64I-NEXT: addw a0, a0, a1
```

```
; RV64I-NEXT: lui a1, 61681
```

```
; RV64I-NEXT: addiw a1, a1, -241
```

```
; RV64I-NEXT: and a0, a0, a1
```

```
; RV64I-NEXT: lui a1, 4112
```

```
; RV64I-NEXT: addiw a1, a1, 257
```

```
; RV64I-NEXT: call __muldi3
```

```
; RV64I-NEXT: srliw a0, a0, 24
```

```
; RV64I-NEXT: ld ra, 8(sp) # 8-byte Folded Reload
```

```

; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
; RV64I-NEXT:  .LBB0_2:
; RV64I-NEXT:  li a0, 32
; RV64I-NEXT:  ret
;
; RV64ZBB-LABEL: ctlz_i32:
; RV64ZBB:      # %bb.0:
; RV64ZBB-NEXT:  clzw a0, a0
; RV64ZBB-NEXT:  ret
%1 = call i32 @llvm.ctlz.i32(i32 %a, i1 false)
ret i32 %1
}

define signext i32 @log2_i32(i32 signext %a) nounwind {
; RV64I-LABEL: log2_i32:
; RV64I:      # %bb.0:
; RV64I-NEXT:  beqz a0, .LBB1_2
; RV64I-NEXT:  # %bb.1: # %cond.false
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  srlw a1, a0, 1
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  srlw a1, a0, 2
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  srlw a1, a0, 4
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  srlw a1, a0, 8
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  srlw a1, a0, 16
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  not a0, a0
; RV64I-NEXT:  srlw a1, a0, 1
; RV64I-NEXT:  lui a2, 349525
; RV64I-NEXT:  addi a2, a2, 1365
; RV64I-NEXT:  and a1, a1, a2
; RV64I-NEXT:  subw a0, a0, a1
; RV64I-NEXT:  lui a1, 209715
; RV64I-NEXT:  addi a1, a1, 819
; RV64I-NEXT:  and a2, a0, a1
; RV64I-NEXT:  srlw a0, a0, 2
; RV64I-NEXT:  and a0, a0, a1
; RV64I-NEXT:  add a0, a2, a0
; RV64I-NEXT:
; RV64I-NEXT:  srlw a1, a0, 4
; RV64I-NEXT:  addw a0, a0, a1
; RV64I-NEXT:  lui a1, 61681
; RV64I-NEXT:  addiw a1, a1, -241

```

```

; RV64I-NEXT: and a0, a0, a1
; RV64I-NEXT: lui a1, 4112
; RV64I-NEXT: addiw a1, a1, 257
; RV64I-NEXT: call __muldi3
; RV64I-NEXT: srliw a0, a0, 24
; RV64I-NEXT: ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT: addi sp, sp, 16
; RV64I-NEXT: j .LBB1_3
; RV64I-NEXT: .LBB1_2:
; RV64I-NEXT: li a0, 32
; RV64I-NEXT: .LBB1_3: # %cond.end
; RV64I-NEXT: li a1, 31
; RV64I-NEXT: subw a0, a1, a0
; RV64I-NEXT: ret
;
; RV64ZBB-LABEL: log2_i32:
; RV64ZBB: # %bb.0:
; RV64ZBB-NEXT: clzw a0, a0
; RV64ZBB-NEXT: li a1, 31
; RV64ZBB-NEXT: subw a0, a1, a0
; RV64ZBB-NEXT: ret
%1 = call i32 @llvmctlz.i32(i32 %a, i1 false)
%2 = sub i32 31, %1
ret i32 %2
}

define signext i32 @log2_ceil_i32(i32 signext %a) nounwind {
; RV64I-LABEL: log2_ceil_i32:
; RV64I: # %bb.0:
; RV64I-NEXT: addi sp, sp, -16
; RV64I-NEXT: sd ra,
8(sp) # 8-byte Folded Spill
; RV64I-NEXT: sd s0, 0(sp) # 8-byte Folded Spill
; RV64I-NEXT: addiw a0, a0, -1
; RV64I-NEXT: li s0, 32
; RV64I-NEXT: li a1, 32
; RV64I-NEXT: beqz a0, .LBB2_2
; RV64I-NEXT: # %bb.1: # %cond.false
; RV64I-NEXT: srliw a1, a0, 1
; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT: srliw a1, a0, 2
; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT: srliw a1, a0, 4
; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT: srliw a1, a0, 8
; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT: srliw a1, a0, 16
; RV64I-NEXT: or a0, a0, a1

```

```

; RV64I-NEXT:  not a0, a0
; RV64I-NEXT:  srlw a1, a0, 1
; RV64I-NEXT:  lui a2, 349525
; RV64I-NEXT:  addi a2, a2, 1365
; RV64I-NEXT:  and a1, a1, a2
; RV64I-NEXT:  subw a0, a0, a1
; RV64I-NEXT:  lui a1, 209715
; RV64I-NEXT:  addi a1, a1, 819
; RV64I-NEXT:  and a2, a0, a1
; RV64I-NEXT:  srlw a0, a0, 2
; RV64I-NEXT:  and a0, a0, a1
; RV64I-NEXT:  add a0, a2, a0
; RV64I-NEXT:  srlw a1, a0, 4
; RV64I-NEXT:
    addw a0, a0, a1
; RV64I-NEXT:  lui a1, 61681
; RV64I-NEXT:  addiw a1, a1, -241
; RV64I-NEXT:  and a0, a0, a1
; RV64I-NEXT:  lui a1, 4112
; RV64I-NEXT:  addiw a1, a1, 257
; RV64I-NEXT:  call __muldi3
; RV64I-NEXT:  srlw a1, a0, 24
; RV64I-NEXT:  .LBB2_2: # %cond.end
; RV64I-NEXT:  subw a0, s0, a1
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT:  ld s0, 0(sp) # 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
;
; RV64ZBB-LABEL: log2_ceil_i32:
; RV64ZBB:      # %bb.0:
; RV64ZBB-NEXT:  addi a0, a0, -1
; RV64ZBB-NEXT:  clzw a0, a0
; RV64ZBB-NEXT:  li a1, 32
; RV64ZBB-NEXT:  subw a0, a1, a0
; RV64ZBB-NEXT:  ret
%1 = sub i32 %a, 1
%2 = call i32 @llvmctlz.i32(i32 %1, i1 false)
%3 = sub i32 32, %2
ret i32 %3
}

define signext i32 @findLastSet_i32(i32 signext %a) nounwind {
; RV64I-LABEL: findLastSet_i32:
; RV64I:      # %bb.0:
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
;

```

```

RV64I-NEXT: sd s0, 0(sp) # 8-byte Folded Spill
; RV64I-NEXT: mv s0, a0
; RV64I-NEXT: srliw a0, a0, 1
; RV64I-NEXT: or a0, s0, a0
; RV64I-NEXT: srliw a1, a0, 2
; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT: srliw a1, a0, 4
; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT: srliw a1, a0, 8
; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT: srliw a1, a0, 16
; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT: not a0, a0
; RV64I-NEXT: srliw a1, a0, 1
; RV64I-NEXT: lui a2, 349525
; RV64I-NEXT: addi a2, a2, 1365
; RV64I-NEXT: and a1, a1, a2
; RV64I-NEXT: subw a0, a0, a1
; RV64I-NEXT: lui a1, 209715
; RV64I-NEXT: addi a1, a1, 819
; RV64I-NEXT: and a2, a0, a1
; RV64I-NEXT: srliw a0, a0, 2
; RV64I-NEXT: and a0, a0, a1
; RV64I-NEXT: add a0, a2, a0
; RV64I-NEXT: srliw a1, a0, 4
; RV64I-NEXT: addw a0, a0, a1
; RV64I-NEXT: lui a1, 61681
; RV64I-NEXT: addiw a1, a1, -241
; RV64I-NEXT: and a0, a0, a1
; RV64I-NEXT: lui a1, 4112
; RV64I-NEXT:
    addiw a1, a1, 257
; RV64I-NEXT: call __muldi3
; RV64I-NEXT: srliw a0, a0, 24
; RV64I-NEXT: xori a0, a0, 31
; RV64I-NEXT: snez a1, s0
; RV64I-NEXT: addiw a1, a1, -1
; RV64I-NEXT: or a0, a1, a0
; RV64I-NEXT: ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT: ld s0, 0(sp) # 8-byte Folded Reload
; RV64I-NEXT: addi sp, sp, 16
; RV64I-NEXT: ret
;
; RV64ZBB-LABEL: findLastSet_i32:
; RV64ZBB:    # %bb.0:
; RV64ZBB-NEXT: clzw a1, a0
; RV64ZBB-NEXT: xori a1, a1, 31
; RV64ZBB-NEXT: snez a0, a0

```

```

; RV64ZBB-NEXT:  addiw a0, a0, -1
; RV64ZBB-NEXT:  or a0, a0, a1
; RV64ZBB-NEXT:  ret
%1 = call i32 @llvmctlz.i32(i32 %a, i1 true)
%2 = xor i32 31, %1
%3 = icmp eq i32 %a, 0
%4 = select i1 %3, i32 -1, i32 %2
ret i32 %4
}

define i32 @ctlz_lshr_i32(i32 signext %a) {
; RV64I-LABEL: ctlz_lshr_i32:
; RV64I:      # %bb.0:
; RV64I-NEXT:  srlw a0, a0, 1
; RV64I-NEXT:  beqz a0, .LBB4_2
; RV64I-NEXT:  # %bb.1: # %cond.false
; RV64I-NEXT:  addi sp, sp,
-16
; RV64I-NEXT:  .cfi_def_cfa_offset 16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  .cfi_offset ra, -8
; RV64I-NEXT:  srlw a1, a0, 1
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  srlw a1, a0, 2
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  srlw a1, a0, 4
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  srlw a1, a0, 8
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  srlw a1, a0, 16
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  not a0, a0
; RV64I-NEXT:  srlw a1, a0, 1
; RV64I-NEXT:  lui a2, 349525
; RV64I-NEXT:  addi a2, a2, 1365
; RV64I-NEXT:  and a1, a1, a2
; RV64I-NEXT:  subw a0, a0, a1
; RV64I-NEXT:  lui a1, 209715
; RV64I-NEXT:  addi a1, a1, 819
; RV64I-NEXT:  and a2, a0, a1
; RV64I-NEXT:  srlw a0, a0, 2
; RV64I-NEXT:  and a0, a0, a1
; RV64I-NEXT:  add a0, a2, a0
; RV64I-NEXT:  srlw a1, a0, 4
; RV64I-NEXT:  addw a0, a0, a1
; RV64I-NEXT:  lui a1, 61681
; RV64I-NEXT:  addiw a1, a1, -241
; RV64I-NEXT:  and a0,

```

```

a0, a1
; RV64I-NEXT: lui a1, 4112
; RV64I-NEXT: addiw a1, a1, 257
; RV64I-NEXT: call __muldi3
; RV64I-NEXT: srliw a0, a0, 24
; RV64I-NEXT: ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT: addi sp, sp, 16
; RV64I-NEXT: ret
; RV64I-NEXT: .LBB4_2:
; RV64I-NEXT: li a0, 32
; RV64I-NEXT: ret
;
; RV64ZBB-LABEL: ctlz_lshr_i32:
; RV64ZBB:    # %bb.0:
; RV64ZBB-NEXT: srliw a0, a0, 1
; RV64ZBB-NEXT: clzw a0, a0
; RV64ZBB-NEXT: ret
%1 = lshr i32 %a, 1
%2 = call i32 @llvm.ctlz.i32(i32 %1, i1 false)
ret i32 %2
}

```

```

declare i64 @llvm.ctlz.i64(i64, i1)

```

```

define i64 @ctlz_i64(i64 %a) nounwind {
; RV64I-LABEL: ctlz_i64:
; RV64I:    # %bb.0:
; RV64I-NEXT: beqz a0, .LBB5_2
; RV64I-NEXT: # %bb.1: # %cond.false
; RV64I-NEXT: addi sp, sp, -16
; RV64I-NEXT: sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT: srli a1, a0, 1
; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT: srli a1, a0, 2
; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT: srli a1, a0, 4
; RV64I-NEXT:
    or a0, a0, a1
; RV64I-NEXT: srli a1, a0, 8
; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT: srli a1, a0, 16
; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT: srli a1, a0, 32
; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT: not a0, a0
; RV64I-NEXT: srli a1, a0, 1
; RV64I-NEXT: lui a2, 349525
; RV64I-NEXT: addiw a2, a2, 1365

```

```

; RV64I-NEXT:  slli a3, a2, 32
; RV64I-NEXT:  add a2, a2, a3
; RV64I-NEXT:  and a1, a1, a2
; RV64I-NEXT:  sub a0, a0, a1
; RV64I-NEXT:  lui a1, 209715
; RV64I-NEXT:  addiw a1, a1, 819
; RV64I-NEXT:  slli a2, a1, 32
; RV64I-NEXT:  add a1, a1, a2
; RV64I-NEXT:  and a2, a0, a1
; RV64I-NEXT:  srli a0, a0, 2
; RV64I-NEXT:  and a0, a0, a1
; RV64I-NEXT:  add a0, a2, a0
; RV64I-NEXT:  srli a1, a0, 4
; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  lui a1, 61681
; RV64I-NEXT:  addiw a1, a1, -241
; RV64I-NEXT:  slli a2, a1, 32
; RV64I-NEXT:  add a1, a1, a2
; RV64I-NEXT:  and a0, a0, a1
; RV64I-NEXT:  lui a1, 4112
; RV64I-NEXT:
    addiw a1, a1, 257
; RV64I-NEXT:  slli a2, a1, 32
; RV64I-NEXT:  add a1, a1, a2
; RV64I-NEXT:  call __muldi3
; RV64I-NEXT:  srli a0, a0, 56
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
; RV64I-NEXT: .LBB5_2:
; RV64I-NEXT:  li a0, 64
; RV64I-NEXT:  ret
;
; RV64ZBB-LABEL: ctlz_i64:
; RV64ZBB:      # %bb.0:
; RV64ZBB-NEXT:  clz a0, a0
; RV64ZBB-NEXT:  ret
%1 = call i64 @llvm.ctlz.i64(i64 %a, i1 false)
ret i64 %1
}

declare i32 @llvm.cttz.i32(i32, i1)

define signext i32 @cttz_i32(i32 signext %a) nounwind {
; RV64I-LABEL: cttz_i32:
; RV64I:      # %bb.0:
; RV64I-NEXT:  beqz a0, .LBB6_2
; RV64I-NEXT:  # %bb.1: # %cond.false

```



```

; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  negw a1, a0
; RV64I-NEXT:  and a0, a0, a1
; RV64I-NEXT:  lui a1, 30667
; RV64I-NEXT:  addiw a1, a1, 1329
; RV64I-NEXT:  call __muldi3
; RV64I-NEXT:  srliw a0, a0, 27
;
RV64I-NEXT:  lui a1, %hi(.LCPI6_0)
; RV64I-NEXT:  addi a1, a1, %lo(.LCPI6_0)
; RV64I-NEXT:  add a0, a1, a0
; RV64I-NEXT:  lbu a0, 0(a0)
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
; RV64I-NEXT: .LBB6_2:
; RV64I-NEXT:  li a0, 32
; RV64I-NEXT:  ret
;
; RV64ZBB-LABEL: cttz_i32:
; RV64ZBB:      # %bb.0:
; RV64ZBB-NEXT:  ctw a0, a0
; RV64ZBB-NEXT:  ret
%1 = call i32 @llvm.cttz.i32(i32 %a, i1 false)
ret i32 %1
}

define signext i32 @cttz_zero_undef_i32(i32 signext %a) nounwind {
; RV64I-LABEL: cttz_zero_undef_i32:
; RV64I:      # %bb.0:
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  negw a1, a0
; RV64I-NEXT:  and a0, a0, a1
; RV64I-NEXT:  lui a1, 30667
; RV64I-NEXT:  addiw a1, a1, 1329
; RV64I-NEXT:  call __muldi3
; RV64I-NEXT:  srliw a0, a0, 27
; RV64I-NEXT:  lui a1, %hi(.LCPI7_0)
; RV64I-NEXT:  addi a1, a1, %lo(.LCPI7_0)
; RV64I-NEXT:
    add a0, a1, a0
; RV64I-NEXT:  lbu a0, 0(a0)
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
;

```

```

; RV64ZBB-LABEL: cttz_zero_undef_i32:
; RV64ZBB:      # %bb.0:
; RV64ZBB-NEXT:  ctw a0, a0
; RV64ZBB-NEXT:  ret
%1 = call i32 @llvm.cttz.i32(i32 %a, i1 true)
ret i32 %1
}

define signext i32 @findFirstSet_i32(i32 signext %a) nounwind {
; RV64I-LABEL: findFirstSet_i32:
; RV64I:      # %bb.0:
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  sd s0, 0(sp) # 8-byte Folded Spill
; RV64I-NEXT:  mv s0, a0
; RV64I-NEXT:  negw a0, a0
; RV64I-NEXT:  and a0, s0, a0
; RV64I-NEXT:  lui a1, 30667
; RV64I-NEXT:  addiw a1, a1, 1329
; RV64I-NEXT:  call __muldi3
; RV64I-NEXT:  srlw a0, a0, 27
; RV64I-NEXT:  lui a1, %hi(LCPI8_0)
; RV64I-NEXT:  addi a1, a1, %lo(LCPI8_0)
; RV64I-NEXT:  add a0, a1, a0
; RV64I-NEXT:  lbu a0, 0(a0)
; RV64I-NEXT:  snez a1, s0
; RV64I-NEXT:
    addi a1, a1, -1
; RV64I-NEXT:  or a0, a1, a0
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT:  ld s0, 0(sp) # 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
;
; RV64ZBB-LABEL: findFirstSet_i32:
; RV64ZBB:      # %bb.0:
; RV64ZBB-NEXT:  ctw a1, a0
; RV64ZBB-NEXT:  snez a0, a0
; RV64ZBB-NEXT:  addiw a0, a0, -1
; RV64ZBB-NEXT:  or a0, a0, a1
; RV64ZBB-NEXT:  ret
%1 = call i32 @llvm.cttz.i32(i32 %a, i1 true)
%2 = icmp eq i32 %a, 0
%3 = select i1 %2, i32 -1, i32 %1
ret i32 %3
}

define signext i32 @ffs_i32(i32 signext %a) nounwind {

```

```

; RV64I-LABEL: ffs_i32:
; RV64I:    # %bb.0:
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  sd s0, 0(sp) # 8-byte Folded Spill
; RV64I-NEXT:  mv s0, a0
; RV64I-NEXT:  negw a0, a0
; RV64I-NEXT:  and a0, s0, a0
; RV64I-NEXT:  lui a1, 30667
; RV64I-NEXT:  addiw a1, a1, 1329
; RV64I-NEXT:  call __muldi3
; RV64I-NEXT:
    srlw a0, a0, 27
; RV64I-NEXT:  lui a1, %hi(LCPI9_0)
; RV64I-NEXT:  addi a1, a1, %lo(LCPI9_0)
; RV64I-NEXT:  add a0, a1, a0
; RV64I-NEXT:  lbu a0, 0(a0)
; RV64I-NEXT:  addi a0, a0, 1
; RV64I-NEXT:  seqz a1, s0
; RV64I-NEXT:  addi a1, a1, -1
; RV64I-NEXT:  and a0, a1, a0
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  srli a0, a0, 32
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT:  ld s0, 0(sp) # 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
;
; RV64ZBB-LABEL: ffs_i32:
; RV64ZBB:    # %bb.0:
; RV64ZBB-NEXT:  ctw a1, a0
; RV64ZBB-NEXT:  addi a1, a1, 1
; RV64ZBB-NEXT:  seqz a0, a0
; RV64ZBB-NEXT:  addi a0, a0, -1
; RV64ZBB-NEXT:  and a0, a0, a1
; RV64ZBB-NEXT:  zext.h a0, a0
; RV64ZBB-NEXT:  ret
%1 = call i32 @llvm.cttz.i32(i32 %a, i1 true)
%2 = add i32 %1, 1
%3 = icmp eq i32 %a, 0
%4 = select i1 %3, i32 0, i32 %2
ret i32 %4
}

declare i64 @llvm.cttz.i64(i64, i1)

define i64 @cttz_i64(i64

```

```

%a) nounwind {
; RV64I-LABEL: cttz_i64:
; RV64I:      # %bb.0:
; RV64I-NEXT: beqz a0, .LBB10_2
; RV64I-NEXT: # %bb.1: # %cond.false
; RV64I-NEXT: addi sp, sp, -16
; RV64I-NEXT: sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT: neg a1, a0
; RV64I-NEXT: and a0, a0, a1
; RV64I-NEXT: lui a1, %hi(.LCPI10_0)
; RV64I-NEXT: ld a1, %lo(.LCPI10_0)(a1)
; RV64I-NEXT: call __muldi3
; RV64I-NEXT: srli a0, a0, 58
; RV64I-NEXT: lui a1, %hi(.LCPI10_1)
; RV64I-NEXT: addi a1, a1, %lo(.LCPI10_1)
; RV64I-NEXT: add a0, a1, a0
; RV64I-NEXT: lbu a0, 0(a0)
; RV64I-NEXT: ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT: addi sp, sp, 16
; RV64I-NEXT: ret
; RV64I-NEXT: .LBB10_2:
; RV64I-NEXT: li a0, 64
; RV64I-NEXT: ret
;
; RV64ZBB-LABEL: cttz_i64:
; RV64ZBB:      # %bb.0:
; RV64ZBB-NEXT: ctz a0, a0
; RV64ZBB-NEXT: ret
%1 = call i64 @llvm.cttz.i64(i64 %a, i1 false)
ret i64 %1
}

```

```

declare i32 @llvm.ctpop.i32(i32)

```

```

define signext i32 @ctpop_i32(i32
signext %a) nounwind {
; RV64I-LABEL: ctpop_i32:
; RV64I:      # %bb.0:
; RV64I-NEXT: addi sp, sp, -16
; RV64I-NEXT: sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT: srliw a1, a0, 1
; RV64I-NEXT: lui a2, 349525
; RV64I-NEXT: addi a2, a2, 1365
; RV64I-NEXT: and a1, a1, a2
; RV64I-NEXT: subw a0, a0, a1
; RV64I-NEXT: lui a1, 209715
; RV64I-NEXT: addi a1, a1, 819
; RV64I-NEXT: and a2, a0, a1

```

```

; RV64I-NEXT: srliw a0, a0, 2
; RV64I-NEXT: and a0, a0, a1
; RV64I-NEXT: add a0, a2, a0
; RV64I-NEXT: srliw a1, a0, 4
; RV64I-NEXT: addw a0, a0, a1
; RV64I-NEXT: lui a1, 61681
; RV64I-NEXT: addiw a1, a1, -241
; RV64I-NEXT: and a0, a0, a1
; RV64I-NEXT: lui a1, 4112
; RV64I-NEXT: addiw a1, a1, 257
; RV64I-NEXT: call __muldi3
; RV64I-NEXT: srliw a0, a0, 24
; RV64I-NEXT: ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT: addi sp, sp, 16
; RV64I-NEXT: ret
;
; RV64ZBB-LABEL: ctpop_i32:
; RV64ZBB:    # %bb.0:
; RV64ZBB-NEXT: cpopw
a0, a0
; RV64ZBB-NEXT: ret
%1 = call i32 @llvm.ctpop.i32(i32 %a)
ret i32 %1
}

define signext i32 @ctpop_i32_load(ptr %p) nounwind {
; RV64I-LABEL: ctpop_i32_load:
; RV64I:    # %bb.0:
; RV64I-NEXT: addi sp, sp, -16
; RV64I-NEXT: sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT: lw a0, 0(a0)
; RV64I-NEXT: srliw a1, a0, 1
; RV64I-NEXT: lui a2, 349525
; RV64I-NEXT: addi a2, a2, 1365
; RV64I-NEXT: and a1, a1, a2
; RV64I-NEXT: subw a0, a0, a1
; RV64I-NEXT: lui a1, 209715
; RV64I-NEXT: addi a1, a1, 819
; RV64I-NEXT: and a2, a0, a1
; RV64I-NEXT: srliw a0, a0, 2
; RV64I-NEXT: and a0, a0, a1
; RV64I-NEXT: add a0, a2, a0
; RV64I-NEXT: srliw a1, a0, 4
; RV64I-NEXT: addw a0, a0, a1
; RV64I-NEXT: lui a1, 61681
; RV64I-NEXT: addiw a1, a1, -241
; RV64I-NEXT: and a0, a0, a1
; RV64I-NEXT: lui a1, 4112

```

```

; RV64I-NEXT:    addiw a1, a1, 257
; RV64I-NEXT:    call __muldi3
; RV64I-NEXT:    srliw a0, a0, 24
; RV64I-NEXT:    ld ra, 8(sp)
# 8-byte Folded Reload
; RV64I-NEXT:    addi sp, sp, 16
; RV64I-NEXT:    ret
;
; RV64ZBB-LABEL: ctpop_i32_load:
; RV64ZBB:      # %bb.0:
; RV64ZBB-NEXT: lw a0, 0(a0)
; RV64ZBB-NEXT: cpopw a0, a0
; RV64ZBB-NEXT: ret
%a = load i32, ptr %p
%1 = call i32 @llvm.ctpop.i32(i32 %a)
ret i32 %1
}

```

```
declare i64 @llvm.ctpop.i64(i64)
```

```

define i64 @ctpop_i64(i64 %a) nounwind {
; RV64I-LABEL: ctpop_i64:
; RV64I:      # %bb.0:
; RV64I-NEXT: addi sp, sp, -16
; RV64I-NEXT: sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT: srli a1, a0, 1
; RV64I-NEXT: lui a2, 349525
; RV64I-NEXT: addiw a2, a2, 1365
; RV64I-NEXT: slli a3, a2, 32
; RV64I-NEXT: add a2, a2, a3
; RV64I-NEXT: and a1, a1, a2
; RV64I-NEXT: sub a0, a0, a1
; RV64I-NEXT: lui a1, 209715
; RV64I-NEXT: addiw a1, a1, 819
; RV64I-NEXT: slli a2, a1, 32
; RV64I-NEXT: add a1, a1, a2
; RV64I-NEXT: and a2, a0, a1
; RV64I-NEXT: srli a0, a0, 2
; RV64I-NEXT: and a0, a0, a1
; RV64I-NEXT: add a0, a2,
a0
; RV64I-NEXT: srli a1, a0, 4
; RV64I-NEXT: add a0, a0, a1
; RV64I-NEXT: lui a1, 61681
; RV64I-NEXT: addiw a1, a1, -241
; RV64I-NEXT: slli a2, a1, 32
; RV64I-NEXT: add a1, a1, a2
; RV64I-NEXT: and a0, a0, a1

```

```

; RV64I-NEXT:  lui a1, 4112
; RV64I-NEXT:  addiw a1, a1, 257
; RV64I-NEXT:  slli a2, a1, 32
; RV64I-NEXT:  add a1, a1, a2
; RV64I-NEXT:  call __muldi3
; RV64I-NEXT:  srli a0, a0, 56
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
;
; RV64ZBB-LABEL: ctpop_i64:
; RV64ZBB:      # %bb.0:
; RV64ZBB-NEXT:  cpop a0, a0
; RV64ZBB-NEXT:  ret
%1 = call i64 @llvm.ctpop.i64(i64 %a)
ret i64 %1
}

define signext i32 @sextb_i32(i32 signext %a) nounwind {
; RV64I-LABEL: sextb_i32:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a0, a0, 56
; RV64I-NEXT:  srai a0, a0, 56
; RV64I-NEXT:  ret
;
; RV64ZBB-LABEL: sextb_i32:
; RV64ZBB:      # %bb.0:
; RV64ZBB-NEXT:  sext.b a0, a0
; RV64ZBB-NEXT:
    ret
%shl = shl i32 %a, 24
%shr = ashr exact i32 %shl, 24
ret i32 %shr
}

define i64 @sextb_i64(i64 %a) nounwind {
; RV64I-LABEL: sextb_i64:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a0, a0, 56
; RV64I-NEXT:  srai a0, a0, 56
; RV64I-NEXT:  ret
;
; RV64ZBB-LABEL: sextb_i64:
; RV64ZBB:      # %bb.0:
; RV64ZBB-NEXT:  sext.b a0, a0
; RV64ZBB-NEXT:  ret
%shl = shl i64 %a, 56
%shr = ashr exact i64 %shl, 56

```

```

ret i64 %shr
}

define signext i32 @sexth_i32(i32 signext %a) nounwind {
; RV64I-LABEL: sexth_i32:
; RV64I:    # %bb.0:
; RV64I-NEXT:  slli a0, a0, 48
; RV64I-NEXT:  srai a0, a0, 48
; RV64I-NEXT:  ret
;
; RV64ZBB-LABEL: sexth_i32:
; RV64ZBB:    # %bb.0:
; RV64ZBB-NEXT:  sext.h a0, a0
; RV64ZBB-NEXT:  ret
%shl = shl i32 %a, 16
%shr = ashr exact i32 %shl, 16
ret i32 %shr
}

define i64 @sexth_i64(i64 %a) nounwind {
; RV64I-LABEL: sexth_i64:
; RV64I:    # %bb.0:
; RV64I-NEXT:  slli a0, a0, 48
; RV64I-NEXT:  srai a0, a0, 48
; RV64I-NEXT:
ret
;
; RV64ZBB-LABEL: sexth_i64:
; RV64ZBB:    # %bb.0:
; RV64ZBB-NEXT:  sext.h a0, a0
; RV64ZBB-NEXT:  ret
%shl = shl i64 %a, 48
%shr = ashr exact i64 %shl, 48
ret i64 %shr
}

define signext i32 @min_i32(i32 signext %a, i32 signext %b) nounwind {
; RV64I-LABEL: min_i32:
; RV64I:    # %bb.0:
; RV64I-NEXT:  blt a0, a1, .LBB18_2
; RV64I-NEXT:  # %bb.1:
; RV64I-NEXT:  mv a0, a1
; RV64I-NEXT:  .LBB18_2:
; RV64I-NEXT:  ret
;
; RV64ZBB-LABEL: min_i32:
; RV64ZBB:    # %bb.0:
; RV64ZBB-NEXT:  min a0, a0, a1

```



```

; RV64ZBB-NEXT:  ret
%cmp = icmp slt i32 %a, %b
%cond = select i1 %cmp, i32 %a, i32 %b
ret i32 %cond
}

define i64 @min_i64(i64 %a, i64 %b) nounwind {
; RV64I-LABEL: min_i64:
; RV64I:      # %bb.0:
; RV64I-NEXT:  blt a0, a1, .LBB19_2
; RV64I-NEXT: # %bb.1:
; RV64I-NEXT:  mv a0, a1
; RV64I-NEXT: .LBB19_2:
; RV64I-NEXT:  ret
;
; RV64ZBB-LABEL: min_i64:
; RV64ZBB:    # %bb.0:
; RV64ZBB-NEXT:  min a0, a0, a1
; RV64ZBB-NEXT:  ret
%cmp = icmp
slt i64 %a, %b
%cond = select i1 %cmp, i64 %a, i64 %b
ret i64 %cond
}

define signext i32 @max_i32(i32 signext %a, i32 signext %b) nounwind {
; RV64I-LABEL: max_i32:
; RV64I:      # %bb.0:
; RV64I-NEXT:  blt a1, a0, .LBB20_2
; RV64I-NEXT: # %bb.1:
; RV64I-NEXT:  mv a0, a1
; RV64I-NEXT: .LBB20_2:
; RV64I-NEXT:  ret
;
; RV64ZBB-LABEL: max_i32:
; RV64ZBB:    # %bb.0:
; RV64ZBB-NEXT:  max a0, a0, a1
; RV64ZBB-NEXT:  ret
%cmp = icmp sgt i32 %a, %b
%cond = select i1 %cmp, i32 %a, i32 %b
ret i32 %cond
}

define i64 @max_i64(i64 %a, i64 %b) nounwind {
; RV64I-LABEL: max_i64:
; RV64I:      # %bb.0:
; RV64I-NEXT:  blt a1, a0, .LBB21_2
; RV64I-NEXT: # %bb.1:

```

```

; RV64I-NEXT:  mv a0, a1
; RV64I-NEXT:  .LBB21_2:
; RV64I-NEXT:  ret
;
; RV64ZBB-LABEL: max_i64:
; RV64ZBB:     # %bb.0:
; RV64ZBB-NEXT:  max a0, a0, a1
; RV64ZBB-NEXT:  ret
%cmp = icmp sgt i64 %a, %b
%cond = select i1 %cmp, i64 %a, i64 %b
ret i64 %cond
}

```

```

define signext i32 @minu_i32(i32 signext
%a, i32 signext %b) nounwind {
; RV64I-LABEL: minu_i32:
; RV64I:     # %bb.0:
; RV64I-NEXT:  bltu a0, a1, .LBB22_2
; RV64I-NEXT: # %bb.1:
; RV64I-NEXT:  mv a0, a1
; RV64I-NEXT: .LBB22_2:
; RV64I-NEXT:  ret
;
; RV64ZBB-LABEL: minu_i32:
; RV64ZBB:     # %bb.0:
; RV64ZBB-NEXT:  minu a0, a0, a1
; RV64ZBB-NEXT:  ret
%cmp = icmp ult i32 %a, %b
%cond = select i1 %cmp, i32 %a, i32 %b
ret i32 %cond
}

```

```

define i64 @minu_i64(i64 %a, i64 %b) nounwind {
; RV64I-LABEL: minu_i64:
; RV64I:     # %bb.0:
; RV64I-NEXT:  bltu a0, a1, .LBB23_2
; RV64I-NEXT: # %bb.1:
; RV64I-NEXT:  mv a0, a1
; RV64I-NEXT: .LBB23_2:
; RV64I-NEXT:  ret
;
; RV64ZBB-LABEL: minu_i64:
; RV64ZBB:     # %bb.0:
; RV64ZBB-NEXT:  minu a0, a0, a1
; RV64ZBB-NEXT:  ret
%cmp = icmp ult i64 %a, %b
%cond = select i1 %cmp, i64 %a, i64 %b
ret i64 %cond

```

```
}
```

```
define signext i32 @maxu_i32(i32 signext %a, i32 signext %b) nounwind {  
; RV64I-LABEL: maxu_i32:  
; RV64I:      # %bb.0:  
; RV64I-NEXT:  bltu a1,  
a0, .LBB24_2  
; RV64I-NEXT: # %bb.1:  
; RV64I-NEXT:  mv a0, a1  
; RV64I-NEXT: .LBB24_2:  
; RV64I-NEXT:  ret  
;  
; RV64ZBB-LABEL: maxu_i32:  
; RV64ZBB:     # %bb.0:  
; RV64ZBB-NEXT: maxu a0, a0, a1  
; RV64ZBB-NEXT: ret  
%cmp = icmp ugt i32 %a, %b  
%cond = select i1 %cmp, i32 %a, i32 %b  
ret i32 %cond  
}
```

```
define i64 @maxu_i64(i64 %a, i64 %b) nounwind {  
; RV64I-LABEL: maxu_i64:  
; RV64I:      # %bb.0:  
; RV64I-NEXT:  bltu a1, a0, .LBB25_2  
; RV64I-NEXT: # %bb.1:  
; RV64I-NEXT:  mv a0, a1  
; RV64I-NEXT: .LBB25_2:  
; RV64I-NEXT:  ret  
;  
; RV64ZBB-LABEL: maxu_i64:  
; RV64ZBB:     # %bb.0:  
; RV64ZBB-NEXT: maxu a0, a0, a1  
; RV64ZBB-NEXT: ret  
%cmp = icmp ugt i64 %a, %b  
%cond = select i1 %cmp, i64 %a, i64 %b  
ret i64 %cond  
}
```

```
declare i32 @llvm.abs.i32(i32, i1 immarg)
```

```
define i32 @abs_i32(i32 %x) {  
; RV64I-LABEL: abs_i32:  
; RV64I:      # %bb.0:  
; RV64I-NEXT:  sraiw a1, a0, 31  
; RV64I-NEXT:  xor a0, a0, a1  
; RV64I-NEXT:  subw a0, a0, a1  
; RV64I-NEXT:  ret  
}
```

```

;
; RV64ZBB-LABEL:
abs_i32:
; RV64ZBB:    # %bb.0:
; RV64ZBB-NEXT:  sraiw a1, a0, 31
; RV64ZBB-NEXT:  xor a0, a0, a1
; RV64ZBB-NEXT:  subw a0, a0, a1
; RV64ZBB-NEXT:  ret
%abs = tail call i32 @llvm.abs.i32(i32 %x, i1 true)
ret i32 %abs
}

```

```

define signext i32 @abs_i32_sext(i32 signext %x) {
; RV64I-LABEL: abs_i32_sext:
; RV64I:    # %bb.0:
; RV64I-NEXT:  sraiw a1, a0, 31
; RV64I-NEXT:  xor a0, a0, a1
; RV64I-NEXT:  subw a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBB-LABEL: abs_i32_sext:
; RV64ZBB:    # %bb.0:
; RV64ZBB-NEXT:  sraiw a1, a0, 31
; RV64ZBB-NEXT:  xor a0, a0, a1
; RV64ZBB-NEXT:  subw a0, a0, a1
; RV64ZBB-NEXT:  ret
%abs = tail call i32 @llvm.abs.i32(i32 %x, i1 true)
ret i32 %abs
}

```

```

declare i64 @llvm.abs.i64(i64, i1 immarg)

```

```

define i64 @abs_i64(i64 %x) {
; RV64I-LABEL: abs_i64:
; RV64I:    # %bb.0:
; RV64I-NEXT:  srai a1, a0, 63
; RV64I-NEXT:  xor a0, a0, a1
; RV64I-NEXT:  sub a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBB-LABEL: abs_i64:
; RV64ZBB:
# %bb.0:
; RV64ZBB-NEXT:  neg a1, a0
; RV64ZBB-NEXT:  max a0, a0, a1
; RV64ZBB-NEXT:  ret
%abs = tail call i64 @llvm.abs.i64(i64 %x, i1 true)
ret i64 %abs

```

```
}
```

```
define i32 @zexth_i32(i32 %a) nounwind {  
; RV64I-LABEL: zexth_i32:  
; RV64I:      # %bb.0:  
; RV64I-NEXT:  slli a0, a0, 48  
; RV64I-NEXT:  srli a0, a0, 48  
; RV64I-NEXT:  ret  
;  
; RV64ZBB-LABEL: zexth_i32:  
; RV64ZBB:     # %bb.0:  
; RV64ZBB-NEXT: slli a0, a0, 48  
; RV64ZBB-NEXT: srli a0, a0, 48  
; RV64ZBB-NEXT: ret  
%and = and i32 %a, 65535  
ret i32 %and  
}
```

```
define i64 @zexth_i64(i64 %a) nounwind {  
; RV64I-LABEL: zexth_i64:  
; RV64I:      # %bb.0:  
; RV64I-NEXT:  slli a0, a0, 48  
; RV64I-NEXT:  srli a0, a0, 48  
; RV64I-NEXT:  ret  
;  
; RV64ZBB-LABEL: zexth_i64:  
; RV64ZBB:     # %bb.0:  
; RV64ZBB-NEXT: zext.h a0, a0  
; RV64ZBB-NEXT: ret  
%and = and i64 %a, 65535  
ret i64 %and  
}
```

```
declare i32 @llvm.bswap.i32(i32)
```

```
define signext i32 @bswap_i32(i32 signext %a) nounwind {  
; RV64I-LABEL: bswap_i32:  
;  
RV64I:      # %bb.0:  
; RV64I-NEXT:  srlw a1, a0, 8  
; RV64I-NEXT:  lui a2, 16  
; RV64I-NEXT:  addiw a2, a2, -256  
; RV64I-NEXT:  and a1, a1, a2  
; RV64I-NEXT:  srlw a3, a0, 24  
; RV64I-NEXT:  or a1, a1, a3  
; RV64I-NEXT:  and a2, a0, a2  
; RV64I-NEXT:  sllw a2, a2, 8  
; RV64I-NEXT:  sllw a0, a0, 24
```

```

; RV64I-NEXT:  or a0, a0, a2
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBB-LABEL: bswap_i32:
; RV64ZBB:     # %bb.0:
; RV64ZBB-NEXT:  rev8 a0, a0
; RV64ZBB-NEXT:  srli a0, a0, 32
; RV64ZBB-NEXT:  ret
%1 = tail call i32 @llvm.bswap.i32(i32 %a)
ret i32 %1
}

; Similar to bswap_i32 but the result is not sign extended.
define void @bswap_i32_nosext(i32 signext %a, ptr %x) nounwind {
; RV64I-LABEL: bswap_i32_nosext:
; RV64I:       # %bb.0:
; RV64I-NEXT:  srlw a2, a0, 8
; RV64I-NEXT:  lui a3, 16
; RV64I-NEXT:  addi a3, a3, -256
; RV64I-NEXT:  and a2, a2, a3
; RV64I-NEXT:  srlw a4, a0, 24
; RV64I-NEXT:  or a2, a2, a4
; RV64I-NEXT:
    and a3, a0, a3
; RV64I-NEXT:  slli a3, a3, 8
; RV64I-NEXT:  slli a0, a0, 24
; RV64I-NEXT:  or a0, a0, a3
; RV64I-NEXT:  or a0, a0, a2
; RV64I-NEXT:  sw a0, 0(a1)
; RV64I-NEXT:  ret
;
; RV64ZBB-LABEL: bswap_i32_nosext:
; RV64ZBB:     # %bb.0:
; RV64ZBB-NEXT:  rev8 a0, a0
; RV64ZBB-NEXT:  srli a0, a0, 32
; RV64ZBB-NEXT:  sw a0, 0(a1)
; RV64ZBB-NEXT:  ret
%1 = tail call i32 @llvm.bswap.i32(i32 %a)
store i32 %1, ptr %x
ret void
}

declare i64 @llvm.bswap.i64(i64)

define i64 @bswap_i64(i64 %a) {
; RV64I-LABEL: bswap_i64:
; RV64I:       # %bb.0:

```

```

; RV64I-NEXT: srli a1, a0, 40
; RV64I-NEXT: lui a2, 16
; RV64I-NEXT: addiw a2, a2, -256
; RV64I-NEXT: and a1, a1, a2
; RV64I-NEXT: srli a3, a0, 56
; RV64I-NEXT: or a1, a1, a3
; RV64I-NEXT: srli a3, a0, 24
; RV64I-NEXT: lui a4, 4080
; RV64I-NEXT: and a3, a3, a4
; RV64I-NEXT: srli a5, a0, 8
; RV64I-NEXT: srliw a5, a5, 24
; RV64I-NEXT: slli a5, a5, 24
; RV64I-NEXT: or a3, a5, a3
; RV64I-NEXT:
    or a1, a3, a1
; RV64I-NEXT: and a4, a0, a4
; RV64I-NEXT: slli a4, a4, 24
; RV64I-NEXT: srliw a3, a0, 24
; RV64I-NEXT: slli a3, a3, 32
; RV64I-NEXT: or a3, a4, a3
; RV64I-NEXT: and a2, a0, a2
; RV64I-NEXT: slli a2, a2, 40
; RV64I-NEXT: slli a0, a0, 56
; RV64I-NEXT: or a0, a0, a2
; RV64I-NEXT: or a0, a0, a3
; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT: ret
;
; RV64ZBB-LABEL: bswap_i64:
; RV64ZBB:    # %bb.0:
; RV64ZBB-NEXT: rev8 a0, a0
; RV64ZBB-NEXT: ret
%1 = call i64 @llvm.bswap.i64(i64 %a)
ret i64 %1
}
; NOTE: Assertions have been autogenerated by utils/update_llc_test_checks.py
; RUN: llc -mtriple=riscv64 -verify-machineinstrs < %s \
; RUN: -riscv-experimental-rv64-legal-i32 | FileCheck %s -check-prefix=RV64I
; RUN: llc -mtriple=riscv64 -mattr=+zbkb -verify-machineinstrs < %s \
; RUN: -riscv-experimental-rv64-legal-i32 | FileCheck %s -check-prefix=RV64ZBKB

define signext i32 @pack_i32(i32 signext %a, i32 signext %b) nounwind {
; RV64I-LABEL: pack_i32:
; RV64I:    # %bb.0:
; RV64I-NEXT: slli a0, a0, 48
; RV64I-NEXT: srli a0, a0, 48
; RV64I-NEXT: slliw a1, a1, 16
; RV64I-NEXT: or a0, a1, a0

```

```

; RV64I-NEXT:  ret
;
; RV64ZBKB-LABEL: pack_i32:
; RV64ZBKB:    # %bb.0:
; RV64ZBKB-NEXT:  packw a0, a0, a1
; RV64ZBKB-NEXT:  ret
%shl = and i32 %a, 65535
%shl1 = shl i32 %b, 16
%or = or i32 %shl1, %shl
ret i32 %or
}

```

```

define signext i32 @pack_i32_2(i16 zeroext %a, i16 zeroext %b) nounwind {
; RV64I-LABEL: pack_i32_2:
; RV64I:    # %bb.0:
; RV64I-NEXT:  slliw
a1, a1, 16
; RV64I-NEXT:  or a0, a1, a0
; RV64I-NEXT:  ret
;
; RV64ZBKB-LABEL: pack_i32_2:
; RV64ZBKB:    # %bb.0:
; RV64ZBKB-NEXT:  packw a0, a0, a1
; RV64ZBKB-NEXT:  ret
%zexta = zext i16 %a to i32
%zextb = zext i16 %b to i32
%shl1 = shl i32 %zextb, 16
%or = or i32 %shl1, %zexta
ret i32 %or
}

```

```

; Test case where we don't have a sign_extend_inreg after the or.
define signext i32 @pack_i32_3(i16 zeroext %0, i16 zeroext %1, i32 signext %2) {
; RV64I-LABEL: pack_i32_3:
; RV64I:    # %bb.0:
; RV64I-NEXT:  slli a0, a0, 16
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  addw a0, a0, a2
; RV64I-NEXT:  ret
;
; RV64ZBKB-LABEL: pack_i32_3:
; RV64ZBKB:    # %bb.0:
; RV64ZBKB-NEXT:  packw a0, a1, a0
; RV64ZBKB-NEXT:  addw a0, a0, a2
; RV64ZBKB-NEXT:  ret
%4 = zext i16 %0 to i32
%5 = shl nuw i32 %4, 16
%6 = zext i16 %1 to i32

```



```

%7 = or i32 %5, %6
%8 = add i32 %7, %2
ret i32 %8
}

```

```

define i64 @pack_i64(i64 %a, i64 %b) nounwind {
; RV64I-LABEL: pack_i64:
;
RV64I:    # %bb.0:
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  srli a0, a0, 32
; RV64I-NEXT:  slli a1, a1, 32
; RV64I-NEXT:  or a0, a1, a0
; RV64I-NEXT:  ret
;
; RV64ZBKB-LABEL: pack_i64:
; RV64ZBKB:    # %bb.0:
; RV64ZBKB-NEXT:  pack a0, a0, a1
; RV64ZBKB-NEXT:  ret
%shl = and i64 %a, 4294967295
%shl1 = shl i64 %b, 32
%or = or i64 %shl1, %shl
ret i64 %or
}

```

```

define i64 @pack_i64_2(i32 signext %a, i32 signext %b) nounwind {
; RV64I-LABEL: pack_i64_2:
; RV64I:    # %bb.0:
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  srli a0, a0, 32
; RV64I-NEXT:  slli a1, a1, 32
; RV64I-NEXT:  or a0, a1, a0
; RV64I-NEXT:  ret
;
; RV64ZBKB-LABEL: pack_i64_2:
; RV64ZBKB:    # %bb.0:
; RV64ZBKB-NEXT:  pack a0, a0, a1
; RV64ZBKB-NEXT:  ret
%zexta = zext i32 %a to i64
%zextb = zext i32 %b to i64
%shl1 = shl i64 %zextb, 32
%or = or i64 %shl1, %zexta
ret i64 %or
}

```

```

define i64 @pack_i64_3(ptr %0, ptr %1) {
; RV64I-LABEL: pack_i64_3:
; RV64I:    #

```

```

%bb.0:
; RV64I-NEXT:  lw a0, 0(a0)
; RV64I-NEXT:  lwu a1, 0(a1)
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBKB-LABEL: pack_i64_3:
; RV64ZBKB:    # %bb.0:
; RV64ZBKB-NEXT:  lw a0, 0(a0)
; RV64ZBKB-NEXT:  lwu a1, 0(a1)
; RV64ZBKB-NEXT:  pack a0, a1, a0
; RV64ZBKB-NEXT:  ret
%3 = load i32, ptr %0, align 4
%4 = zext i32 %3 to i64
%5 = shl i64 %4, 32
%6 = load i32, ptr %1, align 4
%7 = zext i32 %6 to i64
%8 = or i64 %5, %7
ret i64 %8
}

define signext i32 @packh_i32(i32 signext %a, i32 signext %b) nounwind {
; RV64I-LABEL: packh_i32:
; RV64I:    # %bb.0:
; RV64I-NEXT:  andi a0, a0, 255
; RV64I-NEXT:  slli a1, a1, 56
; RV64I-NEXT:  srli a1, a1, 48
; RV64I-NEXT:  or a0, a1, a0
; RV64I-NEXT:  ret
;
; RV64ZBKB-LABEL: packh_i32:
; RV64ZBKB:    # %bb.0:
; RV64ZBKB-NEXT:  packh a0, a0, a1
; RV64ZBKB-NEXT:  ret
%and = and i32 %a, 255
%and1 = shl i32 %b, 8
%shl = and i32 %and1, 65280
%or = or
i32 %shl, %and
ret i32 %or
}

define i32 @packh_i32_2(i32 %a, i32 %b) nounwind {
; RV64I-LABEL: packh_i32_2:
; RV64I:    # %bb.0:
; RV64I-NEXT:  andi a0, a0, 255
; RV64I-NEXT:  andi a1, a1, 255

```

```

; RV64I-NEXT:  slliw a1, a1, 8
; RV64I-NEXT:  or a0, a1, a0
; RV64I-NEXT:  ret
;
; RV64ZBKB-LABEL: packh_i32_2:
; RV64ZBKB:      # %bb.0:
; RV64ZBKB-NEXT:  packh a0, a0, a1
; RV64ZBKB-NEXT:  ret
%and = and i32 %a, 255
%and1 = and i32 %b, 255
%shl = shl i32 %and1, 8
%or = or i32 %shl, %and
ret i32 %or
}

define i64 @packh_i64(i64 %a, i64 %b) nounwind {
; RV64I-LABEL: packh_i64:
; RV64I:      # %bb.0:
; RV64I-NEXT:  andi a0, a0, 255
; RV64I-NEXT:  slli a1, a1, 56
; RV64I-NEXT:  srli a1, a1, 48
; RV64I-NEXT:  or a0, a1, a0
; RV64I-NEXT:  ret
;
; RV64ZBKB-LABEL: packh_i64:
; RV64ZBKB:      # %bb.0:
; RV64ZBKB-NEXT:  packh a0, a0, a1
; RV64ZBKB-NEXT:  ret
%and = and i64 %a, 255
%and1 = shl i64 %b, 8
%shl = and i64 %and1, 65280
%or = or i64 %shl,
%and
ret i64 %or
}

define i64 @packh_i64_2(i64 %a, i64 %b) nounwind {
; RV64I-LABEL: packh_i64_2:
; RV64I:      # %bb.0:
; RV64I-NEXT:  andi a0, a0, 255
; RV64I-NEXT:  andi a1, a1, 255
; RV64I-NEXT:  slli a1, a1, 8
; RV64I-NEXT:  or a0, a1, a0
; RV64I-NEXT:  ret
;
; RV64ZBKB-LABEL: packh_i64_2:
; RV64ZBKB:      # %bb.0:
; RV64ZBKB-NEXT:  packh a0, a0, a1

```

```

; RV64ZBKB-NEXT:  ret
%and = and i64 %a, 255
%and1 = and i64 %b, 255
%shl = shl i64 %and1, 8
%or = or i64 %shl, %and
ret i64 %or
}

define zeroext i16 @packh_i16(i8 zeroext %a, i8 zeroext %b) nounwind {
; RV64I-LABEL: packh_i16:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slliw a1, a1, 8
; RV64I-NEXT:  or a0, a1, a0
; RV64I-NEXT:  ret
;
; RV64ZBKB-LABEL: packh_i16:
; RV64ZBKB:    # %bb.0:
; RV64ZBKB-NEXT:  packh a0, a0, a1
; RV64ZBKB-NEXT:  ret
%zext = zext i8 %a to i16
%zext1 = zext i8 %b to i16
%shl = shl i16 %zext1, 8
%or = or i16 %shl, %zext
ret i16 %or
}

define zeroext i16 @packh_i16_2(i8
zeroext %0, i8 zeroext %1, i8 zeroext %2) {
; RV64I-LABEL: packh_i16_2:
; RV64I:      # %bb.0:
; RV64I-NEXT:  add a0, a1, a0
; RV64I-NEXT:  slli a0, a0, 8
; RV64I-NEXT:  or a0, a0, a2
; RV64I-NEXT:  slli a0, a0, 48
; RV64I-NEXT:  srli a0, a0, 48
; RV64I-NEXT:  ret
;
; RV64ZBKB-LABEL: packh_i16_2:
; RV64ZBKB:    # %bb.0:
; RV64ZBKB-NEXT:  add a0, a1, a0
; RV64ZBKB-NEXT:  packh a0, a2, a0
; RV64ZBKB-NEXT:  ret
%4 = add i8 %1, %0
%5 = zext i8 %4 to i16
%6 = shl i16 %5, 8
%7 = zext i8 %2 to i16
%8 = or i16 %6, %7
ret i16 %8

```

```
}
```

```
define i64 @pack_i64_allWUsers(i32 signext %0, i32 signext %1, i32 signext %2) {  
; RV64I-LABEL: pack_i64_allWUsers:  
; RV64I:    # %bb.0:  
; RV64I-NEXT:  add a0, a1, a0  
; RV64I-NEXT:  slli a0, a0, 32  
; RV64I-NEXT:  slli a2, a2, 32  
; RV64I-NEXT:  srli a2, a2, 32  
; RV64I-NEXT:  or a0, a0, a2  
; RV64I-NEXT:  ret  
;  
; RV64ZBKB-LABEL: pack_i64_allWUsers:  
; RV64ZBKB:    # %bb.0:  
; RV64ZBKB-NEXT:  add a0, a1, a0  
; RV64ZBKB-NEXT:  
    pack a0, a2, a0  
; RV64ZBKB-NEXT:  ret  
%4 = add i32 %1, %0  
%5 = zext i32 %4 to i64  
%6 = shl i64 %5, 32  
%7 = zext i32 %2 to i64  
%8 = or i64 %6, %7  
ret i64 %8  
}
```

```
define signext i32 @pack_i32_allWUsers(i16 zeroext %0, i16 zeroext %1, i16 zeroext %2) {  
; RV64I-LABEL: pack_i32_allWUsers:  
; RV64I:    # %bb.0:  
; RV64I-NEXT:  add a0, a1, a0  
; RV64I-NEXT:  slliw a0, a0, 16  
; RV64I-NEXT:  or a0, a0, a2  
; RV64I-NEXT:  ret  
;  
; RV64ZBKB-LABEL: pack_i32_allWUsers:  
; RV64ZBKB:    # %bb.0:  
; RV64ZBKB-NEXT:  add a0, a1, a0  
; RV64ZBKB-NEXT:  packw a0, a2, a0  
; RV64ZBKB-NEXT:  ret  
%4 = add i16 %1, %0  
%5 = zext i16 %4 to i32  
%6 = shl i32 %5, 16  
%7 = zext i16 %2 to i32  
%8 = or i32 %6, %7  
ret i32 %8  
}
```

```
define i64 @pack_i64_imm() {
```

```

; RV64I-LABEL: pack_i64_imm:
; RV64I:    # %bb.0:
; RV64I-NEXT:  lui a0, 65793
; RV64I-NEXT:  addiw a0, a0, 16
; RV64I-NEXT:  slli a1, a0, 32
; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBKB-LABEL:
pack_i64_imm:
; RV64ZBKB:    # %bb.0:
; RV64ZBKB-NEXT:  lui a0, 65793
; RV64ZBKB-NEXT:  addi a0, a0, 16
; RV64ZBKB-NEXT:  pack a0, a0, a0
; RV64ZBKB-NEXT:  ret
ret i64 1157442765409226768 ; 0x0101010101010101
}
; NOTE: Assertions have been autogenerated by utils/update_llc_test_checks.py
; RUN: llc -mtriple=riscv64 -verify-machineinstrs < %s \
; RUN: -riscv-experimental-rv64-legal-i32 | FileCheck -check-prefix=RV64I %s

```

; Check indexed and unindexed, sext, zext and anyext loads

```

define void @lb(ptr %a, ptr %b) nounwind {
; RV64I-LABEL: lb:
; RV64I:    # %bb.0:
; RV64I-NEXT:  lb a2, 1(a0)
; RV64I-NEXT:  lbu zero, 0(a0)
; RV64I-NEXT:  sw a2, 0(a1)
; RV64I-NEXT:  ret
%1 = getelementptr i8, ptr %a, i32 1
%2 = load i8, ptr %1
%3 = sext i8 %2 to i32
; the unused load will produce an anyext for selection
%4 = load volatile i8, ptr %a
store i32 %3, ptr %b
ret void
}

```

```

define void @lbu(ptr %a, ptr %b) nounwind {
; RV64I-LABEL: lbu:
; RV64I:    # %bb.0:
; RV64I-NEXT:  lbu a0, 1(a0)
; RV64I-NEXT:  sw a0, 0(a1)
; RV64I-NEXT:  ret
%1 = getelementptr i8, ptr %a, i32 1
%2 = load i8, ptr %1
%3 = zext i8 %2 to i32

```

```

store i32 %3, ptr %b
ret void
}

define void @lh(ptr
  %a, ptr %b) nounwind {
; RV64I-LABEL: lh:
; RV64I:      # %bb.0:
; RV64I-NEXT:  lh a2, 2(a0)
; RV64I-NEXT:  lh zero, 0(a0)
; RV64I-NEXT:  sw a2, 0(a1)
; RV64I-NEXT:  ret
%1 = getelementptr i16, ptr %a, i32 1
%2 = load i16, ptr %1
%3 = sext i16 %2 to i32
; the unused load will produce an anyext for selection
%4 = load volatile i16, ptr %a
store i32 %3, ptr %b
ret void
}

define void @lhu(ptr %a, ptr %b) nounwind {
; RV64I-LABEL: lhu:
; RV64I:      # %bb.0:
; RV64I-NEXT:  lhu a0, 2(a0)
; RV64I-NEXT:  sw a0, 0(a1)
; RV64I-NEXT:  ret
%1 = getelementptr i16, ptr %a, i32 1
%2 = load i16, ptr %1
%3 = zext i16 %2 to i32
store i32 %3, ptr %b
ret void
}

define void @lw(ptr %a, ptr %b) nounwind {
; RV64I-LABEL: lw:
; RV64I:      # %bb.0:
; RV64I-NEXT:  lw a2, 4(a0)
; RV64I-NEXT:  lw zero, 0(a0)
; RV64I-NEXT:  sd a2, 0(a1)
; RV64I-NEXT:  ret
%1 = getelementptr i32, ptr %a, i64 1
%2 = load i32, ptr %1
%3 = sext i32 %2 to i64
; the unused load
will produce an anyext for selection
%4 = load volatile i32, ptr %a
store i64 %3, ptr %b

```

```

ret void
}

define void @lwu(ptr %a, ptr %b) nounwind {
; RV64I-LABEL: lwu:
; RV64I:      # %bb.0:
; RV64I-NEXT:  lwu a0, 4(a0)
; RV64I-NEXT:  sd a0, 0(a1)
; RV64I-NEXT:  ret
%1 = getelementptr i32, ptr %a, i64 1
%2 = load i32, ptr %1
%3 = zext i32 %2 to i64
store i64 %3, ptr %b
ret void
}

; NOTE: Assertions have been autogenerated by utils/update_llc_test_checks.py
; RUN: llc -mtriple=riscv64 -riscv-disable-using-constant-pool-for-large-ints -verify-machineinstrs < %s \
; RUN:  -riscv-experimental-rv64-legal-i32 | FileCheck %s -check-prefixes=RV64I,RV64I-NOPOOL
; RUN: llc -mtriple=riscv64 -verify-machineinstrs < %s \
; RUN:  -riscv-experimental-rv64-legal-i32 | FileCheck %s -check-prefixes=RV64I,RV64I-POOL
; RUN: llc -mtriple=riscv64 -riscv-disable-using-constant-pool-for-large-ints -mattr=+zba \
; RUN:  -riscv-experimental-rv64-legal-i32 -verify-machineinstrs < %s | FileCheck %s -check-prefix=RV64IZBA
; RUN: llc -mtriple=riscv64 -riscv-disable-using-constant-pool-for-large-ints -mattr=+zbb \
; RUN:  -riscv-experimental-rv64-legal-i32 -verify-machineinstrs < %s | FileCheck %s -check-prefix=RV64IZBB
; RUN: llc -mtriple=riscv64 -riscv-disable-using-constant-pool-for-large-ints -mattr=+zbs \
; RUN:  -riscv-experimental-rv64-legal-i32 -verify-machineinstrs < %s | FileCheck
% s -check-prefix=RV64IZBS
; RUN: llc -mtriple=riscv64 -riscv-disable-using-constant-pool-for-large-ints -mattr=+xtheadbb \
; RUN:  -riscv-experimental-rv64-legal-i32 -verify-machineinstrs < %s | FileCheck %s -check-
prefix=RV64IXTHEADBB

; Materializing constants

; TODO: It would be preferable if anyext constant returns were sign rather
; than zero extended. See PR39092. For now, mark returns as explicitly signext
; (this matches what Clang would generate for equivalent C/C++ anyway).

define signext i32 @zero() nounwind {
; RV64I-LABEL: zero:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a0, 0
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: zero:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  li a0, 0
; RV64IZBA-NEXT:  ret
;

```



```

; RV64IZBB-LABEL: zero:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  li a0, 0
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: zero:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:  li a0, 0
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: zero:
; RV64IXTHEADBB:  # %bb.0:
;
RV64IXTHEADBB-NEXT:  li a0, 0
; RV64IXTHEADBB-NEXT:  ret
ret i32 0
}

```

```

define signext i32 @pos_small() nounwind {
; RV64I-LABEL: pos_small:
; RV64I:    # %bb.0:
; RV64I-NEXT:  li a0, 2047
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: pos_small:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  li a0, 2047
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: pos_small:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  li a0, 2047
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: pos_small:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:  li a0, 2047
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: pos_small:
; RV64IXTHEADBB:  # %bb.0:
; RV64IXTHEADBB-NEXT:  li a0, 2047
; RV64IXTHEADBB-NEXT:  ret
ret i32 2047
}

```

```

define signext i32 @neg_small() nounwind {
; RV64I-LABEL: neg_small:

```

```

; RV64I:    # %bb.0:
; RV64I-NEXT:  li a0, -2048
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: neg_small:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  li a0, -2048
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL:
neg_small:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  li a0, -2048
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: neg_small:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:  li a0, -2048
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: neg_small:
; RV64IXTHEADBB:    # %bb.0:
; RV64IXTHEADBB-NEXT:  li a0, -2048
; RV64IXTHEADBB-NEXT:  ret
ret i32 -2048
}

```

```

define signext i32 @pos_i32() nounwind {
; RV64I-LABEL: pos_i32:
; RV64I:    # %bb.0:
; RV64I-NEXT:  lui a0, 423811
; RV64I-NEXT:  addiw a0, a0, -1297
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: pos_i32:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  lui a0, 423811
; RV64IZBA-NEXT:  addiw a0, a0, -1297
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: pos_i32:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  lui a0, 423811
; RV64IZBB-NEXT:  addiw a0, a0, -1297
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: pos_i32:
; RV64IZBS:    # %bb.0:

```

```

; RV64IZBS-NEXT:  lui a0, 423811
; RV64IZBS-NEXT:  addiw a0, a0, -1297
; RV64IZBS-NEXT:
    ret
;
; RV64IXTHEADBB-LABEL: pos_i32:
; RV64IXTHEADBB:    # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 423811
; RV64IXTHEADBB-NEXT:  addiw a0, a0, -1297
; RV64IXTHEADBB-NEXT:  ret
    ret i32 1735928559
}

```

```

define signext i32 @neg_i32() nounwind {
; RV64I-LABEL: neg_i32:
; RV64I:    # %bb.0:
; RV64I-NEXT:  lui a0, 912092
; RV64I-NEXT:  addiw a0, a0, -273
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: neg_i32:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  lui a0, 912092
; RV64IZBA-NEXT:  addiw a0, a0, -273
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: neg_i32:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  lui a0, 912092
; RV64IZBB-NEXT:  addiw a0, a0, -273
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: neg_i32:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:  lui a0, 912092
; RV64IZBS-NEXT:  addiw a0, a0, -273
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: neg_i32:
; RV64IXTHEADBB:    # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 912092
; RV64IXTHEADBB-NEXT:  addiw a0, a0, -273
;
    RV64IXTHEADBB-NEXT:  ret
    ret i32 -559038737
}

```

```

define signext i32 @pos_i32_hi20_only() nounwind {

```

```

; RV64I-LABEL: pos_i32_hi20_only:
; RV64I:    # %bb.0:
; RV64I-NEXT:  lui a0, 16
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: pos_i32_hi20_only:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  lui a0, 16
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: pos_i32_hi20_only:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  lui a0, 16
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: pos_i32_hi20_only:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:  lui a0, 16
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: pos_i32_hi20_only:
; RV64IXTHEADBB:    # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 16
; RV64IXTHEADBB-NEXT:  ret
ret i32 65536 ; 0x10000
}

```

```

define signext i32 @neg_i32_hi20_only() nounwind {

```

```

; RV64I-LABEL: neg_i32_hi20_only:
; RV64I:    # %bb.0:
; RV64I-NEXT:  lui a0, 1048560
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: neg_i32_hi20_only:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  lui a0,
1048560
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: neg_i32_hi20_only:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  lui a0, 1048560
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: neg_i32_hi20_only:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:  lui a0, 1048560
; RV64IZBS-NEXT:  ret

```

```

;
; RV64IXTHEADBB-LABEL: neg_i32_hi20_only:
; RV64IXTHEADBB:    # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 1048560
; RV64IXTHEADBB-NEXT:  ret
ret i32 -65536 ; -0x10000
}

```

; This can be materialized with ADDI+SLLI, improving compressibility.

```

define signext i32 @imm_left_shifted_addi() nounwind {
; RV64I-LABEL: imm_left_shifted_addi:
; RV64I:    # %bb.0:
; RV64I-NEXT:  lui a0, 32
; RV64I-NEXT:  addiw a0, a0, -64
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm_left_shifted_addi:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  lui a0, 32
; RV64IZBA-NEXT:  addiw a0, a0, -64
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm_left_shifted_addi:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  lui a0, 32
;
RV64IZBB-NEXT:  addiw a0, a0, -64
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm_left_shifted_addi:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:  lui a0, 32
; RV64IZBS-NEXT:  addiw a0, a0, -64
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm_left_shifted_addi:
; RV64IXTHEADBB:    # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 32
; RV64IXTHEADBB-NEXT:  addiw a0, a0, -64
; RV64IXTHEADBB-NEXT:  ret
ret i32 131008 ; 0x1FFC0
}

```

; This can be materialized with ADDI+SRLI, improving compressibility.

```

define signext i32 @imm_right_shifted_addi() nounwind {
; RV64I-LABEL: imm_right_shifted_addi:

```

```

; RV64I:    # %bb.0:
; RV64I-NEXT:  lui a0, 524288
; RV64I-NEXT:  addiw a0, a0, -1
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm_right_shifted_addi:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  lui a0, 524288
; RV64IZBA-NEXT:  addiw a0, a0, -1
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm_right_shifted_addi:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  lui a0, 524288
; RV64IZBB-NEXT:
;               addiw a0, a0, -1
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm_right_shifted_addi:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:  lui a0, 524288
; RV64IZBS-NEXT:  addiw a0, a0, -1
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm_right_shifted_addi:
; RV64IXTHEADBB:  # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 524288
; RV64IXTHEADBB-NEXT:  addiw a0, a0, -1
; RV64IXTHEADBB-NEXT:  ret
;               ret i32 2147483647 ; 0x7FFFFFFF
}

```

; This can be materialized with LUI+SRLI, improving compressibility.

```

define signext i32 @imm_right_shifted_lui() nounwind {
; RV64I-LABEL: imm_right_shifted_lui:
; RV64I:    # %bb.0:
; RV64I-NEXT:  lui a0, 56
; RV64I-NEXT:  addiw a0, a0, 580
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm_right_shifted_lui:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  lui a0, 56
; RV64IZBA-NEXT:  addiw a0, a0, 580
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm_right_shifted_lui:

```

```

; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  lui a0, 56
; RV64IZBB-NEXT:
    addiw a0, a0, 580
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm_right_shifted_lui:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:  lui a0, 56
; RV64IZBS-NEXT:  addiw a0, a0, 580
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm_right_shifted_lui:
; RV64IXTHEADBB:    # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 56
; RV64IXTHEADBB-NEXT:  addiw a0, a0, 580
; RV64IXTHEADBB-NEXT:  ret
ret i32 229956 ; 0x38244
}

```

```

define i64 @imm64_1() nounwind {
; RV64I-LABEL: imm64_1:
; RV64I:    # %bb.0:
; RV64I-NEXT:  li a0, 1
; RV64I-NEXT:  slli a0, a0, 31
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm64_1:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  li a0, 1
; RV64IZBA-NEXT:  slli a0, a0, 31
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm64_1:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  li a0, 1
; RV64IZBB-NEXT:  slli a0, a0, 31
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm64_1:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:  bseti a0, zero, 31
; RV64IZBS-NEXT:  ret
;
;
RV64IXTHEADBB-LABEL: imm64_1:
; RV64IXTHEADBB:    # %bb.0:
; RV64IXTHEADBB-NEXT:  li a0, 1

```

```
; RV64IXTHEADBB-NEXT:  slli a0, a0, 31
; RV64IXTHEADBB-NEXT:  ret
ret i64 2147483648 ; 0x8000_0000
}
```

```
define i64 @imm64_2() nounwind {
; RV64I-LABEL: imm64_2:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a0, -1
; RV64I-NEXT:  srli a0, a0, 32
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm64_2:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  li a0, -1
; RV64IZBA-NEXT:  srli a0, a0, 32
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm64_2:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  li a0, -1
; RV64IZBB-NEXT:  srli a0, a0, 32
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm64_2:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:  li a0, -1
; RV64IZBS-NEXT:  srli a0, a0, 32
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm64_2:
; RV64IXTHEADBB:    # %bb.0:
; RV64IXTHEADBB-NEXT:  li a0, -1
; RV64IXTHEADBB-NEXT:  srli a0, a0, 32
; RV64IXTHEADBB-NEXT:  ret
ret i64 4294967295 ;
0xFFFF_FFFF
}
```

```
define i64 @imm64_3() nounwind {
; RV64I-LABEL: imm64_3:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a0, 1
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm64_3:
; RV64IZBA:    # %bb.0:
```



```

; RV64IZBA-NEXT:  li a0, 1
; RV64IZBA-NEXT:  slli a0, a0, 32
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm64_3:
; RV64IZBB:      # %bb.0:
; RV64IZBB-NEXT:  li a0, 1
; RV64IZBB-NEXT:  slli a0, a0, 32
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm64_3:
; RV64IZBS:      # %bb.0:
; RV64IZBS-NEXT:  bseti a0, zero, 32
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm64_3:
; RV64IXTHEADBB:  # %bb.0:
; RV64IXTHEADBB-NEXT:  li a0, 1
; RV64IXTHEADBB-NEXT:  slli a0, a0, 32
; RV64IXTHEADBB-NEXT:  ret
ret i64 4294967296 ; 0x1_0000_0000
}

```

```

define i64 @imm64_4() nounwind {
; RV64I-LABEL: imm64_4:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a0, -1
; RV64I-NEXT:  slli a0, a0, 63
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm64_4:
; RV64IZBA:
;   # %bb.0:
; RV64IZBA-NEXT:  li a0, -1
; RV64IZBA-NEXT:  slli a0, a0, 63
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm64_4:
; RV64IZBB:      # %bb.0:
; RV64IZBB-NEXT:  li a0, -1
; RV64IZBB-NEXT:  slli a0, a0, 63
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm64_4:
; RV64IZBS:      # %bb.0:
; RV64IZBS-NEXT:  bseti a0, zero, 63
; RV64IZBS-NEXT:  ret
;
}

```

```

; RV64IXTHEADBB-LABEL: imm64_4:
; RV64IXTHEADBB:    # %bb.0:
; RV64IXTHEADBB-NEXT:  li a0, -1
; RV64IXTHEADBB-NEXT:  slli a0, a0, 63
; RV64IXTHEADBB-NEXT:  ret
ret i64 9223372036854775808 ; 0x8000_0000_0000_0000
}

```

```

define i64 @imm64_5() nounwind {
; RV64I-LABEL: imm64_5:
; RV64I:    # %bb.0:
; RV64I-NEXT:  li a0, -1
; RV64I-NEXT:  slli a0, a0, 63
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm64_5:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  li a0, -1
; RV64IZBA-NEXT:  slli a0, a0, 63
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm64_5:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  li a0, -1
; RV64IZBB-NEXT:
;               slli a0, a0, 63
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm64_5:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:  bseti a0, zero, 63
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm64_5:
; RV64IXTHEADBB:    # %bb.0:
; RV64IXTHEADBB-NEXT:  li a0, -1
; RV64IXTHEADBB-NEXT:  slli a0, a0, 63
; RV64IXTHEADBB-NEXT:  ret
ret i64 -9223372036854775808 ; 0x8000_0000_0000_0000
}

```

```

define i64 @imm64_6() nounwind {
; RV64I-LABEL: imm64_6:
; RV64I:    # %bb.0:
; RV64I-NEXT:  lui a0, 9321
; RV64I-NEXT:  addi a0, a0, -1329
; RV64I-NEXT:  slli a0, a0, 35
; RV64I-NEXT:  ret

```

```

;
; RV64IZBA-LABEL: imm64_6:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  lui a0, 9321
; RV64IZBA-NEXT:  addi a0, a0, -1329
; RV64IZBA-NEXT:  slli a0, a0, 35
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm64_6:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  lui a0, 9321
; RV64IZBB-NEXT:  addi a0, a0, -1329
; RV64IZBB-NEXT:  slli a0, a0, 35
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm64_6:
;
RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:  lui a0, 9321
; RV64IZBS-NEXT:  addi a0, a0, -1329
; RV64IZBS-NEXT:  slli a0, a0, 35
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm64_6:
; RV64IXTHEADBB:    # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 9321
; RV64IXTHEADBB-NEXT:  addi a0, a0, -1329
; RV64IXTHEADBB-NEXT:  slli a0, a0, 35
; RV64IXTHEADBB-NEXT:  ret
ret i64 1311768464867721216 ; 0x1234_5678_0000_0000
}

```

```

define i64 @imm64_7() nounwind {
; RV64I-LABEL: imm64_7:
; RV64I:    # %bb.0:
; RV64I-NEXT:  li a0, 7
; RV64I-NEXT:  slli a0, a0, 36
; RV64I-NEXT:  addi a0, a0, 11
; RV64I-NEXT:  slli a0, a0, 24
; RV64I-NEXT:  addi a0, a0, 15
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm64_7:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  li a0, 7
; RV64IZBA-NEXT:  slli a0, a0, 36
; RV64IZBA-NEXT:  addi a0, a0, 11
; RV64IZBA-NEXT:  slli a0, a0, 24

```

```

; RV64IZBA-NEXT:  addi a0, a0, 15
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm64_7:
; RV64IZBB:      #
%bb.0:
; RV64IZBB-NEXT:  li a0, 7
; RV64IZBB-NEXT:  slli a0, a0, 36
; RV64IZBB-NEXT:  addi a0, a0, 11
; RV64IZBB-NEXT:  slli a0, a0, 24
; RV64IZBB-NEXT:  addi a0, a0, 15
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm64_7:
; RV64IZBS:      # %bb.0:
; RV64IZBS-NEXT:  li a0, 7
; RV64IZBS-NEXT:  slli a0, a0, 36
; RV64IZBS-NEXT:  addi a0, a0, 11
; RV64IZBS-NEXT:  slli a0, a0, 24
; RV64IZBS-NEXT:  addi a0, a0, 15
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm64_7:
; RV64IXTHEADBB: # %bb.0:
; RV64IXTHEADBB-NEXT:  li a0, 7
; RV64IXTHEADBB-NEXT:  slli a0, a0, 36
; RV64IXTHEADBB-NEXT:  addi a0, a0, 11
; RV64IXTHEADBB-NEXT:  slli a0, a0, 24
; RV64IXTHEADBB-NEXT:  addi a0, a0, 15
; RV64IXTHEADBB-NEXT:  ret
ret i64 8070450532432478223 ; 0x7000_0000_0B00_000F
}

```

; TODO: it can be preferable to put constants that are expensive to materialise  
into the constant pool, especially for -Os.

```

define i64 @imm64_8() nounwind {
; RV64-NOPOOL-LABEL: imm64_8:
; RV64-NOPOOL:
    # %bb.0:
; RV64-NOPOOL-NEXT:  lui a0, 583
; RV64-NOPOOL-NEXT:  addiw a0, a0, -1875
; RV64-NOPOOL-NEXT:  slli a0, a0, 14
; RV64-NOPOOL-NEXT:  addi a0, a0, -947
; RV64-NOPOOL-NEXT:  slli a0, a0, 12
; RV64-NOPOOL-NEXT:  addi a0, a0, 1511
; RV64-NOPOOL-NEXT:  slli a0, a0, 13
; RV64-NOPOOL-NEXT:  addi a0, a0, -272
; RV64-NOPOOL-NEXT:  ret

```

```

;
; RV64I-POOL-LABEL: imm64_8:
; RV64I-POOL:    # %bb.0:
; RV64I-POOL-NEXT:  lui a0, %hi(LCPI17_0)
; RV64I-POOL-NEXT:  ld a0, %lo(LCPI17_0)(a0)
; RV64I-POOL-NEXT:  ret
;
; RV64IZBA-LABEL: imm64_8:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  lui a0, 596523
; RV64IZBA-NEXT:  addi a0, a0, 965
; RV64IZBA-NEXT:  slli.uw a0, a0, 13
; RV64IZBA-NEXT:  addi a0, a0, -1347
; RV64IZBA-NEXT:  slli a0, a0, 12
; RV64IZBA-NEXT:  addi a0, a0, -529
; RV64IZBA-NEXT:  slli a0, a0, 4
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm64_8:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  lui a0, 583
; RV64IZBB-NEXT:  addiw
a0, a0, -1875
; RV64IZBB-NEXT:  slli a0, a0, 14
; RV64IZBB-NEXT:  addi a0, a0, -947
; RV64IZBB-NEXT:  slli a0, a0, 12
; RV64IZBB-NEXT:  addi a0, a0, 1511
; RV64IZBB-NEXT:  slli a0, a0, 13
; RV64IZBB-NEXT:  addi a0, a0, -272
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm64_8:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:  lui a0, 583
; RV64IZBS-NEXT:  addiw a0, a0, -1875
; RV64IZBS-NEXT:  slli a0, a0, 14
; RV64IZBS-NEXT:  addi a0, a0, -947
; RV64IZBS-NEXT:  slli a0, a0, 12
; RV64IZBS-NEXT:  addi a0, a0, 1511
; RV64IZBS-NEXT:  slli a0, a0, 13
; RV64IZBS-NEXT:  addi a0, a0, -272
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm64_8:
; RV64IXTHEADBB:    # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 583
; RV64IXTHEADBB-NEXT:  addiw a0, a0, -1875
; RV64IXTHEADBB-NEXT:  slli a0, a0, 14

```

```
; RV64IXTHEADBB-NEXT: addi a0, a0, -947
; RV64IXTHEADBB-NEXT: slli a0, a0, 12
; RV64IXTHEADBB-NEXT: addi a0, a0, 1511
; RV64IXTHEADBB-NEXT: slli a0, a0, 13
; RV64IXTHEADBB-NEXT:
    addi a0, a0, -272
; RV64IXTHEADBB-NEXT: ret
ret i64 1311768467463790320 ; 0x1234_5678_9ABC_DEF0
}
```

```
define i64 @imm64_9() nounwind {
; RV64I-LABEL: imm64_9:
; RV64I:    # %bb.0:
; RV64I-NEXT: li a0, -1
; RV64I-NEXT: ret
;
; RV64IZBA-LABEL: imm64_9:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT: li a0, -1
; RV64IZBA-NEXT: ret
;
; RV64IZBB-LABEL: imm64_9:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT: li a0, -1
; RV64IZBB-NEXT: ret
;
; RV64IZBS-LABEL: imm64_9:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT: li a0, -1
; RV64IZBS-NEXT: ret
;
; RV64IXTHEADBB-LABEL: imm64_9:
; RV64IXTHEADBB:    # %bb.0:
; RV64IXTHEADBB-NEXT: li a0, -1
; RV64IXTHEADBB-NEXT: ret
ret i64 -1
}
```

; Various cases where extraneous ADDIs can be inserted where a (left shifted)  
; LUI suffices.

```
define i64 @imm_left_shifted_lui_1() nounwind {
; RV64I-LABEL: imm_left_shifted_lui_1:
; RV64I:    # %bb.0:
; RV64I-NEXT: lui a0, 262145
; RV64I-NEXT: slli a0, a0, 1
;
}
```

```

RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm_left_shifted_lui_1:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  lui a0, 262145
; RV64IZBA-NEXT:  slli a0, a0, 1
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm_left_shifted_lui_1:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  lui a0, 262145
; RV64IZBB-NEXT:  slli a0, a0, 1
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm_left_shifted_lui_1:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:  lui a0, 262145
; RV64IZBS-NEXT:  slli a0, a0, 1
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm_left_shifted_lui_1:
; RV64IXTHEADBB:  # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 262145
; RV64IXTHEADBB-NEXT:  slli a0, a0, 1
; RV64IXTHEADBB-NEXT:  ret
ret i64 2147491840 ; 0x8000_2000
}

```

```

define i64 @imm_left_shifted_lui_2() nounwind {
; RV64I-LABEL: imm_left_shifted_lui_2:
; RV64I:    # %bb.0:
; RV64I-NEXT:  lui a0, 262145
; RV64I-NEXT:  slli a0, a0, 2
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm_left_shifted_lui_2:
; RV64IZBA:
; # %bb.0:
; RV64IZBA-NEXT:  lui a0, 262145
; RV64IZBA-NEXT:  slli a0, a0, 2
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm_left_shifted_lui_2:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  lui a0, 262145
; RV64IZBB-NEXT:  slli a0, a0, 2
; RV64IZBB-NEXT:  ret
;

```

```

; RV64IZBS-LABEL: imm_left_shifted_lui_2:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:  lui a0, 262145
; RV64IZBS-NEXT:  slli a0, a0, 2
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm_left_shifted_lui_2:
; RV64IXTHEADBB:    # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 262145
; RV64IXTHEADBB-NEXT:  slli a0, a0, 2
; RV64IXTHEADBB-NEXT:  ret
ret i64 4294983680 ; 0x1_0000_4000
}

```

```

define i64 @imm_left_shifted_lui_3() nounwind {
; RV64I-LABEL: imm_left_shifted_lui_3:
; RV64I:    # %bb.0:
; RV64I-NEXT:  lui a0, 4097
; RV64I-NEXT:  slli a0, a0, 20
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm_left_shifted_lui_3:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  lui a0, 4097
; RV64IZBA-NEXT:  slli a0, a0, 20
;
RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm_left_shifted_lui_3:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  lui a0, 4097
; RV64IZBB-NEXT:  slli a0, a0, 20
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm_left_shifted_lui_3:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:  lui a0, 4097
; RV64IZBS-NEXT:  slli a0, a0, 20
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm_left_shifted_lui_3:
; RV64IXTHEADBB:    # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 4097
; RV64IXTHEADBB-NEXT:  slli a0, a0, 20
; RV64IXTHEADBB-NEXT:  ret
ret i64 17596481011712 ; 0x1001_0000_0000
}

```



; Various cases where extraneous ADDIs can be inserted where a (right shifted)  
; LUI suffices, or where multiple ADDIs can be used instead of a single LUI.

```
define i64 @imm_right_shifted_lui_1() nounwind {  
; RV64I-LABEL: imm_right_shifted_lui_1:  
; RV64I:    # %bb.0:  
; RV64I-NEXT:  lui a0, 983056  
; RV64I-NEXT:  srli a0, a0, 16  
; RV64I-NEXT:  ret  
;  
; RV64IZBA-LABEL: imm_right_shifted_lui_1:  
; RV64IZBA:  
    # %bb.0:  
; RV64IZBA-NEXT:  lui a0, 983056  
; RV64IZBA-NEXT:  srli a0, a0, 16  
; RV64IZBA-NEXT:  ret  
;  
; RV64IZBB-LABEL: imm_right_shifted_lui_1:  
; RV64IZBB:    # %bb.0:  
; RV64IZBB-NEXT:  lui a0, 983056  
; RV64IZBB-NEXT:  srli a0, a0, 16  
; RV64IZBB-NEXT:  ret  
;  
; RV64IZBS-LABEL: imm_right_shifted_lui_1:  
; RV64IZBS:    # %bb.0:  
; RV64IZBS-NEXT:  lui a0, 983056  
; RV64IZBS-NEXT:  srli a0, a0, 16  
; RV64IZBS-NEXT:  ret  
;  
; RV64IXTHEADBB-LABEL: imm_right_shifted_lui_1:  
; RV64IXTHEADBB:  # %bb.0:  
; RV64IXTHEADBB-NEXT:  lui a0, 983056  
; RV64IXTHEADBB-NEXT:  srli a0, a0, 16  
; RV64IXTHEADBB-NEXT:  ret  
ret i64 281474976706561 ; 0xFFFF_FFFF_F001  
}
```

```
define i64 @imm_right_shifted_lui_2() nounwind {  
; RV64I-LABEL: imm_right_shifted_lui_2:  
; RV64I:    # %bb.0:  
; RV64I-NEXT:  lui a0, 1044481  
; RV64I-NEXT:  slli a0, a0, 12  
; RV64I-NEXT:  srli a0, a0, 24  
; RV64I-NEXT:  ret  
;  
; RV64IZBA-LABEL: imm_right_shifted_lui_2:  
; RV64IZBA:    # %bb.0:  
; RV64IZBA-NEXT:
```

```

    lui a0, 1044481
; RV64IZBA-NEXT:  slli a0, a0, 12
; RV64IZBA-NEXT:  srli a0, a0, 24
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm_right_shifted_lui_2:
; RV64IZBB:      # %bb.0:
; RV64IZBB-NEXT:  lui a0, 1044481
; RV64IZBB-NEXT:  slli a0, a0, 12
; RV64IZBB-NEXT:  srli a0, a0, 24
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm_right_shifted_lui_2:
; RV64IZBS:      # %bb.0:
; RV64IZBS-NEXT:  lui a0, 1044481
; RV64IZBS-NEXT:  slli a0, a0, 12
; RV64IZBS-NEXT:  srli a0, a0, 24
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm_right_shifted_lui_2:
; RV64IXTHEADBB:  # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 1044481
; RV64IXTHEADBB-NEXT:  slli a0, a0, 12
; RV64IXTHEADBB-NEXT:  srli a0, a0, 24
; RV64IXTHEADBB-NEXT:  ret
ret i64 1099511623681 ; 0xFF_FFFF_F001
}

```

; We can materialize the upper bits with a single (shifted) LUI, but that option  
; can be missed due to the lower bits, which aren't just 1s or just 0s.

```

define i64 @imm_decoupled_lui_addi() nounwind
{
; RV64I-LABEL: imm_decoupled_lui_addi:
; RV64I:      # %bb.0:
; RV64I-NEXT:  lui a0, 4097
; RV64I-NEXT:  slli a0, a0, 20
; RV64I-NEXT:  addi a0, a0, -3
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm_decoupled_lui_addi:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  lui a0, 4097
; RV64IZBA-NEXT:  slli a0, a0, 20
; RV64IZBA-NEXT:  addi a0, a0, -3
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm_decoupled_lui_addi:

```

```

; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT: lui a0, 4097
; RV64IZBB-NEXT: slli a0, a0, 20
; RV64IZBB-NEXT: addi a0, a0, -3
; RV64IZBB-NEXT: ret
;
; RV64IZBS-LABEL: imm_decoupled_lui_addi:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT: lui a0, 4097
; RV64IZBS-NEXT: slli a0, a0, 20
; RV64IZBS-NEXT: addi a0, a0, -3
; RV64IZBS-NEXT: ret
;
; RV64IXTHEADBB-LABEL: imm_decoupled_lui_addi:
; RV64IXTHEADBB:    # %bb.0:
; RV64IXTHEADBB-NEXT: lui a0, 4097
; RV64IXTHEADBB-NEXT: slli a0, a0, 20
; RV64IXTHEADBB-NEXT: addi a0, a0, -3
; RV64IXTHEADBB-NEXT:
    ret
ret i64 17596481011709 ; 0x1000_FFFF_FFFD
}

```

; This constant can be materialized for RV64 with LUI+SRLI+XORI.

```

define i64 @imm_end_xori_1() nounwind {
; RV64I-LABEL: imm_end_xori_1:
; RV64I:    # %bb.0:
; RV64I-NEXT: lui a0, 983040
; RV64I-NEXT: srli a0, a0, 3
; RV64I-NEXT: not a0, a0
; RV64I-NEXT: ret
;
; RV64IZBA-LABEL: imm_end_xori_1:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT: lui a0, 983040
; RV64IZBA-NEXT: srli a0, a0, 3
; RV64IZBA-NEXT: not a0, a0
; RV64IZBA-NEXT: ret
;
; RV64IZBB-LABEL: imm_end_xori_1:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT: lui a0, 983040
; RV64IZBB-NEXT: srli a0, a0, 3
; RV64IZBB-NEXT: not a0, a0
; RV64IZBB-NEXT: ret
;
; RV64IZBS-LABEL: imm_end_xori_1:

```

```

; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:  lui a0, 983040
; RV64IZBS-NEXT:  srli a0, a0, 3
; RV64IZBS-NEXT:  not a0, a0
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm_end_xori_1:
; RV64IXTHEADBB:    # %bb.0:
; RV64IXTHEADBB-NEXT:
    lui a0, 983040
; RV64IXTHEADBB-NEXT:  srli a0, a0, 3
; RV64IXTHEADBB-NEXT:  not a0, a0
; RV64IXTHEADBB-NEXT:  ret
ret i64 -2305843009180139521 ; 0xE000_0000_01FF_FFFF
}

```

; This constant can be materialized for RV64 with ADDI+SLLI+ADDI+ADDI.

```

define i64 @imm_end_2addi_1() nounwind {
; RV64I-LABEL: imm_end_2addi_1:
; RV64I:    # %bb.0:
; RV64I-NEXT:  li a0, -2047
; RV64I-NEXT:  slli a0, a0, 39
; RV64I-NEXT:  addi a0, a0, -2048
; RV64I-NEXT:  addi a0, a0, -1
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm_end_2addi_1:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  li a0, -2047
; RV64IZBA-NEXT:  slli a0, a0, 39
; RV64IZBA-NEXT:  addi a0, a0, -2048
; RV64IZBA-NEXT:  addi a0, a0, -1
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm_end_2addi_1:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  li a0, -2047
; RV64IZBB-NEXT:  slli a0, a0, 39
; RV64IZBB-NEXT:  addi a0, a0, -2048
; RV64IZBB-NEXT:  addi a0, a0, -1
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm_end_2addi_1:
;
RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:  li a0, -2047
; RV64IZBS-NEXT:  slli a0, a0, 39

```

```

; RV64IZBS-NEXT:  addi a0, a0, -2048
; RV64IZBS-NEXT:  addi a0, a0, -1
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm_end_2addi_1:
; RV64IXTHEADBB:   # %bb.0:
; RV64IXTHEADBB-NEXT:  li a0, -2047
; RV64IXTHEADBB-NEXT:  slli a0, a0, 39
; RV64IXTHEADBB-NEXT:  addi a0, a0, -2048
; RV64IXTHEADBB-NEXT:  addi a0, a0, -1
; RV64IXTHEADBB-NEXT:  ret
ret i64 -1125350151030785 ; 0xFFFC_007F_FFFF_F7FF
}

```

; This constant can be more efficiently materialized for RV64 if we use two  
; registers instead of one.

```

define i64 @imm_2reg_1() nounwind {
; RV64I-LABEL: imm_2reg_1:
; RV64I:      # %bb.0:
; RV64I-NEXT:  lui a0, 74565
; RV64I-NEXT:  addiw a0, a0, 1656
; RV64I-NEXT:  slli a1, a0, 57
; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm_2reg_1:
; RV64IZBA:   # %bb.0:
; RV64IZBA-NEXT:  lui a0, 74565
; RV64IZBA-NEXT:  addiw a0, a0, 1656
; RV64IZBA-NEXT:
;               slli a1, a0, 57
; RV64IZBA-NEXT:  add a0, a0, a1
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm_2reg_1:
; RV64IZBB:   # %bb.0:
; RV64IZBB-NEXT:  lui a0, 74565
; RV64IZBB-NEXT:  addiw a0, a0, 1656
; RV64IZBB-NEXT:  slli a1, a0, 57
; RV64IZBB-NEXT:  add a0, a0, a1
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm_2reg_1:
; RV64IZBS:   # %bb.0:
; RV64IZBS-NEXT:  lui a0, 74565
; RV64IZBS-NEXT:  addiw a0, a0, 1656
; RV64IZBS-NEXT:  slli a1, a0, 57

```

```

; RV64IZBS-NEXT:  add a0, a0, a1
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm_2reg_1:
; RV64IXTHEADBB:   # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 74565
; RV64IXTHEADBB-NEXT:  addiw a0, a0, 1656
; RV64IXTHEADBB-NEXT:  slli a1, a0, 57
; RV64IXTHEADBB-NEXT:  add a0, a0, a1
; RV64IXTHEADBB-NEXT:  ret
ret i64 -1152921504301427080 ; 0xF000_0000_1234_5678
}

```

; FIXME: This should use a single ADDI for the immediate.

```
define void @imm_store_i16_neg1(ptr %p) nounwind {
```

```

; RV64I-LABEL: imm_store_i16_neg1:
;
RV64I:   # %bb.0:
; RV64I-NEXT:  li a1, -1
; RV64I-NEXT:  sh a1, 0(a0)
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm_store_i16_neg1:
; RV64IZBA:   # %bb.0:
; RV64IZBA-NEXT:  li a1, -1
; RV64IZBA-NEXT:  sh a1, 0(a0)
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm_store_i16_neg1:
; RV64IZBB:   # %bb.0:
; RV64IZBB-NEXT:  li a1, -1
; RV64IZBB-NEXT:  sh a1, 0(a0)
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm_store_i16_neg1:
; RV64IZBS:   # %bb.0:
; RV64IZBS-NEXT:  li a1, -1
; RV64IZBS-NEXT:  sh a1, 0(a0)
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm_store_i16_neg1:
; RV64IXTHEADBB:   # %bb.0:
; RV64IXTHEADBB-NEXT:  li a1, -1
; RV64IXTHEADBB-NEXT:  sh a1, 0(a0)
; RV64IXTHEADBB-NEXT:  ret
store i16 -1, ptr %p
ret void
}

```

; FIXME: This should use a single ADDI for the immediate.

define void @imm\_store\_i32\_neg1(ptr %p) nounwind {

; RV64I-LABEL: imm\_store\_i32\_neg1:

; RV64I: # %bb.0:

; RV64I-NEXT: li a1, -1

; RV64I-NEXT:

sw a1, 0(a0)

; RV64I-NEXT: ret

;

; RV64IZBA-LABEL: imm\_store\_i32\_neg1:

; RV64IZBA: # %bb.0:

; RV64IZBA-NEXT: li a1, -1

; RV64IZBA-NEXT: sw a1, 0(a0)

; RV64IZBA-NEXT: ret

;

; RV64IZBB-LABEL: imm\_store\_i32\_neg1:

; RV64IZBB: # %bb.0:

; RV64IZBB-NEXT: li a1, -1

; RV64IZBB-NEXT: sw a1, 0(a0)

; RV64IZBB-NEXT: ret

;

; RV64IZBS-LABEL: imm\_store\_i32\_neg1:

; RV64IZBS: # %bb.0:

; RV64IZBS-NEXT: li a1, -1

; RV64IZBS-NEXT: sw a1, 0(a0)

; RV64IZBS-NEXT: ret

;

; RV64IXTHEADBB-LABEL: imm\_store\_i32\_neg1:

; RV64IXTHEADBB: # %bb.0:

; RV64IXTHEADBB-NEXT: li a1, -1

; RV64IXTHEADBB-NEXT: sw a1, 0(a0)

; RV64IXTHEADBB-NEXT: ret

store i32 -1, ptr %p

ret void

}

define i64 @imm\_5372288229() {

; RV64I-LABEL: imm\_5372288229:

; RV64I: # %bb.0:

; RV64I-NEXT: lui a0, 160

; RV64I-NEXT: addiw a0, a0, 437

; RV64I-NEXT: slli a0, a0, 13

; RV64I-NEXT: addi a0, a0, -795

; RV64I-NEXT: ret

;

; RV64IZBA-LABEL: imm\_5372288229:

; RV64IZBA:

```

    # %bb.0:
; RV64IZBA-NEXT: lui a0, 655797
; RV64IZBA-NEXT: slli.uw a0, a0, 1
; RV64IZBA-NEXT: addi a0, a0, -795
; RV64IZBA-NEXT: ret
;
; RV64IZBB-LABEL: imm_5372288229:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT: lui a0, 160
; RV64IZBB-NEXT: addiw a0, a0, 437
; RV64IZBB-NEXT: slli a0, a0, 13
; RV64IZBB-NEXT: addi a0, a0, -795
; RV64IZBB-NEXT: ret
;
; RV64IZBS-LABEL: imm_5372288229:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT: lui a0, 263018
; RV64IZBS-NEXT: addiw a0, a0, -795
; RV64IZBS-NEXT: bseti a0, a0, 32
; RV64IZBS-NEXT: ret
;
; RV64IXTHEADBB-LABEL: imm_5372288229:
; RV64IXTHEADBB:    # %bb.0:
; RV64IXTHEADBB-NEXT: lui a0, 160
; RV64IXTHEADBB-NEXT: addiw a0, a0, 437
; RV64IXTHEADBB-NEXT: slli a0, a0, 13
; RV64IXTHEADBB-NEXT: addi a0, a0, -795
; RV64IXTHEADBB-NEXT: ret
ret i64 5372288229
}

```

```

define i64 @imm_neg_5372288229() {
; RV64I-LABEL: imm_neg_5372288229:
; RV64I:    # %bb.0:
; RV64I-NEXT: lui a0, 1048416
; RV64I-NEXT:
    addiw a0, a0, -437
; RV64I-NEXT: slli a0, a0, 13
; RV64I-NEXT: addi a0, a0, 795
; RV64I-NEXT: ret
;
; RV64IZBA-LABEL: imm_neg_5372288229:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT: lui a0, 611378
; RV64IZBA-NEXT: addiw a0, a0, 265
; RV64IZBA-NEXT: sh1add a0, a0, a0
; RV64IZBA-NEXT: ret
;

```



```

; RV64IZBB-LABEL: imm_neg_5372288229:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  lui a0, 1048416
; RV64IZBB-NEXT:  addiw a0, a0, -437
; RV64IZBB-NEXT:  slli a0, a0, 13
; RV64IZBB-NEXT:  addi a0, a0, 795
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm_neg_5372288229:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:  lui a0, 785558
; RV64IZBS-NEXT:  addiw a0, a0, 795
; RV64IZBS-NEXT:  bclri a0, a0, 32
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm_neg_5372288229:
; RV64IXTHEADBB:    # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 1048416
; RV64IXTHEADBB-NEXT:  addiw a0, a0, -437
; RV64IXTHEADBB-NEXT:  slli a0, a0, 13
; RV64IXTHEADBB-NEXT:  addi a0, a0,
795
; RV64IXTHEADBB-NEXT:  ret
ret i64 -5372288229
}

```

```

define i64 @imm_8953813715() {
; RV64I-LABEL: imm_8953813715:
; RV64I:    # %bb.0:
; RV64I-NEXT:  lui a0, 267
; RV64I-NEXT:  addiw a0, a0, -637
; RV64I-NEXT:  slli a0, a0, 13
; RV64I-NEXT:  addi a0, a0, -1325
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm_8953813715:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  lui a0, 437198
; RV64IZBA-NEXT:  addiw a0, a0, -265
; RV64IZBA-NEXT:  sh2add a0, a0, a0
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm_8953813715:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  lui a0, 267
; RV64IZBB-NEXT:  addiw a0, a0, -637
; RV64IZBB-NEXT:  slli a0, a0, 13
; RV64IZBB-NEXT:  addi a0, a0, -1325

```

```

; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm_8953813715:
; RV64IZBS:      # %bb.0:
; RV64IZBS-NEXT:  lui a0, 88838
; RV64IZBS-NEXT:  addiw a0, a0, -1325
; RV64IZBS-NEXT:  bseti a0, a0, 33
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm_8953813715:
; RV64IXTHEADBB:  # %bb.0:
;
RV64IXTHEADBB-NEXT:  lui a0, 267
; RV64IXTHEADBB-NEXT:  addiw a0, a0, -637
; RV64IXTHEADBB-NEXT:  slli a0, a0, 13
; RV64IXTHEADBB-NEXT:  addi a0, a0, -1325
; RV64IXTHEADBB-NEXT:  ret
ret i64 8953813715
}

```

```

define i64 @imm_neg_8953813715() {
; RV64I-LABEL: imm_neg_8953813715:
; RV64I:      # %bb.0:
; RV64I-NEXT:  lui a0, 1048309
; RV64I-NEXT:  addiw a0, a0, 637
; RV64I-NEXT:  slli a0, a0, 13
; RV64I-NEXT:  addi a0, a0, 1325
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm_neg_8953813715:
; RV64IZBA:      # %bb.0:
; RV64IZBA-NEXT:  lui a0, 611378
; RV64IZBA-NEXT:  addiw a0, a0, 265
; RV64IZBA-NEXT:  sh2add a0, a0, a0
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm_neg_8953813715:
; RV64IZBB:      # %bb.0:
; RV64IZBB-NEXT:  lui a0, 1048309
; RV64IZBB-NEXT:  addiw a0, a0, 637
; RV64IZBB-NEXT:  slli a0, a0, 13
; RV64IZBB-NEXT:  addi a0, a0, 1325
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm_neg_8953813715:
; RV64IZBS:      # %bb.0:
; RV64IZBS-NEXT:

```

```

    lui a0, 959738
; RV64IZBS-NEXT:    addiw a0, a0, 1325
; RV64IZBS-NEXT:    bclri a0, a0, 33
; RV64IZBS-NEXT:    ret
;
; RV64IXTHEADBB-LABEL: imm_neg_8953813715:
; RV64IXTHEADBB:    # %bb.0:
; RV64IXTHEADBB-NEXT:    lui a0, 1048309
; RV64IXTHEADBB-NEXT:    addiw a0, a0, 637
; RV64IXTHEADBB-NEXT:    slli a0, a0, 13
; RV64IXTHEADBB-NEXT:    addi a0, a0, 1325
; RV64IXTHEADBB-NEXT:    ret
ret i64 -8953813715
}

```

```

define i64 @imm_16116864687() {
; RV64I-LABEL: imm_16116864687:
; RV64I:    # %bb.0:
; RV64I-NEXT:    lui a0, 961
; RV64I-NEXT:    addiw a0, a0, -1475
; RV64I-NEXT:    slli a0, a0, 12
; RV64I-NEXT:    addi a0, a0, 1711
; RV64I-NEXT:    ret
;
; RV64IZBA-LABEL: imm_16116864687:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:    lui a0, 437198
; RV64IZBA-NEXT:    addiw a0, a0, -265
; RV64IZBA-NEXT:    sh3add a0, a0, a0
; RV64IZBA-NEXT:    ret
;
; RV64IZBB-LABEL: imm_16116864687:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:    lui a0, 961
; RV64IZBB-NEXT:    addiw a0, a0, -1475
; RV64IZBB-NEXT:
    slli a0, a0, 12
; RV64IZBB-NEXT:    addi a0, a0, 1711
; RV64IZBB-NEXT:    ret
;
; RV64IZBS-LABEL: imm_16116864687:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:    lui a0, 961
; RV64IZBS-NEXT:    addiw a0, a0, -1475
; RV64IZBS-NEXT:    slli a0, a0, 12
; RV64IZBS-NEXT:    addi a0, a0, 1711
; RV64IZBS-NEXT:    ret
;

```

```
; RV64IXTHEADBB-LABEL: imm_16116864687:
; RV64IXTHEADBB:    # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 961
; RV64IXTHEADBB-NEXT:  addiw a0, a0, -1475
; RV64IXTHEADBB-NEXT:  slli a0, a0, 12
; RV64IXTHEADBB-NEXT:  addi a0, a0, 1711
; RV64IXTHEADBB-NEXT:  ret
ret i64 16116864687
}
```

```
define i64 @imm_neg_16116864687() {
; RV64I-LABEL: imm_neg_16116864687:
; RV64I:    # %bb.0:
; RV64I-NEXT:  lui a0, 1047615
; RV64I-NEXT:  addiw a0, a0, 1475
; RV64I-NEXT:  slli a0, a0, 12
; RV64I-NEXT:  addi a0, a0, -1711
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm_neg_16116864687:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  lui a0, 611378
; RV64IZBA-NEXT:
addiw a0, a0, 265
; RV64IZBA-NEXT:  sh3add a0, a0, a0
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm_neg_16116864687:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  lui a0, 1047615
; RV64IZBB-NEXT:  addiw a0, a0, 1475
; RV64IZBB-NEXT:  slli a0, a0, 12
; RV64IZBB-NEXT:  addi a0, a0, -1711
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm_neg_16116864687:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:  lui a0, 1047615
; RV64IZBS-NEXT:  addiw a0, a0, 1475
; RV64IZBS-NEXT:  slli a0, a0, 12
; RV64IZBS-NEXT:  addi a0, a0, -1711
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm_neg_16116864687:
; RV64IXTHEADBB:    # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 1047615
; RV64IXTHEADBB-NEXT:  addiw a0, a0, 1475
; RV64IXTHEADBB-NEXT:  slli a0, a0, 12
```

```

; RV64IXTHEADBB-NEXT:  addi a0, a0, -1711
; RV64IXTHEADBB-NEXT:  ret
ret i64 -16116864687
}

define i64 @imm_2344336315() {
; RV64I-LABEL: imm_2344336315:
; RV64I:      # %bb.0:
; RV64I-NEXT:  lui a0, 143087
; RV64I-NEXT:
    slli a0, a0, 2
; RV64I-NEXT:  addi a0, a0, -1093
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm_2344336315:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  lui a0, 143087
; RV64IZBA-NEXT:  slli a0, a0, 2
; RV64IZBA-NEXT:  addi a0, a0, -1093
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm_2344336315:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  lui a0, 143087
; RV64IZBB-NEXT:  slli a0, a0, 2
; RV64IZBB-NEXT:  addi a0, a0, -1093
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm_2344336315:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:  lui a0, 143087
; RV64IZBS-NEXT:  slli a0, a0, 2
; RV64IZBS-NEXT:  addi a0, a0, -1093
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm_2344336315:
; RV64IXTHEADBB:    # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 143087
; RV64IXTHEADBB-NEXT:  slli a0, a0, 2
; RV64IXTHEADBB-NEXT:  addi a0, a0, -1093
; RV64IXTHEADBB-NEXT:  ret
ret i64 2344336315 ; 0x8bbbbbbb
}

define i64 @imm_70370820078523() {
; RV64-NOPOOL-LABEL: imm_70370820078523:
;

```

```

RV64-NOPOOL:    # %bb.0:
; RV64-NOPOOL-NEXT:  lui a0, 256
; RV64-NOPOOL-NEXT:  addiw a0, a0, 31
; RV64-NOPOOL-NEXT:  slli a0, a0, 12
; RV64-NOPOOL-NEXT:  addi a0, a0, -273
; RV64-NOPOOL-NEXT:  slli a0, a0, 14
; RV64-NOPOOL-NEXT:  addi a0, a0, -1093
; RV64-NOPOOL-NEXT:  ret
;
; RV64I-POOL-LABEL: imm_70370820078523:
; RV64I-POOL:    # %bb.0:
; RV64I-POOL-NEXT:  lui a0, %hi(LCPI37_0)
; RV64I-POOL-NEXT:  ld a0, %lo(LCPI37_0)(a0)
; RV64I-POOL-NEXT:  ret
;
; RV64IZBA-LABEL: imm_70370820078523:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  lui a0, 256
; RV64IZBA-NEXT:  addiw a0, a0, 31
; RV64IZBA-NEXT:  slli a0, a0, 12
; RV64IZBA-NEXT:  addi a0, a0, -273
; RV64IZBA-NEXT:  slli a0, a0, 14
; RV64IZBA-NEXT:  addi a0, a0, -1093
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm_70370820078523:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  lui a0, 256
; RV64IZBB-NEXT:  addiw a0, a0, 31
; RV64IZBB-NEXT:  slli a0, a0, 12
; RV64IZBB-NEXT:  addi a0, a0, -273
;
RV64IZBB-NEXT:  slli a0, a0, 14
; RV64IZBB-NEXT:  addi a0, a0, -1093
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm_70370820078523:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:  lui a0, 506812
; RV64IZBS-NEXT:  addiw a0, a0, -1093
; RV64IZBS-NEXT:  bseti a0, a0, 46
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm_70370820078523:
; RV64IXTHEADBB:    # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 256
; RV64IXTHEADBB-NEXT:  addiw a0, a0, 31
; RV64IXTHEADBB-NEXT:  slli a0, a0, 12

```

```

; RV64IXTHEADBB-NEXT:  addi a0, a0, -273
; RV64IXTHEADBB-NEXT:  slli a0, a0, 14
; RV64IXTHEADBB-NEXT:  addi a0, a0, -1093
; RV64IXTHEADBB-NEXT:  ret
ret i64 70370820078523 ; 0x40007bbbbbbb
}

define i64 @imm_neg_9223372034778874949() {
; RV64I-LABEL: imm_neg_9223372034778874949:
; RV64I:    # %bb.0:
; RV64I-NEXT:  lui a0, 506812
; RV64I-NEXT:  addiw a0, a0, -1093
; RV64I-NEXT:  slli a1, a0, 63
; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm_neg_9223372034778874949:
;
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  lui a0, 506812
; RV64IZBA-NEXT:  addiw a0, a0, -1093
; RV64IZBA-NEXT:  slli a1, a0, 63
; RV64IZBA-NEXT:  add a0, a0, a1
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm_neg_9223372034778874949:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  lui a0, 506812
; RV64IZBB-NEXT:  addiw a0, a0, -1093
; RV64IZBB-NEXT:  slli a1, a0, 63
; RV64IZBB-NEXT:  add a0, a0, a1
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm_neg_9223372034778874949:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:  lui a0, 506812
; RV64IZBS-NEXT:  addiw a0, a0, -1093
; RV64IZBS-NEXT:  bseti a0, a0, 63
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm_neg_9223372034778874949:
; RV64IXTHEADBB:    # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 506812
; RV64IXTHEADBB-NEXT:  addiw a0, a0, -1093
; RV64IXTHEADBB-NEXT:  slli a1, a0, 63
; RV64IXTHEADBB-NEXT:  add a0, a0, a1
; RV64IXTHEADBB-NEXT:  ret
ret i64 -9223372034778874949 ; 0x800000007bbbbbbb

```

```

}

define
i64 @imm_neg_9223301666034697285() {
; RV64-NOPOOL-LABEL: imm_neg_9223301666034697285:
; RV64-NOPOOL:    # %bb.0:
; RV64-NOPOOL-NEXT:  lui a0, 917505
; RV64-NOPOOL-NEXT:  slli a0, a0, 8
; RV64-NOPOOL-NEXT:  addi a0, a0, 31
; RV64-NOPOOL-NEXT:  slli a0, a0, 12
; RV64-NOPOOL-NEXT:  addi a0, a0, -273
; RV64-NOPOOL-NEXT:  slli a0, a0, 14
; RV64-NOPOOL-NEXT:  addi a0, a0, -1093
; RV64-NOPOOL-NEXT:  ret
;
; RV64I-POOL-LABEL: imm_neg_9223301666034697285:
; RV64I-POOL:    # %bb.0:
; RV64I-POOL-NEXT:  lui a0, %hi(LCPI39_0)
; RV64I-POOL-NEXT:  ld a0, %lo(LCPI39_0)(a0)
; RV64I-POOL-NEXT:  ret
;
; RV64IZBA-LABEL: imm_neg_9223301666034697285:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  lui a0, 917505
; RV64IZBA-NEXT:  slli a0, a0, 8
; RV64IZBA-NEXT:  addi a0, a0, 31
; RV64IZBA-NEXT:  slli a0, a0, 12
; RV64IZBA-NEXT:  addi a0, a0, -273
; RV64IZBA-NEXT:  slli a0, a0, 14
; RV64IZBA-NEXT:  addi a0, a0, -1093
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL:
imm_neg_9223301666034697285:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  lui a0, 917505
; RV64IZBB-NEXT:  slli a0, a0, 8
; RV64IZBB-NEXT:  addi a0, a0, 31
; RV64IZBB-NEXT:  slli a0, a0, 12
; RV64IZBB-NEXT:  addi a0, a0, -273
; RV64IZBB-NEXT:  slli a0, a0, 14
; RV64IZBB-NEXT:  addi a0, a0, -1093
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm_neg_9223301666034697285:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:  lui a0, 506812
; RV64IZBS-NEXT:  addiw a0, a0, -1093

```



```

; RV64IZBS-NEXT: bseti a0, a0, 46
; RV64IZBS-NEXT: bseti a0, a0, 63
; RV64IZBS-NEXT: ret
;
; RV64IXTHEADBB-LABEL: imm_neg_9223301666034697285:
; RV64IXTHEADBB:    # %bb.0:
; RV64IXTHEADBB-NEXT: lui a0, 917505
; RV64IXTHEADBB-NEXT: slli a0, a0, 8
; RV64IXTHEADBB-NEXT: addi a0, a0, 31
; RV64IXTHEADBB-NEXT: slli a0, a0, 12
; RV64IXTHEADBB-NEXT: addi a0, a0, -273
; RV64IXTHEADBB-NEXT: slli a0, a0, 14
; RV64IXTHEADBB-NEXT: addi a0, a0, -1093
; RV64IXTHEADBB-NEXT: ret
ret i64 -9223301666034697285 ; 0x800040007bbbbbbb
}

```

```

define i64 @imm_neg_2219066437() {
; RV64I-LABEL: imm_neg_2219066437:
; RV64I:    # %bb.0:
; RV64I-NEXT: lui a0, 913135
; RV64I-NEXT: slli a0, a0, 2
; RV64I-NEXT: addi a0, a0, -1093
; RV64I-NEXT: ret
;
; RV64IZBA-LABEL: imm_neg_2219066437:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT: lui a0, 913135
; RV64IZBA-NEXT: slli a0, a0, 2
; RV64IZBA-NEXT: addi a0, a0, -1093
; RV64IZBA-NEXT: ret
;
; RV64IZBB-LABEL: imm_neg_2219066437:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT: lui a0, 913135
; RV64IZBB-NEXT: slli a0, a0, 2
; RV64IZBB-NEXT: addi a0, a0, -1093
; RV64IZBB-NEXT: ret
;
; RV64IZBS-LABEL: imm_neg_2219066437:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT: lui a0, 913135
; RV64IZBS-NEXT: slli a0, a0, 2
; RV64IZBS-NEXT: addi a0, a0, -1093
; RV64IZBS-NEXT: ret
;
; RV64IXTHEADBB-LABEL: imm_neg_2219066437:
; RV64IXTHEADBB:    # %bb.0:

```

```

; RV64IXTHEADBB-NEXT:  lui a0, 913135
; RV64IXTHEADBB-NEXT:
    slli a0, a0, 2
; RV64IXTHEADBB-NEXT:  addi a0, a0, -1093
; RV64IXTHEADBB-NEXT:  ret
ret i64 -2219066437 ; 0xffffffff7bbbbbbb
}

define i64 @imm_neg_8798043653189() {
; RV64I-LABEL: imm_neg_8798043653189:
; RV64I:    # %bb.0:
; RV64I-NEXT:  lui a0, 917475
; RV64I-NEXT:  addiw a0, a0, -273
; RV64I-NEXT:  slli a0, a0, 14
; RV64I-NEXT:  addi a0, a0, -1093
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm_neg_8798043653189:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  lui a0, 917475
; RV64IZBA-NEXT:  addiw a0, a0, -273
; RV64IZBA-NEXT:  slli a0, a0, 14
; RV64IZBA-NEXT:  addi a0, a0, -1093
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm_neg_8798043653189:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  lui a0, 917475
; RV64IZBB-NEXT:  addiw a0, a0, -273
; RV64IZBB-NEXT:  slli a0, a0, 14
; RV64IZBB-NEXT:  addi a0, a0, -1093
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm_neg_8798043653189:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:  lui a0, 572348
; RV64IZBS-NEXT:
    addiw a0, a0, -1093
; RV64IZBS-NEXT:  bclri a0, a0, 43
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm_neg_8798043653189:
; RV64IXTHEADBB:    # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 917475
; RV64IXTHEADBB-NEXT:  addiw a0, a0, -273
; RV64IXTHEADBB-NEXT:  slli a0, a0, 14
; RV64IXTHEADBB-NEXT:  addi a0, a0, -1093
; RV64IXTHEADBB-NEXT:  ret

```

```

ret i64 -8798043653189 ; 0xfffff7ff8bbbbbbb
}

define i64 @imm_9223372034904144827() {
; RV64I-LABEL: imm_9223372034904144827:
; RV64I:    # %bb.0:
; RV64I-NEXT:  lui a0, 572348
; RV64I-NEXT:  addiw a0, a0, -1093
; RV64I-NEXT:  slli a1, a0, 63
; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm_9223372034904144827:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  lui a0, 572348
; RV64IZBA-NEXT:  addiw a0, a0, -1093
; RV64IZBA-NEXT:  slli a1, a0, 63
; RV64IZBA-NEXT:  add a0, a0, a1
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm_9223372034904144827:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:
    lui a0, 572348
; RV64IZBB-NEXT:  addiw a0, a0, -1093
; RV64IZBB-NEXT:  slli a1, a0, 63
; RV64IZBB-NEXT:  add a0, a0, a1
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm_9223372034904144827:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:  lui a0, 572348
; RV64IZBS-NEXT:  addiw a0, a0, -1093
; RV64IZBS-NEXT:  bclri a0, a0, 63
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm_9223372034904144827:
; RV64IXTHEADBB:    # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 572348
; RV64IXTHEADBB-NEXT:  addiw a0, a0, -1093
; RV64IXTHEADBB-NEXT:  slli a1, a0, 63
; RV64IXTHEADBB-NEXT:  add a0, a0, a1
; RV64IXTHEADBB-NEXT:  ret
ret i64 9223372034904144827 ; 0x7ffffff8bbbbbbb
}

define i64 @imm_neg_9223354442718100411() {
; RV64-NOPOOL-LABEL: imm_neg_9223354442718100411:

```

```

; RV64-NOPOOL:    # %bb.0:
; RV64-NOPOOL-NEXT:  lui a0, 524287
; RV64-NOPOOL-NEXT:  slli a0, a0, 6
; RV64-NOPOOL-NEXT:  addi a0, a0, -29
; RV64-NOPOOL-NEXT:  slli a0, a0, 12
; RV64-NOPOOL-NEXT:
    addi a0, a0, -273
; RV64-NOPOOL-NEXT:  slli a0, a0, 14
; RV64-NOPOOL-NEXT:  addi a0, a0, -1093
; RV64-NOPOOL-NEXT:  ret
;
; RV64I-POOL-LABEL: imm_neg_9223354442718100411:
; RV64I-POOL:      # %bb.0:
; RV64I-POOL-NEXT:  lui a0, %hi(LCPI43_0)
; RV64I-POOL-NEXT:  ld a0, %lo(LCPI43_0)(a0)
; RV64I-POOL-NEXT:  ret
;
; RV64IZBA-LABEL: imm_neg_9223354442718100411:
; RV64IZBA:      # %bb.0:
; RV64IZBA-NEXT:  lui a0, 524287
; RV64IZBA-NEXT:  slli a0, a0, 6
; RV64IZBA-NEXT:  addi a0, a0, -29
; RV64IZBA-NEXT:  slli a0, a0, 12
; RV64IZBA-NEXT:  addi a0, a0, -273
; RV64IZBA-NEXT:  slli a0, a0, 14
; RV64IZBA-NEXT:  addi a0, a0, -1093
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm_neg_9223354442718100411:
; RV64IZBB:      # %bb.0:
; RV64IZBB-NEXT:  lui a0, 524287
; RV64IZBB-NEXT:  slli a0, a0, 6
; RV64IZBB-NEXT:  addi a0, a0, -29
; RV64IZBB-NEXT:  slli a0, a0, 12
; RV64IZBB-NEXT:  addi a0, a0, -273
; RV64IZBB-NEXT:  slli a0, a0, 14
; RV64IZBB-NEXT:
    addi a0, a0, -1093
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm_neg_9223354442718100411:
; RV64IZBS:      # %bb.0:
; RV64IZBS-NEXT:  lui a0, 572348
; RV64IZBS-NEXT:  addiw a0, a0, -1093
; RV64IZBS-NEXT:  bclri a0, a0, 44
; RV64IZBS-NEXT:  bclri a0, a0, 63
; RV64IZBS-NEXT:  ret
;

```

```

; RV64IXTHEADBB-LABEL: imm_neg_9223354442718100411:
; RV64IXTHEADBB:    # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 524287
; RV64IXTHEADBB-NEXT:  slli a0, a0, 6
; RV64IXTHEADBB-NEXT:  addi a0, a0, -29
; RV64IXTHEADBB-NEXT:  slli a0, a0, 12
; RV64IXTHEADBB-NEXT:  addi a0, a0, -273
; RV64IXTHEADBB-NEXT:  slli a0, a0, 14
; RV64IXTHEADBB-NEXT:  addi a0, a0, -1093
; RV64IXTHEADBB-NEXT:  ret
ret i64 9223354442718100411 ; 0x7ffefff8bbbbbbb
}

```

```

define i64 @imm_2863311530() {
; RV64I-LABEL: imm_2863311530:
; RV64I:    # %bb.0:
; RV64I-NEXT:  lui a0, 349525
; RV64I-NEXT:  addiw a0, a0, 1365
; RV64I-NEXT:  slli a0, a0, 1
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm_2863311530:
; RV64IZBA:
;   # %bb.0:
; RV64IZBA-NEXT:  lui a0, 349525
; RV64IZBA-NEXT:  addiw a0, a0, 1365
; RV64IZBA-NEXT:  slli a0, a0, 1
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm_2863311530:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  lui a0, 349525
; RV64IZBB-NEXT:  addiw a0, a0, 1365
; RV64IZBB-NEXT:  slli a0, a0, 1
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm_2863311530:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:  lui a0, 349525
; RV64IZBS-NEXT:  addiw a0, a0, 1365
; RV64IZBS-NEXT:  slli a0, a0, 1
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm_2863311530:
; RV64IXTHEADBB:    # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 349525
; RV64IXTHEADBB-NEXT:  addiw a0, a0, 1365
; RV64IXTHEADBB-NEXT:  slli a0, a0, 1

```

```

; RV64IXTHEADBB-NEXT:  ret
ret i64 2863311530 ; #0xaaaaaaaa
}

define i64 @imm_neg_2863311530() {
; RV64I-LABEL: imm_neg_2863311530:
; RV64I:      # %bb.0:
; RV64I-NEXT:  lui a0, 699051
; RV64I-NEXT:  addiw a0, a0, -1365
; RV64I-NEXT:  slli a0,
a0, 1
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm_neg_2863311530:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  lui a0, 699051
; RV64IZBA-NEXT:  addiw a0, a0, -1365
; RV64IZBA-NEXT:  slli a0, a0, 1
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm_neg_2863311530:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  lui a0, 699051
; RV64IZBB-NEXT:  addiw a0, a0, -1365
; RV64IZBB-NEXT:  slli a0, a0, 1
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm_neg_2863311530:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:  lui a0, 699051
; RV64IZBS-NEXT:  addiw a0, a0, -1365
; RV64IZBS-NEXT:  slli a0, a0, 1
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm_neg_2863311530:
; RV64IXTHEADBB:    # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 699051
; RV64IXTHEADBB-NEXT:  addiw a0, a0, -1365
; RV64IXTHEADBB-NEXT:  slli a0, a0, 1
; RV64IXTHEADBB-NEXT:  ret
ret i64 -2863311530 ; #0xffffffff55555556
}

define i64 @imm_2147486378() {
; RV64I-LABEL: imm_2147486378:
; RV64I:      # %bb.0:
; RV64I-NEXT:

```

```

    li a0, 1
; RV64I-NEXT:  slli a0, a0, 31
; RV64I-NEXT:  addi a0, a0, 1365
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm_2147486378:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  li a0, 1
; RV64IZBA-NEXT:  slli a0, a0, 31
; RV64IZBA-NEXT:  addi a0, a0, 1365
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm_2147486378:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  li a0, 1
; RV64IZBB-NEXT:  slli a0, a0, 31
; RV64IZBB-NEXT:  addi a0, a0, 1365
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm_2147486378:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:  li a0, 1365
; RV64IZBS-NEXT:  bseti a0, a0, 31
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm_2147486378:
; RV64IXTHEADBB:  # %bb.0:
; RV64IXTHEADBB-NEXT:  li a0, 1
; RV64IXTHEADBB-NEXT:  slli a0, a0, 31
; RV64IXTHEADBB-NEXT:  addi a0, a0, 1365
; RV64IXTHEADBB-NEXT:  ret
ret i64 2147485013
}

```

```

define i64 @imm_neg_2147485013() {
; RV64I-LABEL: imm_neg_2147485013:
; RV64I:    # %bb.0:
; RV64I-NEXT:
    lui a0, 524288
; RV64I-NEXT:  addi a0, a0, -1365
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm_neg_2147485013:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  lui a0, 524288
; RV64IZBA-NEXT:  addi a0, a0, -1365
; RV64IZBA-NEXT:  ret
;

```

```

; RV64IZBB-LABEL: imm_neg_2147485013:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  lui a0, 524288
; RV64IZBB-NEXT:  addi a0, a0, -1365
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm_neg_2147485013:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:  lui a0, 524288
; RV64IZBS-NEXT:  addi a0, a0, -1365
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm_neg_2147485013:
; RV64IXTHEADBB:  # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 524288
; RV64IXTHEADBB-NEXT:  addi a0, a0, -1365
; RV64IXTHEADBB-NEXT:  ret
ret i64 -2147485013
}

```

```

define i64 @imm_12900924131259() {
; RV64I-LABEL: imm_12900924131259:
; RV64I:    # %bb.0:
; RV64I-NEXT:  lui a0, 188
; RV64I-NEXT:  addiw a0, a0, -1093
; RV64I-NEXT:  slli a0, a0, 24
; RV64I-NEXT:  addi a0,
a0, 1979
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm_12900924131259:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  lui a0, 768955
; RV64IZBA-NEXT:  slli.uw a0, a0, 12
; RV64IZBA-NEXT:  addi a0, a0, 1979
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm_12900924131259:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  lui a0, 188
; RV64IZBB-NEXT:  addiw a0, a0, -1093
; RV64IZBB-NEXT:  slli a0, a0, 24
; RV64IZBB-NEXT:  addi a0, a0, 1979
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm_12900924131259:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:  lui a0, 188

```



```

; RV64IZBS-NEXT:  addiw a0, a0, -1093
; RV64IZBS-NEXT:  slli a0, a0, 24
; RV64IZBS-NEXT:  addi a0, a0, 1979
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm_12900924131259:
; RV64IXTHEADBB:   # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 188
; RV64IXTHEADBB-NEXT:  addiw a0, a0, -1093
; RV64IXTHEADBB-NEXT:  slli a0, a0, 24
; RV64IXTHEADBB-NEXT:  addi a0, a0, 1979
; RV64IXTHEADBB-NEXT:  ret
ret i64 12900924131259
}

```

```

define
i64 @imm_50394234880() {
; RV64I-LABEL: imm_50394234880:
; RV64I:      # %bb.0:
; RV64I-NEXT:  lui a0, 188
; RV64I-NEXT:  addiw a0, a0, -1093
; RV64I-NEXT:  slli a0, a0, 16
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm_50394234880:
; RV64IZBA:   # %bb.0:
; RV64IZBA-NEXT:  lui a0, 768955
; RV64IZBA-NEXT:  slli.uw a0, a0, 4
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm_50394234880:
; RV64IZBB:   # %bb.0:
; RV64IZBB-NEXT:  lui a0, 188
; RV64IZBB-NEXT:  addiw a0, a0, -1093
; RV64IZBB-NEXT:  slli a0, a0, 16
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm_50394234880:
; RV64IZBS:   # %bb.0:
; RV64IZBS-NEXT:  lui a0, 188
; RV64IZBS-NEXT:  addiw a0, a0, -1093
; RV64IZBS-NEXT:  slli a0, a0, 16
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm_50394234880:
; RV64IXTHEADBB:   # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 188
; RV64IXTHEADBB-NEXT:  addiw a0, a0, -1093

```

```

; RV64IXTHEADBB-NEXT:  slli a0, a0, 16
; RV64IXTHEADBB-NEXT:  ret
ret
i64 50394234880
}

define i64 @imm_12900936431479() {
; RV64I-LABEL: imm_12900936431479:
; RV64I:      # %bb.0:
; RV64I-NEXT:  lui a0, 192239
; RV64I-NEXT:  slli a0, a0, 2
; RV64I-NEXT:  addi a0, a0, -1093
; RV64I-NEXT:  slli a0, a0, 12
; RV64I-NEXT:  addi a0, a0, 1911
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm_12900936431479:
; RV64IZBA:   # %bb.0:
; RV64IZBA-NEXT:  lui a0, 768956
; RV64IZBA-NEXT:  addi a0, a0, -1093
; RV64IZBA-NEXT:  slli.uw a0, a0, 12
; RV64IZBA-NEXT:  addi a0, a0, 1911
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm_12900936431479:
; RV64IZBB:   # %bb.0:
; RV64IZBB-NEXT:  lui a0, 192239
; RV64IZBB-NEXT:  slli a0, a0, 2
; RV64IZBB-NEXT:  addi a0, a0, -1093
; RV64IZBB-NEXT:  slli a0, a0, 12
; RV64IZBB-NEXT:  addi a0, a0, 1911
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm_12900936431479:
; RV64IZBS:   # %bb.0:
; RV64IZBS-NEXT:  lui a0, 192239
; RV64IZBS-NEXT:  slli a0, a0, 2
; RV64IZBS-NEXT:  addi a0, a0, -1093
; RV64IZBS-NEXT:
    slli a0, a0, 12
; RV64IZBS-NEXT:  addi a0, a0, 1911
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm_12900936431479:
; RV64IXTHEADBB:   # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 192239
; RV64IXTHEADBB-NEXT:  slli a0, a0, 2
; RV64IXTHEADBB-NEXT:  addi a0, a0, -1093

```

```

; RV64IXTHEADBB-NEXT:  slli a0, a0, 12
; RV64IXTHEADBB-NEXT:  addi a0, a0, 1911
; RV64IXTHEADBB-NEXT:  ret
ret i64 12900936431479
}

define i64 @imm_12900918536874() {
; RV64I-LABEL: imm_12900918536874:
; RV64I:      # %bb.0:
; RV64I-NEXT:  lui a0, 384477
; RV64I-NEXT:  addiw a0, a0, 1365
; RV64I-NEXT:  slli a0, a0, 12
; RV64I-NEXT:  addi a0, a0, 1365
; RV64I-NEXT:  slli a0, a0, 1
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm_12900918536874:
; RV64IZBA:   # %bb.0:
; RV64IZBA-NEXT:  lui a0, 768955
; RV64IZBA-NEXT:  addi a0, a0, -1365
; RV64IZBA-NEXT:  slli.uw a0, a0, 12
; RV64IZBA-NEXT:  addi a0, a0, -1366
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm_12900918536874:
;
; RV64IZBB:   # %bb.0:
; RV64IZBB-NEXT:  lui a0, 384477
; RV64IZBB-NEXT:  addiw a0, a0, 1365
; RV64IZBB-NEXT:  slli a0, a0, 12
; RV64IZBB-NEXT:  addi a0, a0, 1365
; RV64IZBB-NEXT:  slli a0, a0, 1
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm_12900918536874:
; RV64IZBS:   # %bb.0:
; RV64IZBS-NEXT:  lui a0, 384477
; RV64IZBS-NEXT:  addiw a0, a0, 1365
; RV64IZBS-NEXT:  slli a0, a0, 12
; RV64IZBS-NEXT:  addi a0, a0, 1365
; RV64IZBS-NEXT:  slli a0, a0, 1
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm_12900918536874:
; RV64IXTHEADBB:   # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 384477
; RV64IXTHEADBB-NEXT:  addiw a0, a0, 1365
; RV64IXTHEADBB-NEXT:  slli a0, a0, 12

```

```

; RV64IXTHEADBB-NEXT:  addi a0, a0, 1365
; RV64IXTHEADBB-NEXT:  slli a0, a0, 1
; RV64IXTHEADBB-NEXT:  ret
ret i64 12900918536874
}

define i64 @imm_12900925247761() {
; RV64I-LABEL: imm_12900925247761:
; RV64I:      # %bb.0:
; RV64I-NEXT:  lui a0, 384478
; RV64I-NEXT:  addiw
a0, a0, -1911
; RV64I-NEXT:  slli a0, a0, 13
; RV64I-NEXT:  addi a0, a0, -2048
; RV64I-NEXT:  addi a0, a0, -1775
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm_12900925247761:
; RV64IZBA:   # %bb.0:
; RV64IZBA-NEXT:  lui a0, 768955
; RV64IZBA-NEXT:  addi a0, a0, 273
; RV64IZBA-NEXT:  slli.uw a0, a0, 12
; RV64IZBA-NEXT:  addi a0, a0, 273
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm_12900925247761:
; RV64IZBB:   # %bb.0:
; RV64IZBB-NEXT:  lui a0, 384478
; RV64IZBB-NEXT:  addiw a0, a0, -1911
; RV64IZBB-NEXT:  slli a0, a0, 13
; RV64IZBB-NEXT:  addi a0, a0, -2048
; RV64IZBB-NEXT:  addi a0, a0, -1775
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm_12900925247761:
; RV64IZBS:   # %bb.0:
; RV64IZBS-NEXT:  lui a0, 384478
; RV64IZBS-NEXT:  addiw a0, a0, -1911
; RV64IZBS-NEXT:  slli a0, a0, 13
; RV64IZBS-NEXT:  addi a0, a0, -2048
; RV64IZBS-NEXT:  addi a0, a0, -1775
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm_12900925247761:
; RV64IXTHEADBB:
# %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 384478
; RV64IXTHEADBB-NEXT:  addiw a0, a0, -1911

```

```

; RV64IXTHEADBB-NEXT:  slli a0, a0, 13
; RV64IXTHEADBB-NEXT:  addi a0, a0, -2048
; RV64IXTHEADBB-NEXT:  addi a0, a0, -1775
; RV64IXTHEADBB-NEXT:  ret
ret i64 12900925247761
}

define i64 @imm_7158272001() {
; RV64I-LABEL: imm_7158272001:
; RV64I:    # %bb.0:
; RV64I-NEXT:  lui a0, 427
; RV64I-NEXT:  addiw a0, a0, -1367
; RV64I-NEXT:  slli a0, a0, 12
; RV64I-NEXT:  addi a0, a0, 1
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm_7158272001:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  lui a0, 349525
; RV64IZBA-NEXT:  sh2add a0, a0, a0
; RV64IZBA-NEXT:  addi a0, a0, 1
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm_7158272001:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  lui a0, 427
; RV64IZBB-NEXT:  addiw a0, a0, -1367
; RV64IZBB-NEXT:  slli a0, a0, 12
; RV64IZBB-NEXT:  addi a0, a0, 1
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm_7158272001:
; RV64IZBS:
;   # %bb.0:
; RV64IZBS-NEXT:  lui a0, 427
; RV64IZBS-NEXT:  addiw a0, a0, -1367
; RV64IZBS-NEXT:  slli a0, a0, 12
; RV64IZBS-NEXT:  addi a0, a0, 1
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm_7158272001:
; RV64IXTHEADBB:    # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 427
; RV64IXTHEADBB-NEXT:  addiw a0, a0, -1367
; RV64IXTHEADBB-NEXT:  slli a0, a0, 12
; RV64IXTHEADBB-NEXT:  addi a0, a0, 1
; RV64IXTHEADBB-NEXT:  ret
ret i64 7158272001 ; 0x0000_0001_aaaa_9001

```

```

}

define i64 @imm_12884889601() {
; RV64I-LABEL: imm_12884889601:
; RV64I:    # %bb.0:
; RV64I-NEXT:  lui a0, 768
; RV64I-NEXT:  addiw a0, a0, -3
; RV64I-NEXT:  slli a0, a0, 12
; RV64I-NEXT:  addi a0, a0, 1
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm_12884889601:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  lui a0, 349525
; RV64IZBA-NEXT:  sh3add a0, a0, a0
; RV64IZBA-NEXT:  addi a0, a0, 1
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm_12884889601:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:
;         lui a0, 768
; RV64IZBB-NEXT:  addiw a0, a0, -3
; RV64IZBB-NEXT:  slli a0, a0, 12
; RV64IZBB-NEXT:  addi a0, a0, 1
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm_12884889601:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:  lui a0, 768
; RV64IZBS-NEXT:  addiw a0, a0, -3
; RV64IZBS-NEXT:  slli a0, a0, 12
; RV64IZBS-NEXT:  addi a0, a0, 1
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm_12884889601:
; RV64IXTHEADBB:    # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 768
; RV64IXTHEADBB-NEXT:  addiw a0, a0, -3
; RV64IXTHEADBB-NEXT:  slli a0, a0, 12
; RV64IXTHEADBB-NEXT:  addi a0, a0, 1
; RV64IXTHEADBB-NEXT:  ret
ret i64 12884889601 ; 0x0000_0002_ffff_d001
}

define i64 @imm_neg_3435982847() {
; RV64I-LABEL: imm_neg_3435982847:
; RV64I:    # %bb.0:

```

```

; RV64I-NEXT:  lui a0, 1048371
; RV64I-NEXT:  addiw a0, a0, 817
; RV64I-NEXT:  slli a0, a0, 12
; RV64I-NEXT:  addi a0, a0, 1
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm_neg_3435982847:
; RV64IZBA:
# %bb.0:
; RV64IZBA-NEXT:  lui a0, 768955
; RV64IZBA-NEXT:  sh1add a0, a0, a0
; RV64IZBA-NEXT:  addi a0, a0, 1
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm_neg_3435982847:
; RV64IZBB:  # %bb.0:
; RV64IZBB-NEXT:  lui a0, 1048371
; RV64IZBB-NEXT:  addiw a0, a0, 817
; RV64IZBB-NEXT:  slli a0, a0, 12
; RV64IZBB-NEXT:  addi a0, a0, 1
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm_neg_3435982847:
; RV64IZBS:  # %bb.0:
; RV64IZBS-NEXT:  lui a0, 734001
; RV64IZBS-NEXT:  addiw a0, a0, 1
; RV64IZBS-NEXT:  bclri a0, a0, 31
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm_neg_3435982847:
; RV64IXTHEADBB:  # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 1048371
; RV64IXTHEADBB-NEXT:  addiw a0, a0, 817
; RV64IXTHEADBB-NEXT:  slli a0, a0, 12
; RV64IXTHEADBB-NEXT:  addi a0, a0, 1
; RV64IXTHEADBB-NEXT:  ret
ret i64 -3435982847 ; 0xffff_ffff_3333_1001
}

```

```

define i64 @imm_neg_5726842879() {
; RV64I-LABEL: imm_neg_5726842879:
; RV64I:  # %bb.0:
; RV64I-NEXT:
    lui a0, 1048235
; RV64I-NEXT:  addiw a0, a0, -1419
; RV64I-NEXT:  slli a0, a0, 12
; RV64I-NEXT:  addi a0, a0, 1
; RV64I-NEXT:  ret

```

```

;
; RV64IZBA-LABEL: imm_neg_5726842879:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  lui a0, 768945
; RV64IZBA-NEXT:  sh2add a0, a0, a0
; RV64IZBA-NEXT:  addi a0, a0, 1
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm_neg_5726842879:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  lui a0, 1048235
; RV64IZBB-NEXT:  addiw a0, a0, -1419
; RV64IZBB-NEXT:  slli a0, a0, 12
; RV64IZBB-NEXT:  addi a0, a0, 1
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm_neg_5726842879:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:  lui a0, 698997
; RV64IZBS-NEXT:  addiw a0, a0, 1
; RV64IZBS-NEXT:  bclri a0, a0, 32
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm_neg_5726842879:
; RV64IXTHEADBB:  # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 1048235
; RV64IXTHEADBB-NEXT:  addiw a0, a0, -1419
; RV64IXTHEADBB-NEXT:  slli a0, a0, 12
; RV64IXTHEADBB-NEXT:
;   addi a0, a0, 1
; RV64IXTHEADBB-NEXT:  ret
;   ret i64 -5726842879 ; 0xffff_fffe_aaa7_5001
}

```

```

define i64 @imm_neg_10307948543() {
; RV64I-LABEL: imm_neg_10307948543:
; RV64I:    # %bb.0:
; RV64I-NEXT:  lui a0, 1047962
; RV64I-NEXT:  addiw a0, a0, -1645
; RV64I-NEXT:  slli a0, a0, 12
; RV64I-NEXT:  addi a0, a0, 1
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm_neg_10307948543:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  lui a0, 768955
; RV64IZBA-NEXT:  sh3add a0, a0, a0
; RV64IZBA-NEXT:  addi a0, a0, 1

```



```

; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm_neg_10307948543:
; RV64IZBB:      # %bb.0:
; RV64IZBB-NEXT:  lui a0, 1047962
; RV64IZBB-NEXT:  addiw a0, a0, -1645
; RV64IZBB-NEXT:  slli a0, a0, 12
; RV64IZBB-NEXT:  addi a0, a0, 1
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm_neg_10307948543:
; RV64IZBS:      # %bb.0:
; RV64IZBS-NEXT:  lui a0, 629139
; RV64IZBS-NEXT:  addiw a0, a0, 1
; RV64IZBS-NEXT:  bclri a0, a0, 33
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL:
imm_neg_10307948543:
; RV64IXTHEADBB:  # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 1047962
; RV64IXTHEADBB-NEXT:  addiw a0, a0, -1645
; RV64IXTHEADBB-NEXT:  slli a0, a0, 12
; RV64IXTHEADBB-NEXT:  addi a0, a0, 1
; RV64IXTHEADBB-NEXT:  ret
ret i64 -10307948543 ; 0xffff_fffd_9999_3001
}

```

```

define i64 @li_ori_1() {
; RV64I-LABEL: li_ori_1:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a0, -17
; RV64I-NEXT:  slli a0, a0, 43
; RV64I-NEXT:  addi a0, a0, -1
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: li_ori_1:
; RV64IZBA:      # %bb.0:
; RV64IZBA-NEXT:  li a0, -17
; RV64IZBA-NEXT:  slli a0, a0, 43
; RV64IZBA-NEXT:  addi a0, a0, -1
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: li_ori_1:
; RV64IZBB:      # %bb.0:
; RV64IZBB-NEXT:  li a0, -18
; RV64IZBB-NEXT:  rori a0, a0, 21
; RV64IZBB-NEXT:  ret

```

```

;
; RV64IZBS-LABEL: li_ropi_1:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:  li a0, -17
; RV64IZBS-NEXT:  slli a0, a0, 43
; RV64IZBS-NEXT:  addi a0, a0,
-1
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: li_ropi_1:
; RV64IXTHEADBB:    # %bb.0:
; RV64IXTHEADBB-NEXT:  li a0, -18
; RV64IXTHEADBB-NEXT:  th.srri a0, a0, 21
; RV64IXTHEADBB-NEXT:  ret
ret i64 -149533581377537
}

```

```

define i64 @li_ropi_2() {
; RV64I-LABEL: li_ropi_2:
; RV64I:    # %bb.0:
; RV64I-NEXT:  li a0, -5
; RV64I-NEXT:  slli a0, a0, 60
; RV64I-NEXT:  addi a0, a0, -6
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: li_ropi_2:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  li a0, -5
; RV64IZBA-NEXT:  slli a0, a0, 60
; RV64IZBA-NEXT:  addi a0, a0, -6
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: li_ropi_2:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  li a0, -86
; RV64IZBB-NEXT:  rori a0, a0, 4
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: li_ropi_2:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:  li a0, -5
; RV64IZBS-NEXT:  slli a0, a0, 60
; RV64IZBS-NEXT:  addi a0, a0, -6
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: li_ropi_2:
; RV64IXTHEADBB:

```

```

# %bb.0:
; RV64IXTHEADBB-NEXT: li a0, -86
; RV64IXTHEADBB-NEXT: th.srri a0, a0, 4
; RV64IXTHEADBB-NEXT: ret
ret i64 -5764607523034234886
}

```

```

define i64 @li_ropi_3() {
; RV64I-LABEL: li_ropi_3:
; RV64I:    # %bb.0:
; RV64I-NEXT: li a0, -17
; RV64I-NEXT: slli a0, a0, 27
; RV64I-NEXT: addi a0, a0, -1
; RV64I-NEXT: ret
;
; RV64IZBA-LABEL: li_ropi_3:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT: li a0, -17
; RV64IZBA-NEXT: slli a0, a0, 27
; RV64IZBA-NEXT: addi a0, a0, -1
; RV64IZBA-NEXT: ret
;
; RV64IZBB-LABEL: li_ropi_3:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT: li a0, -18
; RV64IZBB-NEXT: rori a0, a0, 37
; RV64IZBB-NEXT: ret
;
; RV64IZBS-LABEL: li_ropi_3:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT: li a0, -17
; RV64IZBS-NEXT: slli a0, a0, 27
; RV64IZBS-NEXT: addi a0, a0, -1
; RV64IZBS-NEXT: ret
;
; RV64IXTHEADBB-LABEL: li_ropi_3:
; RV64IXTHEADBB:    # %bb.0:
; RV64IXTHEADBB-NEXT: li a0, -18
; RV64IXTHEADBB-NEXT: th.srri a0,
a0, 37
; RV64IXTHEADBB-NEXT: ret
ret i64 -2281701377
}

```

; This used to assert when compiled with Zba.

```

define i64 @PR54812() {
; RV64I-LABEL: PR54812:
; RV64I:    # %bb.0:

```

```

; RV64I-NEXT:  lui a0, 1048447
; RV64I-NEXT:  addiw a0, a0, 1407
; RV64I-NEXT:  slli a0, a0, 12
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: PR54812:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  lui a0, 872917
; RV64IZBA-NEXT:  sh1add a0, a0, a0
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: PR54812:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  lui a0, 1048447
; RV64IZBB-NEXT:  addiw a0, a0, 1407
; RV64IZBB-NEXT:  slli a0, a0, 12
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: PR54812:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:  lui a0, 1045887
; RV64IZBS-NEXT:  bclri a0, a0, 31
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: PR54812:
; RV64IXTHEADBB:  # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 1048447
; RV64IXTHEADBB-NEXT:  addiw a0, a0, 1407
; RV64IXTHEADBB-NEXT:  slli a0, a0, 12
; RV64IXTHEADBB-NEXT:
    ret
ret i64 -2158497792;
}

```

```

define signext i32 @pos_2048() nounwind {

```

```

; RV64I-LABEL: pos_2048:
; RV64I:    # %bb.0:
; RV64I-NEXT:  li a0, 1
; RV64I-NEXT:  slli a0, a0, 11
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: pos_2048:
; RV64IZBA:  # %bb.0:
; RV64IZBA-NEXT:  li a0, 1
; RV64IZBA-NEXT:  slli a0, a0, 11
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: pos_2048:

```

```

; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  li a0, 1
; RV64IZBB-NEXT:  slli a0, a0, 11
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: pos_2048:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:  bseti a0, zero, 11
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: pos_2048:
; RV64IXTHEADBB:  # %bb.0:
; RV64IXTHEADBB-NEXT:  li a0, 1
; RV64IXTHEADBB-NEXT:  slli a0, a0, 11
; RV64IXTHEADBB-NEXT:  ret
ret i32 2048
}

```

```

define i64 @imm64_same_lo_hi() nounwind {

```

```

; RV64I-LABEL: imm64_same_lo_hi:
; RV64I:    # %bb.0:
; RV64I-NEXT:  lui a0, 65793
; RV64I-NEXT:  addiw a0, a0, 16
; RV64I-NEXT:
    slli a1, a0, 32
; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm64_same_lo_hi:
; RV64IZBA:  # %bb.0:
; RV64IZBA-NEXT:  lui a0, 65793
; RV64IZBA-NEXT:  addiw a0, a0, 16
; RV64IZBA-NEXT:  slli a1, a0, 32
; RV64IZBA-NEXT:  add a0, a0, a1
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm64_same_lo_hi:
; RV64IZBB:  # %bb.0:
; RV64IZBB-NEXT:  lui a0, 65793
; RV64IZBB-NEXT:  addiw a0, a0, 16
; RV64IZBB-NEXT:  slli a1, a0, 32
; RV64IZBB-NEXT:  add a0, a0, a1
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm64_same_lo_hi:
; RV64IZBS:  # %bb.0:
; RV64IZBS-NEXT:  lui a0, 65793
; RV64IZBS-NEXT:  addiw a0, a0, 16

```

```

; RV64IZBS-NEXT:  slli a1, a0, 32
; RV64IZBS-NEXT:  add a0, a0, a1
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm64_same_lo_hi:
; RV64IXTHEADBB:   # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 65793
; RV64IXTHEADBB-NEXT:  addiw a0, a0, 16
; RV64IXTHEADBB-NEXT:  slli a1, a0, 32
; RV64IXTHEADBB-NEXT:  add a0, a0, a1
;
RV64IXTHEADBB-NEXT:  ret
ret i64 1157442765409226768 ; 0x0101010101010101
}

```

; Same as above with optsize. Make sure we use constant pool on RV64

```
define i64 @imm64_same_lo_hi_optsize() nounwind optsize {
```

```

; RV64-NOPOOL-LABEL: imm64_same_lo_hi_optsize:
; RV64-NOPOOL:   # %bb.0:
; RV64-NOPOOL-NEXT:  lui a0, 65793
; RV64-NOPOOL-NEXT:  addiw a0, a0, 16
; RV64-NOPOOL-NEXT:  slli a1, a0, 32
; RV64-NOPOOL-NEXT:  add a0, a0, a1
; RV64-NOPOOL-NEXT:  ret
;
; RV64I-POOL-LABEL: imm64_same_lo_hi_optsize:
; RV64I-POOL:   # %bb.0:
; RV64I-POOL-NEXT:  lui a0, %hi(.LCPI64_0)
; RV64I-POOL-NEXT:  ld a0, %lo(.LCPI64_0)(a0)
; RV64I-POOL-NEXT:  ret
;
; RV64IZBA-LABEL: imm64_same_lo_hi_optsize:
; RV64IZBA:   # %bb.0:
; RV64IZBA-NEXT:  lui a0, 65793
; RV64IZBA-NEXT:  addiw a0, a0, 16
; RV64IZBA-NEXT:  slli a1, a0, 32
; RV64IZBA-NEXT:  add a0, a0, a1
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm64_same_lo_hi_optsize:
; RV64IZBB:   # %bb.0:
; RV64IZBB-NEXT:  lui
a0, 65793
; RV64IZBB-NEXT:  addiw a0, a0, 16
; RV64IZBB-NEXT:  slli a1, a0, 32
; RV64IZBB-NEXT:  add a0, a0, a1
; RV64IZBB-NEXT:  ret
;

```

```

; RV64IZBS-LABEL: imm64_same_lo_hi_optsize:
; RV64IZBS:      # %bb.0:
; RV64IZBS-NEXT: lui a0, 65793
; RV64IZBS-NEXT: addiw a0, a0, 16
; RV64IZBS-NEXT: slli a1, a0, 32
; RV64IZBS-NEXT: add a0, a0, a1
; RV64IZBS-NEXT: ret
;
; RV64IXTHEADBB-LABEL: imm64_same_lo_hi_optsize:
; RV64IXTHEADBB: # %bb.0:
; RV64IXTHEADBB-NEXT: lui a0, 65793
; RV64IXTHEADBB-NEXT: addiw a0, a0, 16
; RV64IXTHEADBB-NEXT: slli a1, a0, 32
; RV64IXTHEADBB-NEXT: add a0, a0, a1
; RV64IXTHEADBB-NEXT: ret
ret i64 1157442765409226768 ; 0x0101010101010101
}
; NOTE: Assertions have been autogenerated by utils/update_llc_test_checks.py
; RUN: llc < %s -mtriple=x86_64-linux-android -mattr=+mmx -enable-legalize-types-checking | FileCheck %s
;
; D31946
; Check that we dont end up with the ""LLVM ERROR: Cannot select" error.
; Additionally ensure that the output code actually put fp128 values in SSE registers.

```

```

declare fp128 @llvm.fabs.f128(fp128)
declare fp128 @llvm.copysign.f128(fp128, fp128)

```

```

define fp128 @TestSelect(fp128 %a, fp128 %b) {
; CHECK-LABEL: TestSelect:
; CHECK:      # %bb.0:
; CHECK-NEXT: pushq %rbx
; CHECK-NEXT: .cfi_def_cfa_offset 16
; CHECK-NEXT: subq $32, %rsp
; CHECK-NEXT: .cfi_def_cfa_offset 48
; CHECK-NEXT: .cfi_offset %rbx, -16
; CHECK-NEXT: movaps %xmm1, {[[-0-9]+]}(%r{[sb]})p) # 16-byte Spill
; CHECK-NEXT: movaps %xmm0, (%rsp) # 16-byte Spill
; CHECK-NEXT: callq __gttf2@PLT
; CHECK-NEXT: movl %eax, %ebx
; CHECK-NEXT: movaps (%rsp), %xmm0 # 16-byte Reload
; CHECK-NEXT: movaps {[[-0-9]+]}(%r{[sb]})p),
;               %xmm1 # 16-byte Reload
; CHECK-NEXT: callq __subtf3@PLT
; CHECK-NEXT: testl %ebx, %ebx
; CHECK-NEXT: jg .LBB0_2
; CHECK-NEXT: # %bb.1:
; CHECK-NEXT: xorps %xmm0, %xmm0
; CHECK-NEXT: .LBB0_2:

```

```

; CHECK-NEXT: addq $32, %rsp
; CHECK-NEXT: .cfi_def_cfa_offset 16
; CHECK-NEXT: popq %rbx
; CHECK-NEXT: .cfi_def_cfa_offset 8
; CHECK-NEXT: retq
%cmp = fcmp ogt fp128 %a, %b
%sub = fsub fp128 %a, %b
%res = select i1 %cmp, fp128 %sub, fp128 0xL00000000000000000000000000000000
ret fp128 %res
}

```

```

define fp128 @TestFabs(fp128 %a) {
; CHECK-LABEL: TestFabs:
; CHECK:      # %bb.0:
; CHECK-NEXT: andps {{\.?LCPI[0-9]+\_[0-9]+\}}(%rip), %xmm0
; CHECK-NEXT: retq
%res = call fp128 @llvm.fabs.f128(fp128 %a)
ret fp128 %res
}

```

```

define fp128 @TestCopysign(fp128 %a, fp128 %b) {
; CHECK-LABEL: TestCopysign:
; CHECK:      # %bb.0:
; CHECK-NEXT: andps {{\.?LCPI[0-9]+\_[0-9]+\}}(%rip), %xmm1
; CHECK-NEXT: andps {{\.?LCPI[0-9]+\_[0-9]+\}}(%rip), %xmm0
; CHECK-NEXT:
    orps %xmm1, %xmm0
; CHECK-NEXT: retq
%res = call fp128 @llvm.copysign.f128(fp128 %a, fp128 %b)
ret fp128 %res
}

```

```

define fp128 @TestFneg(fp128 %a) {
; CHECK-LABEL: TestFneg:
; CHECK:      # %bb.0:
; CHECK-NEXT: pushq %rax
; CHECK-NEXT: .cfi_def_cfa_offset 16
; CHECK-NEXT: movaps %xmm0, %xmm1
; CHECK-NEXT: callq __multf3@PLT
; CHECK-NEXT: xorps {{\.?LCPI[0-9]+\_[0-9]+\}}(%rip), %xmm0
; CHECK-NEXT: popq %rax
; CHECK-NEXT: .cfi_def_cfa_offset 8
; CHECK-NEXT: retq
%mul = fmul fp128 %a, %a
%res = fsub fp128 0xL00000000000000008000000000000000, %mul
ret fp128 %res
}

```



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=====

/\*-

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```

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* @(#)COPYRIGHT 8.1 (Berkeley) 3/16/94
*/
; NOTE: Assertions have been autogenerated by utils/update_llc_test_checks.py
; RUN: llc -mtriple=riscv64 -mattr=+zbbk -verify-machineinstrs < %s \
; RUN: | FileCheck %s -check-prefix=RV64ZBKB

declare i64 @llvm.riscv.brev8.i64(i64)

define i64 @brev8(i64 %a) nounwind {
; RV64ZBKB-LABEL: brev8:
; RV64ZBKB:      # %bb.0:
; RV64ZBKB-NEXT:  brev8 a0, a0
; RV64ZBKB-NEXT:  ret
    %val = call i64 @llvm.riscv.brev8.i64(i64 %a)
    ret i64 %val
}

; Test that rev8 is recognized as preserving zero extension.
define zeroext i16 @brev8_knownbits(i16 zeroext %a) nounwind {
; RV64ZBKB-LABEL: brev8_knownbits:
; RV64ZBKB:      # %bb.0:
; RV64ZBKB-NEXT:  brev8 a0, a0

```

```

; RV64ZBKB-NEXT:  ret
%zext = zext i16 %a to i64
%val = call i64 @llvm.riscv.brev8.i64(i64 %zext)
%trunc = trunc i64 %val to i16
ret i16 %trunc
}

declare i64 @llvm.bswap.i64(i64)

define i64 @rev8_i64(i64 %a) {
; RV64ZBKB-LABEL: rev8_i64:
; RV64ZBKB:      # %bb.0:
; RV64ZBKB-NEXT:  rev8 a0, a0
; RV64ZBKB-NEXT:  ret
    %1 = call i64 @llvm.bswap.i64(i64 %a)
    ret i64 %1
}

declare i32 @llvm.riscv.brev8.i32(i32)

define signext i32 @brev8_i32(i32 signext %a) nounwind {
; RV64ZBKB-LABEL: brev8_i32:
; RV64ZBKB:      # %bb.0:
; RV64ZBKB-NEXT:  brev8 a0, a0
; RV64ZBKB-NEXT:  sext.w a0, a0
; RV64ZBKB-NEXT:  ret
    %val = call i32 @llvm.riscv.brev8.i32(i32 %a)
    ret i32 %val
}

; Test that rev8 is recognized as preserving zero extension.
define zeroext i16 @brev8_i32_knownbits(i16 zeroext %a) nounwind {
; RV64ZBKB-LABEL: brev8_i32_knownbits:
; RV64ZBKB:      # %bb.0:
; RV64ZBKB-NEXT:  brev8 a0, a0
; RV64ZBKB-NEXT:  ret
    %zext = zext i16 %a to i32
    %val = call i32 @llvm.riscv.brev8.i32(i32 %zext)
    %trunc = trunc i32 %val to i16
    ret i16 %trunc
}

declare i32 @llvm.bswap.i32(i32)

define signext i32 @rev8_i32(i32 signext %a) {
; RV64ZBKB-LABEL: rev8_i32:
; RV64ZBKB:      # %bb.0:
; RV64ZBKB-NEXT:  rev8 a0, a0

```

```

; RV64ZBKB-NEXT:  srai a0, a0, 32
; RV64ZBKB-NEXT:  ret
%1 = call i32 @llvm.bswap.i32(i32
%a)
ret i32 %1
}
; NOTE: Assertions have been autogenerated by utils/update_llc_test_checks.py
; RUN: llc < %s -mtriple=x86_64-unknown-unknown -mcpu=skylake-avx512 -mattr=prefer-256-bit | FileCheck %s
--check-prefixes=CHECK,CHECK-SKX
; RUN: llc < %s -mtriple=x86_64-unknown-unknown -mcpu=skylake-avx512 -mattr=prefer-256-bit,avx512vbmi |
FileCheck %s --check-prefixes=CHECK,CHECK-SKX,CHECK-SKX-VBMI
; Make sure CPUs default to prefer-256-bit. avx512vnni isn't interesting as it just adds an isel peephole for
vpaddwd+vpadd
; RUN: llc < %s -mtriple=x86_64-unknown-unknown -mcpu=skylake-avx512 | FileCheck %s --check-
prefixes=CHECK,CHECK-AVX512
; RUN: llc < %s -mtriple=x86_64-unknown-unknown -mattr=-avx512vnni -mcpu=cascadelake | FileCheck %s --
check-prefixes=CHECK,CHECK-AVX512
; RUN: llc < %s -mtriple=x86_64-unknown-unknown -mattr=-avx512vnni -mcpu=cooperlake | FileCheck %s --
check-prefixes=CHECK,CHECK-AVX512
; RUN: llc < %s -mtriple=x86_64-unknown-unknown -mcpu=cannonlake | FileCheck %s --check-
prefixes=CHECK,CHECK-VBMI
;
; RUN: llc < %s -mtriple=x86_64-unknown-unknown -mattr=-avx512vnni -mcpu=icelake-client | FileCheck %s --
check-prefixes=CHECK,CHECK-VBMI
; RUN: llc < %s -mtriple=x86_64-unknown-unknown -mattr=-avx512vnni -mcpu=icelake-server | FileCheck %s --
check-prefixes=CHECK,CHECK-VBMI
; RUN: llc < %s -mtriple=x86_64-unknown-unknown -mattr=-avx512vnni -mcpu=tigerlake | FileCheck %s --check-
prefixes=CHECK,CHECK-VBMI

```

; This file primarily contains tests for specific places in X86ISelLowering.cpp that needed be made aware of the legalizer not allowing 512-bit vectors due to prefer-256-bit even though AVX512 is enabled.

```

define dso_local void @add256(<16 x i32>* %a, <16 x i32>* %b, <16 x i32>* %c) "min-legal-vector-
width"="256" {
; CHECK-LABEL: add256:
; CHECK:      # %bb.0:
; CHECK-NEXT:  vmovdqa (%rdi), %ymm0
; CHECK-NEXT:  vmovdqa 32(%rdi), %ymm1
; CHECK-NEXT:  vpadd 32(%rsi), %ymm1, %ymm1
; CHECK-NEXT:  vpadd (%rsi), %ymm0, %ymm0
; CHECK-NEXT:  vmovdqa %ymm0, (%rdx)
; CHECK-NEXT:
;               vmovdqa %ymm1, 32(%rdx)
; CHECK-NEXT:  vzeroupper
; CHECK-NEXT:  retq
%d = load <16 x i32>, <16 x i32>* %a
%e = load <16 x i32>, <16 x i32>* %b
%f = add <16 x i32> %d, %e

```



```
define dso_local void @pmaddwd_32_256(<32 x i16>* %APtr, <32 x i16>* %BPtr, <16 x i32>* %CPtr) "min-legal-vector-width"="256" {
; CHECK-LABEL: pmaddwd_32_256:
; CHECK:      # %bb.0:
; CHECK-NEXT:  vmovdqa (%rdi), %ymm0
; CHECK-NEXT:  vmovdqa 32(%rdi), %ymm1
; CHECK-NEXT:  vpmaddwd 32(%rsi), %ymm1, %ymm1
; CHECK-NEXT:  vpmaddwd (%rsi), %ymm0, %ymm0
; CHECK-NEXT:  vmovdqa %ymm0, (%rdx)
; CHECK-NEXT:  vmovdqa %ymm1, 32(%rdx)
; CHECK-NEXT:  vzeroupper
; CHECK-NEXT:  retq

%A = load <32 x i16>, <32 x i16>* %APtr
%B = load <32 x i16>, <32 x i16>* %BPtr
%a = sext <32 x i16> %A to <32 x i32>
%b = sext <32 x i16> %B to <32 x i32>
```

```

    %m = mul nsw <32 x i32> %a, %b
    %odd = shufflevector <32 x i32> %m, <32 x i32> undef, <16 x i32> <i32 0, i32 2, i32 4, i32 6, i32 8, i32 10, i32 12, i32 14, i32 16, i32 18, i32 20, i32 22, i32 24, i32 26, i32 28, i32 30>
    %even = shufflevector <32 x i32> %m, <32 x i32> undef, <16 x i32> <i32 1, i32 3, i32 5, i32 7, i32 9, i32 11, i32 13, i32 15, i32 17, i32 19, i32 21, i32 23, i32 25, i32 27, i32 29, i32 31>
    %ret = add <16 x i32> %odd, %even
    store <16 x i32> %ret, <16 x i32>* %CPtr
    ret void
}

```

```

define dso_local void @pmaddwd_32_512(<32 x i16>* %APtr, <32 x i16>* %BPtr, <16 x i32>* %CPtr) "min-legal-vector-width"="512" {
; CHECK-LABEL: pmaddwd_32_512:
; CHECK:      # %bb.0:
; CHECK-NEXT: vmovdqa64 (%rdi), %zmm0
; CHECK-NEXT: vpmaddwd (%rsi), %zmm0, %zmm0
; CHECK-NEXT: vmovdqa64 %zmm0, (%rdx)
; CHECK-NEXT: vzeroupper
; CHECK-NEXT: retq
    %A = load <32 x i16>, <32 x i16>* %APtr
    %B = load <32 x i16>, <32 x i16>* %BPtr
    %a = sext <32 x i16> %A to <32 x i32>
    %b = sext <32 x i16> %B to <32 x i32>
    %m = mul nsw <32 x i32> %a, %b
    %odd = shufflevector <32 x i32> %m, <32 x i32> undef, <16 x i32> <i32 0, i32 2, i32 4, i32 6, i32 8, i32 10, i32 12, i32 14, i32 16, i32 18, i32 20, i32 22, i32 24, i32 26, i32 28, i32 30>
    %even = shufflevector <32 x i32> %m, <32 x i32> undef, <16 x i32> <i32 1, i32 3, i32 5, i32 7, i32 9, i32 11, i32 13, i32 15, i32 17, i32 19, i32 21, i32 23, i32 25, i32 27, i32 29, i32 31>
    %ret = add <16 x i32> %odd, %even
    store <16 x i32> %ret, <16 x i32>* %CPtr
    ret void
}

```

```

define dso_local void @psubus_64i8_max_256(<64 x i8>* %xptr, <64 x i8>* %yptr, <64 x i8>* %zptr) "min-legal-vector-width"="256" {
; CHECK-LABEL: psubus_64i8_max_256:
; CHECK:      # %bb.0:
; CHECK-NEXT: vmovdqa (%rdi), %ymm0
; CHECK-NEXT: vmovdqa 32(%rdi), %ymm1
; CHECK-NEXT: vpsubusb 32(%rsi), %ymm1, %ymm1
; CHECK-NEXT: vpsubusb (%rsi), %ymm0, %ymm0
; CHECK-NEXT: vmovdqa %ymm0, (%rdx)
; CHECK-NEXT: vmovdqa %ymm1, 32(%rdx)
; CHECK-NEXT: vzeroupper
; CHECK-NEXT: retq
    %x = load <64 x i8>, <64 x i8>* %xptr
    %y = load <64 x i8>, <64 x i8>* %yptr

```

```

%cmp = icmp ult <64 x i8> %x, %y
%max = select <64 x i1> %cmp, <64 x i8> %y, <64 x i8> %x
%res = sub <64 x i8> %max, %y
store <64 x i8> %res, <64 x i8>* %zptr
ret void
}

```

define

```

dso_local void @psubus_64i8_max_512(<64 x i8>* %xptr, <64 x i8>* %yptr, <64 x i8>* %zptr) "min-legal-
vector-width"="512" {
; CHECK-LABEL: psubus_64i8_max_512:
; CHECK:      # %bb.0:
; CHECK-NEXT: vmovdqa64 (%rdi), %zmm0
; CHECK-NEXT: vpsubusb (%rsi), %zmm0, %zmm0
; CHECK-NEXT: vmovdqa64 %zmm0, (%rdx)
; CHECK-NEXT: vzeroupper
; CHECK-NEXT: retq
%x = load <64 x i8>, <64 x i8>* %xptr
%y = load <64 x i8>, <64 x i8>* %yptr
%cmp = icmp ult <64 x i8> %x, %y
%max = select <64 x i1> %cmp, <64 x i8> %y, <64 x i8> %x
%res = sub <64 x i8> %max, %y
store <64 x i8> %res, <64 x i8>* %zptr
ret void
}

```

define dso\_local i32 @\_Z9test\_charPcS\_i\_256(i8\* nocapture readonly, i8\* nocapture readonly, i32) "min-legal-
vector-width"="256" {

```

; CHECK-SKX-LABEL: _Z9test_charPcS_i_256:
; CHECK-SKX:      # %bb.0: # %entry
; CHECK-SKX-NEXT: movl %edx, %eax
; CHECK-SKX-NEXT: vpxor %xmm0, %xmm0, %xmm0
; CHECK-SKX-NEXT: xorl %ecx, %ecx
; CHECK-SKX-NEXT: vpxor %xmm1, %xmm1, %xmm1
;
CHECK-SKX-NEXT: vpxor %xmm2, %xmm2, %xmm2
; CHECK-SKX-NEXT: .p2align 4, 0x90
; CHECK-SKX-NEXT: .LBB8_1: # %vector.body
; CHECK-SKX-NEXT: # =>This Inner Loop Header: Depth=1
; CHECK-SKX-NEXT: vpmovsxbw 16(%rdi,%rcx), %ymm3
; CHECK-SKX-NEXT: vpmovsxbw (%rdi,%rcx), %ymm4
; CHECK-SKX-NEXT: vpmovsxbw (%rsi,%rcx), %ymm5
; CHECK-SKX-NEXT: vpmaddwd %ymm3, %ymm5, %ymm3
; CHECK-SKX-NEXT: vpadd %ymm2, %ymm3, %ymm2
; CHECK-SKX-NEXT: vpmovsxbw (%rsi,%rcx), %ymm3
; CHECK-SKX-NEXT: vpmaddwd %ymm4, %ymm3, %ymm3
; CHECK-SKX-NEXT: vpadd %ymm1, %ymm3, %ymm1
; CHECK-SKX-NEXT: addq $32, %rcx

```



```

; CHECK-SKX-NEXT:  cmpq %rcx, %rax
; CHECK-SKX-NEXT:  jne .LBB8_1
; CHECK-SKX-NEXT:  # %bb.2: # %middle.block
; CHECK-SKX-NEXT:  vpaddd %ymm0, %ymm1, %ymm1
; CHECK-SKX-NEXT:  vpaddd %ymm0, %ymm2, %ymm0
; CHECK-SKX-NEXT:  vpaddd %ymm0, %ymm1, %ymm0
; CHECK-SKX-NEXT:  vextracti128 $1, %ymm0, %xmm1
; CHECK-SKX-NEXT:  vpaddd %xmm1, %xmm0, %xmm0
; CHECK-SKX-NEXT:
    vpslq $32, %xmm0, %xmm1
; CHECK-SKX-NEXT:  vpaddd %xmm1, %xmm0, %xmm0
; CHECK-SKX-NEXT:  vpsrlq $32, %xmm0, %xmm1
; CHECK-SKX-NEXT:  vpaddd %xmm1, %xmm0, %xmm0
; CHECK-SKX-NEXT:  vmovd %xmm0, %eax
; CHECK-SKX-NEXT:  vzeroupper
; CHECK-SKX-NEXT:  retq
;
; CHECK-AVX512-LABEL: _Z9test_charPcS_i_256:
; CHECK-AVX512:    # %bb.0: # %entry
; CHECK-AVX512-NEXT:  movl %edx, %eax
; CHECK-AVX512-NEXT:  vpxor %xmm0, %xmm0, %xmm0
; CHECK-AVX512-NEXT:  xorl %ecx, %ecx
; CHECK-AVX512-NEXT:  vpxor %xmm1, %xmm1, %xmm1
; CHECK-AVX512-NEXT:  vpxor %xmm2, %xmm2, %xmm2
; CHECK-AVX512-NEXT:  .p2align 4, 0x90
; CHECK-AVX512-NEXT: .LBB8_1: # %vector.body
; CHECK-AVX512-NEXT: # =>This Inner Loop Header: Depth=1
; CHECK-AVX512-NEXT: vpmovsxbw 16(%rdi,%rcx), %ymm3
; CHECK-AVX512-NEXT: vpmovsxbw (%rdi,%rcx), %ymm4
; CHECK-AVX512-NEXT: vpmovsxbw 16(%rsi,%rcx), %ymm5
; CHECK-AVX512-NEXT: vpmaddwd %ymm3, %ymm5, %ymm3
; CHECK-AVX512-NEXT: vpaddd %ymm2, %ymm3,
    %ymm2
; CHECK-AVX512-NEXT: vpmovsxbw (%rsi,%rcx), %ymm3
; CHECK-AVX512-NEXT: vpmaddwd %ymm4, %ymm3, %ymm3
; CHECK-AVX512-NEXT: vpaddd %ymm1, %ymm3, %ymm1
; CHECK-AVX512-NEXT: addq $32, %rcx
; CHECK-AVX512-NEXT: cmpq %rcx, %rax
; CHECK-AVX512-NEXT: jne .LBB8_1
; CHECK-AVX512-NEXT: # %bb.2: # %middle.block
; CHECK-AVX512-NEXT: vpaddd %ymm0, %ymm1, %ymm1
; CHECK-AVX512-NEXT: vpaddd %ymm0, %ymm2, %ymm0
; CHECK-AVX512-NEXT: vpaddd %ymm0, %ymm1, %ymm0
; CHECK-AVX512-NEXT: vextracti128 $1, %ymm0, %xmm1
; CHECK-AVX512-NEXT: vpaddd %xmm1, %xmm0, %xmm0
; CHECK-AVX512-NEXT: vpslq $32, %xmm0, %xmm1
; CHECK-AVX512-NEXT: vpaddd %xmm1, %xmm0, %xmm0
; CHECK-AVX512-NEXT: vpsrlq $32, %xmm0, %xmm1

```

```

; CHECK-AVX512-NEXT: vpaddd %xmm1, %xmm0, %xmm0
; CHECK-AVX512-NEXT: vmovd %xmm0, %eax
; CHECK-AVX512-NEXT: vzeroupper
; CHECK-AVX512-NEXT: retq
;
; CHECK-VBMI-LABEL: _Z9test_charPcS_i_256:
; CHECK-VBMI: # %bb.0: # %entry
; CHECK-VBMI-NEXT:
    movl %edx, %eax
; CHECK-VBMI-NEXT: vpxor %xmm0, %xmm0, %xmm0
; CHECK-VBMI-NEXT: xorl %ecx, %ecx
; CHECK-VBMI-NEXT: vpxor %xmm1, %xmm1, %xmm1
; CHECK-VBMI-NEXT: vpxor %xmm2, %xmm2, %xmm2
; CHECK-VBMI-NEXT: .p2align 4, 0x90
; CHECK-VBMI-NEXT: .LBB8_1: # %vector.body
; CHECK-VBMI-NEXT: # =>This Inner Loop Header: Depth=1
; CHECK-VBMI-NEXT: vpmovsxbw 16(%rdi,%rcx), %ymm3
; CHECK-VBMI-NEXT: vpmovsxbw (%rdi,%rcx), %ymm4
; CHECK-VBMI-NEXT: vpmovsxbw 16(%rsi,%rcx), %ymm5
; CHECK-VBMI-NEXT: vpmaddwd %ymm3, %ymm5, %ymm3
; CHECK-VBMI-NEXT: vpaddd %ymm2, %ymm3, %ymm2
; CHECK-VBMI-NEXT: vpmovsxbw (%rsi,%rcx), %ymm3
; CHECK-VBMI-NEXT: vpmaddwd %ymm4, %ymm3, %ymm3
; CHECK-VBMI-NEXT: vpaddd %ymm1, %ymm3, %ymm1
; CHECK-VBMI-NEXT: addq $32, %rcx
; CHECK-VBMI-NEXT: cmpq %rcx, %rax
; CHECK-VBMI-NEXT: jne .LBB8_1
; CHECK-VBMI-NEXT: # %bb.2: # %middle.block
; CHECK-VBMI-NEXT: vpaddd %ymm0, %ymm1, %ymm1
; CHECK-VBMI-NEXT: vpaddd %ymm0, %ymm2,
    %ymm0
; CHECK-VBMI-NEXT: vpaddd %ymm0, %ymm1, %ymm0
; CHECK-VBMI-NEXT: vextracti128 $1, %ymm0, %xmm1
; CHECK-VBMI-NEXT: vpaddd %xmm1, %xmm0, %xmm0
; CHECK-VBMI-NEXT: vpslufd {{.*#+}} xmm1 = xmm0[2,3,2,3]
; CHECK-VBMI-NEXT: vpaddd %xmm1, %xmm0, %xmm0
; CHECK-VBMI-NEXT: vpslufd {{.*#+}} xmm1 = xmm0[1,1,1,1]
; CHECK-VBMI-NEXT: vpaddd %xmm1, %xmm0, %xmm0
; CHECK-VBMI-NEXT: vmovd %xmm0, %eax
; CHECK-VBMI-NEXT: vzeroupper
; CHECK-VBMI-NEXT: retq
entry:
    %3 = zext i32 %2 to i64
    br label %vector.body

vector.body:
    %index = phi i64 [ %index.next, %vector.body ], [ 0, %entry ]
    %vec.phi = phi <32 x i32> [ %11, %vector.body ], [ zeroinitializer, %entry ]

```

```

%4 = getelementptr inbounds i8, i8* %0, i64 %index
%5 = bitcast i8* %4 to <32 x i8>*
%wide.load = load <32 x i8>, <32 x i8>* %5, align 1
%6 = sext <32 x i8> %wide.load to <32 x i32>
%7 = getelementptr inbounds i8, i8* %1, i64 %index
%8 = bitcast i8* %7 to <32 x i8>*
%wide.load14 = load <32 x
i8>, <32 x i8>* %8, align 1
%9 = sext <32 x i8> %wide.load14 to <32 x i32>
%10 = mul nsw <32 x i32> %9, %6
%11 = add nsw <32 x i32> %10, %vec.phi
%index.next = add i64 %index, 32
%12 = icmp eq i64 %index.next, %3
br i1 %12, label %middle.block, label %vector.body

```

middle.block:

```

%rdx.shuf1 = shufflevector <32 x i32> %11, <32 x i32> undef, <32 x i32> <i32 16, i32 17, i32 18, i32 19, i32 20,
i32 21, i32 22, i32 23, i32 24, i32 25, i32 26, i32 27, i32 28, i32 29, i32 30, i32 31, i32 undef, i32 undef, i32 undef,
i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32
undef, i32 undef, i32 undef>
%bin.rdx1 = add <32 x i32> %11, %rdx.shuf1
%rdx.shuf = shufflevector <32 x i32> %bin.rdx1, <32 x i32> undef, <32 x i32> <i32 8, i32 9, i32 10, i32 11, i32
12, i32 13, i32 14, i32 15, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32
undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32
undef>
%bin.rdx = add <32 x i32> %bin.rdx1, %rdx.shuf
%rdx.shuf15 = shufflevector <32 x i32> %bin.rdx, <32 x i32> undef, <32 x i32> <i32 4, i32 5, i32 6, i32 7, i32
undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef,
i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32
undef>
%bin.rdx32 = add <32 x i32> %bin.rdx, %rdx.shuf15
%rdx.shuf17 = shufflevector <32 x i32> %bin.rdx32, <32 x i32> undef, <32 x i32> <i32 2, i32 3, i32 undef, i32
undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef,
i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32
undef, i32 undef>
i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef>
%bin.rdx18 = add <32 x i32> %bin.rdx32, %rdx.shuf17
%rdx.shuf19 = shufflevector <32 x i32> %bin.rdx18, <32 x i32> undef, <32 x i32> <i32 1, i32 undef, i32 undef,
i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32
undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef>
%bin.rdx20 = add <32 x i32> %bin.rdx18, %rdx.shuf19
%13 = extractelement <32 x i32> %bin.rdx20, i32 0
ret i32 %13
}

```

```

define dso_local i32 @_Z9test_charPcS_i_512(i8* nocapture readonly, i8* nocapture readonly, i32) "min-legal-

```

```

vector-width"="512" {
; CHECK-SKX-LABEL: _Z9test_charPcS_i_512:
; CHECK-SKX:      # %bb.0: # %entry
; CHECK-SKX-NEXT:  movl %edx, %eax
; CHECK-SKX-NEXT:  vpxor %xmm0, %xmm0, %xmm0
; CHECK-SKX-NEXT:  xorl %ecx,
%ecx
; CHECK-SKX-NEXT:  vpxor %xmm1, %xmm1, %xmm1
; CHECK-SKX-NEXT:  .p2align 4, 0x90
; CHECK-SKX-NEXT:  .LBB9_1: # %vector.body
; CHECK-SKX-NEXT:  # =>This Inner Loop Header: Depth=1
; CHECK-SKX-NEXT:  vpmovsxbw (%rdi,%rcx), %zmm2
; CHECK-SKX-NEXT:  vpmovsxbw (%rsi,%rcx), %zmm3
; CHECK-SKX-NEXT:  vpmaddwd %zmm2, %zmm3, %zmm2
; CHECK-SKX-NEXT:  vpaddd %zmm1, %zmm2, %zmm1
; CHECK-SKX-NEXT:  addq $32, %rcx
; CHECK-SKX-NEXT:  cmpq %rcx, %rax
; CHECK-SKX-NEXT:  jne .LBB9_1
; CHECK-SKX-NEXT:  # %bb.2: # %middle.block
; CHECK-SKX-NEXT:  vpaddd %zmm0, %zmm1, %zmm0
; CHECK-SKX-NEXT:  vextracti64x4 $1, %zmm0, %ymm1
; CHECK-SKX-NEXT:  vpaddd %zmm1, %zmm0, %zmm0
; CHECK-SKX-NEXT:  vextracti128 $1, %ymm0, %xmm1
; CHECK-SKX-NEXT:  vpaddd %xmm1, %xmm0, %xmm0
; CHECK-SKX-NEXT:  vpslufd {{.*#+}} xmm1 = xmm0[2,3,2,3]
; CHECK-SKX-NEXT:  vpaddd %xmm1, %xmm0, %xmm0
; CHECK-SKX-NEXT:  vpsrlq $32, %xmm0, %xmm1
; CHECK-SKX-NEXT:  vpaddd %xmm1, %xmm0, %xmm0
; CHECK-SKX-NEXT:
vmovd %xmm0, %eax
; CHECK-SKX-NEXT:  vzeroupper
; CHECK-SKX-NEXT:  retq
;
; CHECK-AVX512-LABEL: _Z9test_charPcS_i_512:
; CHECK-AVX512:    # %bb.0: # %entry
; CHECK-AVX512-NEXT:  movl %edx, %eax
; CHECK-AVX512-NEXT:  vpxor %xmm0, %xmm0, %xmm0
; CHECK-AVX512-NEXT:  xorl %ecx, %ecx
; CHECK-AVX512-NEXT:  vpxor %xmm1, %xmm1, %xmm1
; CHECK-AVX512-NEXT:  .p2align 4, 0x90
; CHECK-AVX512-NEXT:  .LBB9_1: # %vector.body
; CHECK-AVX512-NEXT:  # =>This Inner Loop Header: Depth=1
; CHECK-AVX512-NEXT:  vpmovsxbw (%rdi,%rcx), %zmm2
; CHECK-AVX512-NEXT:  vpmovsxbw (%rsi,%rcx), %zmm3
; CHECK-AVX512-NEXT:  vpmaddwd %zmm2, %zmm3, %zmm2
; CHECK-AVX512-NEXT:  vpaddd %zmm1, %zmm2, %zmm1
; CHECK-AVX512-NEXT:  addq $32, %rcx
; CHECK-AVX512-NEXT:  cmpq %rcx, %rax

```

```

; CHECK-AVX512-NEXT:   jne .LBB9_1
; CHECK-AVX512-NEXT:   # %bb.2: # %middle.block
; CHECK-AVX512-NEXT:   vpaddd %zmm0, %zmm1, %zmm0
; CHECK-AVX512-NEXT:   vextracti64x4 $1, %zmm0, %ymm1
; CHECK-AVX512-NEXT:   vpaddd
;                       %zmm1, %zmm0, %zmm0
; CHECK-AVX512-NEXT:   vextracti128 $1, %ymm0, %xmm1
; CHECK-AVX512-NEXT:   vpaddd %xmm1, %xmm0, %xmm0
; CHECK-AVX512-NEXT:   vpshufd {{.*#+}} xmm1 = xmm0[2,3,2,3]
; CHECK-AVX512-NEXT:   vpaddd %xmm1, %xmm0, %xmm0
; CHECK-AVX512-NEXT:   vpsrlq $32, %xmm0, %xmm1
; CHECK-AVX512-NEXT:   vpaddd %xmm1, %xmm0, %xmm0
; CHECK-AVX512-NEXT:   vmovd %xmm0, %eax
; CHECK-AVX512-NEXT:   vzeroupper
; CHECK-AVX512-NEXT:   retq
;
; CHECK-VBMI-LABEL:   _Z9test_charPcS_i_512:
; CHECK-VBMI:         # %bb.0: # %entry
; CHECK-VBMI-NEXT:    movl %edx, %eax
; CHECK-VBMI-NEXT:    vpxor %xmm0, %xmm0, %xmm0
; CHECK-VBMI-NEXT:    xorl %ecx, %ecx
; CHECK-VBMI-NEXT:    vpxor %xmm1, %xmm1, %xmm1
; CHECK-VBMI-NEXT:    .p2align 4, 0x90
; CHECK-VBMI-NEXT:    .LBB9_1: # %vector.body
; CHECK-VBMI-NEXT:    # =>This Inner Loop Header: Depth=1
; CHECK-VBMI-NEXT:    vpmovsxbw (%rdi,%rcx), %zmm2
; CHECK-VBMI-NEXT:    vpmovsxbw (%rsi,%rcx), %zmm3
; CHECK-VBMI-NEXT:    vpmaddwd %zmm2, %zmm3, %zmm2
;
; CHECK-VBMI-NEXT:    vpaddd %zmm1, %zmm2, %zmm1
; CHECK-VBMI-NEXT:    addq $32, %rcx
; CHECK-VBMI-NEXT:    cmpq %rcx, %rax
; CHECK-VBMI-NEXT:    jne .LBB9_1
; CHECK-VBMI-NEXT:    # %bb.2: # %middle.block
; CHECK-VBMI-NEXT:    vpaddd %zmm0, %zmm1, %zmm0
; CHECK-VBMI-NEXT:    vextracti64x4 $1, %zmm0, %ymm1
; CHECK-VBMI-NEXT:    vpaddd %zmm1, %zmm0, %zmm0
; CHECK-VBMI-NEXT:    vextracti128 $1, %ymm0, %xmm1
; CHECK-VBMI-NEXT:    vpaddd %xmm1, %xmm0, %xmm0
; CHECK-VBMI-NEXT:    vpshufd {{.*#+}} xmm1 = xmm0[2,3,2,3]
; CHECK-VBMI-NEXT:    vpaddd %xmm1, %xmm0, %xmm0
; CHECK-VBMI-NEXT:    vpshufd {{.*#+}} xmm1 = xmm0[1,1,1,1]
; CHECK-VBMI-NEXT:    vpaddd %xmm1, %xmm0, %xmm0
; CHECK-VBMI-NEXT:    vmovd %xmm0, %eax
; CHECK-VBMI-NEXT:    vzeroupper
; CHECK-VBMI-NEXT:    retq
entry:
%3 = zext i32 %2 to i64

```

br label %vector.body

vector.body:

```
%index = phi i64 [ %index.next, %vector.body ], [ 0, %entry ]
%vec.phi = phi <32 x i32> [ %11, %vector.body ], [ zeroinitializer, %entry ]
%4 = getelementptr
inbounds i8, i8* %0, i64 %index
%5 = bitcast i8* %4 to <32 x i8>*
%wide.load = load <32 x i8>, <32 x i8>* %5, align 1
%6 = sext <32 x i8> %wide.load to <32 x i32>
%7 = getelementptr inbounds i8, i8* %1, i64 %index
%8 = bitcast i8* %7 to <32 x i8>*
%wide.load14 = load <32 x i8>, <32 x i8>* %8, align 1
%9 = sext <32 x i8> %wide.load14 to <32 x i32>
%10 = mul nsw <32 x i32> %9, %6
%11 = add nsw <32 x i32> %10, %vec.phi
%index.next = add i64 %index, 32
%12 = icmp eq i64 %index.next, %3
br i1 %12, label %middle.block, label %vector.body
```

middle.block:

```
%rdx.shuf1 = shufflevector <32 x i32> %11, <32 x i32> undef, <32 x i32> <i32 16, i32 17, i32 18, i32 19, i32 20,
i32 21, i32 22, i32 23, i32 24, i32 25, i32 26, i32 27, i32 28, i32 29, i32 30, i32 31, i32 undef, i32 undef, i32 undef,
i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32
undef, i32 undef, i32 undef>
%bin.rdx1 = add <32 x i32> %11, %rdx.shuf1
%rdx.shuf = shufflevector <32 x i32> %bin.rdx1, <32 x i32> undef, <32 x i32> <i32 8, i32 9, i32 10, i32 11, i32
12, i32 13, i32 14, i32 15, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef,
i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef,
i32 undef, i32 undef, i32 undef, i32 undef, i32 undef>
%bin.rdx = add <32 x i32> %bin.rdx1, %rdx.shuf
%rdx.shuf15 = shufflevector <32 x i32> %bin.rdx, <32 x i32> undef, <32 x i32> <i32 4, i32 5, i32 6, i32 7, i32
undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef,
i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef,
i32 undef, i32 undef, i32 undef, i32 undef, i32 undef>
%bin.rdx32 = add <32 x i32> %bin.rdx, %rdx.shuf15
%rdx.shuf17 = shufflevector <32 x i32> %bin.rdx32, <32 x i32> undef,
<32 x i32> <i32 2, i32 3, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32
undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef,
i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef>
%bin.rdx18 = add <32 x i32> %bin.rdx32, %rdx.shuf17
%rdx.shuf19 = shufflevector <32 x i32> %bin.rdx18, <32 x i32> undef, <32 x i32> <i32 1, i32 undef, i32 undef,
i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef,
i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef,
i32 undef, i32 undef, i32 undef, i32 undef, i32 undef>
%bin.rdx20 = add <32 x i32> %bin.rdx18, %rdx.shuf19
%13 = extractelement <32 x i32> %bin.rdx20, i32 0
```

```
ret i32 %13
}
```

```
@a = dso_local global [1024 x i8]
zeroinitializer, align 16
@b = dso_local global [1024 x i8] zeroinitializer, align 16
```

```
define dso_local i32 @sad_16i8_256() "min-legal-vector-width"="256" {
; CHECK-SKX-LABEL: sad_16i8_256:
; CHECK-SKX:      # %bb.0: # %entry
; CHECK-SKX-NEXT: vpxor %xmm0, %xmm0, %xmm0
; CHECK-SKX-NEXT: movq $-1024, %rax # imm = 0xFC00
; CHECK-SKX-NEXT: vpxor %xmm1, %xmm1, %xmm1
; CHECK-SKX-NEXT: .p2align 4, 0x90
; CHECK-SKX-NEXT: .LBB10_1: # %vector.body
; CHECK-SKX-NEXT: # =>This Inner Loop Header: Depth=1
; CHECK-SKX-NEXT: vmovdqu a+1024(%rax), %xmm2
; CHECK-SKX-NEXT: vpsadbw b+1024(%rax), %xmm2, %xmm2
; CHECK-SKX-NEXT: vpadd %ymm1, %ymm2, %ymm1
; CHECK-SKX-NEXT: addq $4, %rax
; CHECK-SKX-NEXT: jne .LBB10_1
; CHECK-SKX-NEXT: # %bb.2: # %middle.block
; CHECK-SKX-NEXT: vpadd %ymm0, %ymm1, %ymm0
; CHECK-SKX-NEXT: vextractq128 $1, %ymm0, %xmm1
; CHECK-SKX-NEXT: vpadd %xmm1, %xmm0, %xmm0
; CHECK-SKX-NEXT: vpshufd {{.*#+}} xmm1 = xmm0[2,3,2,3]
; CHECK-SKX-NEXT:
; CHECK-SKX-NEXT: vpadd %xmm1, %xmm0, %xmm0
; CHECK-SKX-NEXT: vpsrlq $32, %xmm0, %xmm1
; CHECK-SKX-NEXT: vpadd %xmm1, %xmm0, %xmm0
; CHECK-SKX-NEXT: vmovd %xmm0, %eax
; CHECK-SKX-NEXT: vzeroupper
; CHECK-SKX-NEXT: retq
;
; CHECK-AVX512-LABEL: sad_16i8_256:
; CHECK-AVX512:    # %bb.0: # %entry
; CHECK-AVX512-NEXT: vpxor %xmm0, %xmm0, %xmm0
; CHECK-AVX512-NEXT: movq $-1024, %rax # imm = 0xFC00
; CHECK-AVX512-NEXT: vpxor %xmm1, %xmm1, %xmm1
; CHECK-AVX512-NEXT: .p2align 4, 0x90
; CHECK-AVX512-NEXT: .LBB10_1: # %vector.body
; CHECK-AVX512-NEXT: # =>This Inner Loop Header: Depth=1
; CHECK-AVX512-NEXT: vmovdqu a+1024(%rax), %xmm2
; CHECK-AVX512-NEXT: vpsadbw b+1024(%rax), %xmm2, %xmm2
; CHECK-AVX512-NEXT: vpadd %ymm1, %ymm2, %ymm1
; CHECK-AVX512-NEXT: addq $4, %rax
; CHECK-AVX512-NEXT: jne .LBB10_1
; CHECK-AVX512-NEXT: # %bb.2: # %middle.block
```

```

; CHECK-AVX512-NEXT: vpaddd %ymm0, %ymm1, %ymm0
; CHECK-AVX512-NEXT: vextracti128 $1, %ymm0, %xmm1
;
CHECK-AVX512-NEXT: vpaddd %xmm1, %xmm0, %xmm0
; CHECK-AVX512-NEXT: vpshufd {{.*#+}} xmm1 = xmm0[2,3,2,3]
; CHECK-AVX512-NEXT: vpaddd %xmm1, %xmm0, %xmm0
; CHECK-AVX512-NEXT: vpsrlq $32, %xmm0, %xmm1
; CHECK-AVX512-NEXT: vpaddd %xmm1, %xmm0, %xmm0
; CHECK-AVX512-NEXT: vmovd %xmm0, %eax
; CHECK-AVX512-NEXT: vzeroupper
; CHECK-AVX512-NEXT: retq
;
; CHECK-VBMI-LABEL: sad_16i8_256:
; CHECK-VBMI: # %bb.0: # %entry
; CHECK-VBMI-NEXT: vpxor %xmm0, %xmm0, %xmm0
; CHECK-VBMI-NEXT: movq $-1024, %rax # imm = 0xFC00
; CHECK-VBMI-NEXT: vpxor %xmm1, %xmm1, %xmm1
; CHECK-VBMI-NEXT: .p2align 4, 0x90
; CHECK-VBMI-NEXT: .LBB10_1: # %vector.body
; CHECK-VBMI-NEXT: # =>This Inner Loop Header: Depth=1
; CHECK-VBMI-NEXT: vmovdqu a+1024(%rax), %xmm2
; CHECK-VBMI-NEXT: vpsadbw b+1024(%rax), %xmm2, %xmm2
; CHECK-VBMI-NEXT: vpaddd %ymm1, %ymm2, %ymm1
; CHECK-VBMI-NEXT: addq $4, %rax
; CHECK-VBMI-NEXT: jne .LBB10_1
; CHECK-VBMI-NEXT: # %bb.2: # %middle.block
;
CHECK-VBMI-NEXT: vpaddd %ymm0, %ymm1, %ymm0
; CHECK-VBMI-NEXT: vextracti128 $1, %ymm0, %xmm1
; CHECK-VBMI-NEXT: vpaddd %xmm1, %xmm0, %xmm0
; CHECK-VBMI-NEXT: vpshufd {{.*#+}} xmm1 = xmm0[2,3,2,3]
; CHECK-VBMI-NEXT: vpaddd %xmm1, %xmm0, %xmm0
; CHECK-VBMI-NEXT: vpshufd {{.*#+}} xmm1 = xmm0[1,1,1,1]
; CHECK-VBMI-NEXT: vpaddd %xmm1, %xmm0, %xmm0
; CHECK-VBMI-NEXT: vmovd %xmm0, %eax
; CHECK-VBMI-NEXT: vzeroupper
; CHECK-VBMI-NEXT: retq
entry:
br label %vector.body

vector.body:
%index = phi i64 [ 0, %entry ], [ %index.next, %vector.body ]
%vec.phi = phi <16 x i32> [ zeroinitializer, %entry ], [ %10, %vector.body ]
%0 = getelementptr inbounds [1024 x i8], [1024 x i8]* @a, i64 0, i64 %index
%1 = bitcast i8* %0 to <16 x i8>*
%wide.load = load <16 x i8>, <16 x i8>* %1, align 4
%2 = zext <16 x i8> %wide.load to <16 x i32>
%3 = getelementptr inbounds [1024 x i8], [1024 x i8]* @b, i64 0, i64 %index

```



```

%4 = bitcast i8* %3 to <16 x i8>*
%wide.load1
= load <16 x i8>, <16 x i8>* %4, align 4
%5 = zext <16 x i8> %wide.load1 to <16 x i32>
%6 = sub nsw <16 x i32> %2, %5
%7 = icmp sgt <16 x i32> %6, <i32 -1, i32 -1, i32 -1, i32 -1, i32 -1, i32 -1, i32 -1, i32 -1, i32 -1, i32 -1, i32 -1, i32 -1, i32 -1, i32 -1, i32 -1, i32 -1>
%8 = sub nsw <16 x i32> zeroinitializer, %6
%9 = select <16 x i1> %7, <16 x i32> %6, <16 x i32> %8
%10 = add nsw <16 x i32> %9, %vec.phi
%index.next = add i64 %index, 4
%11 = icmp eq i64 %index.next, 1024
br i1 %11, label %middle.block, label %vector.body

```

middle.block:

```

%rdx.shuf = shufflevector <16 x i32> %10, <16 x i32> undef, <16 x i32> <i32 8, i32 9, i32 10, i32 11, i32 12, i32 13, i32 14, i32 15, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef>
%bin.rdx = add <16 x i32> %10, %rdx.shuf
%rdx.shuf2 = shufflevector <16 x i32> %bin.rdx, <16 x i32> undef, <16 x i32> <i32 4, i32 5, i32 6, i32 7, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef>
%bin.rdx2 = add <16 x i32> %bin.rdx, %rdx.shuf2
%rdx.shuf3 = shufflevector <16 x i32> %bin.rdx2, <16 x i32> undef, <16 x i32> <i32 2, i32 3, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef>
%bin.rdx3 = add <16 x i32> %bin.rdx2, %rdx.shuf3
%rdx.shuf4 = shufflevector <16 x i32> %bin.rdx3, <16 x i32> undef, <16 x i32> <i32 1, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef>
%bin.rdx4 = add <16 x i32> %bin.rdx3, %rdx.shuf4
%12 = extractelement <16 x i32> %bin.rdx4, i32 0
ret i32 %12
}

```

```

define dso_local i32 @sad_16i8_512() "min-legal-vector-width"="512" {
; CHECK-SKX-LABEL: sad_16i8_512:
; CHECK-SKX:      # %bb.0: # %entry
; CHECK-SKX-NEXT:  vpxor %xmm0, %xmm0, %xmm0
; CHECK-SKX-NEXT:
    movq $-1024, %rax # imm = 0xFC00
; CHECK-SKX-NEXT:  .p2align 4, 0x90
; CHECK-SKX-NEXT:  .LBB11_1: # %vector.body
; CHECK-SKX-NEXT:  # =>This Inner Loop Header: Depth=1
; CHECK-SKX-NEXT:  vmovdqu a+1024(%rax), %xmm1
; CHECK-SKX-NEXT:  vpsadbw b+1024(%rax), %xmm1, %xmm1
; CHECK-SKX-NEXT:  vpaddq %xmm0, %xmm1, %xmm0
; CHECK-SKX-NEXT:  addq $4, %rax
; CHECK-SKX-NEXT:  jne .LBB11_1

```

```

; CHECK-SKX-NEXT: # %bb.2: # %middle.block
; CHECK-SKX-NEXT: vextracti64x4 $1, %zmm0, %ymm1
; CHECK-SKX-NEXT: vpaddd %zmm1, %zmm0, %zmm0
; CHECK-SKX-NEXT: vextracti128 $1, %ymm0, %xmm1
; CHECK-SKX-NEXT: vpaddd %xmm1, %xmm0, %xmm0
; CHECK-SKX-NEXT: vpslufd {{.*#+}} xmm1 = xmm0[2,3,2,3]
; CHECK-SKX-NEXT: vpaddd %xmm1, %xmm0, %xmm0
; CHECK-SKX-NEXT: vpsrlq $32, %xmm0, %xmm1
; CHECK-SKX-NEXT: vpaddd %xmm1, %xmm0, %xmm0
; CHECK-SKX-NEXT: vmovd %xmm0, %eax
; CHECK-SKX-NEXT: vzeroupper
; CHECK-SKX-NEXT: retq
;
; CHECK-AVX512-LABEL: sad_16i8_512:
; CHECK-AVX512:
    # %bb.0: # %entry
; CHECK-AVX512-NEXT: vpxor %xmm0, %xmm0, %xmm0
; CHECK-AVX512-NEXT: movq $-1024, %rax # imm = 0xFC00
; CHECK-AVX512-NEXT: .p2align 4, 0x90
; CHECK-AVX512-NEXT: .LBB11_1: # %vector.body
; CHECK-AVX512-NEXT: # =>This Inner Loop Header: Depth=1
; CHECK-AVX512-NEXT: vmovdqu a+1024(%rax), %xmm1
; CHECK-AVX512-NEXT: vpsadbw b+1024(%rax), %xmm1, %xmm1
; CHECK-AVX512-NEXT: vpaddd %zmm0, %zmm1, %zmm0
; CHECK-AVX512-NEXT: addq $4, %rax
; CHECK-AVX512-NEXT: jne .LBB11_1
; CHECK-AVX512-NEXT: # %bb.2: # %middle.block
; CHECK-AVX512-NEXT: vextracti64x4 $1, %zmm0, %ymm1
; CHECK-AVX512-NEXT: vpaddd %zmm1, %zmm0, %zmm0
; CHECK-AVX512-NEXT: vextracti128 $1, %ymm0, %xmm1
; CHECK-AVX512-NEXT: vpaddd %xmm1, %xmm0, %xmm0
; CHECK-AVX512-NEXT: vpslufd {{.*#+}} xmm1 = xmm0[2,3,2,3]
; CHECK-AVX512-NEXT: vpaddd %xmm1, %xmm0, %xmm0
; CHECK-AVX512-NEXT: vpsrlq $32, %xmm0, %xmm1
; CHECK-AVX512-NEXT: vpaddd %xmm1, %xmm0, %xmm0
; CHECK-AVX512-NEXT:
    vmovd %xmm0, %eax
; CHECK-AVX512-NEXT: vzeroupper
; CHECK-AVX512-NEXT: retq
;
; CHECK-VBMI-LABEL: sad_16i8_512:
; CHECK-VBMI:    # %bb.0: # %entry
; CHECK-VBMI-NEXT: vpxor %xmm0, %xmm0, %xmm0
; CHECK-VBMI-NEXT: movq $-1024, %rax # imm = 0xFC00
; CHECK-VBMI-NEXT: .p2align 4, 0x90
; CHECK-VBMI-NEXT: .LBB11_1: # %vector.body
; CHECK-VBMI-NEXT: # =>This Inner Loop Header: Depth=1
; CHECK-VBMI-NEXT: vmovdqu a+1024(%rax), %xmm1

```

```

; CHECK-VBMI-NEXT: vpsadbw b+1024(%rax), %xmm1, %xmm1
; CHECK-VBMI-NEXT: vpadd %zmm0, %zmm1, %zmm0
; CHECK-VBMI-NEXT: addq $4, %rax
; CHECK-VBMI-NEXT: jne .LBB11_1
; CHECK-VBMI-NEXT: # %bb.2: # %middle.block
; CHECK-VBMI-NEXT: vextracti64x4 $1, %zmm0, %ymm1
; CHECK-VBMI-NEXT: vpadd %zmm1, %zmm0, %zmm0
; CHECK-VBMI-NEXT: vextracti128 $1, %ymm0, %xmm1
; CHECK-VBMI-NEXT: vpadd %xmm1, %xmm0, %xmm0
; CHECK-VBMI-NEXT: vpshufd {{.*#+}} xmm1 = xmm0[2,3,2,3]
; CHECK-VBMI-NEXT: vpadd %xmm1, %xmm0, %xmm0
; CHECK-VBMI-NEXT:
    vpshufd {{.*#+}} xmm1 = xmm0[1,1,1,1]
; CHECK-VBMI-NEXT: vpadd %xmm1, %xmm0, %xmm0
; CHECK-VBMI-NEXT: vmovd %xmm0, %eax
; CHECK-VBMI-NEXT: vzeroupper
; CHECK-VBMI-NEXT: retq
entry:
br label %vector.body

```

vector.body:

```

%index = phi i64 [ 0, %entry ], [ %index.next, %vector.body ]
%vec.phi = phi <16 x i32> [ zeroinitializer, %entry ], [ %10, %vector.body ]
%0 = getelementptr inbounds [1024 x i8], [1024 x i8]* @a, i64 0, i64 %index
%1 = bitcast i8* %0 to <16 x i8>*
%wide.load = load <16 x i8>, <16 x i8>* %1, align 4
%2 = zext <16 x i8> %wide.load to <16 x i32>
%3 = getelementptr inbounds [1024 x i8], [1024 x i8]* @b, i64 0, i64 %index
%4 = bitcast i8* %3 to <16 x i8>*
%wide.load1 = load <16 x i8>, <16 x i8>* %4, align 4
%5 = zext <16 x i8> %wide.load1 to <16 x i32>
%6 = sub nsw <16 x i32> %2, %5
%7 = icmp sgt <16 x i32> %6, <i32 -1, i32 -1, i32 -1, i32 -1, i32 -1, i32 -1, i32 -1, i32 -1, i32 -1, i32 -1, i32 -1, i32 -1, i32 -1, i32 -1, i32 -1>
%8 = sub nsw <16 x i32> zeroinitializer, %6
%9 = select <16 x i1> %7, <16 x i32> %6, <16 x i32> %8
%10 = add nsw <16 x i32> %9, %vec.phi
%index.next = add i64 %index, 4
%11 = icmp eq i64 %index.next, 1024
br i1 %11, label %middle.block, label %vector.body

```

middle.block:

```

%rdx.shuf = shufflevector <16 x i32> %10, <16 x i32> undef, <16 x i32> <i32 8, i32 9, i32 10, i32 11, i32 12, i32 13, i32 14, i32 15, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef>
%bin.rdx = add <16 x i32> %10, %rdx.shuf
%rdx.shuf2 = shufflevector <16 x i32> %bin.rdx, <16 x i32> undef, <16 x i32> <i32 4, i32 5, i32 6, i32 7, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef>

```

```

i32 undef>
%bin.rdx2 = add <16 x i32> %bin.rdx, %rdx.shuf2
%rdx.shuf3 = shufflevector <16 x i32> %bin.rdx2, <16 x i32> undef, <16 x i32> <i32 2, i32 3, i32 undef, i32
undef, i32 undef, i32 undef, i32 undef,
i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef>
%bin.rdx3 = add <16 x i32> %bin.rdx2, %rdx.shuf3
%rdx.shuf4 = shufflevector <16 x i32> %bin.rdx3, <16 x i32> undef, <16 x i32> <i32 1, i32 undef, i32 undef, i32
undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef,
i32 undef, i32 undef>
%bin.rdx4 = add <16 x i32> %bin.rdx3, %rdx.shuf4
%12 = extractelement <16 x i32> %bin.rdx4, i32 0
ret i32 %12
}

```

```

define dso_local void @sbto16f32_256(<16 x i16> %a, <16 x float>* %res) "min-legal-vector-width"="256" {
; CHECK-LABEL: sbto16f32_256:
; CHECK:      # %bb.0:
; CHECK-NEXT: vpmovw2m %ymm0, %k0
; CHECK-NEXT: kshiftrw $8, %k0, %k1
; CHECK-NEXT: vpmovm2d %k1, %ymm0
; CHECK-NEXT: vcvt dq2ps %ymm0, %ymm0
; CHECK-NEXT: vpmovm2d %k0, %ymm1
; CHECK-NEXT: vcvt dq2ps %ymm1, %ymm1
; CHECK-NEXT: vmovaps %ymm1, (%rdi)
; CHECK-NEXT: vmovaps %ymm0, 32(%rdi)
; CHECK-NEXT:
    vzeroupper
; CHECK-NEXT: retq
%mask = icmp slt <16 x i16> %a, zeroinitializer
%1 = sitofp <16 x i1> %mask to <16 x float>
store <16 x float> %1, <16 x float>* %res
ret void
}

```

```

define dso_local void @sbto16f32_512(<16 x i16> %a, <16 x float>* %res) "min-legal-vector-width"="512" {
; CHECK-LABEL: sbto16f32_512:
; CHECK:      # %bb.0:
; CHECK-NEXT: vpmovw2m %ymm0, %k0
; CHECK-NEXT: vpmovm2d %k0, %zmm0
; CHECK-NEXT: vcvt dq2ps %zmm0, %zmm0
; CHECK-NEXT: vmovaps %zmm0, (%rdi)
; CHECK-NEXT: vzeroupper
; CHECK-NEXT: retq
%mask = icmp slt <16 x i16> %a, zeroinitializer
%1 = sitofp <16 x i1> %mask to <16 x float>
store <16 x float> %1, <16 x float>* %res
ret void
}

```

```

define dso_local void @sbto16f64_256(<16 x i16> %a, <16 x double>* %res) "min-legal-vector-width"="256" {
; CHECK-LABEL: sbto16f64_256:
; CHECK:      # %bb.0:
; CHECK-NEXT:  vpmovw2m %ymm0, %k0
; CHECK-NEXT:  kshiftrw $8, %k0, %k1
; CHECK-NEXT:  vpmovm2d %k1, %ymm0
; CHECK-NEXT:
    vcvtdq2pd %xmm0, %ymm1
; CHECK-NEXT:  vextracti128 $1, %ymm0, %xmm0
; CHECK-NEXT:  vcvtdq2pd %xmm0, %ymm0
; CHECK-NEXT:  vpmovm2d %k0, %ymm2
; CHECK-NEXT:  vcvtdq2pd %xmm2, %ymm3
; CHECK-NEXT:  vextracti128 $1, %ymm2, %xmm2
; CHECK-NEXT:  vcvtdq2pd %xmm2, %ymm2
; CHECK-NEXT:  vmovaps %ymm2, 32(%rdi)
; CHECK-NEXT:  vmovaps %ymm3, (%rdi)
; CHECK-NEXT:  vmovaps %ymm0, 96(%rdi)
; CHECK-NEXT:  vmovaps %ymm1, 64(%rdi)
; CHECK-NEXT:  vzeroupper
; CHECK-NEXT:  retq
    %mask = icmp slt <16 x i16> %a, zeroinitializer
    %1 = sitofp <16 x i1> %mask to <16 x double>
    store <16 x double> %1, <16 x double>* %res
    ret void
}

```

```

define dso_local void @sbto16f64_512(<16 x i16> %a, <16 x double>* %res) "min-legal-vector-width"="512" {
; CHECK-LABEL: sbto16f64_512:
; CHECK:      # %bb.0:
; CHECK-NEXT:  vpmovw2m %ymm0, %k0
; CHECK-NEXT:  vpmovm2d %k0, %zmm0
; CHECK-NEXT:  vcvtdq2pd %ymm0, %zmm1
; CHECK-NEXT:  vextracti64x4 $1, %zmm0, %ymm0
; CHECK-NEXT:  vcvtdq2pd
    %ymm0, %zmm0
; CHECK-NEXT:  vmovaps %zmm0, 64(%rdi)
; CHECK-NEXT:  vmovaps %zmm1, (%rdi)
; CHECK-NEXT:  vzeroupper
; CHECK-NEXT:  retq
    %mask = icmp slt <16 x i16> %a, zeroinitializer
    %1 = sitofp <16 x i1> %mask to <16 x double>
    store <16 x double> %1, <16 x double>* %res
    ret void
}

```

```

define dso_local void @ubto16f32_256(<16 x i16> %a, <16 x float>* %res) "min-legal-vector-width"="256" {
; CHECK-LABEL: ubto16f32_256:

```

```

; CHECK:    # %bb.0:
; CHECK-NEXT:  vpmovw2m %ymm0, %k0
; CHECK-NEXT:  kshiftrw $8, %k0, %k1
; CHECK-NEXT:  vpmovm2d %k1, %ymm0
; CHECK-NEXT:  vpsrld $31, %ymm0, %ymm0
; CHECK-NEXT:  vcvtdq2ps %ymm0, %ymm0
; CHECK-NEXT:  vpmovm2d %k0, %ymm1
; CHECK-NEXT:  vpsrld $31, %ymm1, %ymm1
; CHECK-NEXT:  vcvtdq2ps %ymm1, %ymm1
; CHECK-NEXT:  vmovaps %ymm1, (%rdi)
; CHECK-NEXT:  vmovaps %ymm0, 32(%rdi)
; CHECK-NEXT:  vzeroupper
; CHECK-NEXT:  retq
%mask = icmp slt <16 x i16> %a, zeroinitializer
%1 = uitofp <16 x i1> %mask to <16 x float>
store <16 x float> %1, <16 x float>* %res
ret void
}

define dso_local void @ubto16f32_512(<16 x i16> %a, <16 x float>* %res) "min-legal-vector-width"="512" {
; CHECK-LABEL: ubto16f32_512:
; CHECK:    # %bb.0:
; CHECK-NEXT:  vpmovw2m %ymm0, %k0
; CHECK-NEXT:  vpmovm2d %k0, %zmm0
; CHECK-NEXT:  vpsrld $31, %zmm0, %zmm0
; CHECK-NEXT:  vcvtdq2ps %zmm0, %zmm0
; CHECK-NEXT:  vmovaps %zmm0, (%rdi)
; CHECK-NEXT:  vzeroupper
; CHECK-NEXT:  retq
%mask = icmp slt <16 x i16> %a, zeroinitializer
%1 = uitofp <16 x i1> %mask to <16 x float>
store <16 x float> %1, <16 x float>* %res
ret void
}

define dso_local void @ubto16f64_256(<16 x i16> %a, <16 x double>* %res) "min-legal-vector-width"="256" {
; CHECK-LABEL: ubto16f64_256:
; CHECK:    # %bb.0:
; CHECK-NEXT:  vpmovw2m %ymm0, %k0
; CHECK-NEXT:  kshiftrw $8, %k0, %k1
; CHECK-NEXT:  vpmovm2d %k1, %ymm0
; CHECK-NEXT:  vpsrld $31, %ymm0, %ymm0
; CHECK-NEXT:  vcvtdq2pd %xmm0, %ymm1
; CHECK-NEXT:  vextracti128
$1, %ymm0, %xmm0
; CHECK-NEXT:  vcvtdq2pd %xmm0, %ymm0
; CHECK-NEXT:  vpmovm2d %k0, %ymm2
; CHECK-NEXT:  vpsrld $31, %ymm2, %ymm2

```

```

; CHECK-NEXT: vcvtdq2pd %xmm2, %ymm3
; CHECK-NEXT: vextracti128 $1, %ymm2, %xmm2
; CHECK-NEXT: vcvtdq2pd %xmm2, %ymm2
; CHECK-NEXT: vmovaps %ymm2, 32(%rdi)
; CHECK-NEXT: vmovaps %ymm3, (%rdi)
; CHECK-NEXT: vmovaps %ymm0, 96(%rdi)
; CHECK-NEXT: vmovaps %ymm1, 64(%rdi)
; CHECK-NEXT: vzeroupper
; CHECK-NEXT: retq
%mask = icmp slt <16 x i16> %a, zeroinitializer
%1 = uitofp <16 x i1> %mask to <16 x double>
store <16 x double> %1, <16 x double>* %res
ret void
}

```

```

define dso_local void @ubto16f64_512(<16 x i16> %a, <16 x double>* %res) "min-legal-vector-width"="512" {
; CHECK-LABEL: ubto16f64_512:
; CHECK:      # %bb.0:
; CHECK-NEXT: vpmovw2m %ymm0, %k0
; CHECK-NEXT: vpmovm2d %k0, %zmm0
; CHECK-NEXT: vpsrld $31, %zmm0, %zmm0
; CHECK-NEXT: vcvtdq2pd %ymm0, %zmm1
; CHECK-NEXT: vextracti64x4 $1, %zmm0, %ymm0
; CHECK-NEXT:
    vcvtdq2pd %ymm0, %zmm0
; CHECK-NEXT: vmovaps %zmm0, 64(%rdi)
; CHECK-NEXT: vmovaps %zmm1, (%rdi)
; CHECK-NEXT: vzeroupper
; CHECK-NEXT: retq
%mask = icmp slt <16 x i16> %a, zeroinitializer
%1 = uitofp <16 x i1> %mask to <16 x double>
store <16 x double> %1, <16 x double>* %res
ret void
}

```

```

define <16 x i16> @test_16f32toub_256(<16 x float>* %ptr, <16 x i16> %passthru) "min-legal-vector-
width"="256" {
; CHECK-LABEL: test_16f32toub_256:
; CHECK:      # %bb.0:
; CHECK-NEXT: vcvttps2dq (%rdi), %ymm1
; CHECK-NEXT: vpslld $31, %ymm1, %ymm1
; CHECK-NEXT: vpmovd2m %ymm1, %k0
; CHECK-NEXT: vcvttps2dq 32(%rdi), %ymm1
; CHECK-NEXT: vpslld $31, %ymm1, %ymm1
; CHECK-NEXT: vpmovd2m %ymm1, %k1
; CHECK-NEXT: kunpckbw %k0, %k1, %k1
; CHECK-NEXT: vmovdqu16 %ymm0, %ymm0 {%k1} {z}
; CHECK-NEXT: retq

```

```

%a = load <16 x float>, <16 x float>* %ptr
%mask = fptoui <16 x float> %a to <16 x i1>
%select = select <16 x i1> %mask, <16 x i16> %passthru,
<16 x i16> zeroinitializer
ret <16 x i16> %select
}

define <16 x i16> @test_16f32toub_512(<16 x float>* %ptr, <16 x i16> %passthru) "min-legal-vector-
width"="512" {
; CHECK-LABEL: test_16f32toub_512:
; CHECK:      # %bb.0:
; CHECK-NEXT:  vcvttps2dq (%rdi), %zmm1
; CHECK-NEXT:  vpslld $31, %zmm1, %zmm1
; CHECK-NEXT:  vpmovd2m %zmm1, %k1
; CHECK-NEXT:  vmovdqu16 %ymm0, %ymm0 {%k1} {z}
; CHECK-NEXT:  retq
%a = load <16 x float>, <16 x float>* %ptr
%mask = fptoui <16 x float> %a to <16 x i1>
%select = select <16 x i1> %mask, <16 x i16> %passthru, <16 x i16> zeroinitializer
ret <16 x i16> %select
}

define <16 x i16> @test_16f32tosb_256(<16 x float>* %ptr, <16 x i16> %passthru) "min-legal-vector-
width"="256" {
; CHECK-LABEL: test_16f32tosb_256:
; CHECK:      # %bb.0:
; CHECK-NEXT:  vcvttps2dq (%rdi), %ymm1
; CHECK-NEXT:  vpmovd2m %ymm1, %k0
; CHECK-NEXT:  vcvttps2dq 32(%rdi), %ymm1
; CHECK-NEXT:  vpmovd2m %ymm1, %k1
; CHECK-NEXT:  kunpckbw %k0, %k1, %k1
; CHECK-NEXT:
vmovdqu16 %ymm0, %ymm0 {%k1} {z}
; CHECK-NEXT:  retq
%a = load <16 x float>, <16 x float>* %ptr
%mask = fptosi <16 x float> %a to <16 x i1>
%select = select <16 x i1> %mask, <16 x i16> %passthru, <16 x i16> zeroinitializer
ret <16 x i16> %select
}

define <16 x i16> @test_16f32tosb_512(<16 x float>* %ptr, <16 x i16> %passthru) "min-legal-vector-
width"="512" {
; CHECK-LABEL: test_16f32tosb_512:
; CHECK:      # %bb.0:
; CHECK-NEXT:  vcvttps2dq (%rdi), %zmm1
; CHECK-NEXT:  vpmovd2m %zmm1, %k1
; CHECK-NEXT:  vmovdqu16 %ymm0, %ymm0 {%k1} {z}
; CHECK-NEXT:  retq

```



```

%a = load <16 x float>, <16 x float>* %ptr
%mask = fptosi <16 x float> %a to <16 x i1>
%select = select <16 x i1> %mask, <16 x i16> %passthru, <16 x i16> zeroinitializer
ret <16 x i16> %select
}

```

```

define dso_local void @mul256(<64 x i8>* %a, <64 x i8>* %b, <64 x i8>* %c) "min-legal-vector-width"="256" {
; CHECK-SKX-VBMI-LABEL: mul256:
; CHECK-SKX-VBMI:      # %bb.0:
; CHECK-SKX-VBMI-NEXT:  vmovdqa
                        (%rdi), %ymm0
; CHECK-SKX-VBMI-NEXT:  vmovdqa 32(%rdi), %ymm1
; CHECK-SKX-VBMI-NEXT:  vmovdqa (%rsi), %ymm2
; CHECK-SKX-VBMI-NEXT:  vmovdqa 32(%rsi), %ymm3
; CHECK-SKX-VBMI-NEXT:  vpunpckhbw {{.*#+}} ymm4 =
ymm3[8,8,9,9,10,10,11,11,12,12,13,13,14,14,15,15,24,24,25,25,26,26,27,27,28,28,29,29,30,30,31,31]
; CHECK-SKX-VBMI-NEXT:  vpunpckhbw {{.*#+}} ymm5 =
ymm1[8,8,9,9,10,10,11,11,12,12,13,13,14,14,15,15,24,24,25,25,26,26,27,27,28,28,29,29,30,30,31,31]
; CHECK-SKX-VBMI-NEXT:  vmullw %ymm4, %ymm5, %ymm4
; CHECK-SKX-VBMI-NEXT:  vpunpcklbw {{.*#+}} ymm3 =
ymm3[0,0,1,1,2,2,3,3,4,4,5,5,6,6,7,7,16,16,17,17,18,18,19,19,20,20,21,21,22,22,23,23]
; CHECK-SKX-VBMI-NEXT:  vpunpcklbw {{.*#+}} ymm1 =
ymm1[0,0,1,1,2,2,3,3,4,4,5,5,6,6,7,7,16,16,17,17,18,18,19,19,20,20,21,21,22,22,23,23]
; CHECK-SKX-VBMI-NEXT:  vmullw %ymm3, %ymm1, %ymm1
; CHECK-SKX-VBMI-NEXT:  vmovdqa {{.*#+}} ymm3 =
[0,2,4,6,8,10,12,14,32,34,36,38,40,42,44,46,16,18,20,22,24,26,28,30,48,50,52,54,56,58,60,62]
;
; CHECK-SKX-VBMI-NEXT:  vpermt2b %ymm4, %ymm3, %ymm1
; CHECK-SKX-VBMI-NEXT:  vpunpckhbw {{.*#+}} ymm4 =
ymm2[8,8,9,9,10,10,11,11,12,12,13,13,14,14,15,15,24,24,25,25,26,26,27,27,28,28,29,29,30,30,31,31]
; CHECK-SKX-VBMI-NEXT:  vpunpckhbw {{.*#+}} ymm5 =
ymm0[8,8,9,9,10,10,11,11,12,12,13,13,14,14,15,15,24,24,25,25,26,26,27,27,28,28,29,29,30,30,31,31]
; CHECK-SKX-VBMI-NEXT:  vmullw %ymm4, %ymm5, %ymm4
; CHECK-SKX-VBMI-NEXT:  vpunpcklbw {{.*#+}} ymm2 =
ymm2[0,0,1,1,2,2,3,3,4,4,5,5,6,6,7,7,16,16,17,17,18,18,19,19,20,20,21,21,22,22,23,23]
; CHECK-SKX-VBMI-NEXT:  vpunpcklbw {{.*#+}} ymm0 =
ymm0[0,0,1,1,2,2,3,3,4,4,5,5,6,6,7,7,16,16,17,17,18,18,19,19,20,20,21,21,22,22,23,23]
; CHECK-SKX-VBMI-NEXT:  vmullw %ymm2, %ymm0, %ymm0
; CHECK-SKX-VBMI-NEXT:  vpermt2b %ymm4, %ymm3, %ymm0
; CHECK-SKX-VBMI-NEXT:  vmovdqa %ymm0, (%rdx)
; CHECK-SKX-VBMI-NEXT:  vmovdqa %ymm1, 32(%rdx)
; CHECK-SKX-VBMI-NEXT:  vzeroupper
; CHECK-SKX-VBMI-NEXT:  retq
;
; CHECK-AVX512-LABEL: mul256:
; CHECK-AVX512:
                        # %bb.0:
; CHECK-AVX512-NEXT:  vmovdqa (%rdi), %ymm0

```

```

; CHECK-AVX512-NEXT: vmovdqa 32(%rdi), %ymm1
; CHECK-AVX512-NEXT: vmovdqa (%rsi), %ymm2
; CHECK-AVX512-NEXT: vmovdqa 32(%rsi), %ymm3
; CHECK-AVX512-NEXT: vpunpckhbw {{.*#+}} ymm4 =
ymm3[8,8,9,9,10,10,11,11,12,12,13,13,14,14,15,15,24,24,25,25,26,26,27,27,28,28,29,29,30,30,31,31]
; CHECK-AVX512-NEXT: vpunpckhbw {{.*#+}} ymm5 =
ymm1[8,8,9,9,10,10,11,11,12,12,13,13,14,14,15,15,24,24,25,25,26,26,27,27,28,28,29,29,30,30,31,31]
; CHECK-AVX512-NEXT: vpmullw %ymm4, %ymm5, %ymm4
; CHECK-AVX512-NEXT: vpbroadcastw {{.*#+}} ymm5 =
[255,255,255,255,255,255,255,255,255,255,255,255,255,255,255,255]
; CHECK-AVX512-NEXT: vpand %ymm5, %ymm4, %ymm4
; CHECK-AVX512-NEXT: vpunpcklbw {{.*#+}} ymm3 =
ymm3[0,0,1,1,2,2,3,3,4,4,5,5,6,6,7,7,16,16,17,17,18,18,19,19,20,20,21,21,22,22,23,23]
; CHECK-AVX512-NEXT: vpunpcklbw {{.*#+}} ymm1 =
ymm1[0,0,1,1,2,2,3,3,4,4,5,5,6,6,7,7,16,16,17,17,18,18,19,19,20,20,21,21,22,22,23,23]
;
CHECK-AVX512-NEXT: vpmullw %ymm3, %ymm1, %ymm1
; CHECK-AVX512-NEXT: vpand %ymm5, %ymm1, %ymm1
; CHECK-AVX512-NEXT: vpackuswb %ymm4, %ymm1, %ymm1
; CHECK-AVX512-NEXT: vpunpckhbw {{.*#+}} ymm3 =
ymm2[8,8,9,9,10,10,11,11,12,12,13,13,14,14,15,15,24,24,25,25,26,26,27,27,28,28,29,29,30,30,31,31]
; CHECK-AVX512-NEXT: vpunpckhbw {{.*#+}} ymm4 =
ymm0[8,8,9,9,10,10,11,11,12,12,13,13,14,14,15,15,24,24,25,25,26,26,27,27,28,28,29,29,30,30,31,31]
; CHECK-AVX512-NEXT: vpmullw %ymm3, %ymm4, %ymm3
; CHECK-AVX512-NEXT: vpand %ymm5, %ymm3, %ymm3
; CHECK-AVX512-NEXT: vpunpcklbw {{.*#+}} ymm2 =
ymm2[0,0,1,1,2,2,3,3,4,4,5,5,6,6,7,7,16,16,17,17,18,18,19,19,20,20,21,21,22,22,23,23]
; CHECK-AVX512-NEXT: vpunpcklbw {{.*#+}} ymm0 =
ymm0[0,0,1,1,2,2,3,3,4,4,5,5,6,6,7,7,16,16,17,17,18,18,19,19,20,20,21,21,22,22,23,23]
; CHECK-AVX512-NEXT: vpmullw %ymm2, %ymm0, %ymm0
; CHECK-AVX512-NEXT: vpand %ymm5, %ymm0, %ymm0
; CHECK-AVX512-NEXT: vpackuswb %ymm3, %ymm0, %ymm0
; CHECK-AVX512-NEXT:
vmovdqa %ymm0, (%rdx)
; CHECK-AVX512-NEXT: vmovdqa %ymm1, 32(%rdx)
; CHECK-AVX512-NEXT: vzeroupper
; CHECK-AVX512-NEXT: retq
;
; CHECK-VBMI-LABEL: mul256:
; CHECK-VBMI: # %bb.0:
; CHECK-VBMI-NEXT: vmovdqa (%rdi), %ymm0
; CHECK-VBMI-NEXT: vmovdqa 32(%rdi), %ymm1
; CHECK-VBMI-NEXT: vmovdqa (%rsi), %ymm2
; CHECK-VBMI-NEXT: vmovdqa 32(%rsi), %ymm3
; CHECK-VBMI-NEXT: vpunpckhbw {{.*#+}} ymm4 =
ymm3[8,8,9,9,10,10,11,11,12,12,13,13,14,14,15,15,24,24,25,25,26,26,27,27,28,28,29,29,30,30,31,31]
; CHECK-VBMI-NEXT: vpunpckhbw {{.*#+}} ymm5 =
ymm1[8,8,9,9,10,10,11,11,12,12,13,13,14,14,15,15,24,24,25,25,26,26,27,27,28,28,29,29,30,30,31,31]

```

```

; CHECK-VBMI-NEXT:  vmullw %ymm4, %ymm5, %ymm4
; CHECK-VBMI-NEXT:  vpunpcklbw {{.*#+}} ymm3 =
ymm3[0,0,1,1,2,2,3,3,4,4,5,5,6,6,7,7,16,16,17,17,18,18,19,19,20,20,21,21,22,22,23,23]
; CHECK-VBMI-NEXT:  vpunpcklbw {{.*#+}} ymm1 =
ymm1[0,0,1,1,2,2,3,3,4,4,5,5,6,6,7,7,16,16,17,17,18,18,19,19,20,20,21,21,22,22,23,23]
;
CHECK-VBMI-NEXT:  vmullw %ymm3, %ymm1, %ymm1
; CHECK-VBMI-NEXT:  vmovdqa {{.*#+}} ymm3 =
[0,2,4,6,8,10,12,14,32,34,36,38,40,42,44,46,16,18,20,22,24,26,28,30,48,50,52,54,56,58,60,62]
; CHECK-VBMI-NEXT:  vpermt2b %ymm4, %ymm3, %ymm1
; CHECK-VBMI-NEXT:  vpunpckhbw {{.*#+}} ymm4 =
ymm2[8,8,9,9,10,10,11,11,12,12,13,13,14,14,15,15,24,24,25,25,26,26,27,27,28,28,29,29,30,30,31,31]
; CHECK-VBMI-NEXT:  vpunpckhbw {{.*#+}} ymm5 =
ymm0[8,8,9,9,10,10,11,11,12,12,13,13,14,14,15,15,24,24,25,25,26,26,27,27,28,28,29,29,30,30,31,31]
; CHECK-VBMI-NEXT:  vmullw %ymm4, %ymm5, %ymm4
; CHECK-VBMI-NEXT:  vpunpcklbw {{.*#+}} ymm2 =
ymm2[0,0,1,1,2,2,3,3,4,4,5,5,6,6,7,7,16,16,17,17,18,18,19,19,20,20,21,21,22,22,23,23]
; CHECK-VBMI-NEXT:  vpunpcklbw {{.*#+}} ymm0 =
ymm0[0,0,1,1,2,2,3,3,4,4,5,5,6,6,7,7,16,16,17,17,18,18,19,19,20,20,21,21,22,22,23,23]
; CHECK-VBMI-NEXT:  vmullw %ymm2, %ymm0, %ymm0
; CHECK-VBMI-NEXT:  vpermt2b %ymm4, %ymm3, %ymm0
; CHECK-VBMI-NEXT:  vmovdqa %ymm0, (%rdx)
;
CHECK-VBMI-NEXT:  vmovdqa %ymm1, 32(%rdx)
; CHECK-VBMI-NEXT:  vzeroupper
; CHECK-VBMI-NEXT:  retq
%d = load <64 x i8>, <64 x i8>* %a
%e = load <64 x i8>, <64 x i8>* %b
%f = mul <64 x i8> %d, %e
store <64 x i8> %f, <64 x i8>* %c
ret void
}

define dso_local void @mul512(<64 x i8>* %a, <64 x i8>* %b, <64 x i8>* %c) "min-legal-vector-width"="512" {
; CHECK-SKX-VBMI-LABEL: mul512:
; CHECK-SKX-VBMI:      # %bb.0:
; CHECK-SKX-VBMI-NEXT:  vmovdqa64 (%rdi), %zmm0
; CHECK-SKX-VBMI-NEXT:  vmovdqa64 (%rsi), %zmm1
; CHECK-SKX-VBMI-NEXT:  vpunpckhbw {{.*#+}} zmm2 =
zmm1[8,8,9,9,10,10,11,11,12,12,13,13,14,14,15,15,24,24,25,25,26,26,27,27,28,28,29,29,30,30,31,31,40,40,41,41,4
2,42,43,43,44,44,45,45,46,46,47,47,56,56,57,57,58,58,59,59,60,60,61,61,62,62,63,63]
; CHECK-SKX-VBMI-NEXT:  vpunpckhbw {{.*#+}} zmm3 =
zmm0[8,8,9,9,10,10,11,11,12,12,13,13,14,14,15,15,24,24,25,25,26,26,27,27,28,28,29,29,30,30,31,31,40,40,41,41,4
2,42,43,43,44,44,45,45,46,46,47,47,56,56,57,57,58,58,59,59,60,60,61,61,62,62,63,63]
;
CHECK-SKX-VBMI-NEXT:  vmullw %zmm2, %zmm3, %zmm2
; CHECK-SKX-VBMI-NEXT:  vpunpcklbw {{.*#+}} zmm1 =
zmm1[0,0,1,1,2,2,3,3,4,4,5,5,6,6,7,7,16,16,17,17,18,18,19,19,20,20,21,21,22,22,23,23,32,32,33,33,34,34,35,35,36,3

```

```

6,37,37,38,38,39,39,48,48,49,49,50,50,51,51,52,52,53,53,54,54,55,55]
; CHECK-SKX-VBMI-NEXT:  vpunpcklbw {{.*#+}} zmm0 =
zmm0[0,0,1,1,2,2,3,3,4,4,5,5,6,6,7,7,16,16,17,17,18,18,19,19,20,20,21,21,22,22,23,23,32,32,33,33,34,34,35,35,36,3
6,37,37,38,38,39,39,48,48,49,49,50,50,51,51,52,52,53,53,54,54,55,55]
; CHECK-SKX-VBMI-NEXT:  vpmullw %zmm1, %zmm0, %zmm0
; CHECK-SKX-VBMI-NEXT:  vmovdqa64 {{.*#+}} zmm1 =
[0,2,4,6,8,10,12,14,64,66,68,70,72,74,76,78,16,18,20,22,24,26,28,30,80,82,84,86,88,90,92,94,32,34,36,38,40,42,44,
46,96,98,100,102,104,106,108,110,48,50,52,54,56,58,60,62,112,114,116,118,120,122,124,126]
; CHECK-SKX-VBMI-NEXT:  vpermi2b %zmm2, %zmm0, %zmm1
; CHECK-SKX-VBMI-NEXT:  vmovdqa64 %zmm1, (%rdx)
; CHECK-SKX-VBMI-NEXT:  vzeroupper
;
CHECK-SKX-VBMI-NEXT:  retq
;
; CHECK-AVX512-LABEL: mul512:
; CHECK-AVX512:        # %bb.0:
; CHECK-AVX512-NEXT:  vmovdqa64 (%rdi), %zmm0
; CHECK-AVX512-NEXT:  vmovdqa64 (%rsi), %zmm1
; CHECK-AVX512-NEXT:  vpunpckhbw {{.*#+}} zmm2 =
zmm1[8,8,9,9,10,10,11,11,12,12,13,13,14,14,15,15,24,24,25,25,26,26,27,27,28,28,29,29,30,30,31,31,40,40,41,41,4
2,42,43,43,44,44,45,45,46,46,47,47,56,56,57,57,58,58,59,59,60,60,61,61,62,62,63,63]
; CHECK-AVX512-NEXT:  vpunpckhbw {{.*#+}} zmm3 =
zmm0[8,8,9,9,10,10,11,11,12,12,13,13,14,14,15,15,24,24,25,25,26,26,27,27,28,28,29,29,30,30,31,31,40,40,41,41,4
2,42,43,43,44,44,45,45,46,46,47,47,56,56,57,57,58,58,59,59,60,60,61,61,62,62,63,63]
; CHECK-AVX512-NEXT:  vpmullw %zmm2, %zmm3, %zmm2
; CHECK-AVX512-NEXT:  vpbroadcastw {{.*#+}} zmm3 =
[255,255,255,255,255,255,255,255,255,255,255,255,255,255,255,255,255,255,255,255,255,255,255,255,255,255,2
55,255,255,255,255,255]
; CHECK-AVX512-NEXT:  vpandq %zmm3, %zmm2, %zmm2
; CHECK-AVX512-NEXT:  vpunpcklbw
{{.*#+}} zmm1 =
zmm1[0,0,1,1,2,2,3,3,4,4,5,5,6,6,7,7,16,16,17,17,18,18,19,19,20,20,21,21,22,22,23,23,32,32,33,33,34,34,35,35,36,3
6,37,37,38,38,39,39,48,48,49,49,50,50,51,51,52,52,53,53,54,54,55,55]
; CHECK-AVX512-NEXT:  vpunpcklbw {{.*#+}} zmm0 =
zmm0[0,0,1,1,2,2,3,3,4,4,5,5,6,6,7,7,16,16,17,17,18,18,19,19,20,20,21,21,22,22,23,23,32,32,33,33,34,34,35,35,36,3
6,37,37,38,38,39,39,48,48,49,49,50,50,51,51,52,52,53,53,54,54,55,55]
; CHECK-AVX512-NEXT:  vpmullw %zmm1, %zmm0, %zmm0
; CHECK-AVX512-NEXT:  vpandq %zmm3, %zmm0, %zmm0
; CHECK-AVX512-NEXT:  vpackuswb %zmm2, %zmm0, %zmm0
; CHECK-AVX512-NEXT:  vmovdqa64 %zmm0, (%rdx)
; CHECK-AVX512-NEXT:  vzeroupper
; CHECK-AVX512-NEXT:  retq
;
; CHECK-VBMI-LABEL: mul512:
; CHECK-VBMI:        # %bb.0:
; CHECK-VBMI-NEXT:  vmovdqa64 (%rdi), %zmm0
; CHECK-VBMI-NEXT:  vmovdqa64 (%rsi), %zmm1
; CHECK-VBMI-NEXT:  vpunpckhbw {{.*#+}} zmm2 =

```

```

zmm1[8,8,9,9,10,10,11,11,12,12,13,13,14,14,15,15,24,24,25,25,26,26,27,27,28,28,29,29,30,30,31,31,40,40,41,41,4
2,42,43,43,44,44,45,45,46,46,47,47,56,56,57,57,58,58,59,59,60,60,61,61,62,62,63,63]
;
CHECK-VBMI-NEXT:  vpunpckhbw {{.*#+}} zmm3 =
zmm0[8,8,9,9,10,10,11,11,12,12,13,13,14,14,15,15,24,24,25,25,26,26,27,27,28,28,29,29,30,30,31,31,40,40,41,41,4
2,42,43,43,44,44,45,45,46,46,47,47,56,56,57,57,58,58,59,59,60,60,61,61,62,62,63,63]
; CHECK-VBMI-NEXT:  vpmullw %zmm2, %zmm3, %zmm2
; CHECK-VBMI-NEXT:  vpunpcklbw {{.*#+}} zmm1 =
zmm1[0,0,1,1,2,2,3,3,4,4,5,5,6,6,7,7,16,16,17,17,18,18,19,19,20,20,21,21,22,22,23,23,32,32,33,33,34,34,35,35,36,3
6,37,37,38,38,39,39,48,48,49,49,50,50,51,51,52,52,53,53,54,54,55,55]
; CHECK-VBMI-NEXT:  vpunpcklbw {{.*#+}} zmm0 =
zmm0[0,0,1,1,2,2,3,3,4,4,5,5,6,6,7,7,16,16,17,17,18,18,19,19,20,20,21,21,22,22,23,23,32,32,33,33,34,34,35,35,36,3
6,37,37,38,38,39,39,48,48,49,49,50,50,51,51,52,52,53,53,54,54,55,55]
; CHECK-VBMI-NEXT:  vpmullw %zmm1, %zmm0, %zmm0
; CHECK-VBMI-NEXT:  vmovdqa64 {{.*#+}} zmm1 =
[0,2,4,6,8,10,12,14,64,66,68,70,72,74,76,78,16,18,20,22,24,26,28,30,80,82,84,86,88,90,92,94,32,34,36,38,40,42,44,
46,96,98,100,102,104,106,108,110,48,50,52,54,56,58,60,62,112,114,116,118,120,122,124,126]
;
CHECK-VBMI-NEXT:  vpermi2b %zmm2, %zmm0, %zmm1
; CHECK-VBMI-NEXT:  vmovdqa64 %zmm1, (%rdx)
; CHECK-VBMI-NEXT:  vzeroupper
; CHECK-VBMI-NEXT:  retq
%d = load <64 x i8>, <64 x i8>* %a
%e = load <64 x i8>, <64 x i8>* %b
%f = mul <64 x i8> %d, %e
store <64 x i8> %f, <64 x i8>* %c
ret void
}

; This threw an assertion at one point.
define <4 x i32> @mload_v4i32(<4 x i32> %trigger, <4 x i32>* %addr, <4 x i32> %dst) "min-legal-vector-
width"="256" {
; CHECK-LABEL: mload_v4i32:
; CHECK:      # %bb.0:
; CHECK-NEXT:  vptestnmd %xmm0, %xmm0, %k1
; CHECK-NEXT:  vblendmd (%rdi), %xmm1, %xmm0 {%k1}
; CHECK-NEXT:  retq
%mask = icmp eq <4 x i32> %trigger, zeroinitializer
%res = call <4 x i32> @llvm.masked.load.v4i32.p0v4i32(<4 x i32>* %addr, i32 4, <4 x i1> %mask, <4 x i32>
%dst)
ret <4 x i32> %res
}
declare <4 x i32>
@llvm.masked.load.v4i32.p0v4i32(<4 x i32>*, i32, <4 x i1>, <4 x i32>)

define <16 x i32> @trunc_v16i64_v16i32(<16 x i64>* %x) nounwind "min-legal-vector-width"="256" {
; CHECK-LABEL: trunc_v16i64_v16i32:
; CHECK:      # %bb.0:

```

```
; CHECK-NEXT: vmovdqa (%rdi), %ymm0
; CHECK-NEXT: vmovdqa 32(%rdi), %ymm1
; CHECK-NEXT: vmovdqa 64(%rdi), %ymm2
; CHECK-NEXT: vmovdqa 96(%rdi), %ymm3
; CHECK-NEXT: vpmovqd %ymm0, %xmm0
; CHECK-NEXT: vpmovqd %ymm1, %xmm1
; CHECK-NEXT: vinserti128 $1, %xmm1, %ymm0, %ymm0
; CHECK-NEXT: vpmovqd %ymm2, %xmm1
; CHECK-NEXT: vpmovqd %ymm3, %xmm2
; CHECK-NEXT: vinserti128 $1, %xmm2, %ymm1, %ymm1
; CHECK-NEXT: retq
%a = load <16 x i64>, <16 x i64>* %x
%b = trunc <16 x i64> %a to <16 x i32>
ret <16 x i32> %b
}
```

```
define <16 x i8> @trunc_v16i64_v16i8(<16 x i64>* %x) nounwind "min-legal-vector-width"="256" {
; CHECK-LABEL: trunc_v16i64_v16i8:
; CHECK:      # %bb.0:
; CHECK-NEXT: vmovdqa (%rdi), %ymm0
; CHECK-NEXT: vmovdqa 32(%rdi),
%ymm1
; CHECK-NEXT: vmovdqa 64(%rdi), %ymm2
; CHECK-NEXT: vmovdqa 96(%rdi), %ymm3
; CHECK-NEXT: vpmovqb %ymm3, %xmm3
; CHECK-NEXT: vpmovqb %ymm2, %xmm2
; CHECK-NEXT: vpunpckldq {{.*#+}} xmm2 = xmm2[0],xmm3[0],xmm2[1],xmm3[1]
; CHECK-NEXT: vpmovqb %ymm1, %xmm1
; CHECK-NEXT: vpmovqb %ymm0, %xmm0
; CHECK-NEXT: vpunpckldq {{.*#+}} xmm0 = xmm0[0],xmm1[0],xmm0[1],xmm1[1]
; CHECK-NEXT: vpunpckldq {{.*#+}} xmm0 = xmm0[0],xmm2[0]
; CHECK-NEXT: vzeroupper
; CHECK-NEXT: retq
%a = load <16 x i64>, <16 x i64>* %x
%b = trunc <16 x i64> %a to <16 x i8>
ret <16 x i8> %b
}
```

```
define <16 x i8> @trunc_v16i32_v16i8(<16 x i32>* %x) nounwind "min-legal-vector-width"="256" {
; CHECK-LABEL: trunc_v16i32_v16i8:
; CHECK:      # %bb.0:
; CHECK-NEXT: vmovdqa (%rdi), %ymm0
; CHECK-NEXT: vmovdqa 32(%rdi), %ymm1
; CHECK-NEXT: vpmovdb %ymm1, %xmm1
; CHECK-NEXT: vpmovdb %ymm0, %xmm0
; CHECK-NEXT: vpunpckldq {{.*#+}} xmm0 = xmm0[0],xmm1[0]
; CHECK-NEXT: vzeroupper
;
;
```

```

CHECK-NEXT:    retq
%a = load <16 x i32>, <16 x i32>* %x
%b = trunc <16 x i32> %a to <16 x i8>
ret <16 x i8> %b
}

define <8 x i8> @trunc_v8i64_v8i8(<8 x i64>* %x) nounwind "min-legal-vector-width"="256" {
; CHECK-LABEL: trunc_v8i64_v8i8:
; CHECK:      # %bb.0:
; CHECK-NEXT: vmovdqa (%rdi), %ymm0
; CHECK-NEXT: vmovdqa 32(%rdi), %ymm1
; CHECK-NEXT: vpmovqb %ymm1, %xmm1
; CHECK-NEXT: vpmovqb %ymm0, %xmm0
; CHECK-NEXT: vpunpckldq { {. *#+ } } xmm0 = xmm0[0],xmm1[0],xmm0[1],xmm1[1]
; CHECK-NEXT: vzeroupper
; CHECK-NEXT: retq
%a = load <8 x i64>, <8 x i64>* %x
%b = trunc <8 x i64> %a to <8 x i8>
ret <8 x i8> %b
}

define <8 x i16> @trunc_v8i64_v8i16(<8 x i64>* %x) nounwind "min-legal-vector-width"="256" {
; CHECK-LABEL: trunc_v8i64_v8i16:
; CHECK:      # %bb.0:
; CHECK-NEXT: vmovdqa (%rdi), %ymm0
; CHECK-NEXT: vmovdqa 32(%rdi), %ymm1
; CHECK-NEXT: vpmovqw %ymm1, %xmm1
; CHECK-NEXT: vpmovqw %ymm0, %xmm0
; CHECK-NEXT: vpunpckldq { {. *#+ } } xmm0
= xmm0[0],xmm1[0]
; CHECK-NEXT: vzeroupper
; CHECK-NEXT: retq
%a = load <8 x i64>, <8 x i64>* %x
%b = trunc <8 x i64> %a to <8 x i16>
ret <8 x i16> %b
}

define <8 x i32> @trunc_v8i64_v8i32_zeroes(<8 x i64>* %x) nounwind "min-legal-vector-width"="256" {
; CHECK-LABEL: trunc_v8i64_v8i32_zeroes:
; CHECK:      # %bb.0:
; CHECK-NEXT: vpsrlq $48, 32(%rdi), %ymm0
; CHECK-NEXT: vpsrlq $48, (%rdi), %ymm1
; CHECK-NEXT: vpackusdw %ymm0, %ymm1, %ymm0
; CHECK-NEXT: vpermq { {. *#+ } } ymm0 = ymm0[0,2,1,3]
; CHECK-NEXT: retq
%a = load <8 x i64>, <8 x i64>* %x
%b = lshr <8 x i64> %a, <i64 48, i64 48, i64 48, i64 48, i64 48, i64 48, i64 48, i64 48>
%c = trunc <8 x i64> %b to <8 x i32>

```

```

ret <8 x i32> %c
}

define <16 x i16> @trunc_v16i32_v16i16_zeroes(<16 x i32>* %x) nounwind "min-legal-vector-width"="256" {
; CHECK-LABEL: trunc_v16i32_v16i16_zeroes:
; CHECK:      # %bb.0:
; CHECK-NEXT: vmovdqa (%rdi), %ymm1
; CHECK-NEXT: vmovdqa {{.*#+}} ymm0 = [1,3,5,7,9,11,13,15,17,19,21,23,25,27,29,31]
;
; CHECK-NEXT: vperm2w 32(%rdi), %ymm1, %ymm0
; CHECK-NEXT: retq
%a = load <16 x i32>, <16 x i32>* %x
%b = lshr <16 x i32> %a, <i32 16, i32 16, i32 16, i32 16, i32 16, i32 16, i32 16, i32 16, i32 16, i32 16, i32 16, i32 16, i32 16, i32 16, i32 16>
%c = trunc <16 x i32> %b to <16 x i16>
ret <16 x i16> %c
}

define <32 x i8> @trunc_v32i16_v32i8_zeroes(<32 x i16>* %x) nounwind "min-legal-vector-width"="256" {
; CHECK-SKX-VBMI-LABEL: trunc_v32i16_v32i8_zeroes:
; CHECK-SKX-VBMI:      # %bb.0:
; CHECK-SKX-VBMI-NEXT: vmovdqa (%rdi), %ymm1
; CHECK-SKX-VBMI-NEXT: vmovdqa {{.*#+}} ymm0 =
[1,3,5,7,9,11,13,15,17,19,21,23,25,27,29,31,33,35,37,39,41,43,45,47,49,51,53,55,57,59,61,63]
; CHECK-SKX-VBMI-NEXT: vperm2b 32(%rdi), %ymm1, %ymm0
; CHECK-SKX-VBMI-NEXT: retq
;
; CHECK-AVX512-LABEL: trunc_v32i16_v32i8_zeroes:
; CHECK-AVX512:      # %bb.0:
; CHECK-AVX512-NEXT: vpsrlw $8, 32(%rdi), %ymm0
; CHECK-AVX512-NEXT: vpsrlw $8, (%rdi),
%ymm1
; CHECK-AVX512-NEXT: vpackuswb %ymm0, %ymm1, %ymm0
; CHECK-AVX512-NEXT: vpermq {{.*#+}} ymm0 = ymm0[0,2,1,3]
; CHECK-AVX512-NEXT: retq
;
; CHECK-VBMI-LABEL: trunc_v32i16_v32i8_zeroes:
; CHECK-VBMI:      # %bb.0:
; CHECK-VBMI-NEXT: vmovdqa (%rdi), %ymm1
; CHECK-VBMI-NEXT: vmovdqa {{.*#+}} ymm0 =
[1,3,5,7,9,11,13,15,17,19,21,23,25,27,29,31,33,35,37,39,41,43,45,47,49,51,53,55,57,59,61,63]
; CHECK-VBMI-NEXT: vperm2b 32(%rdi), %ymm1, %ymm0
; CHECK-VBMI-NEXT: retq
%a = load <32 x i16>, <32 x i16>* %x
%b = lshr <32 x i16> %a, <i16 8, i16 8, i16 8, i16 8, i16 8, i16 8, i16 8, i16 8, i16 8, i16 8, i16 8, i16 8, i16 8, i16 8, i16 8, i16 8, i16 8, i16 8, i16 8, i16 8, i16 8, i16 8, i16 8, i16 8, i16 8, i16 8, i16 8, i16 8, i16 8>
%c = trunc <32 x i16> %b to <32 x i8>
ret <32 x i8> %c
}

```



```
}
```

```
define <8 x i32> @trunc_v8i64_v8i32_sign(<8 x i64>* %x) nounwind "min-legal-vector-width"="256" {  
; CHECK-LABEL: trunc_v8i64_v8i32_sign:  
; CHECK:  
# %bb.0:  
; CHECK-NEXT: vpsraq $48, 32(%rdi), %ymm0  
; CHECK-NEXT: vpsraq $48, (%rdi), %ymm1  
; CHECK-NEXT: vpackssdw %ymm0, %ymm1, %ymm0  
; CHECK-NEXT: vpermq {{.*#+}} ymm0 = ymm0[0,2,1,3]  
; CHECK-NEXT: retq  
%a = load <8 x i64>, <8 x i64>* %x  
%b = ashr <8 x i64> %a, <i64 48, i64 48, i64 48, i64 48, i64 48, i64 48, i64 48, i64 48>  
%c = trunc <8 x i64> %b to <8 x i32>  
ret <8 x i32> %c  
}
```

```
define <16 x i16> @trunc_v16i32_v16i16_sign(<16 x i32>* %x) nounwind "min-legal-vector-width"="256" {  
; CHECK-LABEL: trunc_v16i32_v16i16_sign:  
; CHECK: # %bb.0:  
; CHECK-NEXT: vmovdqa (%rdi), %ymm1  
; CHECK-NEXT: vmovdqa {{.*#+}} ymm0 = [1,3,5,7,9,11,13,15,17,19,21,23,25,27,29,31]  
; CHECK-NEXT: vpermi2w 32(%rdi), %ymm1, %ymm0  
; CHECK-NEXT: retq  
%a = load <16 x i32>, <16 x i32>* %x  
%b = ashr <16 x i32> %a, <i32 16, i32 16, i32 16, i32 16, i32 16, i32 16, i32 16, i32 16, i32 16, i32 16, i32 16, i32 16, i32 16, i32 16, i32 16>  
%c = trunc <16 x i32> %b to <16  
x i16>  
ret <16 x i16> %c  
}
```

```
define <32 x i8> @trunc_v32i16_v32i8_sign(<32 x i16>* %x) nounwind "min-legal-vector-width"="256" {  
; CHECK-SKX-VBMI-LABEL: trunc_v32i16_v32i8_sign:  
; CHECK-SKX-VBMI: # %bb.0:  
; CHECK-SKX-VBMI-NEXT: vmovdqa (%rdi), %ymm1  
; CHECK-SKX-VBMI-NEXT: vmovdqa {{.*#+}} ymm0 =  
[1,3,5,7,9,11,13,15,17,19,21,23,25,27,29,31,33,35,37,39,41,43,45,47,49,51,53,55,57,59,61,63]  
; CHECK-SKX-VBMI-NEXT: vpermi2b 32(%rdi), %ymm1, %ymm0  
; CHECK-SKX-VBMI-NEXT: retq  
;  
; CHECK-AVX512-LABEL: trunc_v32i16_v32i8_sign:  
; CHECK-AVX512: # %bb.0:  
; CHECK-AVX512-NEXT: vpsrlw $8, 32(%rdi), %ymm0  
; CHECK-AVX512-NEXT: vpsrlw $8, (%rdi), %ymm1  
; CHECK-AVX512-NEXT: vpackuswb %ymm0, %ymm1, %ymm0  
; CHECK-AVX512-NEXT: vpermq {{.*#+}} ymm0 = ymm0[0,2,1,3]  
; CHECK-AVX512-NEXT: retq
```

```
;
; CHECK-VBMI-LABEL: trunc_v32i16_v32i8_sign:
; CHECK-VBMI:    # %bb.0:
; CHECK-VBMI-NEXT:  vmovdqa (%rdi), %ymm1
; CHECK-VBMI-NEXT:  vmovdqa {{.*#+}} ymm0 =
[1,3,5,7,9,11,13,15,17,19,21,23,25,27,29,31,33,35,37,39,41,43,45,47,49,51,53,55,57,59,61,63]
;
CHECK-VBMI-NEXT:  vpermi2b 32(%rdi), %ymm1, %ymm0
; CHECK-VBMI-NEXT:  retq
%a = load <32 x i16>, <32 x i16>* %x
%b = ashr <32 x i16> %a, <i16 8, i16 8, i16 8, i16 8, i16 8, i16 8, i16 8, i16 8, i16 8, i16 8, i16 8, i16 8, i16 8, i16 8, i16 8, i16 8>
%c = trunc <32 x i16> %b to <32 x i8>
ret <32 x i8> %c
}
```

```

define dso_local void @sext_v16i8_v16i64(<16 x i8> %x, <16 x i64>* %y) nounwind "min-legal-vector-
width"="256" {
; CHECK-LABEL: sext_v16i8_v16i64:
; CHECK:      # %bb.0:
; CHECK-NEXT: vpmovsxbw %xmm0, %ymm1
; CHECK-NEXT: vpshufd {{.*#+}} xmm2 = xmm1[2,3,2,3]
; CHECK-NEXT: vpmovsxbw %xmm2, %ymm2
; CHECK-NEXT: vextracti128 $1, %ymm1, %xmm1
; CHECK-NEXT: vpshufd {{.*#+}} xmm3 = xmm1[2,3,2,3]
; CHECK-NEXT: vpmovsxbw %xmm3, %ymm3
; CHECK-NEXT: vpmovsxbw %xmm1, %ymm1
; CHECK-NEXT: vpmovsxbq %xmm0, %ymm0
; CHECK-NEXT: vmovdqa %ymm0, (%rdi)
; CHECK-NEXT: vmovdqa %ymm1, 64(%rdi)
; CHECK-NEXT: vmovdqa %ymm3, 96(%rdi)
; CHECK-NEXT: vmovdqa %ymm2, 32(%rdi)
; CHECK-NEXT: vzeroupper
; CHECK-NEXT: retq
    %a = sext <16 x i8> %x to <16 x i64>
    store <16 x i64> %a, <16 x i64>* %y
    ret void
}

```

```

define dso_local void @vselect_split_v8i16_setcc(<8 x i16> %s, <8 x i16> %t, <8 x i64>* %p, <8 x i64>* %q, <8
x i64>* %r) "min-legal-vector-width"="256"
{
; CHECK-LABEL: vselect_split_v8i16_setcc:
; CHECK:      # %bb.0:
; CHECK-NEXT: vmovdqa (%rsi), %ymm2
; CHECK-NEXT: vmovdqa 32(%rsi), %ymm3
; CHECK-NEXT: vpcmpeqw %xmm1, %xmm0, %k1
; CHECK-NEXT: kshiftrb $4, %k1, %k2
; CHECK-NEXT: vmovdqa64 32(%rdi), %ymm3 {%k2}
; CHECK-NEXT: vmovdqa64 (%rdi), %ymm2 {%k1}
; CHECK-NEXT: vmovdqa %ymm2, (%rdx)
; CHECK-NEXT: vmovdqa %ymm3, 32(%rdx)
; CHECK-NEXT: vzeroupper
; CHECK-NEXT: retq
    %x = load <8 x i64>, <8 x i64>* %p
    %y = load <8 x i64>, <8 x i64>* %q
    %a = icmp eq <8 x i16> %s, %t
    %b = select <8 x i16> %a, <8 x i64> %x, <8 x i64> %y
    store <8 x i64> %b, <8 x i64>* %r
    ret void
}

```

```

define dso_local void @vselect_split_v8i32_setcc(<8 x i32> %s, <8 x i32> %t, <8 x i64>* %p, <8 x i64>* %q, <8

```

```

x i64>* %r) "min-legal-vector-width"="256" {
; CHECK-LABEL: vselect_split_v8i32_setcc:
; CHECK:      # %bb.0:
; CHECK-NEXT: vmovdqa (%rsi), %ymm2
; CHECK-NEXT: vmovdqa 32(%rsi), %ymm3
; CHECK-NEXT: vpcmpeqd %ymm1,
%ymm0, %k1
; CHECK-NEXT: kshiftrb $4, %k1, %k2
; CHECK-NEXT: vmovdqa64 32(%rdi), %ymm3 {%k2}
; CHECK-NEXT: vmovdqa64 (%rdi), %ymm2 {%k1}
; CHECK-NEXT: vmovdqa %ymm2, (%rdx)
; CHECK-NEXT: vmovdqa %ymm3, 32(%rdx)
; CHECK-NEXT: vzeroupper
; CHECK-NEXT: retq
%x = load <8 x i64>, <8 x i64>* %p
%y = load <8 x i64>, <8 x i64>* %q
%a = icmp eq <8 x i32> %s, %t
%b = select <8 x i1> %a, <8 x i64> %x, <8 x i64> %y
store <8 x i64> %b, <8 x i64>* %r
ret void
}

```

```

define dso_local void @vselect_split_v16i8_setcc(<16 x i8> %s, <16 x i8> %t, <16 x i32>* %p, <16 x i32>* %q,
<16 x i32>* %r) "min-legal-vector-width"="256" {
; CHECK-LABEL: vselect_split_v16i8_setcc:
; CHECK:      # %bb.0:
; CHECK-NEXT: vmovdqa (%rsi), %ymm2
; CHECK-NEXT: vmovdqa 32(%rsi), %ymm3
; CHECK-NEXT: vpcmpeqb %xmm1, %xmm0, %k1
; CHECK-NEXT: kshiftrw $8, %k1, %k2
; CHECK-NEXT: vmovdqa32 32(%rdi), %ymm3 {%k2}
; CHECK-NEXT: vmovdqa32 (%rdi), %ymm2 {%k1}
; CHECK-NEXT: vmovdqa %ymm2,
(%rdx)
; CHECK-NEXT: vmovdqa %ymm3, 32(%rdx)
; CHECK-NEXT: vzeroupper
; CHECK-NEXT: retq
%x = load <16 x i32>, <16 x i32>* %p
%y = load <16 x i32>, <16 x i32>* %q
%a = icmp eq <16 x i8> %s, %t
%b = select <16 x i1> %a, <16 x i32> %x, <16 x i32> %y
store <16 x i32> %b, <16 x i32>* %r
ret void
}

```

```

define dso_local void @vselect_split_v16i16_setcc(<16 x i16> %s, <16 x i16> %t, <16 x i32>* %p, <16 x i32>*
%q, <16 x i32>* %r) "min-legal-vector-width"="256" {
; CHECK-LABEL: vselect_split_v16i16_setcc:

```

```

; CHECK:    # %bb.0:
; CHECK-NEXT: vmovdqa (%rsi), %ymm2
; CHECK-NEXT: vmovdqa 32(%rsi), %ymm3
; CHECK-NEXT: vpcmpeqw %ymm1, %ymm0, %k1
; CHECK-NEXT: kshiftrw $8, %k1, %k2
; CHECK-NEXT: vmovdqa32 32(%rdi), %ymm3 {%k2}
; CHECK-NEXT: vmovdqa32 (%rdi), %ymm2 {%k1}
; CHECK-NEXT: vmovdqa %ymm2, (%rdx)
; CHECK-NEXT: vmovdqa %ymm3, 32(%rdx)
; CHECK-NEXT: vzeroupper
; CHECK-NEXT: retq
%x = load <16 x i32>, <16 x i32>* %p
%y = load <16 x i32>,
<16 x i32>* %q
%a = icmp eq <16 x i16> %s, %t
%b = select <16 x i1> %a, <16 x i32> %x, <16 x i32> %y
store <16 x i32> %b, <16 x i32>* %r
ret void
}

define <16 x i8> @trunc_packus_v16i32_v16i8(<16 x i32>* %p) "min-legal-vector-width"="256" {
; CHECK-LABEL: trunc_packus_v16i32_v16i8:
; CHECK:    # %bb.0:
; CHECK-NEXT: vmovdqa (%rdi), %ymm0
; CHECK-NEXT: vpackusdw 32(%rdi), %ymm0, %ymm0
; CHECK-NEXT: vpermq {{.*#+}} ymm0 = ymm0[0,2,1,3]
; CHECK-NEXT: vpmovuswb %ymm0, %xmm0
; CHECK-NEXT: vzeroupper
; CHECK-NEXT: retq
%a = load <16 x i32>, <16 x i32>* %p
%b = icmp slt <16 x i32> %a, <i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255>
%c = select <16 x i1> %b, <16 x i32> %a, <16 x i32> <i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255>
%d = icmp sgt <16 x i32> %c, zeroinitializer
%e = select <16 x i1> %d, <16 x i32> %c, <16 x i32> zeroinitializer
%f = trunc <16 x i32> %e to <16 x i8>
ret <16 x i8> %f
}

define dso_local void @trunc_packus_v16i32_v16i8_store(<16 x i32>* %p, <16 x i8>* %q) "min-legal-vector-width"="256" {
; CHECK-LABEL: trunc_packus_v16i32_v16i8_store:
; CHECK:    # %bb.0:
; CHECK-NEXT: vmovdqa (%rdi), %ymm0
; CHECK-NEXT: vpackusdw 32(%rdi), %ymm0, %ymm0
; CHECK-NEXT: vpermq {{.*#+}} ymm0 = ymm0[0,2,1,3]
; CHECK-NEXT: vpmovuswb %ymm0, (%rsi)

```

```

; CHECK-NEXT:  vzeroupper
; CHECK-NEXT:  retq
%a = load <16 x i32>, <16 x i32>* %p
%b = icmp slt <16 x i32> %a, <i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255>
%c = select <16 x i1> %b, <16 x i32> %a, <16 x i32> <i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255>
%d = icmp sgt <16
x i32> %c, zeroinitializer
%e = select <16 x i1> %d, <16 x i32> %c, <16 x i32> zeroinitializer
%f = trunc <16 x i32> %e to <16 x i8>
store <16 x i8> %f, <16 x i8>* %q
ret void
}

```

```

define <64 x i1> @v64i1_argument_return(<64 x i1> %x) "min-legal-vector-width"="256" {
; CHECK-LABEL: v64i1_argument_return:
; CHECK:      # %bb.0:
; CHECK-NEXT:  retq
ret <64 x i1> %x
}

```

```

define dso_local void @v64i1_shuffle(<64 x i8>* %x, <64 x i8>* %y) "min-legal-vector-width"="256" {
; CHECK-LABEL: v64i1_shuffle:
; CHECK:      # %bb.0: # %entry
; CHECK-NEXT:  vmovdqa (%rdi), %ymm1
; CHECK-NEXT:  vmovdqa 32(%rdi), %ymm0
; CHECK-NEXT:  vptestnmb %ymm1, %ymm1, %k0
; CHECK-NEXT:  kshiftrd $1, %k0, %k1
; CHECK-NEXT:  kshiftrlq $63, %k0, %k2
; CHECK-NEXT:  kshiftrq $62, %k2, %k2
; CHECK-NEXT:  kshiftrlq $63, %k1, %k1
; CHECK-NEXT:  kshiftrq $63, %k1, %k1
; CHECK-NEXT:  korq %k2, %k1, %k1
; CHECK-NEXT:  movq $-5, %rax
; CHECK-NEXT:  kmovq %rax, %k2
; CHECK-NEXT:  kandq %k2, %k1,
%k1
; CHECK-NEXT:  kshiftrd $3, %k0, %k2
; CHECK-NEXT:  kshiftrlq $63, %k2, %k2
; CHECK-NEXT:  kshiftrq $61, %k2, %k2
; CHECK-NEXT:  korq %k2, %k1, %k1
; CHECK-NEXT:  movq $-9, %rax
; CHECK-NEXT:  kmovq %rax, %k2
; CHECK-NEXT:  kandq %k2, %k1, %k1
; CHECK-NEXT:  kshiftrd $2, %k0, %k2
; CHECK-NEXT:  kshiftrlq $63, %k2, %k2
; CHECK-NEXT:  kshiftrq $60, %k2, %k2

```

```

; CHECK-NEXT: korq %k2, %k1, %k1
; CHECK-NEXT: movq $-17, %rax
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k1, %k1
; CHECK-NEXT: kshiftrd $5, %k0, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $59, %k2, %k2
; CHECK-NEXT: korq %k2, %k1, %k1
; CHECK-NEXT: movq $-33, %rax
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k1, %k1
; CHECK-NEXT: kshiftrd $4, %k0, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $58, %k2, %k2
; CHECK-NEXT: korq %k2, %k1, %k1
; CHECK-NEXT: movq $-65, %rax
; CHECK-NEXT: kmovq %rax, %k2
;
CHECK-NEXT: kandq %k2, %k1, %k1
; CHECK-NEXT: kshiftrd $7, %k0, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $57, %k2, %k2
; CHECK-NEXT: korq %k2, %k1, %k1
; CHECK-NEXT: movq $-129, %rax
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k1, %k1
; CHECK-NEXT: kshiftrd $6, %k0, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $56, %k2, %k2
; CHECK-NEXT: korq %k2, %k1, %k1
; CHECK-NEXT: movq $-257, %rax # imm = 0xFEFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k1, %k1
; CHECK-NEXT: kshiftrd $9, %k0, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $55, %k2, %k2
; CHECK-NEXT: korq %k2, %k1, %k1
; CHECK-NEXT: movq $-513, %rax # imm = 0xFDF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k1, %k1
; CHECK-NEXT: kshiftrd $8, %k0, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $54, %k2, %k2
; CHECK-NEXT: korq %k2, %k1, %k1
;
CHECK-NEXT: movq $-1025, %rax # imm = 0xFBFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k1, %k1

```

```

; CHECK-NEXT: kshiftrd $11, %k0, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $53, %k2, %k2
; CHECK-NEXT: korq %k2, %k1, %k1
; CHECK-NEXT: movq $-2049, %rax # imm = 0xF7FF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k1, %k1
; CHECK-NEXT: kshiftrd $10, %k0, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $52, %k2, %k2
; CHECK-NEXT: korq %k2, %k1, %k1
; CHECK-NEXT: movq $-4097, %rax # imm = 0xEFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k1, %k1
; CHECK-NEXT: kshiftrd $13, %k0, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $51, %k2, %k2
; CHECK-NEXT: korq %k2, %k1, %k1
; CHECK-NEXT: movq $-8193, %rax # imm = 0xDFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k1, %k1
; CHECK-NEXT: kshiftrd $12, %k0, %k2
; CHECK-NEXT:
    kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $50, %k2, %k2
; CHECK-NEXT: korq %k2, %k1, %k1
; CHECK-NEXT: movq $-16385, %rax # imm = 0xBFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k1, %k1
; CHECK-NEXT: kshiftrd $15, %k0, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $49, %k2, %k2
; CHECK-NEXT: korq %k2, %k1, %k1
; CHECK-NEXT: movq $-32769, %rax # imm = 0xFFFF7FFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k1, %k1
; CHECK-NEXT: kshiftrd $14, %k0, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $48, %k2, %k2
; CHECK-NEXT: korq %k2, %k1, %k1
; CHECK-NEXT: movq $-65537, %rax # imm = 0xFFFFFFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k1, %k1
; CHECK-NEXT: kshiftrd $17, %k0, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $47, %k2, %k2
; CHECK-NEXT: korq %k2, %k1, %k1
; CHECK-NEXT: movq $-131073, %rax # imm = 0xFFFFDFFF

```



```

;
CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k1, %k1
; CHECK-NEXT: kshiftrd $16, %k0, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $46, %k2, %k2
; CHECK-NEXT: korq %k2, %k1, %k1
; CHECK-NEXT: movq $-262145, %rax # imm = 0xFFFBFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k1, %k1
; CHECK-NEXT: kshiftrd $19, %k0, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $45, %k2, %k2
; CHECK-NEXT: korq %k2, %k1, %k1
; CHECK-NEXT: movq $-524289, %rax # imm = 0xFFF7FFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k1, %k1
; CHECK-NEXT: kshiftrd $18, %k0, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $44, %k2, %k2
; CHECK-NEXT: korq %k2, %k1, %k1
; CHECK-NEXT: movq $-1048577, %rax # imm = 0xFFEFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k1, %k1
; CHECK-NEXT: kshiftrd $21, %k0, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT:
    kshiftrq $43, %k2, %k2
; CHECK-NEXT: korq %k2, %k1, %k1
; CHECK-NEXT: movq $-2097153, %rax # imm = 0xFFDFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k1, %k1
; CHECK-NEXT: kshiftrd $20, %k0, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $42, %k2, %k2
; CHECK-NEXT: korq %k2, %k1, %k1
; CHECK-NEXT: movq $-4194305, %rax # imm = 0xFFBFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k1, %k1
; CHECK-NEXT: kshiftrd $23, %k0, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $41, %k2, %k2
; CHECK-NEXT: korq %k2, %k1, %k1
; CHECK-NEXT: movq $-8388609, %rax # imm = 0xFF7FFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k1, %k1
; CHECK-NEXT: kshiftrd $22, %k0, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2

```

```

; CHECK-NEXT: kshiftrq $40, %k2, %k2
; CHECK-NEXT: korq %k2, %k1, %k1
; CHECK-NEXT: movq $-16777217, %rax # imm = 0xFEFFFFFF
; CHECK-NEXT: kmovq
%rax, %k2
; CHECK-NEXT: kandq %k2, %k1, %k1
; CHECK-NEXT: kshiftrd $25, %k0, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $39, %k2, %k2
; CHECK-NEXT: korq %k2, %k1, %k1
; CHECK-NEXT: movq $-33554433, %rax # imm = 0xFDFFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k1, %k1
; CHECK-NEXT: kshiftrd $24, %k0, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $38, %k2, %k2
; CHECK-NEXT: korq %k2, %k1, %k1
; CHECK-NEXT: movq $-67108865, %rax # imm = 0xFBFFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k1, %k1
; CHECK-NEXT: kshiftrd $27, %k0, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $37, %k2, %k2
; CHECK-NEXT: korq %k2, %k1, %k1
; CHECK-NEXT: movq $-134217729, %rax # imm = 0xF7FFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k1, %k1
; CHECK-NEXT: kshiftrd $26, %k0, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq
$36, %k2, %k2
; CHECK-NEXT: korq %k2, %k1, %k1
; CHECK-NEXT: movq $-268435457, %rax # imm = 0xEFFFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k1, %k1
; CHECK-NEXT: kshiftrd $29, %k0, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $35, %k2, %k2
; CHECK-NEXT: korq %k2, %k1, %k1
; CHECK-NEXT: movq $-536870913, %rax # imm = 0xDFFFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k1, %k1
; CHECK-NEXT: kshiftrd $28, %k0, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $34, %k2, %k2
; CHECK-NEXT: korq %k2, %k1, %k1
; CHECK-NEXT: movq $-1073741825, %rax # imm = 0xBFFFFFFF
; CHECK-NEXT: kmovq %rax, %k2

```

```

; CHECK-NEXT: kandq %k2, %k1, %k1
; CHECK-NEXT: kshiftrd $31, %k0, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $33, %k2, %k2
; CHECK-NEXT: korq %k2, %k1, %k1
; CHECK-NEXT: movabsq $-2147483649, %rax # imm = 0xFFFFFFFF7FFFFFFF
; CHECK-NEXT:
    kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k1, %k2
; CHECK-NEXT: vptestnmb %ymm0, %ymm0, %k1
; CHECK-NEXT: kshiftrd $30, %k0, %k0
; CHECK-NEXT: kshiftrlq $63, %k0, %k0
; CHECK-NEXT: kshiftrq $32, %k0, %k0
; CHECK-NEXT: korq %k0, %k2, %k0
; CHECK-NEXT: movabsq $-4294967297, %rax # imm = 0xFFFFFFFFFFFFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k0, %k0
; CHECK-NEXT: kshiftrd $1, %k1, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $31, %k2, %k2
; CHECK-NEXT: korq %k2, %k0, %k0
; CHECK-NEXT: movabsq $-8589934593, %rax # imm = 0xFFFFFFFFDFFFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k0, %k0
; CHECK-NEXT: kshiftrlq $63, %k1, %k2
; CHECK-NEXT: kshiftrq $30, %k2, %k2
; CHECK-NEXT: korq %k2, %k0, %k0
; CHECK-NEXT: movabsq $-17179869185, %rax # imm = 0xFFFFFFFFBFFFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k0, %k0
; CHECK-NEXT: kshiftrd $3, %k1, %k2
; CHECK-NEXT:
    kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $29, %k2, %k2
; CHECK-NEXT: korq %k2, %k0, %k0
; CHECK-NEXT: movabsq $-34359738369, %rax # imm = 0xFFFFFFFF7FFFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k0, %k0
; CHECK-NEXT: kshiftrd $2, %k1, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $28, %k2, %k2
; CHECK-NEXT: korq %k2, %k0, %k0
; CHECK-NEXT: movabsq $-68719476737, %rax # imm = 0xFFFFFFFFFFFFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k0, %k0
; CHECK-NEXT: kshiftrd $5, %k1, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $27, %k2, %k2

```

```

; CHECK-NEXT: korq %k2, %k0, %k0
; CHECK-NEXT: movabsq $-137438953473, %rax # imm = 0xFFFFFFFFFFFFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k0, %k0
; CHECK-NEXT: kshiftrd $4, %k1, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $26, %k2, %k2
; CHECK-NEXT: korq %k2, %k0, %k0
;
CHECK-NEXT: movabsq $-274877906945, %rax # imm = 0xFFFFFFFFBFFFFFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k0, %k0
; CHECK-NEXT: kshiftrd $7, %k1, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $25, %k2, %k2
; CHECK-NEXT: korq %k2, %k0, %k0
; CHECK-NEXT: movabsq $-549755813889, %rax # imm = 0xFFFFFFFF7FFFFFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k0, %k0
; CHECK-NEXT: kshiftrd $6, %k1, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $24, %k2, %k2
; CHECK-NEXT: korq %k2, %k0, %k0
; CHECK-NEXT: movabsq $-1099511627777, %rax # imm = 0xFFFFFFFFFFFFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k0, %k0
; CHECK-NEXT: kshiftrd $9, %k1, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $23, %k2, %k2
; CHECK-NEXT: korq %k2, %k0, %k0
; CHECK-NEXT: movabsq $-2199023255553, %rax # imm = 0xFFFFFFFFFFFFFFFF
; CHECK-NEXT: kmovq %rax, %k2
;
CHECK-NEXT: kandq %k2, %k0, %k0
; CHECK-NEXT: kshiftrd $8, %k1, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $22, %k2, %k2
; CHECK-NEXT: korq %k2, %k0, %k0
; CHECK-NEXT: movabsq $-4398046511105, %rax # imm = 0xFFFFFFFFBFFFFFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k0, %k0
; CHECK-NEXT: kshiftrd $11, %k1, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $21, %k2, %k2
; CHECK-NEXT: korq %k2, %k0, %k0
; CHECK-NEXT: movabsq $-8796093022209, %rax # imm = 0xFFFFF7FFFFFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k0, %k0

```

```

; CHECK-NEXT: kshiftrd $10, %k1, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $20, %k2, %k2
; CHECK-NEXT: korq %k2, %k0, %k0
; CHECK-NEXT: movabsq $-17592186044417, %rax # imm = 0xFFFFFEFFFFFFFFFFFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k0, %k0
; CHECK-NEXT: kshiftrd $13, %k1, %k2
; CHECK-NEXT: kshiftrlq
$63, %k2, %k2
; CHECK-NEXT: kshiftrq $19, %k2, %k2
; CHECK-NEXT: korq %k2, %k0, %k0
; CHECK-NEXT: movabsq $-35184372088833, %rax # imm = 0xFFFFDFFFFFFFFFFFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k0, %k0
; CHECK-NEXT: kshiftrd $12, %k1, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $18, %k2, %k2
; CHECK-NEXT: korq %k2, %k0, %k0
; CHECK-NEXT: movabsq $-70368744177665, %rax # imm = 0xFFFFBFFFFFFFFFFFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k0, %k0
; CHECK-NEXT: kshiftrd $15, %k1, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $17, %k2, %k2
; CHECK-NEXT: korq %k2, %k0, %k0
; CHECK-NEXT: movabsq $-140737488355329, %rax # imm = 0xFFFFF7FFFFFFFFFFFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k0, %k0
; CHECK-NEXT: kshiftrd $14, %k1, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $16, %k2, %k2
; CHECK-NEXT: korq %k2, %k0, %k0
; CHECK-NEXT:
movabsq $-281474976710657, %rax # imm = 0xFFFEFFFFFFFFFFFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k0, %k0
; CHECK-NEXT: kshiftrd $17, %k1, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $15, %k2, %k2
; CHECK-NEXT: korq %k2, %k0, %k0
; CHECK-NEXT: movabsq $-562949953421313, %rax # imm = 0xFFFDFFFFFFFFFFFFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k0, %k0
; CHECK-NEXT: kshiftrd $16, %k1, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $14, %k2, %k2
; CHECK-NEXT: korq %k2, %k0, %k0

```

```

; CHECK-NEXT: movabsq $-1125899906842625, %rax # imm = 0xFFFBFFFFFFFFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k0, %k0
; CHECK-NEXT: kshiftrd $19, %k1, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $13, %k2, %k2
; CHECK-NEXT: korq %k2, %k0, %k0
; CHECK-NEXT: movabsq $-2251799813685249, %rax # imm = 0xFF7FFFFFFFFFFFFF
; CHECK-NEXT: kmovq
%rax, %k2
; CHECK-NEXT: kandq %k2, %k0, %k0
; CHECK-NEXT: kshiftrd $18, %k1, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $12, %k2, %k2
; CHECK-NEXT: korq %k2, %k0, %k0
; CHECK-NEXT: movabsq $-4503599627370497, %rax # imm = 0xFFEFFFFFFFFFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k0, %k0
; CHECK-NEXT: kshiftrd $21, %k1, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $11, %k2, %k2
; CHECK-NEXT: korq %k2, %k0, %k0
; CHECK-NEXT: movabsq $-9007199254740993, %rax # imm = 0xFFDFFFFFFFFFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k0, %k0
; CHECK-NEXT: kshiftrd $20, %k1, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $10, %k2, %k2
; CHECK-NEXT: korq %k2, %k0, %k0
; CHECK-NEXT: movabsq $-18014398509481985, %rax # imm = 0xFFBFFFFFFFFFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k0, %k0
; CHECK-NEXT: kshiftrd $23, %k1, %k2
;
CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $9, %k2, %k2
; CHECK-NEXT: korq %k2, %k0, %k0
; CHECK-NEXT: movabsq $-36028797018963969, %rax # imm = 0xFF7FFFFFFFFFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k0, %k0
; CHECK-NEXT: kshiftrd $22, %k1, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $8, %k2, %k2
; CHECK-NEXT: korq %k2, %k0, %k0
; CHECK-NEXT: movabsq $-72057594037927937, %rax # imm = 0xFEFFFFFFFFFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k0, %k0
; CHECK-NEXT: kshiftrd $25, %k1, %k2

```

```

; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $7, %k2, %k2
; CHECK-NEXT: korq %k2, %k0, %k0
; CHECK-NEXT: movabsq $-144115188075855873, %rax # imm = 0xFDFFFFFFFFFFFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k0, %k0
; CHECK-NEXT: kshiftrd $24, %k1, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $6, %k2, %k2
; CHECK-NEXT:
    korq %k2, %k0, %k0
; CHECK-NEXT: movabsq $-288230376151711745, %rax # imm = 0xFBFFFFFFFFFFFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k0, %k0
; CHECK-NEXT: kshiftrd $27, %k1, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $5, %k2, %k2
; CHECK-NEXT: korq %k2, %k0, %k0
; CHECK-NEXT: movabsq $-576460752303423489, %rax # imm = 0xF7FFFFFFFFFFFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k0, %k0
; CHECK-NEXT: kshiftrd $26, %k1, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $4, %k2, %k2
; CHECK-NEXT: korq %k2, %k0, %k0
; CHECK-NEXT: movabsq $-1152921504606846977, %rax # imm = 0xEEFFFFFFFFFFFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k0, %k0
; CHECK-NEXT: kshiftrd $29, %k1, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $3, %k2, %k2
; CHECK-NEXT: korq %k2, %k0, %k0
; CHECK-NEXT: movabsq $-2305843009213693953, %rax # imm =
0xDFFFFFFFFFFFFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k0, %k0
; CHECK-NEXT: kshiftrd $28, %k1, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $2, %k2, %k2
; CHECK-NEXT: korq %k2, %k0, %k0
; CHECK-NEXT: movabsq $-4611686018427387905, %rax # imm = 0xBF7FFFFFFFFFFFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k0, %k0
; CHECK-NEXT: kshiftrd $31, %k1, %k2
; CHECK-NEXT: kshiftrlq $62, %k2, %k2
; CHECK-NEXT: korq %k2, %k0, %k0
; CHECK-NEXT: kshiftrd $30, %k1, %k1
; CHECK-NEXT: kshiftrlq $1, %k0, %k0

```

```

; CHECK-NEXT: kshiftrq $1, %k0, %k0
; CHECK-NEXT: kshiftrlq $63, %k1, %k1
; CHECK-NEXT: korq %k1, %k0, %k1
; CHECK-NEXT: vmovdqu8 %ymm1, (%rsi) {%k1}
; CHECK-NEXT: kshiftrq $32, %k1, %k1
; CHECK-NEXT: vmovdqu8 %ymm0, 32(%rsi) {%k1}
; CHECK-NEXT: vzeroupper
; CHECK-NEXT: retq
entry:
%a = load <64 x i8>, <64 x i8>* %x
%b = icmp eq <64 x i8> %a, zeroinitializer
%shuf = shufflevector
<64 x i1> %b, <64 x i1> undef, <64 x i32> <i32 1, i32 0, i32 3, i32 2, i32 5, i32 4, i32 7, i32 6, i32 9, i32 8, i32 11,
i32 10, i32 13, i32 12, i32 15, i32 14, i32 17, i32 16, i32 19, i32 18, i32 21, i32 20, i32 23, i32 22, i32 25, i32 24, i32
27, i32 26, i32 29, i32 28, i32 31, i32 30, i32 33, i32 32, i32 35, i32 34, i32 37, i32 36, i32 39, i32 38, i32 41, i32 40,
i32 43, i32 42, i32 45, i32 44, i32 47, i32 46, i32 49, i32 48, i32 51, i32 50, i32 53, i32 52, i32 55, i32 54, i32 57, i32
56, i32 59, i32 58, i32 61, i32 60, i32 63, i32 62>
call void @llvm.masked.store.v64i8.p0v64i8(<64 x i8> %a, <64 x i8>* %y, i32 1, <64 x i1> %shuf)
ret void
}
declare void @llvm.masked.store.v64i8.p0v64i8(<64 x i8>, <64 x i8>*, i32, <64 x i1>)

@mem64_dst = dso_local global i64 0, align 8
@mem64_src = dso_local global i64 0, align 8
define dso_local i32 @v64i1_inline_asm() "min-legal-vector-width"="256" {
; CHECK-LABEL: v64i1_inline_asm:
; CHECK:      # %bb.0:
; CHECK-NEXT: kmovq mem64_src(%rip),
%k0
; CHECK-NEXT: #APP
; CHECK-NEXT: #NO_APP
; CHECK-NEXT: kmovq %k0, mem64_dst(%rip)
; CHECK-NEXT: movl -{[0-9]+}}(%rsp), %eax
; CHECK-NEXT: retq
%1 = alloca i32, align 4
%2 = load i64, i64* @mem64_src, align 8
%3 = call i64 @asm "", "=k,k,~{dirflag},~{fpsr},~{flags}"(i64 %2)
store i64 %3, i64* @mem64_dst, align 8
%4 = load i32, i32* %1, align 4
ret i32 %4
}

define dso_local void @cmp_v8i64_sext(<8 x i64>* %xptr, <8 x i64>* %yptr, <8 x i64>* %zptr) "min-legal-
vector-width"="256" {
; CHECK-LABEL: cmp_v8i64_sext:
; CHECK:      # %bb.0:
; CHECK-NEXT: vmovdqa (%rsi), %ymm0
; CHECK-NEXT: vmovdqa 32(%rsi), %ymm1

```



```

; CHECK-NEXT: vpcmpgtq 32(%rdi), %ymm1, %ymm1
; CHECK-NEXT: vpcmpgtq (%rdi), %ymm0, %ymm0
; CHECK-NEXT: vmovdqa %ymm0, (%rdx)
; CHECK-NEXT: vmovdqa %ymm1, 32(%rdx)
; CHECK-NEXT: vzeroupper
; CHECK-NEXT: retq
%x = load <8 x i64>, <8 x i64>* %xptr
%y = load <8 x i64>, <8 x i64>* %yptr
%cmp = icmp slt <8 x i64> %x, %y
%ext
= sext <8 x i1> %cmp to <8 x i64>
store <8 x i64> %ext, <8 x i64>* %zptr
ret void
}

```

```

define dso_local void @cmp_v8i64_zext(<8 x i64>* %xptr, <8 x i64>* %yptr, <8 x i64>* %zptr) "min-legal-vector-width"="256" {

```

```

; CHECK-LABEL: cmp_v8i64_zext:
; CHECK:      # %bb.0:
; CHECK-NEXT: vmovdqa (%rsi), %ymm0
; CHECK-NEXT: vmovdqa 32(%rsi), %ymm1
; CHECK-NEXT: vpcmpgtq 32(%rdi), %ymm1, %ymm1
; CHECK-NEXT: vpcmpgtq (%rdi), %ymm0, %ymm0
; CHECK-NEXT: vpsrlq $63, %ymm1, %ymm1
; CHECK-NEXT: vpsrlq $63, %ymm0, %ymm0
; CHECK-NEXT: vmovdqa %ymm0, (%rdx)
; CHECK-NEXT: vmovdqa %ymm1, 32(%rdx)
; CHECK-NEXT: vzeroupper
; CHECK-NEXT: retq
%x = load <8 x i64>, <8 x i64>* %xptr
%y = load <8 x i64>, <8 x i64>* %yptr
%cmp = icmp slt <8 x i64> %x, %y
%ext = zext <8 x i1> %cmp to <8 x i64>
store <8 x i64> %ext, <8 x i64>* %zptr
ret void
}

```

```

define <16 x i8> @var_rotate_v16i8(<16 x i8> %a, <16 x i8> %b) nounwind "min-legal-vector-width"="256" {

```

```

; CHECK-LABEL: var_rotate_v16i8:
;
; CHECK:      # %bb.0:
; CHECK-NEXT: vpandd {{\.?LCPI[0-9]+_[0-9]+}}(%rip){1to4}, %xmm1, %xmm1
; CHECK-NEXT: vpxor %xmm2, %xmm2, %xmm2
; CHECK-NEXT: vpunpckhbw {{\.*#+}} %xmm2 =
xmm1[8],xmm2[8],xmm1[9],xmm2[9],xmm1[10],xmm2[10],xmm1[11],xmm2[11],xmm1[12],xmm2[12],xmm1[13],
xmm2[13],xmm1[14],xmm2[14],xmm1[15],xmm2[15]
; CHECK-NEXT: vpunpckhbw {{\.*#+}} %xmm3 = xmm0[8,8,9,9,10,10,11,11,12,12,13,13,14,14,15,15]
; CHECK-NEXT: vpsllvw %xmm2, %xmm3, %xmm2

```

```

; CHECK-NEXT:    vpsrlw $8, %xmm2, %xmm2
; CHECK-NEXT:    vpunpcklbw {{.*#+}} xmm0 = xmm0[0,0,1,1,2,2,3,3,4,4,5,5,6,6,7,7]
; CHECK-NEXT:    vpmovzxbw {{.*#+}} xmm1 =
xmm1[0],zero,xmm1[1],zero,xmm1[2],zero,xmm1[3],zero,xmm1[4],zero,xmm1[5],zero,xmm1[6],zero,xmm1[7],zer
o
; CHECK-NEXT:    vpsllvw %xmm1, %xmm0, %xmm0
; CHECK-NEXT:    vpsrlw $8, %xmm0, %xmm0
; CHECK-NEXT:    vpackuswb %xmm2, %xmm0, %xmm0
; CHECK-NEXT:    retq

%b8 = sub <16 x i8> <i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8>, %b
i8 8, i8 8, i8 8>, %b
%shl = shl <16 x i8> %a, %b
%lshr = lshr <16 x i8> %a, %b8
%or = or <16 x i8> %shl, %lshr
ret <16 x i8> %or
}

```

```
}
```

```
define <32 x i8> @splatvar_rotate_v32i8(<32 x i8> %a, <32 x i8> %b) nounwind "min-legal-vector-width"="256"
{
; CHECK-LABEL: splatvar_rotate_v32i8:
; CHECK:      # %bb.0:
; CHECK-NEXT:  vpunpckhbw {{.*#+}} ymm2 =
ymm0[8,8,9,9,10,10,11,11,12,12,13,13,14,14,15,15,24,24,25,25,26,26,27,27,28,28,29,29,30,30,31,31]
; CHECK-NEXT:  vpand {{\.?LCPI[0-9]+_?[0-9]+}}(%rip), %xmm1, %xmm1
; CHECK-NEXT:  vpsllw %xmm1, %ymm2, %ymm2
; CHECK-NEXT:  vpsrlw $8, %ymm2, %ymm2
; CHECK-NEXT:  vpunpcklbw {{.*#+}} ymm0 =
ymm0[0,0,1,1,2,2,3,3,4,4,5,5,6,6,7,7,16,16,17,17,18,18,19,19,20,20,21,21,22,22,23,23]
; CHECK-NEXT:  vpsllw %xmm1, %ymm0, %ymm0
; CHECK-NEXT:  vpsrlw $8, %ymm0, %ymm0
; CHECK-NEXT:  vpackuswb %ymm2, %ymm0, %ymm0
; CHECK-NEXT:  retq
%$splat = shufflevector <32 x i8> %b, <32 x i8> undef, <32 x i32> zeroinitializer
%$splat8 = sub <32 x i8> <i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8>, %$splat
%$shl = shl <32 x i8>
%a, %$splat
%$lshr = lshr <32 x i8> %a, %$splat8
%or = or <32 x i8> %$shl, %$lshr
ret <32 x i8> %or
}
```

```
define <32 x i8> @constant_rotate_v32i8(<32 x i8> %a) nounwind "min-legal-vector-width"="256" {
; CHECK-LABEL: constant_rotate_v32i8:
; CHECK:      # %bb.0:
; CHECK-NEXT:  vpunpckhbw {{.*#+}} ymm1 =
ymm0[8,8,9,9,10,10,11,11,12,12,13,13,14,14,15,15,24,24,25,25,26,26,27,27,28,28,29,29,30,30,31,31]
; CHECK-NEXT:  vpsllvw {{\.?LCPI[0-9]+_?[0-9]+}}(%rip), %ymm1, %ymm1
; CHECK-NEXT:  vpsrlw $8, %ymm1, %ymm1
; CHECK-NEXT:  vpunpcklbw {{.*#+}} ymm0 =
ymm0[0,0,1,1,2,2,3,3,4,4,5,5,6,6,7,7,16,16,17,17,18,18,19,19,20,20,21,21,22,22,23,23]
; CHECK-NEXT:  vpsllvw {{\.?LCPI[0-9]+_?[0-9]+}}(%rip), %ymm0, %ymm0
; CHECK-NEXT:  vpsrlw $8, %ymm0, %ymm0
; CHECK-NEXT:  vpackuswb %ymm1, %ymm0, %ymm0
; CHECK-NEXT:  retq
%$shl = shl <32 x i8> %a, <i8 0, i8 1, i8 2, i8 3, i8 4, i8 5, i8 6, i8 7, i8 8, i8 7, i8 6, i8 5, i8 4, i8 3, i8 2, i8 1, i8 0, i8 1, i8 2, i8 3, i8 4, i8 5, i8 6, i8 7, i8 8, i8 7, i8 6, i8 5, i8 4, i8 3, i8 2, i8 1>
%$lshr = lshr <32 x i8> %a, <i8 8, i8 7, i8 6, i8 5, i8 4, i8 3, i8 2, i8 1, i8 0, i8 1, i8 2, i8 3, i8 4, i8 5, i8 6, i8 7, i8 8, i8 7, i8 6, i8 5, i8 4, i8 3, i8 2, i8 1, i8 0, i8 1, i8 2, i8 3, i8 4, i8 5, i8 6, i8 7>
%or = or <32 x i8> %$shl, %$lshr
ret <32 x i8> %or
}
```

```

define <32 x i8> @splatconstant_rotate_v32i8(<32 x i8> %a) nounwind "min-legal-vector-width"="256" {
; CHECK-LABEL: splatconstant_rotate_v32i8:
; CHECK:      # %bb.0:
; CHECK-NEXT:  vpsllw $4, %ymm0, %ymm1
; CHECK-NEXT:  vpsrlw $4, %ymm0, %ymm0
; CHECK-NEXT:  vpternlogd $216, {{\.?LCPI[0-9]+\_[0-9]+\}}(%rip){1to8}, %ymm1, %ymm0
; CHECK-NEXT:  retq
%shl = shl <32 x i8> %a, <i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4>
%lshr = lshr <32 x i8> %a, <i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4>
%or = or <32 x i8> %shl, %lshr
ret <32 x i8> %or
}

```

```

define <32 x i8> @splatconstant_rotate_mask_v32i8(<32 x i8> %a) nounwind "min-legal-vector-width"="256" {
; CHECK-LABEL: splatconstant_rotate_mask_v32i8:
; CHECK:      # %bb.0:
; CHECK-NEXT:  vpsllw $4, %ymm0, %ymm1
; CHECK-NEXT:  vpsrlw $4, %ymm0, %ymm0
; CHECK-NEXT:  vpternlogd $216, {{\.?LCPI[0-9]+\_[0-9]+\}}(%rip){1to8}, %ymm1, %ymm0
; CHECK-NEXT:  vpandd {{\.?LCPI[0-9]+\_[0-9]+\}}(%rip){1to8}, %ymm0, %ymm0
; CHECK-NEXT:  retq
%shl = shl <32 x i8> %a, <i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4>
%lshr = lshr <32 x i8> %a, <i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4>
%rmask = and <32 x i8> %lshr, <i8 55, i8 55, i8 55, i8 55, i8 55, i8 55, i8 55, i8 55, i8 55, i8 55, i8 55, i8 55, i8 55, i8 55, i8 55, i8 55, i8 55, i8 55, i8 55, i8 55, i8 55, i8 55, i8 55, i8 55, i8 55, i8 55, i8 55, i8 55, i8 55, i8 55>
%lmask = and <32 x i8> %shl, <i8 33, i8 33, i8 33, i8 33, i8 33, i8 33, i8 33, i8 33, i8 33, i8 33, i8 33, i8 33, i8 33, i8 33, i8 33, i8 33, i8 33, i8 33, i8 33, i8 33, i8 33, i8 33, i8 33, i8 33, i8 33, i8 33, i8 33, i8 33, i8 33, i8 33>
%or = or <32 x i8> %lmask, %rmask
ret <32 x i8> %or
}

```

; NOTE: Assertions have been autogenerated by utils/update\_llc\_test\_checks.py  
; RUN: llc -mtriple=amdgc -mcpu=fiji < %s | FileCheck -check-prefixes=VI %s

```

; FIXME: This one should fold to rcp
define half @select_fneg_posk_src_rcp_f16(i32 %c, half %x, half %y) {
; VI-LABEL: select_fneg_posk_src_rcp_f16:
; VI:      ; %bb.0:
; VI-NEXT:  s_waitcnt vmcnt(0) expcnt(0) lgkmcnt(0)
; VI-NEXT:  v_rcp_f16_e64 v1, -v1
; VI-NEXT:  v_mov_b32_e32 v2, 0x4000

```

```

; VI-NEXT:  v_cmp_eq_u32_e32 vcc, 0, v0
; VI-NEXT:  v_cndmask_b32_e32 v0, v2, v1, vcc
; VI-NEXT:  s_setpc_b64 s[30:31]
%cmp = icmp eq i32 %c, 0
%rcp = call half @llvm.amdgcn.rcp.f16(half %x)
%fneg = fneg half %rcp
%select = select i1 %cmp, half %fneg, half 2.0
ret half %select
}

declare half @llvm.amdgcn.rcp.f16(half) #0

attributes #0 = { nocallback nofree nosync nounwind speculatable willreturn memory(none) }
; NOTE: Assertions have been autogenerated by utils/update_llc_test_checks.py
; RUN: llc -mtriple=riscv64 -verify-machineinstrs < %s \
; RUN: -riscv-experimental-rv64-legal-i32 | FileCheck %s -check-prefixes=CHECK,RV64I
; RUN: llc -mtriple=riscv64 -mattr=+zbb -verify-machineinstrs < %s \
; RUN: -riscv-experimental-rv64-legal-i32 | FileCheck %s -check-prefixes=CHECK,RV64ZBB-ZBKB,RV64ZBB
; RUN: llc -mtriple=riscv64 -mattr=+zbb -verify-machineinstrs < %s \
; RUN: -riscv-experimental-rv64-legal-i32 | FileCheck %s -check-prefixes=CHECK,RV64ZBB-
ZBKB,RV64ZBKB

define signext i32 @andn_i32(i32 signext %a, i32 signext %b) nounwind {
; RV64I-LABEL: andn_i32:
; RV64I:      # %bb.0:
; RV64I-NEXT:  not a1, a1
; RV64I-NEXT:  and a0, a1, a0
; RV64I-NEXT:  ret
;
; RV64ZBB-ZBKB-LABEL: andn_i32:
; RV64ZBB-ZBKB:  # %bb.0:
; RV64ZBB-ZBKB-NEXT:  andn a0, a0, a1
; RV64ZBB-ZBKB-NEXT:  ret
%neg = xor i32 %b, -1
%and = and i32 %neg, %a
ret i32 %and
}

define i64 @andn_i64(i64 %a, i64
%b) nounwind {
; RV64I-LABEL: andn_i64:
; RV64I:      # %bb.0:
; RV64I-NEXT:  not a1, a1
; RV64I-NEXT:  and a0, a1, a0
; RV64I-NEXT:  ret
;
; RV64ZBB-ZBKB-LABEL: andn_i64:
; RV64ZBB-ZBKB:  # %bb.0:

```

```

; RV64ZBB-ZBKB-NEXT: andn a0, a0, a1
; RV64ZBB-ZBKB-NEXT: ret
%neg = xor i64 %b, -1
%and = and i64 %neg, %a
ret i64 %and
}

define signext i32 @orn_i32(i32 signext %a, i32 signext %b) nounwind {
; RV64I-LABEL: orn_i32:
; RV64I:    # %bb.0:
; RV64I-NEXT: not a1, a1
; RV64I-NEXT: or a0, a1, a0
; RV64I-NEXT: ret
;
; RV64ZBB-ZBKB-LABEL: orn_i32:
; RV64ZBB-ZBKB:    # %bb.0:
; RV64ZBB-ZBKB-NEXT: orn a0, a0, a1
; RV64ZBB-ZBKB-NEXT: ret
%neg = xor i32 %b, -1
%or = or i32 %neg, %a
ret i32 %or
}

define i64 @orn_i64(i64 %a, i64 %b) nounwind {
; RV64I-LABEL: orn_i64:
; RV64I:    # %bb.0:
; RV64I-NEXT: not a1, a1
; RV64I-NEXT: or a0, a1, a0
; RV64I-NEXT: ret
;
; RV64ZBB-ZBKB-LABEL: orn_i64:
; RV64ZBB-ZBKB:    # %bb.0:
; RV64ZBB-ZBKB-NEXT:
    orn a0, a0, a1
; RV64ZBB-ZBKB-NEXT: ret
%neg = xor i64 %b, -1
%or = or i64 %neg, %a
ret i64 %or
}

define signext i32 @xnor_i32(i32 signext %a, i32 signext %b) nounwind {
; CHECK-LABEL: xnor_i32:
; CHECK:    # %bb.0:
; CHECK-NEXT: xor a0, a0, a1
; CHECK-NEXT: not a0, a0
; CHECK-NEXT: ret
%neg = xor i32 %a, -1
%xor = xor i32 %neg, %b

```

```
ret i32 %xor
}
```

```
define i64 @xnor_i64(i64 %a, i64 %b) nounwind {
; RV64I-LABEL: xnor_i64:
; RV64I:      # %bb.0:
; RV64I-NEXT:  xor a0, a0, a1
; RV64I-NEXT:  not a0, a0
; RV64I-NEXT:  ret
;
; RV64ZBB-ZBKB-LABEL: xnor_i64:
; RV64ZBB-ZBKB:  # %bb.0:
; RV64ZBB-ZBKB-NEXT:  xnor a0, a0, a1
; RV64ZBB-ZBKB-NEXT:  ret
%neg = xor i64 %a, -1
%xor = xor i64 %neg, %b
ret i64 %xor
}
```

```
declare i32 @llvm.fshl.i32(i32, i32, i32)
```

```
define signext i32 @rol_i32(i32 signext %a, i32 signext %b) nounwind {
; RV64I-LABEL: rol_i32:
; RV64I:      # %bb.0:
; RV64I-NEXT:  andi a2, a1, -1
; RV64I-NEXT:  sllw a1, a0, a1
; RV64I-NEXT:
    negw a2, a2
; RV64I-NEXT:  srlw a0, a0, a2
; RV64I-NEXT:  or a0, a1, a0
; RV64I-NEXT:  ret
;
; RV64ZBB-ZBKB-LABEL: rol_i32:
; RV64ZBB-ZBKB:  # %bb.0:
; RV64ZBB-ZBKB-NEXT:  rolw a0, a0, a1
; RV64ZBB-ZBKB-NEXT:  ret
%1 = tail call i32 @llvm.fshl.i32(i32 %a, i32 %a, i32 %b)
ret i32 %1
}
```

; Similar to rol\_i32, but doesn't sign extend the result.

```
define void @rol_i32_nosext(i32 signext %a, i32 signext %b, ptr %x) nounwind {
; RV64I-LABEL: rol_i32_nosext:
; RV64I:      # %bb.0:
; RV64I-NEXT:  andi a3, a1, -1
; RV64I-NEXT:  sllw a1, a0, a1
; RV64I-NEXT:  negw a3, a3
; RV64I-NEXT:  srlw a0, a0, a3
```

```

; RV64I-NEXT:  or a0, a1, a0
; RV64I-NEXT:  sw a0, 0(a2)
; RV64I-NEXT:  ret
;
; RV64ZBB-ZBKB-LABEL: rol_i32_nosext:
; RV64ZBB-ZBKB:    # %bb.0:
; RV64ZBB-ZBKB-NEXT:  rolw a0, a0, a1
; RV64ZBB-ZBKB-NEXT:  sw a0, 0(a2)
; RV64ZBB-ZBKB-NEXT:  ret
%1 = tail call i32 @llvm.fshl.i32(i32 %a, i32 %a, i32 %b)
store i32 %1, ptr %x
ret void
}

```

```

define signext
  i32 @rol_i32_neg_constant_rhs(i32 signext %a) nounwind {
; RV64I-LABEL: rol_i32_neg_constant_rhs:
; RV64I:    # %bb.0:
; RV64I-NEXT:  andi a1, a0, -1
; RV64I-NEXT:  li a2, -2
; RV64I-NEXT:  sllw a0, a2, a0
; RV64I-NEXT:  negw a1, a1
; RV64I-NEXT:  srlw a1, a2, a1
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBB-ZBKB-LABEL: rol_i32_neg_constant_rhs:
; RV64ZBB-ZBKB:    # %bb.0:
; RV64ZBB-ZBKB-NEXT:  li a1, -2
; RV64ZBB-ZBKB-NEXT:  rolw a0, a1, a0
; RV64ZBB-ZBKB-NEXT:  ret
%1 = tail call i32 @llvm.fshl.i32(i32 -2, i32 -2, i32 %a)
ret i32 %1
}

```

```

declare i64 @llvm.fshl.i64(i64, i64, i64)

```

```

define i64 @rol_i64(i64 %a, i64 %b) nounwind {
; RV64I-LABEL: rol_i64:
; RV64I:    # %bb.0:
; RV64I-NEXT:  sll a2, a0, a1
; RV64I-NEXT:  negw a1, a1
; RV64I-NEXT:  srl a0, a0, a1
; RV64I-NEXT:  or a0, a2, a0
; RV64I-NEXT:  ret
;
; RV64ZBB-ZBKB-LABEL: rol_i64:
; RV64ZBB-ZBKB:    # %bb.0:

```



```

; RV64ZBB-ZBKB-NEXT:  rol a0, a0, a1
; RV64ZBB-ZBKB-NEXT:
    ret
%or = tail call i64 @llvm.fshl.i64(i64 %a, i64 %a, i64 %b)
ret i64 %or
}

declare i32 @llvm.fshr.i32(i32, i32, i32)

define signext i32 @ror_i32(i32 signext %a, i32 signext %b) nounwind {
; RV64I-LABEL: ror_i32:
; RV64I:      # %bb.0:
; RV64I-NEXT:  andi a2, a1, -1
; RV64I-NEXT:  srlw a1, a0, a1
; RV64I-NEXT:  negw a2, a2
; RV64I-NEXT:  sllw a0, a0, a2
; RV64I-NEXT:  or a0, a1, a0
; RV64I-NEXT:  ret
;
; RV64ZBB-ZBKB-LABEL: ror_i32:
; RV64ZBB-ZBKB:  # %bb.0:
; RV64ZBB-ZBKB-NEXT:  rorw a0, a0, a1
; RV64ZBB-ZBKB-NEXT:  ret
%1 = tail call i32 @llvm.fshr.i32(i32 %a, i32 %a, i32 %b)
ret i32 %1
}

```

```

; Similar to ror_i32, but doesn't sign extend the result.
define void @ror_i32_nosext(i32 signext %a, i32 signext %b, ptr %x) nounwind {
; RV64I-LABEL: ror_i32_nosext:
; RV64I:      # %bb.0:
; RV64I-NEXT:  andi a3, a1, -1
; RV64I-NEXT:  srlw a1, a0, a1
; RV64I-NEXT:  negw a3, a3
; RV64I-NEXT:  sllw a0, a0, a3
; RV64I-NEXT:  or a0, a1, a0
; RV64I-NEXT:
    sw a0, 0(a2)
; RV64I-NEXT:  ret
;
; RV64ZBB-ZBKB-LABEL: ror_i32_nosext:
; RV64ZBB-ZBKB:  # %bb.0:
; RV64ZBB-ZBKB-NEXT:  rorw a0, a0, a1
; RV64ZBB-ZBKB-NEXT:  sw a0, 0(a2)
; RV64ZBB-ZBKB-NEXT:  ret
%1 = tail call i32 @llvm.fshr.i32(i32 %a, i32 %a, i32 %b)
store i32 %1, ptr %x
ret void

```

```
}
```

```
define signext i32 @ror_i32_neg_constant_rhs(i32 signext %a) nounwind {  
; RV64I-LABEL: ror_i32_neg_constant_rhs:  
; RV64I:      # %bb.0:  
; RV64I-NEXT: andi a1, a0, -1  
; RV64I-NEXT: li a2, -2  
; RV64I-NEXT: srlw a0, a2, a0  
; RV64I-NEXT: negw a1, a1  
; RV64I-NEXT: sllw a1, a2, a1  
; RV64I-NEXT: or a0, a0, a1  
; RV64I-NEXT: ret  
;  
; RV64ZBB-ZBKB-LABEL: ror_i32_neg_constant_rhs:  
; RV64ZBB-ZBKB:      # %bb.0:  
; RV64ZBB-ZBKB-NEXT: li a1, -2  
; RV64ZBB-ZBKB-NEXT: rorw a0, a1, a0  
; RV64ZBB-ZBKB-NEXT: ret  
%1 = tail call i32 @llvm.fshr.i32(i32 -2, i32 -2, i32 %a)  
ret i32 %1  
}
```

```
declare i64 @llvm.fshr.i64(i64, i64, i64)
```

```
define i64 @ror_i64(i64 %a, i64 %b) nounwind {  
;  
RV64I-LABEL: ror_i64:  
; RV64I:      # %bb.0:  
; RV64I-NEXT: srl a2, a0, a1  
; RV64I-NEXT: negw a1, a1  
; RV64I-NEXT: sll a0, a0, a1  
; RV64I-NEXT: or a0, a2, a0  
; RV64I-NEXT: ret  
;  
; RV64ZBB-ZBKB-LABEL: ror_i64:  
; RV64ZBB-ZBKB:      # %bb.0:  
; RV64ZBB-ZBKB-NEXT: ror a0, a0, a1  
; RV64ZBB-ZBKB-NEXT: ret  
%or = tail call i64 @llvm.fshr.i64(i64 %a, i64 %a, i64 %b)  
ret i64 %or  
}
```

```
define signext i32 @rori_i32_fshl(i32 signext %a) nounwind {  
; RV64I-LABEL: rori_i32_fshl:  
; RV64I:      # %bb.0:  
; RV64I-NEXT: srliw a1, a0, 1  
; RV64I-NEXT: slliw a0, a0, 31  
; RV64I-NEXT: or a0, a0, a1
```

```

; RV64I-NEXT:  ret
;
; RV64ZBB-ZBKB-LABEL: rori_i32_fshl:
; RV64ZBB-ZBKB:    # %bb.0:
; RV64ZBB-ZBKB-NEXT:  roriw a0, a0, 1
; RV64ZBB-ZBKB-NEXT:  ret
%1 = tail call i32 @llvm.fshl.i32(i32 %a, i32 %a, i32 31)
ret i32 %1
}

; Similar to rori_i32_fshl, but doesn't sign extend the result.
define void @rori_i32_fshl_nosext(i32 signext %a, ptr %x) nounwind {
; RV64I-LABEL: rori_i32_fshl_nosext:
;
RV64I:    # %bb.0:
; RV64I-NEXT:  srlw a2, a0, 1
; RV64I-NEXT:  slli a0, a0, 31
; RV64I-NEXT:  or a0, a0, a2
; RV64I-NEXT:  sw a0, 0(a1)
; RV64I-NEXT:  ret
;
; RV64ZBB-ZBKB-LABEL: rori_i32_fshl_nosext:
; RV64ZBB-ZBKB:    # %bb.0:
; RV64ZBB-ZBKB-NEXT:  roriw a0, a0, 1
; RV64ZBB-ZBKB-NEXT:  sw a0, 0(a1)
; RV64ZBB-ZBKB-NEXT:  ret
%1 = tail call i32 @llvm.fshl.i32(i32 %a, i32 %a, i32 31)
store i32 %1, ptr %x
ret void
}

define signext i32 @rori_i32_fshr(i32 signext %a) nounwind {
; RV64I-LABEL: rori_i32_fshr:
; RV64I:    # %bb.0:
; RV64I-NEXT:  sllw a1, a0, 1
; RV64I-NEXT:  srlw a0, a0, 31
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBB-ZBKB-LABEL: rori_i32_fshr:
; RV64ZBB-ZBKB:    # %bb.0:
; RV64ZBB-ZBKB-NEXT:  roriw a0, a0, 31
; RV64ZBB-ZBKB-NEXT:  ret
%1 = tail call i32 @llvm.fshr.i32(i32 %a, i32 %a, i32 31)
ret i32 %1
}

```

; Similar to rori\_i32\_fshr, but doesn't sign extend the result.

```

define void @rori_i32_fshr_nosext(i32
  signext %a, ptr %x) nounwind {
; RV64I-LABEL: rori_i32_fshr_nosext:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a2, a0, 1
; RV64I-NEXT:  srlw a0, a0, 31
; RV64I-NEXT:  or a0, a0, a2
; RV64I-NEXT:  sw a0, 0(a1)
; RV64I-NEXT:  ret
;
; RV64ZBB-ZBKB-LABEL: rori_i32_fshr_nosext:
; RV64ZBB-ZBKB:  # %bb.0:
; RV64ZBB-ZBKB-NEXT:  roriw a0, a0, 31
; RV64ZBB-ZBKB-NEXT:  sw a0, 0(a1)
; RV64ZBB-ZBKB-NEXT:  ret
%1 = tail call i32 @llvm.fshr.i32(i32 %a, i32 %a, i32 31)
store i32 %1, ptr %x
ret void
}

```

; This test is similar to the type legalized version of the fshl/fshr tests, but  
; instead of having the same input to both shifts it has different inputs. Make  
; sure we don't match it as a roriw.

```

define signext i32 @not_rori_i32(i32 signext %x, i32 signext %y) nounwind {
; CHECK-LABEL: not_rori_i32:
; CHECK:      # %bb.0:
; CHECK-NEXT:  slliw a0, a0, 31
; CHECK-NEXT:  srlw a1, a1, 1
; CHECK-NEXT:  or a0, a0, a1
; CHECK-NEXT:  ret
%a = shl
i32 %x, 31
%b = lshr i32 %y, 1
%c = or i32 %a, %b
ret i32 %c
}

```

; This is similar to the type legalized roriw pattern, but the and mask is more  
; than 32 bits so the lshr doesn't shift zeroes into the lower 32 bits. Make  
; sure we don't match it to roriw.

```

define i64 @roriw_bug(i64 %x) nounwind {
; CHECK-LABEL: roriw_bug:
; CHECK:      # %bb.0:
; CHECK-NEXT:  slli a1, a0, 31
; CHECK-NEXT:  andi a2, a0, -2
; CHECK-NEXT:  srli a0, a0, 1
; CHECK-NEXT:  or a0, a1, a0
; CHECK-NEXT:  sext.w a0, a0

```

```

; CHECK-NEXT:  xor a0, a2, a0
; CHECK-NEXT:  ret
%a = shl i64 %x, 31
%b = and i64 %x, 18446744073709551614
%c = lshr i64 %b, 1
%d = or i64 %a, %c
%e = shl i64 %d, 32
%f = ashr i64 %e, 32
%g = xor i64 %b, %f ; to increase the use count on %b to disable SimplifyDemandedBits.
ret i64 %g
}

```

```

define i64 @rori_i64_fshl(i64 %a) nounwind {
; RV64I-LABEL: rori_i64_fshl:
; RV64I:      # %bb.0:
; RV64I-NEXT:  srli a1, a0, 1
; RV64I-NEXT:  slli a0, a0, 63
; RV64I-NEXT:
    or a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBB-ZBKB-LABEL: rori_i64_fshl:
; RV64ZBB-ZBKB:  # %bb.0:
; RV64ZBB-ZBKB-NEXT:  rori a0, a0, 1
; RV64ZBB-ZBKB-NEXT:  ret
%1 = tail call i64 @llvm.fshl.i64(i64 %a, i64 %a, i64 63)
ret i64 %1
}

```

```

define i64 @rori_i64_fshr(i64 %a) nounwind {
; RV64I-LABEL: rori_i64_fshr:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a1, a0, 1
; RV64I-NEXT:  srli a0, a0, 63
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBB-ZBKB-LABEL: rori_i64_fshr:
; RV64ZBB-ZBKB:  # %bb.0:
; RV64ZBB-ZBKB-NEXT:  rori a0, a0, 63
; RV64ZBB-ZBKB-NEXT:  ret
%1 = tail call i64 @llvm.fshr.i64(i64 %a, i64 %a, i64 63)
ret i64 %1
}

```

```

define signext i32 @not_shl_one_i32(i32 signext %x) {
; RV64I-LABEL: not_shl_one_i32:
; RV64I:      # %bb.0:

```

```

; RV64I-NEXT:  li a1, 1
; RV64I-NEXT:  sllw a0, a1, a0
; RV64I-NEXT:  not a0, a0
; RV64I-NEXT:  ret
;
; RV64ZBB-ZBKB-LABEL: not_shl_one_i32:
; RV64ZBB-ZBKB:    # %bb.0:
; RV64ZBB-ZBKB-NEXT:  li a1,
-2
; RV64ZBB-ZBKB-NEXT:  rolw a0, a1, a0
; RV64ZBB-ZBKB-NEXT:  ret
%1 = shl i32 1, %x
%2 = xor i32 %1, -1
ret i32 %2
}

```

```

define i64 @not_shl_one_i64(i64 %x) {
; RV64I-LABEL: not_shl_one_i64:
; RV64I:    # %bb.0:
; RV64I-NEXT:  li a1, 1
; RV64I-NEXT:  sll a0, a1, a0
; RV64I-NEXT:  not a0, a0
; RV64I-NEXT:  ret
;
; RV64ZBB-ZBKB-LABEL: not_shl_one_i64:
; RV64ZBB-ZBKB:    # %bb.0:
; RV64ZBB-ZBKB-NEXT:  li a1, -2
; RV64ZBB-ZBKB-NEXT:  rol a0, a1, a0
; RV64ZBB-ZBKB-NEXT:  ret
%1 = shl i64 1, %x
%2 = xor i64 %1, -1
ret i64 %2
}

```

```

define i8 @srli_i8(i8 %a) nounwind {
; CHECK-LABEL: srli_i8:
; CHECK:    # %bb.0:
; CHECK-NEXT:  slli a0, a0, 56
; CHECK-NEXT:  srli a0, a0, 62
; CHECK-NEXT:  ret
%1 = lshr i8 %a, 6
ret i8 %1
}

```

; We could use sext.b+srai, but slli+srai offers more opportunities for  
; compressed instructions.

```

define i8 @srai_i8(i8 %a) nounwind {
; RV64I-LABEL: srai_i8:

```

```

; RV64I:    # %bb.0:
; RV64I-NEXT:  slli a0, a0, 24
; RV64I-NEXT:
    sraiw a0, a0, 29
; RV64I-NEXT:  ret
;
; RV64ZBB-LABEL: srli_i8:
; RV64ZBB:    # %bb.0:
; RV64ZBB-NEXT:  slli a0, a0, 56
; RV64ZBB-NEXT:  srli a0, a0, 61
; RV64ZBB-NEXT:  ret
;
; RV64ZBKB-LABEL: srli_i8:
; RV64ZBKB:    # %bb.0:
; RV64ZBKB-NEXT:  slli a0, a0, 24
; RV64ZBKB-NEXT:  sraiw a0, a0, 29
; RV64ZBKB-NEXT:  ret
%1 = ashr i8 %a, 5
ret i8 %1
}

```

; We could use zext.h+srli, but slli+srli offers more opportunities for  
; compressed instructions.

```

define i16 @srli_i16(i16 %a) nounwind {
; CHECK-LABEL: srli_i16:
; CHECK:    # %bb.0:
; CHECK-NEXT:  slli a0, a0, 48
; CHECK-NEXT:  srli a0, a0, 54
; CHECK-NEXT:  ret
%1 = lshr i16 %a, 6
ret i16 %1
}

```

; We could use sext.h+srai, but slli+srai offers more opportunities for  
; compressed instructions.

```

define i16 @srai_i16(i16 %a) nounwind {
; RV64I-LABEL: srai_i16:
; RV64I:    # %bb.0:
; RV64I-NEXT:  slli a0, a0, 16
; RV64I-NEXT:  sraiw a0, a0, 25
; RV64I-NEXT:  ret
;
; RV64ZBB-LABEL: srai_i16:
;
; RV64ZBB:    # %bb.0:
; RV64ZBB-NEXT:  slli a0, a0, 48
; RV64ZBB-NEXT:  srai a0, a0, 57
; RV64ZBB-NEXT:  ret

```

```

;
; RV64ZBKB-LABEL: srai_i16:
; RV64ZBKB:    # %bb.0:
; RV64ZBKB-NEXT:  slli a0, a0, 16
; RV64ZBKB-NEXT:  sraiw a0, a0, 25
; RV64ZBKB-NEXT:  ret
%1 = ashr i16 %a, 9
ret i16 %1
}

define i1 @andn_seqz_i32(i32 signext %a, i32 signext %b) nounwind {
; RV64I-LABEL: andn_seqz_i32:
; RV64I:    # %bb.0:
; RV64I-NEXT:  and a0, a0, a1
; RV64I-NEXT:  xor a0, a0, a1
; RV64I-NEXT:  seqz a0, a0
; RV64I-NEXT:  ret
;
; RV64ZBB-ZBKB-LABEL: andn_seqz_i32:
; RV64ZBB-ZBKB:    # %bb.0:
; RV64ZBB-ZBKB-NEXT:  andn a0, a1, a0
; RV64ZBB-ZBKB-NEXT:  seqz a0, a0
; RV64ZBB-ZBKB-NEXT:  ret
%and = and i32 %a, %b
%cmpeq = icmp eq i32 %and, %b
ret i1 %cmpeq
}

define i1 @andn_seqz_i64(i64 %a, i64 %b) nounwind {
; RV64I-LABEL: andn_seqz_i64:
; RV64I:    # %bb.0:
; RV64I-NEXT:  and a0, a0, a1
; RV64I-NEXT:  xor a0, a0, a1
; RV64I-NEXT:  seqz a0, a0
; RV64I-NEXT:
ret
;
; RV64ZBB-ZBKB-LABEL: andn_seqz_i64:
; RV64ZBB-ZBKB:    # %bb.0:
; RV64ZBB-ZBKB-NEXT:  andn a0, a1, a0
; RV64ZBB-ZBKB-NEXT:  seqz a0, a0
; RV64ZBB-ZBKB-NEXT:  ret
%and = and i64 %a, %b
%cmpeq = icmp eq i64 %and, %b
ret i1 %cmpeq
}

define i1 @andn_snez_i32(i32 signext %a, i32 signext %b) nounwind {

```



```

; RV64I-LABEL: andn_snez_i32:
; RV64I:    # %bb.0:
; RV64I-NEXT:  and a0, a0, a1
; RV64I-NEXT:  xor a0, a0, a1
; RV64I-NEXT:  snez a0, a0
; RV64I-NEXT:  ret
;
; RV64ZBB-ZBKB-LABEL: andn_snez_i32:
; RV64ZBB-ZBKB:    # %bb.0:
; RV64ZBB-ZBKB-NEXT:  andn a0, a1, a0
; RV64ZBB-ZBKB-NEXT:  snez a0, a0
; RV64ZBB-ZBKB-NEXT:  ret
%and = and i32 %a, %b
%cmpeq = icmp ne i32 %and, %b
ret i1 %cmpeq
}

define i1 @andn_snez_i64(i64 %a, i64 %b) nounwind {
; RV64I-LABEL: andn_snez_i64:
; RV64I:    # %bb.0:
; RV64I-NEXT:  and a0, a0, a1
; RV64I-NEXT:  xor a0, a0, a1
; RV64I-NEXT:  snez a0, a0
; RV64I-NEXT:  ret
;
; RV64ZBB-ZBKB-LABEL: andn_snez_i64:
;
; RV64ZBB-ZBKB:    # %bb.0:
; RV64ZBB-ZBKB-NEXT:  andn a0, a1, a0
; RV64ZBB-ZBKB-NEXT:  snez a0, a0
; RV64ZBB-ZBKB-NEXT:  ret
%and = and i64 %a, %b
%cmpeq = icmp ne i64 %and, %b
ret i1 %cmpeq
}

; NOTE: Assertions have been autogenerated by utils/update_llc_test_checks.py
; RUN: llc -mtriple=riscv64 -verify-machineinstrs < %s \
; RUN: -riscv-experimental-rv64-legal-i32 | FileCheck %s -check-prefixes=CHECK,RV64I
; RUN: llc -mtriple=riscv64 -mattr=+zbs -verify-machineinstrs < %s \
; RUN: -riscv-experimental-rv64-legal-i32 | FileCheck %s -check-prefixes=CHECK,RV64ZBS

define signext i32 @bclr_i32(i32 signext %a, i32 signext %b) nounwind {
; RV64I-LABEL: bclr_i32:
; RV64I:    # %bb.0:
; RV64I-NEXT:  li a2, 1
; RV64I-NEXT:  sllw a1, a2, a1
; RV64I-NEXT:  not a1, a1
; RV64I-NEXT:  and a0, a1, a0

```

```

; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: bclr_i32:
; RV64ZBS:      # %bb.0:
; RV64ZBS-NEXT:  andi a1, a1, 31
; RV64ZBS-NEXT:  bclr a0, a0, a1
; RV64ZBS-NEXT:  sext.w a0, a0
; RV64ZBS-NEXT:  ret
%and = and i32 %b, 31
%shl = shl nuw i32 1, %and
%neg = xor i32 %shl, -1
%and1 = and i32 %neg, %a
ret i32 %and1
}

define signext i32 @bclr_i32_no_mask(i32 signext %a,
i32 signext %b) nounwind {
; RV64I-LABEL: bclr_i32_no_mask:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a2, 1
; RV64I-NEXT:  sllw a1, a2, a1
; RV64I-NEXT:  not a1, a1
; RV64I-NEXT:  and a0, a1, a0
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: bclr_i32_no_mask:
; RV64ZBS:      # %bb.0:
; RV64ZBS-NEXT:  bclr a0, a0, a1
; RV64ZBS-NEXT:  sext.w a0, a0
; RV64ZBS-NEXT:  ret
%shl = shl i32 1, %b
%neg = xor i32 %shl, -1
%and1 = and i32 %neg, %a
ret i32 %and1
}

define signext i32 @bclr_i32_load(ptr %p, i32 signext %b) nounwind {
; RV64I-LABEL: bclr_i32_load:
; RV64I:      # %bb.0:
; RV64I-NEXT:  lw a0, 0(a0)
; RV64I-NEXT:  li a2, 1
; RV64I-NEXT:  sllw a1, a2, a1
; RV64I-NEXT:  not a1, a1
; RV64I-NEXT:  and a0, a1, a0
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: bclr_i32_load:
; RV64ZBS:      # %bb.0:

```

```

; RV64ZBS-NEXT:  lw a0, 0(a0)
; RV64ZBS-NEXT:  bclr a0, a0, a1
; RV64ZBS-NEXT:  sext.w a0, a0
; RV64ZBS-NEXT:  ret
%a = load i32, ptr %p
%shl = shl i32 1, %b
%neg
= xor i32 %shl, -1
%and1 = and i32 %neg, %a
ret i32 %and1
}

```

```

define i64 @bclr_i64(i64 %a, i64 %b) nounwind {
; RV64I-LABEL: bclr_i64:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a2, 1
; RV64I-NEXT:  sll a1, a2, a1
; RV64I-NEXT:  not a1, a1
; RV64I-NEXT:  and a0, a1, a0
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: bclr_i64:
; RV64ZBS:      # %bb.0:
; RV64ZBS-NEXT:  bclr a0, a0, a1
; RV64ZBS-NEXT:  ret
%and = and i64 %b, 63
%shl = shl nuw i64 1, %and
%neg = xor i64 %shl, -1
%and1 = and i64 %neg, %a
ret i64 %and1
}

```

```

define i64 @bclr_i64_no_mask(i64 %a, i64 %b) nounwind {
; RV64I-LABEL: bclr_i64_no_mask:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a2, 1
; RV64I-NEXT:  sll a1, a2, a1
; RV64I-NEXT:  not a1, a1
; RV64I-NEXT:  and a0, a1, a0
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: bclr_i64_no_mask:
; RV64ZBS:      # %bb.0:
; RV64ZBS-NEXT:  bclr a0, a0, a1
; RV64ZBS-NEXT:  ret
%shl = shl i64 1, %b
%neg = xor i64 %shl, -1
%and1 = and i64 %neg, %a

```

```

ret i64
%and1
}

define signext i32 @bset_i32(i32 signext %a, i32 signext %b) nounwind {
; RV64I-LABEL: bset_i32:
; RV64I:      # %bb.0:
; RV64I-NEXT: li a2, 1
; RV64I-NEXT: sllw a1, a2, a1
; RV64I-NEXT: or a0, a1, a0
; RV64I-NEXT: ret
;
; RV64ZBS-LABEL: bset_i32:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT: andi a1, a1, 31
; RV64ZBS-NEXT: bset a0, a0, a1
; RV64ZBS-NEXT: sext.w a0, a0
; RV64ZBS-NEXT: ret
%and = and i32 %b, 31
%shl = shl nuw i32 1, %and
%or = or i32 %shl, %a
ret i32 %or
}

define signext i32 @bset_i32_no_mask(i32 signext %a, i32 signext %b) nounwind {
; RV64I-LABEL: bset_i32_no_mask:
; RV64I:      # %bb.0:
; RV64I-NEXT: li a2, 1
; RV64I-NEXT: sllw a1, a2, a1
; RV64I-NEXT: or a0, a1, a0
; RV64I-NEXT: ret
;
; RV64ZBS-LABEL: bset_i32_no_mask:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT: bset a0, a0, a1
; RV64ZBS-NEXT: sext.w a0, a0
; RV64ZBS-NEXT: ret
%shl = shl i32 1, %b
%or = or i32 %shl, %a
ret i32 %or
}

define signext i32
@bset_i32_load(ptr %p, i32 signext %b) nounwind {
; RV64I-LABEL: bset_i32_load:
; RV64I:      # %bb.0:
; RV64I-NEXT: lw a0, 0(a0)
; RV64I-NEXT: li a2, 1

```

```

; RV64I-NEXT:  sllw a1, a2, a1
; RV64I-NEXT:  or a0, a1, a0
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: bset_i32_load:
; RV64ZBS:      # %bb.0:
; RV64ZBS-NEXT:  lw a0, 0(a0)
; RV64ZBS-NEXT:  bset a0, a0, a1
; RV64ZBS-NEXT:  sext.w a0, a0
; RV64ZBS-NEXT:  ret
%a = load i32, ptr %p
%shl = shl i32 1, %b
%or = or i32 %shl, %a
ret i32 %or
}

```

; We can use bsetw for  $1 \ll x$  by setting the first source to zero.  
define signext i32 @bset\_i32\_zero(i32 signext %a) nounwind {

```

; RV64I-LABEL: bset_i32_zero:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a1, 1
; RV64I-NEXT:  sllw a0, a1, a0
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: bset_i32_zero:
; RV64ZBS:      # %bb.0:
; RV64ZBS-NEXT:  bset a0, zero, a0
; RV64ZBS-NEXT:  sext.w a0, a0
; RV64ZBS-NEXT:  ret
%shl = shl i32 1, %a
ret i32 %shl
}

```

```

define i64 @bset_i64(i64 %a,
i64 %b) nounwind {
; RV64I-LABEL: bset_i64:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a2, 1
; RV64I-NEXT:  sll a1, a2, a1
; RV64I-NEXT:  or a0, a1, a0
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: bset_i64:
; RV64ZBS:      # %bb.0:
; RV64ZBS-NEXT:  bset a0, a0, a1
; RV64ZBS-NEXT:  ret
%conv = and i64 %b, 63
%shl = shl nuw i64 1, %conv

```

```

%or = or i64 %shl, %a
ret i64 %or
}

```

```

define i64 @bset_i64_no_mask(i64 %a, i64 %b) nounwind {
; RV64I-LABEL: bset_i64_no_mask:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a2, 1
; RV64I-NEXT:  sll a1, a2, a1
; RV64I-NEXT:  or a0, a1, a0
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: bset_i64_no_mask:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT:  bset a0, a0, a1
; RV64ZBS-NEXT:  ret
%shl = shl i64 1, %b
%or = or i64 %shl, %a
ret i64 %or
}

```

; We can use bsetw for  $1 \ll x$  by setting the first source to zero.

```

define signext i64 @bset_i64_zero(i64 signext %a) nounwind {
; RV64I-LABEL: bset_i64_zero:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li
a1, 1
; RV64I-NEXT:  sll a0, a1, a0
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: bset_i64_zero:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT:  bset a0, zero, a0
; RV64ZBS-NEXT:  ret
%shl = shl i64 1, %a
ret i64 %shl
}

```

```

define signext i32 @binv_i32(i32 signext %a, i32 signext %b) nounwind {
; RV64I-LABEL: binv_i32:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a2, 1
; RV64I-NEXT:  sllw a1, a2, a1
; RV64I-NEXT:  xor a0, a1, a0
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: binv_i32:
; RV64ZBS:    # %bb.0:

```

```

; RV64ZBS-NEXT:  andi a1, a1, 31
; RV64ZBS-NEXT:  binv a0, a0, a1
; RV64ZBS-NEXT:  sext.w a0, a0
; RV64ZBS-NEXT:  ret
%and = and i32 %b, 31
%shl = shl nuw i32 1, %and
%xor = xor i32 %shl, %a
ret i32 %xor
}

```

```

define signext i32 @binv_i32_no_mask(i32 signext %a, i32 signext %b) nounwind {
; RV64I-LABEL: binv_i32_no_mask:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a2, 1
; RV64I-NEXT:  sllw a1, a2, a1
; RV64I-NEXT:  xor a0, a1, a0
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: binv_i32_no_mask:
;
; RV64ZBS:      # %bb.0:
; RV64ZBS-NEXT:  binv a0, a0, a1
; RV64ZBS-NEXT:  sext.w a0, a0
; RV64ZBS-NEXT:  ret
%shl = shl i32 1, %b
%xor = xor i32 %shl, %a
ret i32 %xor
}

```

```

define signext i32 @binv_i32_load(ptr %p, i32 signext %b) nounwind {
; RV64I-LABEL: binv_i32_load:
; RV64I:      # %bb.0:
; RV64I-NEXT:  lw a0, 0(a0)
; RV64I-NEXT:  li a2, 1
; RV64I-NEXT:  sllw a1, a2, a1
; RV64I-NEXT:  xor a0, a1, a0
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: binv_i32_load:
; RV64ZBS:      # %bb.0:
; RV64ZBS-NEXT:  lw a0, 0(a0)
; RV64ZBS-NEXT:  binv a0, a0, a1
; RV64ZBS-NEXT:  sext.w a0, a0
; RV64ZBS-NEXT:  ret
%a = load i32, ptr %p
%shl = shl i32 1, %b
%xor = xor i32 %shl, %a
ret i32 %xor

```

```
}
```

```
define i64 @binv_i64(i64 %a, i64 %b) nounwind {  
; RV64I-LABEL: binv_i64:  
; RV64I:    # %bb.0:  
; RV64I-NEXT:  li a2, 1  
; RV64I-NEXT:  sll a1, a2, a1  
; RV64I-NEXT:  xor a0, a1, a0  
; RV64I-NEXT:  ret  
;  
; RV64ZBS-LABEL: binv_i64:  
; RV64ZBS:    # %bb.0:  
;  
RV64ZBS-NEXT:  binv a0, a0, a1  
; RV64ZBS-NEXT:  ret  
%conv = and i64 %b, 63  
%shl = shl nuw i64 1, %conv  
%xor = xor i64 %shl, %a  
ret i64 %xor  
}
```

```
define i64 @binv_i64_no_mask(i64 %a, i64 %b) nounwind {  
; RV64I-LABEL: binv_i64_no_mask:  
; RV64I:    # %bb.0:  
; RV64I-NEXT:  li a2, 1  
; RV64I-NEXT:  sll a1, a2, a1  
; RV64I-NEXT:  xor a0, a1, a0  
; RV64I-NEXT:  ret  
;  
; RV64ZBS-LABEL: binv_i64_no_mask:  
; RV64ZBS:    # %bb.0:  
; RV64ZBS-NEXT:  binv a0, a0, a1  
; RV64ZBS-NEXT:  ret  
%shl = shl nuw i64 1, %b  
%xor = xor i64 %shl, %a  
ret i64 %xor  
}
```

```
define signext i32 @bext_i32(i32 signext %a, i32 signext %b) nounwind {  
; RV64I-LABEL: bext_i32:  
; RV64I:    # %bb.0:  
; RV64I-NEXT:  srlw a0, a0, a1  
; RV64I-NEXT:  andi a0, a0, 1  
; RV64I-NEXT:  ret  
;  
; RV64ZBS-LABEL: bext_i32:  
; RV64ZBS:    # %bb.0:  
; RV64ZBS-NEXT:  andi a1, a1, 31
```



```

; RV64ZBS-NEXT:  bext a0, a0, a1
; RV64ZBS-NEXT:  ret
%and = and i32 %b, 31
%shr = lshr i32 %a, %and
%and1 = and i32
%shr, 1
ret i32 %and1
}

define signext i32 @bext_i32_no_mask(i32 signext %a, i32 signext %b) nounwind {
; RV64I-LABEL: bext_i32_no_mask:
; RV64I:      # %bb.0:
; RV64I-NEXT:  srlw a0, a0, a1
; RV64I-NEXT:  andi a0, a0, 1
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: bext_i32_no_mask:
; RV64ZBS:      # %bb.0:
; RV64ZBS-NEXT:  bext a0, a0, a1
; RV64ZBS-NEXT:  ret
%shr = lshr i32 %a, %b
%and1 = and i32 %shr, 1
ret i32 %and1
}

```

; This gets previous converted to (i1 (truncate (srl X, Y))). Make sure we are  
; able to use bext.

```

define void @bext_i32_trunc(i32 signext %0, i32 signext %1) {
; RV64I-LABEL: bext_i32_trunc:
; RV64I:      # %bb.0:
; RV64I-NEXT:  srlw a0, a0, a1
; RV64I-NEXT:  andi a0, a0, 1
; RV64I-NEXT:  beqz a0, .LBB19_2
; RV64I-NEXT:  # %bb.1:
; RV64I-NEXT:  ret
; RV64I-NEXT:  .LBB19_2:
; RV64I-NEXT:  tail bar
;
; RV64ZBS-LABEL: bext_i32_trunc:
; RV64ZBS:      # %bb.0:
; RV64ZBS-NEXT:  bext a0, a0, a1
; RV64ZBS-NEXT:  beqz a0, .LBB19_2
; RV64ZBS-NEXT:
; RV64ZBS-NEXT:  # %bb.1:
; RV64ZBS-NEXT:  ret
; RV64ZBS-NEXT:  .LBB19_2:
; RV64ZBS-NEXT:  tail bar
%3 = shl i32 1, %1

```

```

%4 = and i32 %3, %0
%5 = icmp eq i32 %4, 0
br i1 %5, label %6, label %7

```

```

6:                                ; preds = %2
tail call void @bar()
br label %7

```

```

7:                                ; preds = %6, %2
ret void
}

```

```

declare void @bar()

```

```

define i64 @bext_i64(i64 %a, i64 %b) nounwind {
; RV64I-LABEL: bext_i64:
; RV64I:      # %bb.0:
; RV64I-NEXT:  srl a0, a0, a1
; RV64I-NEXT:  andi a0, a0, 1
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: bext_i64:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT:  bext a0, a0, a1
; RV64ZBS-NEXT:  ret
%conv = and i64 %b, 63
%shr = lshr i64 %a, %conv
%and1 = and i64 %shr, 1
ret i64 %and1
}

```

```

define i64 @bext_i64_no_mask(i64 %a, i64 %b) nounwind {
; RV64I-LABEL: bext_i64_no_mask:
; RV64I:      # %bb.0:
; RV64I-NEXT:  srl a0, a0, a1
; RV64I-NEXT:  andi a0, a0, 1
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL:
bext_i64_no_mask:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT:  bext a0, a0, a1
; RV64ZBS-NEXT:  ret
%shr = lshr i64 %a, %b
%and1 = and i64 %shr, 1
ret i64 %and1
}

```

```

define signext i32 @bexti_i32(i32 signext %a) nounwind {
; RV64I-LABEL: bexti_i32:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a0, a0, 58
; RV64I-NEXT:  srli a0, a0, 63
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: bexti_i32:
; RV64ZBS:     # %bb.0:
; RV64ZBS-NEXT:  bexti a0, a0, 5
; RV64ZBS-NEXT:  ret
%shr = lshr i32 %a, 5
%and = and i32 %shr, 1
ret i32 %and
}

define i64 @bexti_i64(i64 %a) nounwind {
; RV64I-LABEL: bexti_i64:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a0, a0, 58
; RV64I-NEXT:  srli a0, a0, 63
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: bexti_i64:
; RV64ZBS:     # %bb.0:
; RV64ZBS-NEXT:  bexti a0, a0, 5
; RV64ZBS-NEXT:  ret
%shr = lshr i64 %a, 5
%and = and i64 %shr, 1
ret i64 %and
}

define signext i32 @bexti_i32_cmp(i32 signext %a) nounwind {
; CHECK-LABEL: bexti_i32_cmp:
;
CHECK:      # %bb.0:
; CHECK-NEXT:  andi a0, a0, 32
; CHECK-NEXT:  snez a0, a0
; CHECK-NEXT:  ret
%and = and i32 %a, 32
%cmp = icmp ne i32 %and, 0
%zext = zext i1 %cmp to i32
ret i32 %zext
}

define i64 @bexti_i64_cmp(i64 %a) nounwind {
; RV64I-LABEL: bexti_i64_cmp:
; RV64I:      # %bb.0:

```

```

; RV64I-NEXT:  slli a0, a0, 58
; RV64I-NEXT:  srli a0, a0, 63
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: bexti_i64_cmp:
; RV64ZBS:      # %bb.0:
; RV64ZBS-NEXT:  bexti a0, a0, 5
; RV64ZBS-NEXT:  ret
%and = and i64 %a, 32
%cmp = icmp ne i64 %and, 0
%zext = zext i1 %cmp to i64
ret i64 %zext
}

define signext i32 @bclri_i32_10(i32 signext %a) nounwind {
; CHECK-LABEL: bclri_i32_10:
; CHECK:      # %bb.0:
; CHECK-NEXT:  andi a0, a0, -1025
; CHECK-NEXT:  ret
%and = and i32 %a, -1025
ret i32 %and
}

define signext i32 @bclri_i32_11(i32 signext %a) nounwind {
; RV64I-LABEL: bclri_i32_11:
; RV64I:      # %bb.0:
; RV64I-NEXT:  lui a1, 1048575
; RV64I-NEXT:  addiw a1,
a1, 2047
; RV64I-NEXT:  and a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: bclri_i32_11:
; RV64ZBS:      # %bb.0:
; RV64ZBS-NEXT:  bclri a0, a0, 11
; RV64ZBS-NEXT:  ret
%and = and i32 %a, -2049
ret i32 %and
}

define signext i32 @bclri_i32_30(i32 signext %a) nounwind {
; RV64I-LABEL: bclri_i32_30:
; RV64I:      # %bb.0:
; RV64I-NEXT:  lui a1, 786432
; RV64I-NEXT:  addiw a1, a1, -1
; RV64I-NEXT:  and a0, a0, a1
; RV64I-NEXT:  ret
;

```

```
; RV64ZBS-LABEL: bclri_i32_30:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT:  bclri a0, a0, 30
; RV64ZBS-NEXT:  ret
%and = and i32 %a, -1073741825
ret i32 %and
}
```

```
define signext i32 @bclri_i32_31(i32 signext %a) nounwind {
; RV64I-LABEL: bclri_i32_31:
; RV64I:    # %bb.0:
; RV64I-NEXT:  slli a0, a0, 33
; RV64I-NEXT:  srli a0, a0, 33
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: bclri_i32_31:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT:  bclri a0, a0, 31
; RV64ZBS-NEXT:  sext.w a0, a0
; RV64ZBS-NEXT:  ret
%and = and i32 %a,
-2147483649
ret i32 %and
}
```

```
define i64 @bclri_i64_10(i64 %a) nounwind {
; CHECK-LABEL: bclri_i64_10:
; CHECK:    # %bb.0:
; CHECK-NEXT:  andi a0, a0, -1025
; CHECK-NEXT:  ret
%and = and i64 %a, -1025
ret i64 %and
}
```

```
define i64 @bclri_i64_11(i64 %a) nounwind {
; RV64I-LABEL: bclri_i64_11:
; RV64I:    # %bb.0:
; RV64I-NEXT:  lui a1, 1048575
; RV64I-NEXT:  addiw a1, a1, 2047
; RV64I-NEXT:  and a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: bclri_i64_11:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT:  bclri a0, a0, 11
; RV64ZBS-NEXT:  ret
%and = and i64 %a, -2049
ret i64 %and
}
```

```
}
```

```
define i64 @bclri_i64_30(i64 %a) nounwind {  
; RV64I-LABEL: bclri_i64_30:  
; RV64I:      # %bb.0:  
; RV64I-NEXT: lui a1, 786432  
; RV64I-NEXT: addiw a1, a1, -1  
; RV64I-NEXT: and a0, a0, a1  
; RV64I-NEXT: ret  
;  
; RV64ZBS-LABEL: bclri_i64_30:  
; RV64ZBS:    # %bb.0:  
; RV64ZBS-NEXT: bclri a0, a0, 30  
; RV64ZBS-NEXT: ret  
%and = and i64 %a, -1073741825  
ret i64 %and  
}
```

```
define  
i64 @bclri_i64_31(i64 %a) nounwind {  
; RV64I-LABEL: bclri_i64_31:  
; RV64I:      # %bb.0:  
; RV64I-NEXT: lui a1, 524288  
; RV64I-NEXT: addi a1, a1, -1  
; RV64I-NEXT: and a0, a0, a1  
; RV64I-NEXT: ret  
;  
; RV64ZBS-LABEL: bclri_i64_31:  
; RV64ZBS:    # %bb.0:  
; RV64ZBS-NEXT: bclri a0, a0, 31  
; RV64ZBS-NEXT: ret  
%and = and i64 %a, -2147483649  
ret i64 %and  
}
```

```
define i64 @bclri_i64_62(i64 %a) nounwind {  
; RV64I-LABEL: bclri_i64_62:  
; RV64I:      # %bb.0:  
; RV64I-NEXT: li a1, -1  
; RV64I-NEXT: slli a1, a1, 62  
; RV64I-NEXT: addi a1, a1, -1  
; RV64I-NEXT: and a0, a0, a1  
; RV64I-NEXT: ret  
;  
; RV64ZBS-LABEL: bclri_i64_62:  
; RV64ZBS:    # %bb.0:  
; RV64ZBS-NEXT: bclri a0, a0, 62  
; RV64ZBS-NEXT: ret
```

```

%and = and i64 %a, -4611686018427387905
ret i64 %and
}

define i64 @bclri_i64_63(i64 %a) nounwind {
; RV64I-LABEL: bclri_i64_63:
; RV64I:    # %bb.0:
; RV64I-NEXT:  slli a0, a0, 1
; RV64I-NEXT:  srli a0, a0, 1
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL:
bclri_i64_63:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT:  bclri a0, a0, 63
; RV64ZBS-NEXT:  ret
%and = and i64 %a, -9223372036854775809
ret i64 %and
}

define i64 @bclri_i64_large0(i64 %a) nounwind {
; RV64I-LABEL: bclri_i64_large0:
; RV64I:    # %bb.0:
; RV64I-NEXT:  lui a1, 1044480
; RV64I-NEXT:  addiw a1, a1, -256
; RV64I-NEXT:  and a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: bclri_i64_large0:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT:  andi a0, a0, -256
; RV64ZBS-NEXT:  bclri a0, a0, 24
; RV64ZBS-NEXT:  ret
%and = and i64 %a, -16777472
ret i64 %and
}

define i64 @bclri_i64_large1(i64 %a) nounwind {
; RV64I-LABEL: bclri_i64_large1:
; RV64I:    # %bb.0:
; RV64I-NEXT:  lui a1, 1044464
; RV64I-NEXT:  addiw a1, a1, -1
; RV64I-NEXT:  and a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: bclri_i64_large1:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT:  bclri a0, a0, 16

```

```

; RV64ZBS-NEXT:  bclri a0, a0, 24
; RV64ZBS-NEXT:  ret
%and = and i64 %a,
-16842753
ret i64 %and
}

define signext i32 @bseti_i32_10(i32 signext %a) nounwind {
; CHECK-LABEL: bseti_i32_10:
; CHECK:      # %bb.0:
; CHECK-NEXT:  ori a0, a0, 1024
; CHECK-NEXT:  ret
%or = or i32 %a, 1024
ret i32 %or
}

define signext i32 @bseti_i32_11(i32 signext %a) nounwind {
; RV64I-LABEL: bseti_i32_11:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a1, 1
; RV64I-NEXT:  slliw a1, a1, 11
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: bseti_i32_11:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT:  bseti a0, a0, 11
; RV64ZBS-NEXT:  ret
%or = or i32 %a, 2048
ret i32 %or
}

define signext i32 @bseti_i32_30(i32 signext %a) nounwind {
; RV64I-LABEL: bseti_i32_30:
; RV64I:      # %bb.0:
; RV64I-NEXT:  lui a1, 262144
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: bseti_i32_30:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT:  bseti a0, a0, 30
; RV64ZBS-NEXT:  ret
%or = or i32 %a, 1073741824
ret i32 %or
}

define signext i32

```



```

@bseti_i32_31(i32 signext %a) nounwind {
; RV64I-LABEL: bseti_i32_31:
; RV64I:      # %bb.0:
; RV64I-NEXT: lui a1, 524288
; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT: ret
;
; RV64ZBS-LABEL: bseti_i32_31:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT: bseti a0, a0, 31
; RV64ZBS-NEXT: sext.w a0, a0
; RV64ZBS-NEXT: ret
%or = or i32 %a, 2147483648
ret i32 %or
}

```

```

define i64 @bseti_i64_10(i64 %a) nounwind {
; CHECK-LABEL: bseti_i64_10:
; CHECK:      # %bb.0:
; CHECK-NEXT: ori a0, a0, 1024
; CHECK-NEXT: ret
%or = or i64 %a, 1024
ret i64 %or
}

```

```

define i64 @bseti_i64_11(i64 %a) nounwind {
; RV64I-LABEL: bseti_i64_11:
; RV64I:      # %bb.0:
; RV64I-NEXT: li a1, 1
; RV64I-NEXT: slli a1, a1, 11
; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT: ret
;
; RV64ZBS-LABEL: bseti_i64_11:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT: bseti a0, a0, 11
; RV64ZBS-NEXT: ret
%or = or i64 %a, 2048
ret i64 %or
}

```

```

define i64 @bseti_i64_30(i64 %a) nounwind {
; RV64I-LABEL: bseti_i64_30:
;
; RV64I:      # %bb.0:
; RV64I-NEXT: lui a1, 262144
; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT: ret

```

```

;
; RV64ZBS-LABEL: bseti_i64_30:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT:  bseti a0, a0, 30
; RV64ZBS-NEXT:  ret
%or = or i64 %a, 1073741824
ret i64 %or
}

define i64 @bseti_i64_31(i64 %a) nounwind {
; RV64I-LABEL: bseti_i64_31:
; RV64I:    # %bb.0:
; RV64I-NEXT:  li a1, 1
; RV64I-NEXT:  slli a1, a1, 31
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: bseti_i64_31:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT:  bseti a0, a0, 31
; RV64ZBS-NEXT:  ret
%or = or i64 %a, 2147483648
ret i64 %or
}

define i64 @bseti_i64_62(i64 %a) nounwind {
; RV64I-LABEL: bseti_i64_62:
; RV64I:    # %bb.0:
; RV64I-NEXT:  li a1, 1
; RV64I-NEXT:  slli a1, a1, 62
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: bseti_i64_62:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT:  bseti a0, a0, 62
; RV64ZBS-NEXT:  ret
%or = or i64 %a,
4611686018427387904
ret i64 %or
}

define i64 @bseti_i64_63(i64 %a) nounwind {
; RV64I-LABEL: bseti_i64_63:
; RV64I:    # %bb.0:
; RV64I-NEXT:  li a1, -1
; RV64I-NEXT:  slli a1, a1, 63
; RV64I-NEXT:  or a0, a0, a1

```

```

; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: bseti_i64_63:
; RV64ZBS:      # %bb.0:
; RV64ZBS-NEXT:  bseti a0, a0, 63
; RV64ZBS-NEXT:  ret
%or = or i64 %a, 9223372036854775808
ret i64 %or
}

```

```

define signext i32 @binvi_i32_10(i32 signext %a) nounwind {
; CHECK-LABEL: binvi_i32_10:
; CHECK:      # %bb.0:
; CHECK-NEXT:  xori a0, a0, 1024
; CHECK-NEXT:  ret
%xor = xor i32 %a, 1024
ret i32 %xor
}

```

```

define signext i32 @binvi_i32_11(i32 signext %a) nounwind {
; RV64I-LABEL: binvi_i32_11:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a1, 1
; RV64I-NEXT:  slliw a1, a1, 11
; RV64I-NEXT:  xor a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: binvi_i32_11:
; RV64ZBS:      # %bb.0:
; RV64ZBS-NEXT:  binvi a0, a0, 11
; RV64ZBS-NEXT:  ret
%xor = xor i32 %a,
2048
ret i32 %xor
}

```

```

define signext i32 @binvi_i32_30(i32 signext %a) nounwind {
; RV64I-LABEL: binvi_i32_30:
; RV64I:      # %bb.0:
; RV64I-NEXT:  lui a1, 262144
; RV64I-NEXT:  xor a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: binvi_i32_30:
; RV64ZBS:      # %bb.0:
; RV64ZBS-NEXT:  binvi a0, a0, 30
; RV64ZBS-NEXT:  ret
%xor = xor i32 %a, 1073741824

```

```

ret i32 %xor
}

define signext i32 @binvi_i32_31(i32 signext %a) nounwind {
; RV64I-LABEL: binvi_i32_31:
; RV64I:      # %bb.0:
; RV64I-NEXT: lui a1, 524288
; RV64I-NEXT: xor a0, a0, a1
; RV64I-NEXT: ret
;
; RV64ZBS-LABEL: binvi_i32_31:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT: binvi a0, a0, 31
; RV64ZBS-NEXT: sext.w a0, a0
; RV64ZBS-NEXT: ret
%xor = xor i32 %a, 2147483648
ret i32 %xor
}

define i64 @binvi_i64_10(i64 %a) nounwind {
; CHECK-LABEL: binvi_i64_10:
; CHECK:      # %bb.0:
; CHECK-NEXT: xori a0, a0, 1024
; CHECK-NEXT: ret
%xor = xor i64 %a, 1024
ret i64 %xor
}

define i64 @binvi_i64_11(i64
%a) nounwind {
; RV64I-LABEL: binvi_i64_11:
; RV64I:      # %bb.0:
; RV64I-NEXT: li a1, 1
; RV64I-NEXT: slli a1, a1, 11
; RV64I-NEXT: xor a0, a0, a1
; RV64I-NEXT: ret
;
; RV64ZBS-LABEL: binvi_i64_11:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT: binvi a0, a0, 11
; RV64ZBS-NEXT: ret
%xor = xor i64 %a, 2048
ret i64 %xor
}

define i64 @binvi_i64_30(i64 %a) nounwind {
; RV64I-LABEL: binvi_i64_30:
; RV64I:      # %bb.0:

```

```

; RV64I-NEXT:  lui a1, 262144
; RV64I-NEXT:  xor a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: binvi_i64_30:
; RV64ZBS:      # %bb.0:
; RV64ZBS-NEXT:  binvi a0, a0, 30
; RV64ZBS-NEXT:  ret
%xor = xor i64 %a, 1073741824
ret i64 %xor
}

define i64 @binvi_i64_31(i64 %a) nounwind {
; RV64I-LABEL: binvi_i64_31:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a1, 1
; RV64I-NEXT:  slli a1, a1, 31
; RV64I-NEXT:  xor a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: binvi_i64_31:
; RV64ZBS:      # %bb.0:
; RV64ZBS-NEXT:  binvi
a0, a0, 31
; RV64ZBS-NEXT:  ret
%xor = xor i64 %a, 2147483648
ret i64 %xor
}

define i64 @binvi_i64_62(i64 %a) nounwind {
; RV64I-LABEL: binvi_i64_62:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a1, 1
; RV64I-NEXT:  slli a1, a1, 62
; RV64I-NEXT:  xor a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: binvi_i64_62:
; RV64ZBS:      # %bb.0:
; RV64ZBS-NEXT:  binvi a0, a0, 62
; RV64ZBS-NEXT:  ret
%xor = xor i64 %a, 4611686018427387904
ret i64 %xor
}

define i64 @binvi_i64_63(i64 %a) nounwind {
; RV64I-LABEL: binvi_i64_63:
; RV64I:      # %bb.0:

```

```

; RV64I-NEXT:  li a1, -1
; RV64I-NEXT:  slli a1, a1, 63
; RV64I-NEXT:  xor a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: binvi_i64_63:
; RV64ZBS:      # %bb.0:
; RV64ZBS-NEXT:  binvi a0, a0, 63
; RV64ZBS-NEXT:  ret
%xor = xor i64 %a, 9223372036854775808
ret i64 %xor
}

define i64 @xor_i64_large(i64 %a) nounwind {
; RV64I-LABEL: xor_i64_large:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a1, 1
; RV64I-NEXT:  slli
a1, a1, 32
; RV64I-NEXT:  addi a1, a1, 1
; RV64I-NEXT:  xor a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: xor_i64_large:
; RV64ZBS:      # %bb.0:
; RV64ZBS-NEXT:  binvi a0, a0, 0
; RV64ZBS-NEXT:  binvi a0, a0, 32
; RV64ZBS-NEXT:  ret
%xor = xor i64 %a, 4294967297
ret i64 %xor
}

define i64 @xor_i64_4099(i64 %a) nounwind {
; RV64I-LABEL: xor_i64_4099:
; RV64I:      # %bb.0:
; RV64I-NEXT:  lui a1, 1
; RV64I-NEXT:  addiw a1, a1, 3
; RV64I-NEXT:  xor a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: xor_i64_4099:
; RV64ZBS:      # %bb.0:
; RV64ZBS-NEXT:  xori a0, a0, 3
; RV64ZBS-NEXT:  binvi a0, a0, 12
; RV64ZBS-NEXT:  ret
%xor = xor i64 %a, 4099
ret i64 %xor
}

```

```

define i64 @xor_i64_96(i64 %a) nounwind {
; CHECK-LABEL: xor_i64_96:
; CHECK:      # %bb.0:
; CHECK-NEXT:  xori a0, a0, 96
; CHECK-NEXT:  ret
%xor = xor i64 %a, 96
ret i64 %xor
}

define i64 @or_i64_large(i64 %a) nounwind {
; RV64I-LABEL: or_i64_large:
; RV64I:      # %bb.0:
; RV64I-NEXT:
    li a1, 1
; RV64I-NEXT:  slli a1, a1, 32
; RV64I-NEXT:  addi a1, a1, 1
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: or_i64_large:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT:  bseti a0, a0, 0
; RV64ZBS-NEXT:  bseti a0, a0, 32
; RV64ZBS-NEXT:  ret
%or = or i64 %a, 4294967297
ret i64 %or
}

define i64 @xor_i64_66901(i64 %a) nounwind {
; RV64I-LABEL: xor_i64_66901:
; RV64I:      # %bb.0:
; RV64I-NEXT:  lui a1, 16
; RV64I-NEXT:  addiw a1, a1, 1365
; RV64I-NEXT:  xor a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: xor_i64_66901:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT:  xori a0, a0, 1365
; RV64ZBS-NEXT:  binvi a0, a0, 16
; RV64ZBS-NEXT:  ret
%xor = xor i64 %a, 66901
ret i64 %xor
}

define i64 @or_i64_4099(i64 %a) nounwind {
; RV64I-LABEL: or_i64_4099:

```

```

; RV64I:    # %bb.0:
; RV64I-NEXT:  lui a1, 1
; RV64I-NEXT:  addiw a1, a1, 3
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: or_i64_4099:
; RV64ZBS:
    # %bb.0:
; RV64ZBS-NEXT:  ori a0, a0, 3
; RV64ZBS-NEXT:  bseti a0, a0, 12
; RV64ZBS-NEXT:  ret
%or = or i64 %a, 4099
ret i64 %or
}

```

```

define i64 @or_i64_96(i64 %a) nounwind {
; CHECK-LABEL: or_i64_96:
; CHECK:    # %bb.0:
; CHECK-NEXT:  ori a0, a0, 96
; CHECK-NEXT:  ret
%or = or i64 %a, 96
ret i64 %or
}

```

```

define i64 @or_i64_66901(i64 %a) nounwind {
; RV64I-LABEL: or_i64_66901:
; RV64I:    # %bb.0:
; RV64I-NEXT:  lui a1, 16
; RV64I-NEXT:  addiw a1, a1, 1365
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: or_i64_66901:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT:  ori a0, a0, 1365
; RV64ZBS-NEXT:  bseti a0, a0, 16
; RV64ZBS-NEXT:  ret
%or = or i64 %a, 66901
ret i64 %or
}

```

```

define signext i32 @bset_trailing_ones_i32_mask(i32 signext %a) nounwind {
; RV64I-LABEL: bset_trailing_ones_i32_mask:
; RV64I:    # %bb.0:
; RV64I-NEXT:  li a1, -1
; RV64I-NEXT:  sllw a0, a1, a0
; RV64I-NEXT:  not a0, a0

```



```

; RV64I-NEXT:  ret
;
;
RV64ZBS-LABEL: bset_trailing_ones_i32_mask:
; RV64ZBS:      # %bb.0:
; RV64ZBS-NEXT:  andi a0, a0, 31
; RV64ZBS-NEXT:  bset a0, zero, a0
; RV64ZBS-NEXT:  addiw a0, a0, -1
; RV64ZBS-NEXT:  ret
%and = and i32 %a, 31
%shift = shl nsw i32 -1, %and
%not = xor i32 %shift, -1
ret i32 %not
}

define signext i32 @bset_trailing_ones_i32_no_mask(i32 signext %a) nounwind {
; RV64I-LABEL: bset_trailing_ones_i32_no_mask:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a1, -1
; RV64I-NEXT:  sllw a0, a1, a0
; RV64I-NEXT:  not a0, a0
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: bset_trailing_ones_i32_no_mask:
; RV64ZBS:      # %bb.0:
; RV64ZBS-NEXT:  bset a0, zero, a0
; RV64ZBS-NEXT:  addiw a0, a0, -1
; RV64ZBS-NEXT:  ret
%shift = shl nsw i32 -1, %a
%not = xor i32 %shift, -1
ret i32 %not
}

define signext i64 @bset_trailing_ones_i64_mask(i64 signext %a) nounwind {
; RV64I-LABEL: bset_trailing_ones_i64_mask:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a1, -1
; RV64I-NEXT:  sll
a0, a1, a0
; RV64I-NEXT:  not a0, a0
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: bset_trailing_ones_i64_mask:
; RV64ZBS:      # %bb.0:
; RV64ZBS-NEXT:  bset a0, zero, a0
; RV64ZBS-NEXT:  addi a0, a0, -1
; RV64ZBS-NEXT:  ret
%and = and i64 %a, 63

```

```

%shift = shl nsw i64 -1, %and
%not = xor i64 %shift, -1
ret i64 %not
}

define signext i64 @bset_trailing_ones_i64_no_mask(i64 signext %a) nounwind {
; RV64I-LABEL: bset_trailing_ones_i64_no_mask:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a1, -1
; RV64I-NEXT:  sll a0, a1, a0
; RV64I-NEXT:  not a0, a0
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: bset_trailing_ones_i64_no_mask:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT:  bset a0, zero, a0
; RV64ZBS-NEXT:  addi a0, a0, -1
; RV64ZBS-NEXT:  ret
%shift = shl nsw i64 -1, %a
%not = xor i64 %shift, -1
ret i64 %not
}

; NOTE: Assertions have been autogenerated by utils/update_llc_test_checks.py
; RUN: llc -mtriple=riscv64 -verify-machineinstrs < %s \
; RUN: -riscv-experimental-rv64-legal-i32 | FileCheck -check-prefix=RV64I %s
; RUN: llc -mtriple=riscv64 -mattr=+m -verify-machineinstrs < %s \
; RUN: -riscv-experimental-rv64-legal-i32 | FileCheck -check-prefix=RV64IM %s

define i32 @urem(i32 %a, i32 %b) nounwind {
; RV64I-LABEL: urem:
; RV64I:      # %bb.0:
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  srli a0, a0, 32
; RV64I-NEXT:  slli a1, a1, 32
; RV64I-NEXT:  srli a1, a1, 32
; RV64I-NEXT:  call __umoddi3
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
;
; RV64IM-LABEL: urem:
; RV64IM:    # %bb.0:
; RV64IM-NEXT:  remuw a0, a0, a1
; RV64IM-NEXT:  ret
%1 = urem i32 %a, %b
ret i32 %1

```

```

}

define i32 @urem_constant_lhs(i32 %a) nounwind {
;
RV64I-LABEL: urem_constant_lhs:
; RV64I:    # %bb.0:
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  srli a1, a0, 32
; RV64I-NEXT:  li a0, 10
; RV64I-NEXT:  call __umoddi3
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
;
RV64IM-LABEL: urem_constant_lhs:
; RV64IM:    # %bb.0:
; RV64IM-NEXT:  li a1, 10
; RV64IM-NEXT:  remuw a0, a1, a0
; RV64IM-NEXT:  ret
%1 = urem i32 10, %a
ret i32 %1
}

```

```

define i32 @srem(i32 %a, i32 %b) nounwind {
; RV64I-LABEL: srem:
; RV64I:    # %bb.0:
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  sext.w a0, a0
; RV64I-NEXT:  sext.w a1, a1
; RV64I-NEXT:  call __moddi3
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
;
RV64IM-LABEL: srem:
; RV64IM:    # %bb.0:
; RV64IM-NEXT:
remw a0, a0, a1
; RV64IM-NEXT:  ret
%1 = srem i32 %a, %b
ret i32 %1
}

```

```

define i32 @srem_pow2(i32 %a) nounwind {
; RV64I-LABEL: srem_pow2:

```

```

; RV64I:    # %bb.0:
; RV64I-NEXT:  sraiw a1, a0, 31
; RV64I-NEXT:  srliw a1, a1, 29
; RV64I-NEXT:  add a1, a0, a1
; RV64I-NEXT:  andi a1, a1, -8
; RV64I-NEXT:  subw a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64IM-LABEL: srem_pow2:
; RV64IM:    # %bb.0:
; RV64IM-NEXT:  sraiw a1, a0, 31
; RV64IM-NEXT:  srliw a1, a1, 29
; RV64IM-NEXT:  add a1, a0, a1
; RV64IM-NEXT:  andi a1, a1, -8
; RV64IM-NEXT:  subw a0, a0, a1
; RV64IM-NEXT:  ret
%1 = srem i32 %a, 8
ret i32 %1
}

```

```

define i32 @srem_pow2_2(i32 %a) nounwind {
; RV64I-LABEL: srem_pow2_2:
; RV64I:    # %bb.0:
; RV64I-NEXT:  sraiw a1, a0, 31
; RV64I-NEXT:  srliw a1, a1, 16
; RV64I-NEXT:  add a1, a0, a1
; RV64I-NEXT:  lui a2, 1048560
; RV64I-NEXT:  and a1, a1, a2
; RV64I-NEXT:  subw a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64IM-LABEL: srem_pow2_2:
; RV64IM:
    # %bb.0:
; RV64IM-NEXT:  sraiw a1, a0, 31
; RV64IM-NEXT:  srliw a1, a1, 16
; RV64IM-NEXT:  add a1, a0, a1
; RV64IM-NEXT:  lui a2, 1048560
; RV64IM-NEXT:  and a1, a1, a2
; RV64IM-NEXT:  subw a0, a0, a1
; RV64IM-NEXT:  ret
%1 = srem i32 %a, 65536
ret i32 %1
}

```

```

define i32 @srem_constant_lhs(i32 %a) nounwind {
; RV64I-LABEL: srem_constant_lhs:
; RV64I:    # %bb.0:

```

```

; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  sext.w a1, a0
; RV64I-NEXT:  li a0, -10
; RV64I-NEXT:  call __moddi3
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
;
; RV64IM-LABEL: srem_constant_lhs:
; RV64IM:      # %bb.0:
; RV64IM-NEXT:  li a1, -10
; RV64IM-NEXT:  remw a0, a1, a0
; RV64IM-NEXT:  ret
%1 = srem i32 -10, %a
ret i32 %1
}

```

```

define i64 @urem64(i64 %a, i64 %b) nounwind {
; RV64I-LABEL: urem64:
; RV64I:      # %bb.0:
; RV64I-NEXT:  tail __umoddi3
;
; RV64IM-LABEL:
urem64:
; RV64IM:      # %bb.0:
; RV64IM-NEXT:  remu a0, a0, a1
; RV64IM-NEXT:  ret
%1 = urem i64 %a, %b
ret i64 %1
}

```

```

define i64 @urem64_constant_lhs(i64 %a) nounwind {
; RV64I-LABEL: urem64_constant_lhs:
; RV64I:      # %bb.0:
; RV64I-NEXT:  mv a1, a0
; RV64I-NEXT:  li a0, 10
; RV64I-NEXT:  tail __umoddi3
;
; RV64IM-LABEL: urem64_constant_lhs:
; RV64IM:      # %bb.0:
; RV64IM-NEXT:  li a1, 10
; RV64IM-NEXT:  remu a0, a1, a0
; RV64IM-NEXT:  ret
%1 = urem i64 10, %a
ret i64 %1
}

```

```

define i64 @srem64(i64 %a, i64 %b) nounwind {
; RV64I-LABEL: srem64:
; RV64I:      # %bb.0:
; RV64I-NEXT:  tail __moddi3
;
; RV64IM-LABEL: srem64:
; RV64IM:      # %bb.0:
; RV64IM-NEXT:  rem a0, a0, a1
; RV64IM-NEXT:  ret
%1 = srem i64 %a, %b
ret i64 %1
}

define i64 @srem64_constant_lhs(i64 %a) nounwind {
; RV64I-LABEL: srem64_constant_lhs:
; RV64I:      # %bb.0:
; RV64I-NEXT:  mv a1, a0
; RV64I-NEXT:  li a0, -10
; RV64I-NEXT:  tail __moddi3
;
; RV64IM-LABEL: srem64_constant_lhs:
;
; RV64IM:      # %bb.0:
; RV64IM-NEXT:  li a1, -10
; RV64IM-NEXT:  rem a0, a1, a0
; RV64IM-NEXT:  ret
%1 = srem i64 -10, %a
ret i64 %1
}

define i8 @urem8(i8 %a, i8 %b) nounwind {
; RV64I-LABEL: urem8:
; RV64I:      # %bb.0:
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  andi a0, a0, 255
; RV64I-NEXT:  andi a1, a1, 255
; RV64I-NEXT:  call __umoddi3
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
;
; RV64IM-LABEL: urem8:
; RV64IM:      # %bb.0:
; RV64IM-NEXT:  andi a1, a1, 255
; RV64IM-NEXT:  andi a0, a0, 255
; RV64IM-NEXT:  remuw a0, a0, a1
; RV64IM-NEXT:  ret

```

```

%1 = urem i8 %a, %b
ret i8 %1
}

define i8 @urem8_constant_lhs(i8 %a) nounwind {
; RV64I-LABEL: urem8_constant_lhs:
; RV64I:      # %bb.0:
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  andi a1, a0, 255
; RV64I-NEXT:
    li a0, 10
; RV64I-NEXT:  call __umoddi3
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
;
; RV64IM-LABEL: urem8_constant_lhs:
; RV64IM:      # %bb.0:
; RV64IM-NEXT:  andi a0, a0, 255
; RV64IM-NEXT:  li a1, 10
; RV64IM-NEXT:  remuw a0, a1, a0
; RV64IM-NEXT:  ret
    %1 = urem i8 10, %a
ret i8 %1
}

```

```

define i8 @srem8(i8 %a, i8 %b) nounwind {
; RV64I-LABEL: srem8:
; RV64I:      # %bb.0:
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  slli a1, a1, 24
; RV64I-NEXT:  sraiw a1, a1, 24
; RV64I-NEXT:  slli a0, a0, 24
; RV64I-NEXT:  sraiw a0, a0, 24
; RV64I-NEXT:  call __moddi3
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
;
; RV64IM-LABEL: srem8:
; RV64IM:      # %bb.0:
; RV64IM-NEXT:  slli a1, a1, 24
; RV64IM-NEXT:  sraiw a1, a1, 24
; RV64IM-NEXT:  slli a0, a0, 24
; RV64IM-NEXT:  sraiw

```

```

a0, a0, 24
; RV64IM-NEXT: remw a0, a0, a1
; RV64IM-NEXT: ret
%1 = srem i8 %a, %b
ret i8 %1
}

define i8 @srem8_constant_lhs(i8 %a) nounwind {
; RV64I-LABEL: srem8_constant_lhs:
; RV64I:    # %bb.0:
; RV64I-NEXT: addi sp, sp, -16
; RV64I-NEXT: sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT: slli a0, a0, 24
; RV64I-NEXT: sraiw a1, a0, 24
; RV64I-NEXT: li a0, -10
; RV64I-NEXT: call __moddi3
; RV64I-NEXT: ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT: addi sp, sp, 16
; RV64I-NEXT: ret
;
; RV64IM-LABEL: srem8_constant_lhs:
; RV64IM:    # %bb.0:
; RV64IM-NEXT: slli a0, a0, 24
; RV64IM-NEXT: sraiw a0, a0, 24
; RV64IM-NEXT: li a1, -10
; RV64IM-NEXT: remw a0, a1, a0
; RV64IM-NEXT: ret
%1 = srem i8 -10, %a
ret i8 %1
}

```

```

define i16 @urem16(i16 %a, i16 %b) nounwind {
; RV64I-LABEL: urem16:
; RV64I:    # %bb.0:
; RV64I-NEXT: addi sp, sp, -16
; RV64I-NEXT: sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT: lui a2, 16
; RV64I-NEXT:
    addiw a2, a2, -1
; RV64I-NEXT: and a0, a0, a2
; RV64I-NEXT: and a1, a1, a2
; RV64I-NEXT: call __umoddi3
; RV64I-NEXT: ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT: addi sp, sp, 16
; RV64I-NEXT: ret
;
; RV64IM-LABEL: urem16:

```



```

; RV64IM:    # %bb.0:
; RV64IM-NEXT:  lui a2, 16
; RV64IM-NEXT:  addi a2, a2, -1
; RV64IM-NEXT:  and a1, a1, a2
; RV64IM-NEXT:  and a0, a0, a2
; RV64IM-NEXT:  remuw a0, a0, a1
; RV64IM-NEXT:  ret
%1 = urem i16 %a, %b
ret i16 %1
}

```

```

define i16 @urem16_constant_lhs(i16 %a) nounwind {
; RV64I-LABEL: urem16_constant_lhs:
; RV64I:    # %bb.0:
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  slli a0, a0, 48
; RV64I-NEXT:  srli a1, a0, 48
; RV64I-NEXT:  li a0, 10
; RV64I-NEXT:  call __umoddi3
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
;
; RV64IM-LABEL: urem16_constant_lhs:
; RV64IM:    # %bb.0:
;
RV64IM-NEXT:  slli a0, a0, 48
; RV64IM-NEXT:  srli a0, a0, 48
; RV64IM-NEXT:  li a1, 10
; RV64IM-NEXT:  remuw a0, a1, a0
; RV64IM-NEXT:  ret
%1 = urem i16 10, %a
ret i16 %1
}

```

```

define i16 @srem16(i16 %a, i16 %b) nounwind {
; RV64I-LABEL: srem16:
; RV64I:    # %bb.0:
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  slli a1, a1, 16
; RV64I-NEXT:  sraiw a1, a1, 16
; RV64I-NEXT:  slli a0, a0, 16
; RV64I-NEXT:  sraiw a0, a0, 16
; RV64I-NEXT:  call __moddi3
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16

```

```

; RV64I-NEXT:  ret
;
; RV64IM-LABEL: srem16:
; RV64IM:      # %bb.0:
; RV64IM-NEXT:  slli a1, a1, 16
; RV64IM-NEXT:  sraiw a1, a1, 16
; RV64IM-NEXT:  slli a0, a0, 16
; RV64IM-NEXT:  sraiw a0, a0, 16
; RV64IM-NEXT:  remw a0, a0, a1
; RV64IM-NEXT:  ret
%1 = srem i16 %a, %b
ret i16 %1
}

define i16 @srem16_constant_lhs(i16 %a) nounwind {
; RV64I-LABEL: srem16_constant_lhs:
;
; RV64I:      # %bb.0:
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  slli a0, a0, 16
; RV64I-NEXT:  sraiw a1, a0, 16
; RV64I-NEXT:  li a0, -10
; RV64I-NEXT:  call __moddi3
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
;
; RV64IM-LABEL: srem16_constant_lhs:
; RV64IM:      # %bb.0:
; RV64IM-NEXT:  slli a0, a0, 16
; RV64IM-NEXT:  sraiw a0, a0, 16
; RV64IM-NEXT:  li a1, -10
; RV64IM-NEXT:  remw a0, a1, a0
; RV64IM-NEXT:  ret
%1 = srem i16 -10, %a
ret i16 %1
}

; NOTE: Assertions have been autogenerated by utils/update_llc_test_checks.py
; RUN: llc -mtriple=aarch64-apple-ios %s -o - | FileCheck %s

```

```

define <16 x double> @test_sitofp_fixed(<16 x i32> %in) {
; CHECK-LABEL: test_sitofp_fixed:
; CHECK:      ; %bb.0:
; CHECK-NEXT:  sshll2.2d v4, v0, #0
; CHECK-NEXT:  sshll.2d v0, v0, #0
; CHECK-NEXT:  sshll2.2d v5, v1, #0
; CHECK-NEXT:  sshll.2d v6, v1, #0

```

```
; CHECK-NEXT:  sshll.2d v7, v2, #0
; CHECK-NEXT:  sshll.2d v16, v2, #0
; CHECK-NEXT:  sshll.2d v17, v3, #0
; CHECK-NEXT:  sshll.2d v18, v3, #0
; CHECK-NEXT:  scvtf.2d v1, v4, #6
; CHECK-NEXT:  scvtf.2d v0, v0, #6
; CHECK-NEXT:  scvtf.2d v3, v5, #6
; CHECK-NEXT:  scvtf.2d v2, v6, #6
; CHECK-NEXT:  scvtf.2d v4, v7, #6
; CHECK-NEXT:  scvtf.2d v5, v16, #6
; CHECK-NEXT:  scvtf.2d v7, v17, #6
; CHECK-NEXT:  scvtf.2d v6, v18, #6
; CHECK-NEXT:  ret
```

```
%flt = sitofp <16 x i32> %in to <16 x double>
%res = fdiv <16 x double> %flt, <double 64.0, double 64.0, double 64.0,
double 64.0, double 64.0, double 64.0, double 64.0, double 64.0, double
64.0, double 64.0, double 64.0, double 64.0, double 64.0>
ret <16 x double> %res
}
```

; This one is small enough to satisfy isSimple, but still illegally large.

```
define <4 x double> @test_sitofp_fixed_shortish(<4 x i64> %in) {
; CHECK-LABEL: test_sitofp_fixed_shortish:
; CHECK:      ; %bb.0:
; CHECK-NEXT:  scvtf.2d v0, v0, #6
; CHECK-NEXT:  scvtf.2d v1, v1, #6
; CHECK-NEXT:  ret
```

```
%flt = sitofp <4 x i64> %in to <4 x double>
%res = fdiv <4 x double> %flt, <double 64.0, double 64.0, double 64.0, double 64.0>
ret <4 x double> %res
}
```

; NOTE: Assertions have been autogenerated by utils/update\_llc\_test\_checks.py

; RUN: llc -mtriple=riscv64 -verify-machineinstrs < %s \

; RUN: -riscv-experimental-rv64-legal-i32 | FileCheck %s -check-prefix=RV64I

; These tests are each targeted at a particular RISC-V ALU instruction. Most  
; other files in this folder exercise LLVM IR instructions that don't directly  
; match a RISC-V instruction.

; Register-immediate instructions.

```
define i32 @addi(i32 %a) nounwind {
; RV64I-LABEL: addi:
; RV64I:      # %bb.0:
; RV64I-NEXT:  addiw a0, a0, 1
```

```

; RV64I-NEXT:  ret
%1 = add i32 %a, 1
ret i32 %1
}

define i32 @slti(i32 %a) nounwind {
; RV64I-LABEL: slti:
; RV64I:      # %bb.0:
; RV64I-NEXT:  sext.w a0, a0
; RV64I-NEXT:  slti a0, a0, 2
; RV64I-NEXT:  ret
%1 = icmp slt i32 %a, 2
%2 = zext i1 %1 to i32
ret i32 %2
}

define i32 @sltiu(i32 %a) nounwind {
; RV64I-LABEL: sltiu:
; RV64I:      # %bb.0:
; RV64I-NEXT:  sext.w a0, a0
; RV64I-NEXT:  sltiu a0, a0, 3
; RV64I-NEXT:
    ret
%1 = icmp ult i32 %a, 3
%2 = zext i1 %1 to i32
ret i32 %2
}

define i32 @xori(i32 %a) nounwind {
; RV64I-LABEL: xori:
; RV64I:      # %bb.0:
; RV64I-NEXT:  xori a0, a0, 4
; RV64I-NEXT:  ret
%1 = xor i32 %a, 4
ret i32 %1
}

define i32 @ori(i32 %a) nounwind {
; RV64I-LABEL: ori:
; RV64I:      # %bb.0:
; RV64I-NEXT:  ori a0, a0, 5
; RV64I-NEXT:  ret
%1 = or i32 %a, 5
ret i32 %1
}

define i32 @andi(i32 %a) nounwind {
; RV64I-LABEL: andi:

```

```
; RV64I:    # %bb.0:
; RV64I-NEXT:  andi a0, a0, 6
; RV64I-NEXT:  ret
%1 = and i32 %a, 6
ret i32 %1
}
```

```
define i32 @slli(i32 %a) nounwind {
; RV64I-LABEL: slli:
; RV64I:    # %bb.0:
; RV64I-NEXT:  slliw a0, a0, 7
; RV64I-NEXT:  ret
%1 = shl i32 %a, 7
ret i32 %1
}
```

```
define i32 @srli(i32 %a) nounwind {
; RV64I-LABEL: srli:
; RV64I:    # %bb.0:
; RV64I-NEXT:  srliw a0, a0, 8
; RV64I-NEXT:  ret
%1 = lshr i32 %a, 8
ret i32 %1
}
```

```
define i32 @srai(i32 %a) nounwind {
; RV64I-LABEL: srai:
; RV64I:
  # %bb.0:
; RV64I-NEXT:  sraiw a0, a0, 9
; RV64I-NEXT:  ret
%1 = ashr i32 %a, 9
ret i32 %1
}
```

```
; Register-register instructions
```

```
define i32 @add(i32 %a, i32 %b) nounwind {
; RV64I-LABEL: add:
; RV64I:    # %bb.0:
; RV64I-NEXT:  addw a0, a0, a1
; RV64I-NEXT:  ret
%1 = add i32 %a, %b
ret i32 %1
}
```

```
define i32 @sub(i32 %a, i32 %b) nounwind {
; RV64I-LABEL: sub:
```

```
; RV64I:    # %bb.0:
; RV64I-NEXT:  subw a0, a0, a1
; RV64I-NEXT:  ret
%1 = sub i32 %a, %b
ret i32 %1
}
```

```
define i32 @sub_negative_constant_lhs(i32 %a) nounwind {
; RV64I-LABEL: sub_negative_constant_lhs:
; RV64I:    # %bb.0:
; RV64I-NEXT:  li a1, -2
; RV64I-NEXT:  subw a0, a1, a0
; RV64I-NEXT:  ret
%1 = sub i32 -2, %a
ret i32 %1
}
```

```
define i32 @sll(i32 %a, i32 %b) nounwind {
; RV64I-LABEL: sll:
; RV64I:    # %bb.0:
; RV64I-NEXT:  sllw a0, a0, a1
; RV64I-NEXT:  ret
%1 = shl i32 %a, %b
ret i32 %1
}
```

; Make sure we don't emit instructions to zero extend the shift amount to i64.

```
define
i32 @sll_shamt_zext(i32 %a, i32 %b) nounwind {
; RV64I-LABEL: sll_shamt_zext:
; RV64I:    # %bb.0:
; RV64I-NEXT:  addi a1, a1, 1
; RV64I-NEXT:  sllw a0, a0, a1
; RV64I-NEXT:  ret
%shamt = add i32 %b, 1
%1 = shl i32 %a, %shamt
ret i32 %1
}
```

```
define i32 @sll_negative_constant_lhs(i32 %a) nounwind {
; RV64I-LABEL: sll_negative_constant_lhs:
; RV64I:    # %bb.0:
; RV64I-NEXT:  li a1, -1
; RV64I-NEXT:  sllw a0, a1, a0
; RV64I-NEXT:  ret
%1 = shl i32 -1, %a
ret i32 %1
}
```

```

define i32 @slt(i32 %a, i32 %b) nounwind {
; RV64I-LABEL: slt:
; RV64I:      # %bb.0:
; RV64I-NEXT: sext.w a1, a1
; RV64I-NEXT: sext.w a0, a0
; RV64I-NEXT: slt a0, a0, a1
; RV64I-NEXT: ret
    %1 = icmp slt i32 %a, %b
    %2 = zext i1 %1 to i32
    ret i32 %2
}

```

```

define i32 @sltu(i32 %a, i32 %b) nounwind {
;
; RV64I-LABEL: sltu:
; RV64I:      # %bb.0:
; RV64I-NEXT: sext.w a1, a1
; RV64I-NEXT: sext.w a0, a0
; RV64I-NEXT: sltu a0, a0, a1
; RV64I-NEXT: ret
    %1 = icmp ult i32 %a,
    %b
    %2 = zext i1 %1 to i32
    ret i32 %2
}

```

```

define i32 @xor(i32 %a, i32 %b) nounwind {
;
; RV64I-LABEL: xor:
; RV64I:      # %bb.0:
; RV64I-NEXT: xor a0, a0, a1
; RV64I-NEXT: ret
    %1 = xor i32 %a, %b
    ret i32 %1
}

```

```

define i32 @srl(i32 %a, i32 %b) nounwind {
;
; RV64I-LABEL: srl:
; RV64I:      # %bb.0:
; RV64I-NEXT: srlw a0, a0, a1
; RV64I-NEXT: ret
    %1 = lshr i32 %a, %b
    ret i32 %1
}

```

; Make sure we don't emit instructions to zero extend the shift amount to i64.

```

define i32 @srl_shamt_zext(i32 %a, i32 %b) nounwind {
; RV64I-LABEL: srl_shamt_zext:
; RV64I:      # %bb.0:
; RV64I-NEXT:  addi a1, a1, 1
; RV64I-NEXT:  srlw a0, a0, a1
; RV64I-NEXT:  ret
%shamt = add i32 %b, 1
%1 = lshr i32 %a, %shamt
ret i32 %1
}

```

```

define i32 @srl_negative_constant_lhs(i32 %a) nounwind {
;
; RV64I-LABEL: srl_negative_constant_lhs:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a1, -1
; RV64I-NEXT:  srlw a0, a1, a0
; RV64I-NEXT:  ret
%1 = lshr i32 -1, %a
ret i32 %1
}

```

```

define
i32 @sra(i32 %a, i32 %b) nounwind {
;
; RV64I-LABEL: sra:
; RV64I:      # %bb.0:
; RV64I-NEXT:  saw a0, a0, a1
; RV64I-NEXT:  ret
%1 = ashr i32 %a, %b
ret i32 %1
}

```

; Make sure we don't emit instructions to zero extend the shift amount to i64.

```

define i32 @sra_shamt_zext(i32 %a, i32 %b) nounwind {
; RV64I-LABEL: sra_shamt_zext:
; RV64I:      # %bb.0:
; RV64I-NEXT:  addi a1, a1, 1
; RV64I-NEXT:  saw a0, a0, a1
; RV64I-NEXT:  ret
%shamt = add i32 %b, 1
%1 = ashr i32 %a, %shamt
ret i32 %1
}

```

```

define i32 @sra_negative_constant_lhs(i32 %a) nounwind {
;
; RV64I-LABEL: sra_negative_constant_lhs:

```



```
; RV64I:    # %bb.0:
; RV64I-NEXT:  lui a1, 524288
; RV64I-NEXT:  sraw a0, a1, a0
; RV64I-NEXT:  ret
%1 = ashr i32 2147483648, %a
ret i32 %1
}
```

```
define i32 @or(i32 %a, i32 %b) nounwind {
;
; RV64I-LABEL: or:
; RV64I:    # %bb.0:
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  ret
%1 = or i32 %a, %b
ret i32 %1
}
```

```
define i32 @and(i32 %a, i32 %b) nounwind {
;
; RV64I-LABEL:
and:
; RV64I:    # %bb.0:
; RV64I-NEXT:  and a0, a0, a1
; RV64I-NEXT:  ret
%1 = and i32 %a, %b
ret i32 %1
}
```

; NOTE: Assertions have been autogenerated by utils/update\_test\_checks.py UTC\_ARGS: --include-generated-funcs

; RUN: opt -S -passes=verify,iroutliner -ir-outlining-no-cost < %s | FileCheck %s

; This test checks that we do outline indirect calls when it is not specified  
; that we should not.

```
declare void @f1(ptr, ptr);
declare void @f2(ptr, ptr);
```

```
define void @function1(ptr %func) {
entry:
%a = alloca i32, align 4
%b = alloca i32, align 4
%c = alloca i32, align 4
store i32 2, ptr %a, align 4
store i32 3, ptr %b, align 4
store i32 4, ptr %c, align 4
call void %func()
%al = load i32, ptr %a
```

```

%bl = load i32, ptr %b
%cl = load i32, ptr %c
ret void
}

define void @function2(ptr %func) {
entry:
%a = alloca i32, align 4
%b = alloca i32, align 4
%c = alloca i32, align 4
store i32 2, ptr %a, align 4
store i32 3, ptr %b, align 4
store i32 4, ptr %c, align 4
call void %func()
%al = load i32, ptr %a
%bl = load i32, ptr %b
%cl = load i32, ptr %c
ret void
}
;
CHECK-LABEL: @function1(
; CHECK-NEXT: entry:
; CHECK-NEXT: [[A:%.*]] = alloca i32, align 4
; CHECK-NEXT: [[B:%.*]] = alloca i32, align 4
; CHECK-NEXT: [[C:%.*]] = alloca i32, align 4
; CHECK-NEXT: call void @outlined_ir_func_0(ptr [[A]], ptr [[B]], ptr [[C]], ptr [[FUNC:%.*]])
; CHECK-NEXT: ret void
;
;
; CHECK-LABEL: @function2(
; CHECK-NEXT: entry:
; CHECK-NEXT: [[A:%.*]] = alloca i32, align 4
; CHECK-NEXT: [[B:%.*]] = alloca i32, align 4
; CHECK-NEXT: [[C:%.*]] = alloca i32, align 4
; CHECK-NEXT: call void @outlined_ir_func_0(ptr [[A]], ptr [[B]], ptr [[C]], ptr [[FUNC:%.*]])
; CHECK-NEXT: ret void
;
;
; CHECK-LABEL: define internal void @outlined_ir_func_0(
; CHECK-NEXT: newFuncRoot:
; CHECK-NEXT: br label [[ENTRY_TO_OUTLINE:%.*]]
; CHECK: entry_to_outline:
; CHECK-NEXT: store i32 2, ptr [[TMP0:%.*]], align 4
; CHECK-NEXT: store i32 3, ptr [[TMP1:%.*]], align 4
; CHECK-NEXT: store i32 4, ptr [[TMP2:%.*]], align 4
; CHECK-NEXT:
call void [[TMP3:%.*]]()
; CHECK-NEXT: [[AL:%.*]] = load i32, ptr [[TMP0]], align 4

```

```
; CHECK-NEXT: [[BL:%.*]] = load i32, ptr [[TMP1]], align 4
; CHECK-NEXT: [[CL:%.*]] = load i32, ptr [[TMP2]], align 4
; CHECK-NEXT: br label [[ENTRY_AFTER_OUTLINE_EXITSTUB:%.*]]
; CHECK:     entry_after_outline.exitStub:
; CHECK-NEXT: ret void
;
```

=====

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```
; NOTE: Assertions have been autogenerated by utils/update_llc_test_checks.py
; RUN: llc -mtriple=riscv64 -verify-machineinstrs < %s \
; RUN: -riscv-experimental-rv64-legal-i32 | FileCheck %s -check-prefix=RV64I
; RUN: llc -mtriple=riscv64 -mattr=+xtheadbb -verify-machineinstrs < %s \
; RUN: -riscv-experimental-rv64-legal-i32 | FileCheck %s -check-prefix=RV64XTHEADBB
```

```
declare i32 @llvmctlz.i32(i32, i1)
```

```
define signext i32 @ctlz_i32(i32 signext %a) nounwind {
; RV64I-LABEL: ctlz_i32:
; RV64I:      # %bb.0:
; RV64I-NEXT: beqz a0, .LBB0_2
; RV64I-NEXT: # %bb.1: # %cond.false
; RV64I-NEXT: addi sp, sp, -16
; RV64I-NEXT: sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT: srliw a1, a0, 1
; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT: srliw a1, a0, 2
; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT: srliw a1, a0, 4
; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT: srliw a1, a0, 8
; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT: srliw a1, a0, 16
; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT:
    not a0, a0
; RV64I-NEXT: srliw a1, a0, 1
; RV64I-NEXT: lui a2, 349525
; RV64I-NEXT: addi a2, a2, 1365
; RV64I-NEXT: and a1, a1, a2
; RV64I-NEXT: subw a0, a0, a1
; RV64I-NEXT: lui a1, 209715
; RV64I-NEXT: addi a1, a1, 819
; RV64I-NEXT: and a2, a0, a1
; RV64I-NEXT: srliw a0, a0, 2
; RV64I-NEXT: and a0, a0, a1
; RV64I-NEXT: add a0, a2, a0
; RV64I-NEXT: srliw a1, a0, 4
```

```

; RV64I-NEXT: addw a0, a0, a1
; RV64I-NEXT: lui a1, 61681
; RV64I-NEXT: addiw a1, a1, -241
; RV64I-NEXT: and a0, a0, a1
; RV64I-NEXT: lui a1, 4112
; RV64I-NEXT: addiw a1, a1, 257
; RV64I-NEXT: call __muldi3
; RV64I-NEXT: srlw a0, a0, 24
; RV64I-NEXT: ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT: addi sp, sp, 16
; RV64I-NEXT: ret
; RV64I-NEXT: .LBB0_2:
; RV64I-NEXT: li a0, 32
; RV64I-NEXT: ret
;
; RV64XTHEADBB-LABEL: ctlz_i32:
; RV64XTHEADBB:    # %bb.0:
; RV64XTHEADBB-NEXT: th.extu a0, a0, 31, 0
; RV64XTHEADBB-NEXT: th.ff1 a0,
a0
; RV64XTHEADBB-NEXT: addi a0, a0, -32
; RV64XTHEADBB-NEXT: ret
%1 = call i32 @llvm.ctlz.i32(i32 %a, i1 false)
ret i32 %1
}

```

```

define signext i32 @log2_i32(i32 signext %a) nounwind {

```

```

; RV64I-LABEL: log2_i32:
; RV64I:    # %bb.0:
; RV64I-NEXT: beqz a0, .LBB1_2
; RV64I-NEXT: # %bb.1: # %cond.false
; RV64I-NEXT: addi sp, sp, -16
; RV64I-NEXT: sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT: srlw a1, a0, 1
; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT: srlw a1, a0, 2
; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT: srlw a1, a0, 4
; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT: srlw a1, a0, 8
; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT: srlw a1, a0, 16
; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT: not a0, a0
; RV64I-NEXT: srlw a1, a0, 1
; RV64I-NEXT: lui a2, 349525
; RV64I-NEXT: addi a2, a2, 1365
; RV64I-NEXT: and a1, a1, a2

```

```

; RV64I-NEXT: subw a0, a0, a1
; RV64I-NEXT: lui a1, 209715
; RV64I-NEXT: addi a1, a1, 819
; RV64I-NEXT:
and a2, a0, a1
; RV64I-NEXT: srliw a0, a0, 2
; RV64I-NEXT: and a0, a0, a1
; RV64I-NEXT: add a0, a2, a0
; RV64I-NEXT: srliw a1, a0, 4
; RV64I-NEXT: addw a0, a0, a1
; RV64I-NEXT: lui a1, 61681
; RV64I-NEXT: addiw a1, a1, -241
; RV64I-NEXT: and a0, a0, a1
; RV64I-NEXT: lui a1, 4112
; RV64I-NEXT: addiw a1, a1, 257
; RV64I-NEXT: call __muldi3
; RV64I-NEXT: srliw a0, a0, 24
; RV64I-NEXT: ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT: addi sp, sp, 16
; RV64I-NEXT: j .LBB1_3
; RV64I-NEXT: .LBB1_2:
; RV64I-NEXT: li a0, 32
; RV64I-NEXT: .LBB1_3: # %cond.end
; RV64I-NEXT: li a1, 31
; RV64I-NEXT: subw a0, a1, a0
; RV64I-NEXT: ret
;
; RV64XTHEADBB-LABEL: log2_i32:
; RV64XTHEADBB:    # %bb.0:
; RV64XTHEADBB-NEXT: th.extu a0, a0, 31, 0
; RV64XTHEADBB-NEXT: th.ff1 a0, a0
; RV64XTHEADBB-NEXT: addi a0, a0, -32
; RV64XTHEADBB-NEXT: li a1, 31
; RV64XTHEADBB-NEXT: subw a0, a1, a0
; RV64XTHEADBB-NEXT: ret
%1 = call i32 @llvm.ctlz.i32(i32
%a, i1 false)
%2 = sub i32 31, %1
ret i32 %2
}

define signext i32 @log2_ceil_i32(i32 signext %a) nounwind {
; RV64I-LABEL: log2_ceil_i32:
; RV64I:    # %bb.0:
; RV64I-NEXT: addi sp, sp, -16
; RV64I-NEXT: sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT: sd s0, 0(sp) # 8-byte Folded Spill
; RV64I-NEXT: addiw a0, a0, -1

```

```

; RV64I-NEXT:  li s0, 32
; RV64I-NEXT:  li a1, 32
; RV64I-NEXT:  beqz a0, .LBB2_2
; RV64I-NEXT:  # %bb.1: # %cond.false
; RV64I-NEXT:  srliw a1, a0, 1
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  srliw a1, a0, 2
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  srliw a1, a0, 4
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  srliw a1, a0, 8
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  srliw a1, a0, 16
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  not a0, a0
; RV64I-NEXT:  srliw a1, a0, 1
; RV64I-NEXT:  lui a2, 349525
; RV64I-NEXT:  addi a2, a2, 1365
; RV64I-NEXT:  and a1, a1, a2
; RV64I-NEXT:  subw a0, a0, a1
; RV64I-NEXT:
    lui a1, 209715
; RV64I-NEXT:  addi a1, a1, 819
; RV64I-NEXT:  and a2, a0, a1
; RV64I-NEXT:  srliw a0, a0, 2
; RV64I-NEXT:  and a0, a0, a1
; RV64I-NEXT:  add a0, a2, a0
; RV64I-NEXT:  srliw a1, a0, 4
; RV64I-NEXT:  addw a0, a0, a1
; RV64I-NEXT:  lui a1, 61681
; RV64I-NEXT:  addiw a1, a1, -241
; RV64I-NEXT:  and a0, a0, a1
; RV64I-NEXT:  lui a1, 4112
; RV64I-NEXT:  addiw a1, a1, 257
; RV64I-NEXT:  call __muldi3
; RV64I-NEXT:  srliw a1, a0, 24
; RV64I-NEXT:  .LBB2_2: # %cond.end
; RV64I-NEXT:  subw a0, s0, a1
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT:  ld s0, 0(sp) # 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
;
; RV64XTHEADBB-LABEL: log2_ceil_i32:
; RV64XTHEADBB:    # %bb.0:
; RV64XTHEADBB-NEXT:  addi a0, a0, -1
; RV64XTHEADBB-NEXT:  slli a0, a0, 32
; RV64XTHEADBB-NEXT:  srli a0, a0, 32

```

```

; RV64XTHEADBB-NEXT:  th.ff1 a0, a0
; RV64XTHEADBB-NEXT:  addi a0, a0, -32
; RV64XTHEADBB-NEXT:
    li a1, 32
; RV64XTHEADBB-NEXT:  subw a0, a1, a0
; RV64XTHEADBB-NEXT:  ret
%1 = sub i32 %a, 1
%2 = call i32 @llvm.ctlz.i32(i32 %1, i1 false)
%3 = sub i32 32, %2
ret i32 %3
}

```

```

define signext i32 @findLastSet_i32(i32 signext %a) nounwind {

```

```

; RV64I-LABEL: findLastSet_i32:

```

```

; RV64I:      # %bb.0:

```

```

; RV64I-NEXT:  addi sp, sp, -16

```

```

; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill

```

```

; RV64I-NEXT:  sd s0, 0(sp) # 8-byte Folded Spill

```

```

; RV64I-NEXT:  mv s0, a0

```

```

; RV64I-NEXT:  srliw a0, a0, 1

```

```

; RV64I-NEXT:  or a0, s0, a0

```

```

; RV64I-NEXT:  srliw a1, a0, 2

```

```

; RV64I-NEXT:  or a0, a0, a1

```

```

; RV64I-NEXT:  srliw a1, a0, 4

```

```

; RV64I-NEXT:  or a0, a0, a1

```

```

; RV64I-NEXT:  srliw a1, a0, 8

```

```

; RV64I-NEXT:  or a0, a0, a1

```

```

; RV64I-NEXT:  srliw a1, a0, 16

```

```

; RV64I-NEXT:  or a0, a0, a1

```

```

; RV64I-NEXT:  not a0, a0

```

```

; RV64I-NEXT:  srliw a1, a0, 1

```

```

; RV64I-NEXT:  lui a2, 349525

```

```

; RV64I-NEXT:  addi a2, a2, 1365

```

```

; RV64I-NEXT:  and a1, a1, a2

```

```

; RV64I-NEXT:  subw a0, a0, a1

```

```

; RV64I-NEXT:

```

```

    lui a1, 209715

```

```

; RV64I-NEXT:  addi a1, a1, 819

```

```

; RV64I-NEXT:  and a2, a0, a1

```

```

; RV64I-NEXT:  srliw a0, a0, 2

```

```

; RV64I-NEXT:  and a0, a0, a1

```

```

; RV64I-NEXT:  add a0, a2, a0

```

```

; RV64I-NEXT:  srliw a1, a0, 4

```

```

; RV64I-NEXT:  addw a0, a0, a1

```

```

; RV64I-NEXT:  lui a1, 61681

```

```

; RV64I-NEXT:  addiw a1, a1, -241

```

```

; RV64I-NEXT:  and a0, a0, a1

```

```

; RV64I-NEXT:  lui a1, 4112

```

```

; RV64I-NEXT:    addiw a1, a1, 257
; RV64I-NEXT:    call __muldi3
; RV64I-NEXT:    srliw a0, a0, 24
; RV64I-NEXT:    xori a0, a0, 31
; RV64I-NEXT:    snez a1, s0
; RV64I-NEXT:    addiw a1, a1, -1
; RV64I-NEXT:    or a0, a1, a0
; RV64I-NEXT:    ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT:    ld s0, 0(sp) # 8-byte Folded Reload
; RV64I-NEXT:    addi sp, sp, 16
; RV64I-NEXT:    ret
;
; RV64XTHEADBB-LABEL: findLastSet_i32:
; RV64XTHEADBB:    # %bb.0:
; RV64XTHEADBB-NEXT:  th.extu a1, a0, 31, 0
; RV64XTHEADBB-NEXT:  th.ff1 a1, a1
; RV64XTHEADBB-NEXT:  addiw a1, a1, -32
; RV64XTHEADBB-NEXT:  xori a1, a1,
31
; RV64XTHEADBB-NEXT:  snez a0, a0
; RV64XTHEADBB-NEXT:  addiw a0, a0, -1
; RV64XTHEADBB-NEXT:  or a0, a0, a1
; RV64XTHEADBB-NEXT:  ret
%1 = call i32 @llvmctlz.i32(i32 %a, i1 true)
%2 = xor i32 31, %1
%3 = icmp eq i32 %a, 0
%4 = select i1 %3, i32 -1, i32 %2
ret i32 %4
}

```

```

define i32 @ctlz_lshr_i32(i32 signext %a) {
; RV64I-LABEL: ctlz_lshr_i32:
; RV64I:    # %bb.0:
; RV64I-NEXT:  srliw a0, a0, 1
; RV64I-NEXT:  beqz a0, .LBB4_2
; RV64I-NEXT:  # %bb.1: # %cond.false
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  .cfi_def_cfa_offset 16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  .cfi_offset ra, -8
; RV64I-NEXT:  srliw a1, a0, 1
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  srliw a1, a0, 2
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  srliw a1, a0, 4
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  srliw a1, a0, 8
; RV64I-NEXT:  or a0, a0, a1

```

```

; RV64I-NEXT:  srlw a1, a0, 16
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  not
a0, a0
; RV64I-NEXT:  srlw a1, a0, 1
; RV64I-NEXT:  lui a2, 349525
; RV64I-NEXT:  addi a2, a2, 1365
; RV64I-NEXT:  and a1, a1, a2
; RV64I-NEXT:  subw a0, a0, a1
; RV64I-NEXT:  lui a1, 209715
; RV64I-NEXT:  addi a1, a1, 819
; RV64I-NEXT:  and a2, a0, a1
; RV64I-NEXT:  srlw a0, a0, 2
; RV64I-NEXT:  and a0, a0, a1
; RV64I-NEXT:  add a0, a2, a0
; RV64I-NEXT:  srlw a1, a0, 4
; RV64I-NEXT:  addw a0, a0, a1
; RV64I-NEXT:  lui a1, 61681
; RV64I-NEXT:  addiw a1, a1, -241
; RV64I-NEXT:  and a0, a0, a1
; RV64I-NEXT:  lui a1, 4112
; RV64I-NEXT:  addiw a1, a1, 257
; RV64I-NEXT:  call __muldi3
; RV64I-NEXT:  srlw a0, a0, 24
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
; RV64I-NEXT:  .LBB4_2:
; RV64I-NEXT:  li a0, 32
; RV64I-NEXT:  ret
;
; RV64XTHEADBB-LABEL: ctlz_lshr_i32:
; RV64XTHEADBB:    # %bb.0:
; RV64XTHEADBB-NEXT:  srlw a0, a0, 1
; RV64XTHEADBB-NEXT:  th.ff1 a0, a0
; RV64XTHEADBB-NEXT:
    addi a0, a0, -32
; RV64XTHEADBB-NEXT:  ret
%1 = lshr i32 %a, 1
%2 = call i32 @llvm.ctlz.i32(i32 %1, i1 false)
ret i32 %2
}

declare i64 @llvm.ctlz.i64(i64, i1)

define i64 @ctlz_i64(i64 %a) nounwind {
; RV64I-LABEL: ctlz_i64:
; RV64I:    # %bb.0:

```

```

; RV64I-NEXT: beqz a0, .LBB5_2
; RV64I-NEXT: # %bb.1: # %cond.false
; RV64I-NEXT: addi sp, sp, -16
; RV64I-NEXT: sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT: srli a1, a0, 1
; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT: srli a1, a0, 2
; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT: srli a1, a0, 4
; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT: srli a1, a0, 8
; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT: srli a1, a0, 16
; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT: srli a1, a0, 32
; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT: not a0, a0
; RV64I-NEXT: srli a1, a0, 1
; RV64I-NEXT: lui a2, 349525
; RV64I-NEXT: addiw a2, a2, 1365
; RV64I-NEXT: slli a3, a2, 32
; RV64I-NEXT: add a2, a2,
a3
; RV64I-NEXT: and a1, a1, a2
; RV64I-NEXT: sub a0, a0, a1
; RV64I-NEXT: lui a1, 209715
; RV64I-NEXT: addiw a1, a1, 819
; RV64I-NEXT: slli a2, a1, 32
; RV64I-NEXT: add a1, a1, a2
; RV64I-NEXT: and a2, a0, a1
; RV64I-NEXT: srli a0, a0, 2
; RV64I-NEXT: and a0, a0, a1
; RV64I-NEXT: add a0, a2, a0
; RV64I-NEXT: srli a1, a0, 4
; RV64I-NEXT: add a0, a0, a1
; RV64I-NEXT: lui a1, 61681
; RV64I-NEXT: addiw a1, a1, -241
; RV64I-NEXT: slli a2, a1, 32
; RV64I-NEXT: add a1, a1, a2
; RV64I-NEXT: and a0, a0, a1
; RV64I-NEXT: lui a1, 4112
; RV64I-NEXT: addiw a1, a1, 257
; RV64I-NEXT: slli a2, a1, 32
; RV64I-NEXT: add a1, a1, a2
; RV64I-NEXT: call __muldi3
; RV64I-NEXT: srli a0, a0, 56
; RV64I-NEXT: ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT: addi sp, sp, 16

```



```

; RV64I-NEXT:  ret
; RV64I-NEXT:  .LBB5_2:
; RV64I-NEXT:  li a0, 64
; RV64I-NEXT:  ret
;
; RV64XTHEADBB-LABEL: ctlz_i64:
; RV64XTHEADBB:      # %bb.0:
; RV64XTHEADBB-NEXT:
    th.ff1 a0, a0
; RV64XTHEADBB-NEXT:  ret
    %1 = call i64 @llvm.ctlz.i64(i64 %a, i1 false)
    ret i64 %1
}

declare i32 @llvm.cttz.i32(i32, i1)

define signext i32 @cttz_i32(i32 signext %a) nounwind {
; RV64I-LABEL: cttz_i32:
; RV64I:      # %bb.0:
; RV64I-NEXT:  beqz a0, .LBB6_2
; RV64I-NEXT:  # %bb.1: # %cond.false
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  negw a1, a0
; RV64I-NEXT:  and a0, a0, a1
; RV64I-NEXT:  lui a1, 30667
; RV64I-NEXT:  addiw a1, a1, 1329
; RV64I-NEXT:  call __muldi3
; RV64I-NEXT:  srliw a0, a0, 27
; RV64I-NEXT:  lui a1, %hi(.LCPI6_0)
; RV64I-NEXT:  addi a1, a1, %lo(.LCPI6_0)
; RV64I-NEXT:  add a0, a1, a0
; RV64I-NEXT:  lbu a0, 0(a0)
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
; RV64I-NEXT:  .LBB6_2:
; RV64I-NEXT:  li a0, 32
; RV64I-NEXT:  ret
;
; RV64XTHEADBB-LABEL: cttz_i32:
; RV64XTHEADBB:      #
    %bb.0:
; RV64XTHEADBB-NEXT:  beqz a0, .LBB6_2
; RV64XTHEADBB-NEXT:  # %bb.1: # %cond.false
; RV64XTHEADBB-NEXT:  addi sp, sp, -16
; RV64XTHEADBB-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64XTHEADBB-NEXT:  negw a1, a0

```

```

; RV64XTHEADBB-NEXT: and a0, a0, a1
; RV64XTHEADBB-NEXT: lui a1, 30667
; RV64XTHEADBB-NEXT: addiw a1, a1, 1329
; RV64XTHEADBB-NEXT: call __muldi3
; RV64XTHEADBB-NEXT: srliw a0, a0, 27
; RV64XTHEADBB-NEXT: lui a1, %hi(.LCPI6_0)
; RV64XTHEADBB-NEXT: addi a1, a1, %lo(.LCPI6_0)
; RV64XTHEADBB-NEXT: add a0, a1, a0
; RV64XTHEADBB-NEXT: lbu a0, 0(a0)
; RV64XTHEADBB-NEXT: ld ra, 8(sp) # 8-byte Folded Reload
; RV64XTHEADBB-NEXT: addi sp, sp, 16
; RV64XTHEADBB-NEXT: ret
; RV64XTHEADBB-NEXT: .LBB6_2:
; RV64XTHEADBB-NEXT: li a0, 32
; RV64XTHEADBB-NEXT: ret
; RV64ZBB-LABEL: cttz_i32:
; RV64ZBB:    # %bb.0:
; RV64ZBB-NEXT: ctw a0, a0
; RV64ZBB-NEXT: ret
%1 = call i32 @llvm.cttz.i32(i32 %a, i1 false)
ret i32 %1
}

```

```

define
  signext i32 @cttz_zero_undef_i32(i32 signext %a) nounwind {
; RV64I-LABEL: cttz_zero_undef_i32:
; RV64I:    # %bb.0:
; RV64I-NEXT: addi sp, sp, -16
; RV64I-NEXT: sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT: negw a1, a0
; RV64I-NEXT: and a0, a0, a1
; RV64I-NEXT: lui a1, 30667
; RV64I-NEXT: addiw a1, a1, 1329
; RV64I-NEXT: call __muldi3
; RV64I-NEXT: srliw a0, a0, 27
; RV64I-NEXT: lui a1, %hi(.LCPI7_0)
; RV64I-NEXT: addi a1, a1, %lo(.LCPI7_0)
; RV64I-NEXT: add a0, a1, a0
; RV64I-NEXT: lbu a0, 0(a0)
; RV64I-NEXT: ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT: addi sp, sp, 16
; RV64I-NEXT: ret
;
; RV64XTHEADBB-LABEL: cttz_zero_undef_i32:
; RV64XTHEADBB:    # %bb.0:
; RV64XTHEADBB-NEXT: addi sp, sp, -16
; RV64XTHEADBB-NEXT: sd ra, 8(sp) # 8-byte Folded Spill
; RV64XTHEADBB-NEXT: negw a1, a0

```

```

; RV64XTHEADBB-NEXT: and a0, a0, a1
; RV64XTHEADBB-NEXT: lui a1, 30667
; RV64XTHEADBB-NEXT: addiw a1, a1, 1329
; RV64XTHEADBB-NEXT:
    call __muldi3
; RV64XTHEADBB-NEXT: srlw a0, a0, 27
; RV64XTHEADBB-NEXT: lui a1, %hi(.LCPI7_0)
; RV64XTHEADBB-NEXT: addi a1, a1, %lo(.LCPI7_0)
; RV64XTHEADBB-NEXT: add a0, a1, a0
; RV64XTHEADBB-NEXT: lbu a0, 0(a0)
; RV64XTHEADBB-NEXT: ld ra, 8(sp) # 8-byte Folded Reload
; RV64XTHEADBB-NEXT: addi sp, sp, 16
; RV64XTHEADBB-NEXT: ret
%1 = call i32 @llvm.cttz.i32(i32 %a, i1 true)
ret i32 %1
}

```

```

define signext i32 @findFirstSet_i32(i32 signext %a) nounwind {

```

```

; RV64I-LABEL: findFirstSet_i32:
; RV64I:    # %bb.0:
; RV64I-NEXT: addi sp, sp, -16
; RV64I-NEXT: sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT: sd s0, 0(sp) # 8-byte Folded Spill
; RV64I-NEXT: mv s0, a0
; RV64I-NEXT: negw a0, a0
; RV64I-NEXT: and a0, s0, a0
; RV64I-NEXT: lui a1, 30667
; RV64I-NEXT: addiw a1, a1, 1329
; RV64I-NEXT: call __muldi3
; RV64I-NEXT: srlw a0, a0, 27
; RV64I-NEXT: lui a1, %hi(.LCPI8_0)
; RV64I-NEXT: addi a1, a1, %lo(.LCPI8_0)
; RV64I-NEXT:
    add a0, a1, a0
; RV64I-NEXT: lbu a0, 0(a0)
; RV64I-NEXT: snez a1, s0
; RV64I-NEXT: addi a1, a1, -1
; RV64I-NEXT: or a0, a1, a0
; RV64I-NEXT: ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT: ld s0, 0(sp) # 8-byte Folded Reload
; RV64I-NEXT: addi sp, sp, 16
; RV64I-NEXT: ret
;
; RV64XTHEADBB-LABEL: findFirstSet_i32:
; RV64XTHEADBB:    # %bb.0:
; RV64XTHEADBB-NEXT: addi sp, sp, -16
; RV64XTHEADBB-NEXT: sd ra, 8(sp) # 8-byte Folded Spill
; RV64XTHEADBB-NEXT: sd s0, 0(sp) # 8-byte Folded Spill

```

```

; RV64XTHEADBB-NEXT:  mv s0, a0
; RV64XTHEADBB-NEXT:  negw a0, a0
; RV64XTHEADBB-NEXT:  and a0, s0, a0
; RV64XTHEADBB-NEXT:  lui a1, 30667
; RV64XTHEADBB-NEXT:  addiw a1, a1, 1329
; RV64XTHEADBB-NEXT:  call __muldi3
; RV64XTHEADBB-NEXT:  srliw a0, a0, 27
; RV64XTHEADBB-NEXT:  lui a1, %hi(.LCPI8_0)
; RV64XTHEADBB-NEXT:  addi a1, a1, %lo(.LCPI8_0)
; RV64XTHEADBB-NEXT:  add a0, a1, a0
; RV64XTHEADBB-NEXT:  lbu a0, 0(a0)
; RV64XTHEADBB-NEXT:
    snez a1, s0
; RV64XTHEADBB-NEXT:  addi a1, a1, -1
; RV64XTHEADBB-NEXT:  or a0, a1, a0
; RV64XTHEADBB-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload
; RV64XTHEADBB-NEXT:  ld s0, 0(sp) # 8-byte Folded Reload
; RV64XTHEADBB-NEXT:  addi sp, sp, 16
; RV64XTHEADBB-NEXT:  ret
%1 = call i32 @llvm.cttz.i32(i32 %a, i1 true)
%2 = icmp eq i32 %a, 0
%3 = select i1 %2, i32 -1, i32 %1
ret i32 %3
}

```

```

define signext i32 @ffs_i32(i32 signext %a) nounwind {

```

```

; RV64I-LABEL: ffs_i32:
; RV64I:      # %bb.0:
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  sd s0, 0(sp) # 8-byte Folded Spill
; RV64I-NEXT:  mv s0, a0
; RV64I-NEXT:  negw a0, a0
; RV64I-NEXT:  and a0, s0, a0
; RV64I-NEXT:  lui a1, 30667
; RV64I-NEXT:  addiw a1, a1, 1329
; RV64I-NEXT:  call __muldi3
; RV64I-NEXT:  srliw a0, a0, 27
; RV64I-NEXT:  lui a1, %hi(.LCPI9_0)
; RV64I-NEXT:  addi a1, a1, %lo(.LCPI9_0)
; RV64I-NEXT:  add a0, a1, a0
; RV64I-NEXT:
    lbu a0, 0(a0)
; RV64I-NEXT:  addi a0, a0, 1
; RV64I-NEXT:  seqz a1, s0
; RV64I-NEXT:  addi a1, a1, -1
; RV64I-NEXT:  and a0, a1, a0
; RV64I-NEXT:  slli a0, a0, 32

```

```

; RV64I-NEXT: srli a0, a0, 32
; RV64I-NEXT: ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT: ld s0, 0(sp) # 8-byte Folded Reload
; RV64I-NEXT: addi sp, sp, 16
; RV64I-NEXT: ret
;
; RV64XTHEADBB-LABEL: ffs_i32:
; RV64XTHEADBB: # %bb.0:
; RV64XTHEADBB-NEXT: addi sp, sp, -16
; RV64XTHEADBB-NEXT: sd ra, 8(sp) # 8-byte Folded Spill
; RV64XTHEADBB-NEXT: sd s0, 0(sp) # 8-byte Folded Spill
; RV64XTHEADBB-NEXT: mv s0, a0
; RV64XTHEADBB-NEXT: negw a0, a0
; RV64XTHEADBB-NEXT: and a0, s0, a0
; RV64XTHEADBB-NEXT: lui a1, 30667
; RV64XTHEADBB-NEXT: addiw a1, a1, 1329
; RV64XTHEADBB-NEXT: call __muldi3
; RV64XTHEADBB-NEXT: srlw a0, a0, 27
; RV64XTHEADBB-NEXT: lui a1, %hi(.LCPI9_0)
; RV64XTHEADBB-NEXT: addi a1, a1, %lo(.LCPI9_0)
; RV64XTHEADBB-NEXT: add a0, a1, a0
;
RV64XTHEADBB-NEXT: lbu a0, 0(a0)
; RV64XTHEADBB-NEXT: addi a0, a0, 1
; RV64XTHEADBB-NEXT: seqz a1, s0
; RV64XTHEADBB-NEXT: addi a1, a1, -1
; RV64XTHEADBB-NEXT: and a0, a1, a0
; RV64XTHEADBB-NEXT: slli a0, a0, 32
; RV64XTHEADBB-NEXT: srli a0, a0, 32
; RV64XTHEADBB-NEXT: ld ra, 8(sp) # 8-byte Folded Reload
; RV64XTHEADBB-NEXT: ld s0, 0(sp) # 8-byte Folded Reload
; RV64XTHEADBB-NEXT: addi sp, sp, 16
; RV64XTHEADBB-NEXT: ret
%1 = call i32 @llvm.cttz.i32(i32 %a, i1 true)
%2 = add i32 %1, 1
%3 = icmp eq i32 %a, 0
%4 = select i1 %3, i32 0, i32 %2
ret i32 %4
}

declare i64 @llvm.cttz.i64(i64, i1)

define i64 @cttz_i64(i64 %a) nounwind {
; RV64I-LABEL: cttz_i64:
; RV64I: # %bb.0:
; RV64I-NEXT: beqz a0, .LBB10_2
; RV64I-NEXT: # %bb.1: # %cond.false
; RV64I-NEXT: addi sp, sp, -16

```

```

; RV64I-NEXT: sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT: neg a1, a0
; RV64I-NEXT: and a0, a0, a1
; RV64I-NEXT: lui a1, %hi(.LCPI10_0)
; RV64I-NEXT:
    ld a1, %lo(.LCPI10_0)(a1)
; RV64I-NEXT: call __muldi3
; RV64I-NEXT: srli a0, a0, 58
; RV64I-NEXT: lui a1, %hi(.LCPI10_1)
; RV64I-NEXT: addi a1, a1, %lo(.LCPI10_1)
; RV64I-NEXT: add a0, a1, a0
; RV64I-NEXT: lbu a0, 0(a0)
; RV64I-NEXT: ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT: addi sp, sp, 16
; RV64I-NEXT: ret
; RV64I-NEXT: .LBB10_2:
; RV64I-NEXT: li a0, 64
; RV64I-NEXT: ret
;
; RV64XTHEADBB-LABEL: cttz_i64:
; RV64XTHEADBB:    # %bb.0:
; RV64XTHEADBB-NEXT: beqz a0, .LBB10_2
; RV64XTHEADBB-NEXT: # %bb.1: # %cond.false
; RV64XTHEADBB-NEXT: addi a1, a0, -1
; RV64XTHEADBB-NEXT: not a0, a0
; RV64XTHEADBB-NEXT: and a0, a0, a1
; RV64XTHEADBB-NEXT: th.ff1 a0, a0
; RV64XTHEADBB-NEXT: li a1, 64
; RV64XTHEADBB-NEXT: sub a0, a1, a0
; RV64XTHEADBB-NEXT: ret
; RV64XTHEADBB-NEXT: .LBB10_2:
; RV64XTHEADBB-NEXT: li a0, 64
; RV64XTHEADBB-NEXT: ret
%1 = call i64 @llvm.cttz.i64(i64 %a, i1 false)
ret i64 %1
}

```

```

define signext
i32 @sextb_i32(i32 signext %a) nounwind {
; RV64I-LABEL: sextb_i32:
; RV64I:    # %bb.0:
; RV64I-NEXT: slli a0, a0, 56
; RV64I-NEXT: srai a0, a0, 56
; RV64I-NEXT: ret
;
; RV64XTHEADBB-LABEL: sextb_i32:
; RV64XTHEADBB:    # %bb.0:
; RV64XTHEADBB-NEXT: th.ext a0, a0, 7, 0

```

```

; RV64XTHEADBB-NEXT:  ret
%shl = shl i32 %a, 24
%shr = ashr exact i32 %shl, 24
ret i32 %shr
}

define i64 @sextb_i64(i64 %a) nounwind {
; RV64I-LABEL: sextb_i64:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a0, a0, 56
; RV64I-NEXT:  srai a0, a0, 56
; RV64I-NEXT:  ret
;
; RV64XTHEADBB-LABEL: sextb_i64:
; RV64XTHEADBB:  # %bb.0:
; RV64XTHEADBB-NEXT:  th.ext a0, a0, 7, 0
; RV64XTHEADBB-NEXT:  ret
%shl = shl i64 %a, 56
%shr = ashr exact i64 %shl, 56
ret i64 %shr
}

define signext i32 @sexth_i32(i32 signext %a) nounwind {
; RV64I-LABEL: sexth_i32:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a0, a0, 48
; RV64I-NEXT:  srai a0, a0, 48
; RV64I-NEXT:  ret
;
; RV64XTHEADBB-LABEL:
sexth_i32:
; RV64XTHEADBB:  # %bb.0:
; RV64XTHEADBB-NEXT:  th.ext a0, a0, 15, 0
; RV64XTHEADBB-NEXT:  ret
%shl = shl i32 %a, 16
%shr = ashr exact i32 %shl, 16
ret i32 %shr
}

define signext i32 @no_sexth_i32(i32 signext %a) nounwind {
; RV64I-LABEL: no_sexth_i32:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a0, a0, 17
; RV64I-NEXT:  sraiw a0, a0, 16
; RV64I-NEXT:  ret
;
; RV64XTHEADBB-LABEL: no_sexth_i32:
; RV64XTHEADBB:  # %bb.0:

```

```

; RV64XTHEADBB-NEXT:  slli a0, a0, 17
; RV64XTHEADBB-NEXT:  sraiw a0, a0, 16
; RV64XTHEADBB-NEXT:  ret
%shl = shl i32 %a, 17
%shr = ashr exact i32 %shl, 16
ret i32 %shr
}

define i64 @sexth_i64(i64 %a) nounwind {
; RV64I-LABEL: sexth_i64:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a0, a0, 48
; RV64I-NEXT:  srai a0, a0, 48
; RV64I-NEXT:  ret
;
; RV64XTHEADBB-LABEL: sexth_i64:
; RV64XTHEADBB:  # %bb.0:
; RV64XTHEADBB-NEXT:  th.ext a0, a0, 15, 0
; RV64XTHEADBB-NEXT:  ret
%shl = shl i64 %a, 48
%shr = ashr
exact i64 %shl, 48
ret i64 %shr
}

define i64 @no_sexth_i64(i64 %a) nounwind {
; RV64I-LABEL: no_sexth_i64:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a0, a0, 49
; RV64I-NEXT:  srai a0, a0, 48
; RV64I-NEXT:  ret
;
; RV64XTHEADBB-LABEL: no_sexth_i64:
; RV64XTHEADBB:  # %bb.0:
; RV64XTHEADBB-NEXT:  slli a0, a0, 49
; RV64XTHEADBB-NEXT:  srai a0, a0, 48
; RV64XTHEADBB-NEXT:  ret
%shl = shl i64 %a, 49
%shr = ashr exact i64 %shl, 48
ret i64 %shr
}

define i32 @zexth_i32(i32 %a) nounwind {
; RV64I-LABEL: zexth_i32:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a0, a0, 48
; RV64I-NEXT:  srli a0, a0, 48
; RV64I-NEXT:  ret

```



```

;
; RV64XTHEADBB-LABEL: zexth_i32:
; RV64XTHEADBB:    # %bb.0:
; RV64XTHEADBB-NEXT:  th.extu a0, a0, 15, 0
; RV64XTHEADBB-NEXT:  ret
%and = and i32 %a, 65535
ret i32 %and
}

```

```

define i64 @zexth_i64(i64 %a) nounwind {
; RV64I-LABEL: zexth_i64:
; RV64I:    # %bb.0:
; RV64I-NEXT:  slli a0, a0, 48
; RV64I-NEXT:  srli a0, a0, 48
; RV64I-NEXT:
    ret
;
; RV64XTHEADBB-LABEL: zexth_i64:
; RV64XTHEADBB:    # %bb.0:
; RV64XTHEADBB-NEXT:  th.extu a0, a0, 15, 0
; RV64XTHEADBB-NEXT:  ret
%and = and i64 %a, 65535
ret i64 %and
}

```

```

define i64 @zext_bf_i64(i64 %a) nounwind {
; RV64I-LABEL: zext_bf_i64:
; RV64I:    # %bb.0:
; RV64I-NEXT:  slli a0, a0, 47
; RV64I-NEXT:  srli a0, a0, 48
; RV64I-NEXT:  ret
;
; RV64XTHEADBB-LABEL: zext_bf_i64:
; RV64XTHEADBB:    # %bb.0:
; RV64XTHEADBB-NEXT:  th.extu a0, a0, 16, 1
; RV64XTHEADBB-NEXT:  ret
%1 = lshr i64 %a, 1
%and = and i64 %1, 65535
ret i64 %and
}

```

```

define i64 @zext_i64_srliw(i64 %a) nounwind {
; RV64I-LABEL: zext_i64_srliw:
; RV64I:    # %bb.0:
; RV64I-NEXT:  srliw a0, a0, 16
; RV64I-NEXT:  ret
;
; RV64XTHEADBB-LABEL: zext_i64_srliw:

```

```
; RV64XTHEADBB:    # %bb.0:
; RV64XTHEADBB-NEXT:  srlw a0, a0, 16
; RV64XTHEADBB-NEXT:  ret
%1 = lshr i64 %a, 16
%and = and i64 %1, 65535
ret i64 %and
}
```

```
declare i32 @llvm.bswap.i32(i32)
```

```
define signext
i32 @bswap_i32(i32 signext %a) nounwind {
; RV64I-LABEL: bswap_i32:
; RV64I:    # %bb.0:
; RV64I-NEXT:  srlw a1, a0, 8
; RV64I-NEXT:  lui a2, 16
; RV64I-NEXT:  addiw a2, a2, -256
; RV64I-NEXT:  and a1, a1, a2
; RV64I-NEXT:  srlw a3, a0, 24
; RV64I-NEXT:  or a1, a1, a3
; RV64I-NEXT:  and a2, a0, a2
; RV64I-NEXT:  sllw a2, a2, 8
; RV64I-NEXT:  sllw a0, a0, 24
; RV64I-NEXT:  or a0, a0, a2
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64XTHEADBB-LABEL: bswap_i32:
; RV64XTHEADBB:    # %bb.0:
; RV64XTHEADBB-NEXT:  th.revw a0, a0
; RV64XTHEADBB-NEXT:  ret
%1 = tail call i32 @llvm.bswap.i32(i32 %a)
ret i32 %1
}
```

; Similar to bswap\_i32 but the result is not sign extended.

```
define void @bswap_i32_nosext(i32 signext %a, ptr %x) nounwind {
; RV64I-LABEL: bswap_i32_nosext:
; RV64I:    # %bb.0:
; RV64I-NEXT:  srlw a2, a0, 8
; RV64I-NEXT:  lui a3, 16
; RV64I-NEXT:  addi a3, a3, -256
; RV64I-NEXT:  and a2, a2, a3
; RV64I-NEXT:  srlw
a4, a0, 24
; RV64I-NEXT:  or a2, a2, a4
; RV64I-NEXT:  and a3, a0, a3
; RV64I-NEXT:  slli a3, a3, 8
```

```

; RV64I-NEXT:  slli a0, a0, 24
; RV64I-NEXT:  or a0, a0, a3
; RV64I-NEXT:  or a0, a0, a2
; RV64I-NEXT:  sw a0, 0(a1)
; RV64I-NEXT:  ret
;
; RV64XTHEADBB-LABEL: bswap_i32_nosext:
; RV64XTHEADBB:      # %bb.0:
; RV64XTHEADBB-NEXT:  th.revsw a0, a0
; RV64XTHEADBB-NEXT:  sw a0, 0(a1)
; RV64XTHEADBB-NEXT:  ret
%1 = tail call i32 @llvm.bswap.i32(i32 %a)
store i32 %1, ptr %x
ret void
}

```

```

declare i64 @llvm.bswap.i64(i64)

```

```

define i64 @bswap_i64(i64 %a) {
; RV64I-LABEL: bswap_i64:
; RV64I:      # %bb.0:
; RV64I-NEXT:  srli a1, a0, 40
; RV64I-NEXT:  lui a2, 16
; RV64I-NEXT:  addiw a2, a2, -256
; RV64I-NEXT:  and a1, a1, a2
; RV64I-NEXT:  srli a3, a0, 56
; RV64I-NEXT:  or a1, a1, a3
; RV64I-NEXT:  srli a3, a0, 24
; RV64I-NEXT:  lui a4, 4080
; RV64I-NEXT:  and a3, a3, a4
; RV64I-NEXT:  srli a5, a0, 8
; RV64I-NEXT:  srliw a5, a5, 24
; RV64I-NEXT:  slli
a5, a5, 24
; RV64I-NEXT:  or a3, a5, a3
; RV64I-NEXT:  or a1, a3, a1
; RV64I-NEXT:  and a4, a0, a4
; RV64I-NEXT:  slli a4, a4, 24
; RV64I-NEXT:  srliw a3, a0, 24
; RV64I-NEXT:  slli a3, a3, 32
; RV64I-NEXT:  or a3, a4, a3
; RV64I-NEXT:  and a2, a0, a2
; RV64I-NEXT:  slli a2, a2, 40
; RV64I-NEXT:  slli a0, a0, 56
; RV64I-NEXT:  or a0, a0, a2
; RV64I-NEXT:  or a0, a0, a3
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  ret

```

```
;
; RV64XTHEADBB-LABEL: bswap_i64:
; RV64XTHEADBB:    # %bb.0:
; RV64XTHEADBB-NEXT:  th.rev a0, a0
; RV64XTHEADBB-NEXT:  ret
%1 = call i64 @llvm.bswap.i64(i64 %a)
ret i64 %1
}
; RUN: opt -passes=consthoist -S -o - %s | FileCheck %s
target datalayout = "e-m:e-p:32:32-i64:64-v128:64:128-a:0:32-n32-S64"
target triple = "thumbv6m-none--musleabi"
```

```
; Check that for i8 type, the maximum legal offset is 31.
; Also check that an constant used as value to be stored rather than
; pointer in a store instruction is hoisted.
; CHECK: foo_i8
; CHECK-DAG: %[[C1:const[0-9]?]] = bitcast i32 805874720 to i32
; CHECK-DAG: %[[C2:const[0-9]?]] = bitcast i32 805874688 to i32
; CHECK-DAG: %[[C3:const[0-9]?]] = bitcast i32 805873720 to i32
; CHECK-DAG: %[[C4:const[0-9]?]] = bitcast i32 805873688 to i32
; CHECK: %0 = inttoptr i32 %[[C2]] to ptr
; CHECK-NEXT: %1 = load volatile i8, ptr %0
; CHECK-NEXT: %[[M1:const_mat[0-9]?]] = add i32 %[[C2]], 4
; CHECK-NEXT: %2 = inttoptr i32 %[[M1]] to ptr
; CHECK-NEXT: %3 = load volatile i8, ptr %2
; CHECK-NEXT: %[[M2:const_mat[0-9]?]] = add i32 %[[C2]], 31
; CHECK-NEXT: %4 = inttoptr i32 %[[M2]] to ptr
; CHECK-NEXT: %5 = load volatile
i8, ptr %4
; CHECK-NEXT: %6 = inttoptr i32 %[[C1]] to ptr
; CHECK-NEXT: %7 = load volatile i8, ptr %6
; CHECK-NEXT: %[[M3:const_mat[0-9]?]] = add i32 %[[C1]], 7
; CHECK-NEXT: %8 = inttoptr i32 %[[M3]] to ptr
; CHECK-NEXT: %9 = load volatile i8, ptr %8
; CHECK-NEXT: %10 = inttoptr i32 %[[C4]] to ptr
; CHECK-NEXT: store i8 %9, ptr %10
; CHECK-NEXT: %[[M4:const_mat[0-9]?]] = add i32 %[[C4]], 31
; CHECK-NEXT: %11 = inttoptr i32 %[[M4]] to ptr
; CHECK-NEXT: store i8 %7, ptr %11
; CHECK-NEXT: %12 = inttoptr i32 %[[C3]] to ptr
; CHECK-NEXT: store i8 %5, ptr %12
; CHECK-NEXT: %[[M5:const_mat[0-9]?]] = add i32 %[[C3]], 7
; CHECK-NEXT: %13 = inttoptr i32 %[[M5]] to ptr
; CHECK-NEXT: store i8 %3, ptr %13
; CHECK-NEXT: %[[M6:const_mat[0-9]?]] = add i32 %[[C1]], 80
; CHECK-NEXT: %14 = inttoptr i32 %[[M6]] to ptr
; CHECK-NEXT: store ptr %14, ptr @goo
```

@goo = global ptr undef

```
define void @foo_i8() {
entry:
  %0 = load volatile i8, ptr inttoptr (i32 805874688 to ptr)
  %1 = load volatile
i8, ptr inttoptr (i32 805874692 to ptr)
  %2 = load volatile i8, ptr inttoptr (i32 805874719 to ptr)
  %3 = load volatile i8, ptr inttoptr (i32 805874720 to ptr)
  %4 = load volatile i8, ptr inttoptr (i32 805874727 to ptr)
  store i8 %4, ptr inttoptr(i32 805873688 to ptr)
  store i8 %3, ptr inttoptr(i32 805873719 to ptr)
  store i8 %2, ptr inttoptr(i32 805873720 to ptr)
  store i8 %1, ptr inttoptr(i32 805873727 to ptr)
  store ptr inttoptr(i32 805874800 to ptr), ptr @goo
  ret void
}
```

```
; Check that for i16 type, the maximum legal offset is 62.
; CHECK: foo_i16
; CHECK-DAG: %[[C1:const[0-9]?]] = bitcast i32 805874752 to i32
; CHECK-DAG: %[[C2:const[0-9]?]] = bitcast i32 805874688 to i32
; CHECK: %0 = inttoptr i32 %[[C2]] to ptr
; CHECK-NEXT: %1 = load volatile i16, ptr %0, align 2
; CHECK-NEXT: %[[M1:const_mat[0-9]?]] = add i32 %[[C2]], 4
; CHECK-NEXT: %2 = inttoptr i32 %[[M1]] to ptr
; CHECK-NEXT: %3 = load volatile i16, ptr %2, align 2
; CHECK-NEXT: %[[M2:const_mat[0-9]?]] = add
i32 %[[C2]], 32
; CHECK-NEXT: %4 = inttoptr i32 %[[M2]] to ptr
; CHECK-NEXT: %5 = load volatile i16, ptr %4, align 2
; CHECK-NEXT: %[[M3:const_mat[0-9]?]] = add i32 %[[C2]], 62
; CHECK-NEXT: %6 = inttoptr i32 %[[M3]] to ptr
; CHECK-NEXT: %7 = load volatile i16, ptr %6, align 2
; CHECK-NEXT: %8 = inttoptr i32 %[[C1]] to ptr
; CHECK-NEXT: %9 = load volatile i16, ptr %8, align 2
; CHECK-NEXT: %[[M4:const_mat[0-9]?]] = add i32 %[[C1]], 22
; CHECK-NEXT: %10 = inttoptr i32 %[[M4]] to ptr
; CHECK-NEXT: %11 = load volatile i16, ptr %10, align 2
```

```
define void @foo_i16() {
entry:
  %0 = load volatile i16, ptr inttoptr (i32 805874688 to ptr), align 2
  %1 = load volatile i16, ptr inttoptr (i32 805874692 to ptr), align 2
  %2 = load volatile i16, ptr inttoptr (i32 805874720 to ptr), align 2
  %3 = load volatile i16, ptr inttoptr (i32 805874750 to ptr), align 2
  %4 = load volatile i16, ptr inttoptr (i32 805874752 to ptr), align 2
  %5 = load volatile i16, ptr inttoptr (i32 805874774 to ptr), align
```

2

```
ret void
}
```

```
; Check that for i32 type, the maximum legal offset is 124.
; CHECK: foo_i32
; CHECK-DAG: %[[C1:const[0-9]?]] = bitcast i32 805874816 to i32
; CHECK-DAG: %[[C2:const[0-9]?]] = bitcast i32 805874688 to i32
; CHECK: %0 = inttoptr i32 %[[C2]] to ptr
; CHECK-NEXT: %1 = load volatile i32, ptr %0, align 4
; CHECK-NEXT: %[[M1:const_mat[0-9]?]] = add i32 %[[C2]], 4
; CHECK-NEXT: %2 = inttoptr i32 %[[M1]] to ptr
; CHECK-NEXT: %3 = load volatile i32, ptr %2, align 4
; CHECK-NEXT: %[[M2:const_mat[0-9]?]] = add i32 %[[C2]], 124
; CHECK-NEXT: %4 = inttoptr i32 %[[M2]] to ptr
; CHECK-NEXT: %5 = load volatile i32, ptr %4, align 4
; CHECK-NEXT: %6 = inttoptr i32 %[[C1]] to ptr
; CHECK-NEXT: %7 = load volatile i32, ptr %6, align 4
; CHECK-NEXT: %[[M3:const_mat[0-9]?]] = add i32 %[[C1]], 8
; CHECK-NEXT: %8 = inttoptr i32 %[[M3]] to ptr
; CHECK-NEXT: %9 = load volatile i32, ptr %8, align 4
; CHECK-NEXT: %[[M4:const_mat[0-9]?]] = add i32 %[[C1]], 12
; CHECK-NEXT: %10 = inttoptr
i32 %[[M4]] to ptr
; CHECK-NEXT: %11 = load volatile i32, ptr %10, align 4
```

```
define void @foo_i32() {
```

```
entry:
```

```
%0 = load volatile i32, ptr inttoptr (i32 805874688 to ptr), align 4
%1 = load volatile i32, ptr inttoptr (i32 805874692 to ptr), align 4
%2 = load volatile i32, ptr inttoptr (i32 805874812 to ptr), align 4
%3 = load volatile i32, ptr inttoptr (i32 805874816 to ptr), align 4
%4 = load volatile i32, ptr inttoptr (i32 805874824 to ptr), align 4
%5 = load volatile i32, ptr inttoptr (i32 805874828 to ptr), align 4
ret void
}
```

```
; RUN: llc < %s -mtriple=s390x-linux-gnu -mcpu=zEC12 -verify-machineinstrs | FileCheck %s
```

```
;
```

```
; Test that early if conversion produces LOCR with operands of the right
; register classes.
```

```
define void @autogen_SD4739(ptr) {
```

```
; CHECK-NOT: Expected a GR32Bit register, but got a GRX32Bit register
```

```
BB:
```

```
%L34 = load i8, ptr %0
%Comp56 = icmp sgt i8 undef, %L34
br label %CF246
```

```

CF246:                                ; preds = %CF246, %BB
%SI163 = select i1 %Cmp56, i8 %L34, i8 undef
br i1 undef, label %CF246, label %CF248

CF248:                                ; preds = %CF248, %CF246
store i8 %SI163, ptr %0
br label %CF248
}
; RUN: llc -march=hexagon -hexagon-hvx-widen=32 < %s | FileCheck %s

; Truncating a type-to-be-widenened to a legal type (v8i8).
; Check that this compiles successfully.
; CHECK-LABEL: f0:
; CHECK: dealloc_return

target datalayout = "e-m:e-p:32:32:32-a:0-n16:32-i64:64:64-i32:32:32-i16:16:16-i1:8:8-f32:32:32-f64:64:64-
v32:32:32-v64:64:64-v512:512:512-v1024:1024:1024-v2048:2048:2048"
target triple = "hexagon"

define dllexport void @f0(ptr %a0) local_unnamed_addr #0 {
b0:
%v0 = load i8, ptr undef, align 1
%v1 = zext i8 %v0 to i16
%v2 = add i16 0, %v1
%v3 = icmp sgt i16 %v2, 1
%v4 = select i1 %v3, i16 %v2, i16 1
%v5 = udiv i16 -32768, %v4
%v6 = zext i16 %v5 to i32
%v7 = insertelement <8 x i32> undef, i32 %v6, i32 0
%v8 = shufflevector <8 x i32> %v7, <8 x i32> undef, <8 x i32> zeroinitializer
%v9 = load <8 x i16>, ptr undef, align 2
%v10 = sext <8 x i16> %v9 to <8 x i32>
%v11 = mul nsw <8 x i32> %v8, %v10
%v12 = add nsw <8 x i32> %v11, <i32 16384, i32 16384, i32 16384,
i32 16384, i32 16384, i32 16384, i32 16384, i32 16384>
%v13 = lshr <8 x i32> %v12, <i32 15, i32 15, i32 15, i32 15, i32 15, i32 15, i32 15, i32 15>
%v14 = trunc <8 x i32> %v13 to <8 x i8>
%v15 = getelementptr inbounds i8, ptr %a0, i32 undef
store <8 x i8> %v14, ptr %v15, align 1
ret void
}

attributes #0 = { "target-features"="+hvx,+hvx-length128b" }
; RUN: llc -march=hexagon < %s
; REQUIRES: asserts

; The two loads based on %struct.0, loading two different data types
; cause LSR to assume type "void" for the memory type. This would then

```

; cause an assert in isLegalAddressingMode. Make sure we no longer crash.

target triple = "hexagon"

%struct.0 = type { ptr, i8, %union.anon.0 }

%union.anon.0 = type { ptr }

define hidden fastcc void @fred() unnamed\_addr #0 {

entry:

br i1 undef, label %while.end, label %while.body.lr.ph

while.body.lr.ph: ; preds = %entry

br label %while.body

while.body: ; preds = %exit.2, %while.body.lr.ph

%lsr.iv = phi ptr [ %cgep22, %exit.2 ], [ undef, %while.body.lr.ph ]

switch i32 undef, label %exit [

i32 1, label %sw.bb.i

i32 2, label %sw.bb3.i

]

sw.bb.i: ; preds = %while.body

unreachable

sw.bb3.i: ; preds = %while.body

unreachable

exit:

; preds = %while.body

switch i32 undef, label %exit.2 [

i32 1, label %sw.bb.i17

i32 2, label %sw.bb3.i20

]

sw.bb.i17: ; preds = %exit

%0 = load i32, ptr %lsr.iv, align 4

unreachable

sw.bb3.i20: ; preds = %exit

%1 = load ptr, ptr %lsr.iv, align 4

unreachable

exit.2: ; preds = %exit

%cgep22 = getelementptr %struct.0, ptr %lsr.iv, i32 1

br label %while.body

while.end: ; preds = %entry

ret void



```
}
```

```
attributes #0 = { nounwind optsize "target-cpu"="hexagonv55" }  
; NOTE: Assertions have been autogenerated by utils/update_test_checks.py UTC_ARGS: --include-generated-funcs  
; RUN: opt -S -passes=verify,iroutliner -ir-outlining-no-cost < %s | FileCheck %s  
; FIXME: Disabled run-line after running into some turbulence with debuginfo-iterators  
; run: opt -S -passes=verify,iroutliner -ir-outlining-no-cost < %s --try-experimental-debuginfo-iterators | FileCheck %s
```

```
; This test checks that debug info is recognized as able to be extracted along  
; with the other instructions, but is not included in the consolidated function.
```

```
define void @function1() !dbg !6 {  
entry:  
  %a = alloca i32, align 4, !dbg !17  
  call void @llvm.dbg.value(metadata ptr %a, metadata !9, metadata !DIExpression()), !dbg !17  
  %b = alloca i32, align 4, !dbg !18  
  call void @llvm.dbg.value(metadata ptr %b, metadata !11, metadata !DIExpression()), !dbg !18  
  %c = alloca i32, align 4, !dbg !19  
  call void @llvm.dbg.value(metadata ptr %c, metadata !12, metadata !DIExpression()), !dbg !19  
  
  store i32 2, ptr %a, align 4, !dbg !20  
  store i32 3, ptr %b, align 4, !dbg !21  
  store i32 4, ptr %c, align 4, !dbg !22  
  %al = load i32, ptr %a, align 4, !dbg !23  
  call void @llvm.dbg.value(metadata i32 %al, metadata !13, metadata !DIExpression()), !dbg !23  
  %bl = load i32, ptr %b, align 4, !dbg !24  
  call void @llvm.dbg.value(metadata i32 %bl, metadata !15, metadata !DIExpression()), !dbg !24  
  %cl = load i32, ptr %c, align 4, !dbg !25  
  call void @llvm.dbg.value(metadata i32 %cl, metadata !16, metadata !DIExpression()), !dbg !25  
  ret void, !dbg !26  
}
```

```
define void @function2() !dbg !27 {  
entry:  
  %a = alloca i32, align 4, !dbg !35  
  call void @llvm.dbg.value(metadata ptr %a, metadata !29, metadata !DIExpression()), !dbg !35  
  %b = alloca i32, align 4, !dbg !36  
  call void @llvm.dbg.value(metadata ptr %b, metadata !30, metadata !DIExpression()), !dbg !36  
  %c = alloca i32, align 4, !dbg !37  
  call void @llvm.dbg.value(metadata ptr %c, metadata !31, metadata !DIExpression()), !dbg !37  
  
  store i32 2, ptr %a, align 4, !dbg !38  
  store i32 3, ptr %b, align 4, !dbg !39  
  store i32 4, ptr %c, align 4, !dbg !40  
  %al = load i32, ptr %a, align 4, !dbg !41  
  call void @llvm.dbg.value(metadata i32 %al, metadata !32, metadata !DIExpression()), !dbg !41
```

```

%bl = load i32, ptr %b, align 4, !dbg !42
call void @llvm.dbg.value(metadata i32 %bl, metadata !33, metadata !DIExpression()), !dbg !42
%cl = load i32, ptr %c, align 4, !dbg !43
call void @llvm.dbg.value(metadata i32 %cl, metadata !34, metadata !DIExpression()), !dbg !43
ret void, !dbg !44
}

```

```

; Function Attrs: nounwind readnone speculatable willreturn
declare void @llvm.dbg.value(metadata, metadata, metadata) #0

```

```

attributes #0 = { nounwind readnone speculatable willreturn }

```

```

!llvm.dbg.cu = !{!0}
!llvm.debugify = !{!3, !4}
!llvm.module.flags = !{!5}

```

```

!0 = distinct !DICompileUnit(language: DW_LANG_C, file: !1, producer: "debugify", isOptimized: true,
runtimeVersion: 0, emissionKind: FullDebug, enums: !2)
!1 = !DIFile(filename:
"legal-debug.ll", directory: "/")
!2 = !{}
!3 = !{i32 20}
!4 = !{i32 12}
!5 = !{i32 2, !"Debug Info Version", i32 3}
!6 = distinct !DISubprogram(name: "function1", linkageName: "function1", scope: null, file: !1, line: 1, type: !7,
scopeLine: 1, spFlags: DISPFlagDefinition | DISPFlagOptimized, unit: !0, retainedNodes: !8)
!7 = !DISubroutineType(types: !2)
!8 = !{!9, !11, !12, !13, !15, !16}
!9 = !DILocalVariable(name: "1", scope: !6, file: !1, line: 1, type: !10)
!10 = !DIBasicType(name: "ty64", size: 64, encoding: DW_ATE_unsigned)
!11 = !DILocalVariable(name: "2", scope: !6, file: !1, line: 2, type: !10)
!12 = !DILocalVariable(name: "3", scope: !6, file: !1, line: 3, type: !10)
!13 = !DILocalVariable(name: "4", scope: !6, file: !1, line: 7, type: !14)
!14 = !DIBasicType(name: "ty32", size: 32, encoding: DW_ATE_unsigned)
!15 = !DILocalVariable(name: "5", scope: !6, file: !1, line: 8, type: !14)
!16 = !DILocalVariable(name: "6", scope: !6, file: !1, line: 9, type: !14)
!17
= !DILocation(line: 1, column: 1, scope: !6)
!18 = !DILocation(line: 2, column: 1, scope: !6)
!19 = !DILocation(line: 3, column: 1, scope: !6)
!20 = !DILocation(line: 4, column: 1, scope: !6)
!21 = !DILocation(line: 5, column: 1, scope: !6)
!22 = !DILocation(line: 6, column: 1, scope: !6)
!23 = !DILocation(line: 7, column: 1, scope: !6)
!24 = !DILocation(line: 8, column: 1, scope: !6)
!25 = !DILocation(line: 9, column: 1, scope: !6)
!26 = !DILocation(line: 10, column: 1, scope: !6)

```

```

!27 = distinct !DISubprogram(name: "function2", linkageName: "function2", scope: null, file: !1, line: 11, type: !7,
scopeLine: 11, spFlags: DISPFlagDefinition | DISPFlagOptimized, unit: !0, retainedNodes: !28)
!28 = !{!29, !30, !31, !32, !33, !34}
!29 = !DILocalVariable(name: "7", scope: !27, file: !1, line: 11, type: !10)
!30 = !DILocalVariable(name: "8", scope: !27, file: !1, line: 12, type: !10)
!31 = !DILocalVariable(name: "9", scope: !27, file: !1, line: 13, type: !10)
!32 = !DILocalVariable(name: "10",
scope: !27, file: !1, line: 17, type: !14)
!33 = !DILocalVariable(name: "11", scope: !27, file: !1, line: 18, type: !14)
!34 = !DILocalVariable(name: "12", scope: !27, file: !1, line: 19, type: !14)
!35 = !DILocation(line: 11, column: 1, scope: !27)
!36 = !DILocation(line: 12, column: 1, scope: !27)
!37 = !DILocation(line: 13, column: 1, scope: !27)
!38 = !DILocation(line: 14, column: 1, scope: !27)
!39 = !DILocation(line: 15, column: 1, scope: !27)
!40 = !DILocation(line: 16, column: 1, scope: !27)
!41 = !DILocation(line: 17, column: 1, scope: !27)
!42 = !DILocation(line: 18, column: 1, scope: !27)
!43 = !DILocation(line: 19, column: 1, scope: !27)
!44 = !DILocation(line: 20, column: 1, scope: !27)
; CHECK-LABEL: @function1(
; CHECK-NEXT: entry:
; CHECK-NEXT: [[A:%.*]] = alloca i32, align 4, !dbg [[DBG17:![0-9]+]]
; CHECK-NEXT: call void @llvm.dbg.value(metadata ptr [[A]], metadata [[META9:![0-9]+]], metadata
!DIExpression()), !dbg [[DBG17]]
; CHECK-NEXT: [[B:%.*]] = alloca
i32, align 4, !dbg [[DBG18:![0-9]+]]
; CHECK-NEXT: call void @llvm.dbg.value(metadata ptr [[B]], metadata [[META11:![0-9]+]], metadata
!DIExpression()), !dbg [[DBG18]]
; CHECK-NEXT: [[C:%.*]] = alloca i32, align 4, !dbg [[DBG19:![0-9]+]]
; CHECK-NEXT: call void @llvm.dbg.value(metadata ptr [[C]], metadata [[META12:![0-9]+]], metadata
!DIExpression()), !dbg [[DBG19]]
; CHECK-NEXT: call void @outlined_ir_func_0(ptr [[A]], ptr [[B]], ptr [[C]]), !dbg [[DBG20:![0-9]+]]
; CHECK-NEXT: ret void, !dbg [[DBG21:![0-9]+]]
;
;
; CHECK-LABEL: @function2(
; CHECK-NEXT: entry:
; CHECK-NEXT: [[A:%.*]] = alloca i32, align 4, !dbg [[DBG30:![0-9]+]]
; CHECK-NEXT: call void @llvm.dbg.value(metadata ptr [[A]], metadata [[META24:![0-9]+]], metadata
!DIExpression()), !dbg [[DBG30]]
; CHECK-NEXT: [[B:%.*]] = alloca i32, align 4, !dbg [[DBG31:![0-9]+]]
; CHECK-NEXT: call void @llvm.dbg.value(metadata ptr [[B]], metadata [[META25:![0-9]+]], metadata
!DIExpression()), !dbg [[DBG31]]
;
CHECK-NEXT: [[C:%.*]] = alloca i32, align 4, !dbg [[DBG32:![0-9]+]]
; CHECK-NEXT: call void @llvm.dbg.value(metadata ptr [[C]], metadata [[META26:![0-9]+]], metadata
!DIExpression()), !dbg [[DBG32]]

```

```

; CHECK-NEXT: call void @outlined_ir_func_0(ptr [[A]], ptr [[B]], ptr [[C]]), !dbg [[DBG33:![0-9]+]]
; CHECK-NEXT: ret void, !dbg [[DBG34:![0-9]+]]
;
;
; CHECK: @outlined_ir_func_0(ptr [[TMP0:%.*]], ptr [[TMP1:%.*]], ptr [[TMP2:%.*]])
; CHECK: entry_to_outline:
; CHECK-NEXT: store i32 2, ptr [[TMP0]], align 4
; CHECK-NEXT: store i32 3, ptr [[TMP1]], align 4
; CHECK-NEXT: store i32 4, ptr [[TMP2]], align 4
; CHECK-NEXT: [[AL:%.*]] = load i32, ptr [[TMP0]], align 4
; CHECK-NEXT: [[BL:%.*]] = load i32, ptr [[TMP1]], align 4
; CHECK-NEXT: [[CL:%.*]] = load i32, ptr [[TMP2]], align 4
; CHECK-NEXT: br label [[ENTRY_AFTER_OUTLINE_EXITSTUB:%.*]]
;
; RUN: opt < %s -passes=argpromotion -S | FileCheck %s

```

```

; CHECK-LABEL: define i32 @foo() #0 {
; CHECK-NEXT:   %.val = load <32 x half>, ptr undef, align 4
; CHECK-NEXT:   call void @bar(<32 x half> %.val)
; CHECK-NEXT:   ret i32 0
; CHECK-NEXT: }

; CHECK-LABEL: define internal void @bar(<32 x half> %.0.val) #0 {
; CHECK-NEXT:   ret void
; CHECK-NEXT: }

```

```

; CHECK: attributes #0 = { uwtable "min-legal-vector-width"="512" }

```

```

define i32 @foo() #0 {
  call void @bar(ptr undef)
  ret i32 0
}

```

```

define internal void @bar(ptr) #0 {
  %2 = load <32 x half>, ptr %0, align 4
  ret void
}

```

```

attributes #0 = { uwtable "min-legal-vector-width"="0" }

```

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```
; NOTE: Assertions have been autogenerated by utils/update_llc_test_checks.py
; RUN: llc -mtriple=riscv64 -mattr=+m -verify-machineinstrs < %s \
; RUN: -riscv-experimental-rv64-legal-i32 | FileCheck %s -check-prefixes=CHECK,RV64I
; RUN: llc -mtriple=riscv64 -mattr=+m,+zba -verify-machineinstrs < %s \
; RUN: -riscv-experimental-rv64-legal-i32 | FileCheck %s -check-
prefixes=CHECK,RV64ZBA,RV64ZBANOZBB
; RUN: llc -mtriple=riscv64 -mattr=+m,+zba,+zbb -verify-machineinstrs < %s \
; RUN: -riscv-experimental-rv64-legal-i32 | FileCheck %s -check-prefixes=CHECK,RV64ZBA,RV64ZBAZBB
```

```
define i64 @slliuw(i64 %a) nounwind {
; RV64I-LABEL: slliuw:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  srli a0, a0, 31
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: slliuw:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  slli.uw a0, a0, 1
; RV64ZBA-NEXT:  ret
%conv1 = shl i64 %a, 1
%shl = and i64 %conv1, 8589934590
ret i64 %shl
}
```

```
define i128 @slliuw_2(i32 signext %0, ptr %1) {
; RV64I-LABEL:
slliuw_2:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  srli a0, a0, 28
; RV64I-NEXT:  add a1, a1, a0
; RV64I-NEXT:  ld a0, 0(a1)
; RV64I-NEXT:  ld a1, 8(a1)
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: slliuw_2:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  slli.uw a0, a0, 4
; RV64ZBA-NEXT:  add a1, a1, a0
; RV64ZBA-NEXT:  ld a0, 0(a1)
; RV64ZBA-NEXT:  ld a1, 8(a1)
; RV64ZBA-NEXT:  ret
%3 = zext i32 %0 to i64
%4 = getelementptr inbounds i128, ptr %1, i64 %3
```

```

%5 = load i128, ptr %4
ret i128 %5
}

define i128 @slliuw_3(i32 signext %0, ptr %1) {
; RV64I-LABEL: slliuw_3:
; RV64I:      # %bb.0:
; RV64I-NEXT:  addi a0, a0, 1
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  srli a0, a0, 28
; RV64I-NEXT:  add a1, a1, a0
; RV64I-NEXT:  ld a0, 0(a1)
; RV64I-NEXT:  ld a1, 8(a1)
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: slliuw_3:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  addi a0, a0, 1
; RV64ZBA-NEXT:  slli.uw a0, a0, 4
; RV64ZBA-NEXT:
    add a1, a1, a0
; RV64ZBA-NEXT:  ld a0, 0(a1)
; RV64ZBA-NEXT:  ld a1, 8(a1)
; RV64ZBA-NEXT:  ret
%add = add i32 %0, 1
%3 = zext i32 %add to i64
%4 = getelementptr inbounds i128, ptr %1, i64 %3
%5 = load i128, ptr %4
ret i128 %5
}

define i64 @adduw(i64 %a, i64 %b) nounwind {
; RV64I-LABEL: adduw:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a1, a1, 32
; RV64I-NEXT:  srli a1, a1, 32
; RV64I-NEXT:  add a0, a1, a0
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: adduw:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  add.uw a0, a1, a0
; RV64ZBA-NEXT:  ret
%and = and i64 %b, 4294967295
%add = add i64 %and, %a
ret i64 %add
}

```

```

define signext i8 @adduw_2(i32 signext %0, ptr %1) {
; RV64I-LABEL: adduw_2:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  srli a0, a0, 32
; RV64I-NEXT:  add a0, a1, a0
; RV64I-NEXT:  lb a0, 0(a0)
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: adduw_2:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  add.uw a0, a0, a1
; RV64ZBA-NEXT:
    lb a0, 0(a0)
; RV64ZBA-NEXT:  ret
%3 = zext i32 %0 to i64
%4 = getelementptr inbounds i8, ptr %1, i64 %3
%5 = load i8, ptr %4
ret i8 %5
}

```

```

define signext i8 @adduw_3(i32 signext %0, ptr %1) {
; RV64I-LABEL: adduw_3:
; RV64I:      # %bb.0:
; RV64I-NEXT:  addi a0, a0, 1
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  srli a0, a0, 32
; RV64I-NEXT:  add a0, a1, a0
; RV64I-NEXT:  lb a0, 0(a0)
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: adduw_3:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  addi a0, a0, 1
; RV64ZBA-NEXT:  add.uw a0, a0, a1
; RV64ZBA-NEXT:  lb a0, 0(a0)
; RV64ZBA-NEXT:  ret
%add = add i32 %0, 1
%3 = zext i32 %add to i64
%4 = getelementptr inbounds i8, ptr %1, i64 %3
%5 = load i8, ptr %4
ret i8 %5
}

```

```

define i64 @zextw_i64(i64 %a) nounwind {
; RV64I-LABEL: zextw_i64:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a0, a0, 32

```

```

; RV64I-NEXT:  srli a0, a0, 32
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: zextw_i64:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:
    zext.w a0, a0
; RV64ZBA-NEXT:  ret
%and = and i64 %a, 4294967295
ret i64 %and
}

```

; This makes sure targetShrinkDemandedConstant changes the and immediate to  
; allow zext.w or slli+srli.

```

define i64 @zextw_demandedbits_i64(i64 %0) {
; RV64I-LABEL: zextw_demandedbits_i64:
; RV64I:      # %bb.0:
; RV64I-NEXT:  ori a0, a0, 1
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  srli a0, a0, 32
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: zextw_demandedbits_i64:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  ori a0, a0, 1
; RV64ZBA-NEXT:  zext.w a0, a0
; RV64ZBA-NEXT:  ret
%2 = and i64 %0, 4294967294
%3 = or i64 %2, 1
ret i64 %3
}

```

```

define signext i16 @sh1add(i64 %0, ptr %1) {
; RV64I-LABEL: sh1add:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a0, a0, 1
; RV64I-NEXT:  add a0, a1, a0
; RV64I-NEXT:  lh a0, 0(a0)
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: sh1add:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  sh1add a0, a0, a1
; RV64ZBA-NEXT:  lh a0, 0(a0)
; RV64ZBA-NEXT:
    ret
%3 = getelementptr inbounds i16, ptr %1, i64 %0
%4 = load i16, ptr %3

```

```

ret i16 %4
}

define signext i32 @sh2add(i64 %0, ptr %1) {
; RV64I-LABEL: sh2add:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a0, a0, 2
; RV64I-NEXT:  add a0, a1, a0
; RV64I-NEXT:  lw a0, 0(a0)
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: sh2add:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  sh2add a0, a0, a1
; RV64ZBA-NEXT:  lw a0, 0(a0)
; RV64ZBA-NEXT:  ret
%3 = getelementptr inbounds i32, ptr %1, i64 %0
%4 = load i32, ptr %3
ret i32 %4
}

define i64 @sh3add(i64 %0, ptr %1) {
; RV64I-LABEL: sh3add:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a0, a0, 3
; RV64I-NEXT:  add a0, a1, a0
; RV64I-NEXT:  ld a0, 0(a0)
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: sh3add:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  sh3add a0, a0, a1
; RV64ZBA-NEXT:  ld a0, 0(a0)
; RV64ZBA-NEXT:  ret
%3 = getelementptr inbounds i64, ptr %1, i64 %0
%4 = load i64, ptr %3
ret i64 %4
}

define signext i16 @sh1adduw(i32
signext %0, ptr %1) {
; RV64I-LABEL: sh1adduw:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  srli a0, a0, 31
; RV64I-NEXT:  add a0, a1, a0
; RV64I-NEXT:  lh a0, 0(a0)
; RV64I-NEXT:  ret

```



```

;
; RV64ZBA-LABEL: sh1adduw:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  sh1add.uw a0, a0, a1
; RV64ZBA-NEXT:  lh a0, 0(a0)
; RV64ZBA-NEXT:  ret
%3 = zext i32 %0 to i64
%4 = getelementptr inbounds i16, ptr %1, i64 %3
%5 = load i16, ptr %4
ret i16 %5
}

define i64 @sh1adduw_2(i64 %0, i64 %1) {
; RV64I-LABEL: sh1adduw_2:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  srli a0, a0, 31
; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: sh1adduw_2:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  sh1add.uw a0, a0, a1
; RV64ZBA-NEXT:  ret
%3 = shl i64 %0, 1
%4 = and i64 %3, 8589934590
%5 = add i64 %4, %1
ret i64 %5
}

define signext i32 @sh2adduw(i32 signext %0, ptr %1) {
; RV64I-LABEL: sh2adduw:
; RV64I:
;   # %bb.0:
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  srli a0, a0, 30
; RV64I-NEXT:  add a0, a1, a0
; RV64I-NEXT:  lw a0, 0(a0)
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: sh2adduw:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  sh2add.uw a0, a0, a1
; RV64ZBA-NEXT:  lw a0, 0(a0)
; RV64ZBA-NEXT:  ret
%3 = zext i32 %0 to i64
%4 = getelementptr inbounds i32, ptr %1, i64 %3
%5 = load i32, ptr %4

```

```
ret i32 %5
}
```

```
define i64 @sh2adduw_2(i64 %0, i64 %1) {
; RV64I-LABEL: sh2adduw_2:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  srli a0, a0, 30
; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: sh2adduw_2:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  sh2add.uw a0, a0, a1
; RV64ZBA-NEXT:  ret
%3 = shl i64 %0, 2
%4 = and i64 %3, 17179869180
%5 = add i64 %4, %1
ret i64 %5
}
```

```
define i64 @sh3adduw(i32 signext %0, ptr %1) {
; RV64I-LABEL: sh3adduw:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:
; RV64I-NEXT:  srli a0, a0, 29
; RV64I-NEXT:  add a0, a1, a0
; RV64I-NEXT:  ld a0, 0(a0)
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: sh3adduw:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  sh3add.uw a0, a0, a1
; RV64ZBA-NEXT:  ld a0, 0(a0)
; RV64ZBA-NEXT:  ret
%3 = zext i32 %0 to i64
%4 = getelementptr inbounds i64, ptr %1, i64 %3
%5 = load i64, ptr %4
ret i64 %5
}
```

```
define i64 @sh3adduw_2(i64 %0, i64 %1) {
; RV64I-LABEL: sh3adduw_2:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  srli a0, a0, 29
; RV64I-NEXT:  add a0, a0, a1
```

```

; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: sh3adduw_2:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  sh3add.uw a0, a0, a1
; RV64ZBA-NEXT:  ret
%3 = shl i64 %0, 3
%4 = and i64 %3, 34359738360
%5 = add i64 %4, %1
ret i64 %5
}

```

; Type legalization inserts a sext\_inreg after the first add. That add will be  
; selected as sh2add which does not sign extend. SimplifyDemandedBits is unable  
; to remove the sext\_inreg because it has multiple uses.

The ashr will use the

; sext\_inreg to become sraiw. This leaves the sext\_inreg only used by the shl.

; If the shl is selected as sllw, we don't need the sext\_inreg.

define i64 @sh2add\_extra\_sext(i32 %x, i32 %y, i32 %z) {

```

; RV64I-LABEL: sh2add_extra_sext:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a0, a0, 2
; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  sllw a1, a2, a0
; RV64I-NEXT:  sraiw a0, a0, 2
; RV64I-NEXT:  mul a0, a1, a0
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: sh2add_extra_sext:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  sh2add a0, a0, a1
; RV64ZBA-NEXT:  sllw a1, a2, a0
; RV64ZBA-NEXT:  sraiw a0, a0, 2
; RV64ZBA-NEXT:  mul a0, a1, a0
; RV64ZBA-NEXT:  ret
%a = shl i32 %x, 2
%b = add i32 %a, %y
%c = shl i32 %z, %b
%d = ashr i32 %b, 2
%e = sext i32 %c to i64
%f = sext i32 %d to i64
%g = mul i64 %e, %f
ret i64 %g
}

```

define i64 @addmul6(i64 %a, i64 %b) {

```

; RV64I-LABEL: addmul6:
; RV64I:      # %bb.0:

```

```

; RV64I-NEXT:  li a2, 6
; RV64I-NEXT:  mul
a0, a0, a2
; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: addmul6:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  sh1add a0, a0, a0
; RV64ZBA-NEXT:  sh1add a0, a0, a1
; RV64ZBA-NEXT:  ret
%c = mul i64 %a, 6
%d = add i64 %c, %b
ret i64 %d
}

```

```

define i64 @addmul10(i64 %a, i64 %b) {
; RV64I-LABEL: addmul10:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a2, 10
; RV64I-NEXT:  mul a0, a0, a2
; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: addmul10:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  sh2add a0, a0, a0
; RV64ZBA-NEXT:  sh1add a0, a0, a1
; RV64ZBA-NEXT:  ret
%c = mul i64 %a, 10
%d = add i64 %c, %b
ret i64 %d
}

```

```

define i64 @addmul12(i64 %a, i64 %b) {
; RV64I-LABEL: addmul12:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a2, 12
; RV64I-NEXT:  mul a0, a0, a2
; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: addmul12:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  sh1add a0, a0, a0
; RV64ZBA-NEXT:  sh2add
a0, a0, a1
; RV64ZBA-NEXT:  ret

```

```

%c = mul i64 %a, 12
%d = add i64 %c, %b
ret i64 %d
}

```

```

define i64 @addmul18(i64 %a, i64 %b) {
; RV64I-LABEL: addmul18:
; RV64I:      # %bb.0:
; RV64I-NEXT: li a2, 18
; RV64I-NEXT: mul a0, a0, a2
; RV64I-NEXT: add a0, a0, a1
; RV64I-NEXT: ret
;
; RV64ZBA-LABEL: addmul18:
; RV64ZBA:    # %bb.0:
; RV64ZBA-NEXT: sh3add a0, a0, a0
; RV64ZBA-NEXT: sh1add a0, a0, a1
; RV64ZBA-NEXT: ret
%c = mul i64 %a, 18
%d = add i64 %c, %b
ret i64 %d
}

```

```

define i64 @addmul20(i64 %a, i64 %b) {
; RV64I-LABEL: addmul20:
; RV64I:      # %bb.0:
; RV64I-NEXT: li a2, 20
; RV64I-NEXT: mul a0, a0, a2
; RV64I-NEXT: add a0, a0, a1
; RV64I-NEXT: ret
;
; RV64ZBA-LABEL: addmul20:
; RV64ZBA:    # %bb.0:
; RV64ZBA-NEXT: sh2add a0, a0, a0
; RV64ZBA-NEXT: sh2add a0, a0, a1
; RV64ZBA-NEXT: ret
%c = mul i64 %a, 20
%d = add i64 %c, %b
ret i64 %d
}

```

```

define i64 @addmul24(i64 %a, i64 %b) {
; RV64I-LABEL: addmul24:
; RV64I:
;   # %bb.0:
; RV64I-NEXT: li a2, 24
; RV64I-NEXT: mul a0, a0, a2
; RV64I-NEXT: add a0, a0, a1

```

```

; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: addmul24:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  sh1add a0, a0, a0
; RV64ZBA-NEXT:  sh3add a0, a0, a1
; RV64ZBA-NEXT:  ret
%c = mul i64 %a, 24
%d = add i64 %c, %b
ret i64 %d
}

```

```

define i64 @addmul36(i64 %a, i64 %b) {
; RV64I-LABEL: addmul36:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a2, 36
; RV64I-NEXT:  mul a0, a0, a2
; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: addmul36:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  sh3add a0, a0, a0
; RV64ZBA-NEXT:  sh2add a0, a0, a1
; RV64ZBA-NEXT:  ret
%c = mul i64 %a, 36
%d = add i64 %c, %b
ret i64 %d
}

```

```

define i64 @addmul40(i64 %a, i64 %b) {
; RV64I-LABEL: addmul40:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a2, 40
; RV64I-NEXT:  mul a0, a0, a2
; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: addmul40:
; RV64ZBA:      # %bb.0:
;
RV64ZBA-NEXT:  sh2add a0, a0, a0
; RV64ZBA-NEXT:  sh3add a0, a0, a1
; RV64ZBA-NEXT:  ret
%c = mul i64 %a, 40
%d = add i64 %c, %b
ret i64 %d
}

```

```

define i64 @addmul72(i64 %a, i64 %b) {
; RV64I-LABEL: addmul72:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a2, 72
; RV64I-NEXT:  mul a0, a0, a2
; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: addmul72:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  sh3add a0, a0, a0
; RV64ZBA-NEXT:  sh3add a0, a0, a1
; RV64ZBA-NEXT:  ret
%c = mul i64 %a, 72
%d = add i64 %c, %b
ret i64 %d
}

```

```

define i64 @mul96(i64 %a) {
; RV64I-LABEL: mul96:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a1, 96
; RV64I-NEXT:  mul a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: mul96:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  sh1add a0, a0, a0
; RV64ZBA-NEXT:  slli a0, a0, 5
; RV64ZBA-NEXT:  ret
%c = mul i64 %a, 96
ret i64 %c
}

```

```

define i64 @mul160(i64 %a) {
; RV64I-LABEL: mul160:
; RV64I:      # %bb.0:
; RV64I-NEXT:
    li a1, 160
; RV64I-NEXT:  mul a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: mul160:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  sh2add a0, a0, a0
; RV64ZBA-NEXT:  slli a0, a0, 5
; RV64ZBA-NEXT:  ret

```

```

%c = mul i64 %a, 160
ret i64 %c
}

define i64 @mul288(i64 %a) {
; RV64I-LABEL: mul288:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a1, 288
; RV64I-NEXT:  mul a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: mul288:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  sh3add a0, a0, a0
; RV64ZBA-NEXT:  slli a0, a0, 5
; RV64ZBA-NEXT:  ret
%c = mul i64 %a, 288
ret i64 %c
}

define i64 @zext_mul96(i32 signext %a) {
; RV64I-LABEL: zext_mul96:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a1, 3
; RV64I-NEXT:  slli a1, a1, 37
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  mulhu a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: zext_mul96:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  slli.uw a0, a0, 5
; RV64ZBA-NEXT:  sh1add a0, a0, a0
; RV64ZBA-NEXT:  ret
%b = zext
i32 %a to i64
%c = mul i64 %b, 96
ret i64 %c
}

define i64 @zext_mul160(i32 signext %a) {
; RV64I-LABEL: zext_mul160:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a1, 5
; RV64I-NEXT:  slli a1, a1, 37
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  mulhu a0, a0, a1
; RV64I-NEXT:  ret

```



```

;
; RV64ZBA-LABEL: zext_mul160:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  slli.uw a0, a0, 5
; RV64ZBA-NEXT:  sh2add a0, a0, a0
; RV64ZBA-NEXT:  ret
%b = zext i32 %a to i64
%c = mul i64 %b, 160
ret i64 %c
}

```

```

define i64 @zext_mul288(i32 signext %a) {
; RV64I-LABEL: zext_mul288:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a1, 9
; RV64I-NEXT:  slli a1, a1, 37
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  mulhu a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: zext_mul288:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  slli.uw a0, a0, 5
; RV64ZBA-NEXT:  sh3add a0, a0, a0
; RV64ZBA-NEXT:  ret
%b = zext i32 %a to i64
%c = mul i64 %b, 288
ret i64 %c
}

```

```

; We can't use slli.uw becaues
the shift amount is more than 31.
; FIXME: The zext.w is unneeded.
define i64 @zext_mul12884901888(i32 signext %a) {
; RV64I-LABEL: zext_mul12884901888:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  srli a0, a0, 32
; RV64I-NEXT:  li a1, 3
; RV64I-NEXT:  slli a1, a1, 32
; RV64I-NEXT:  mul a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: zext_mul12884901888:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  andi a0, a0, -1
; RV64ZBA-NEXT:  sh1add a0, a0, a0
; RV64ZBA-NEXT:  slli a0, a0, 32

```

```
; RV64ZBA-NEXT:  ret
%b = zext i32 %a to i64
%c = mul i64 %b, 12884901888
ret i64 %c
}
```

; We can't use slli.uw becaues the shift amount is more than 31.

; FIXME: The zext.w is unneeded.

```
define i64 @zext_mul21474836480(i32 signext %a) {
```

```
; RV64I-LABEL: zext_mul21474836480:
```

```
; RV64I:      # %bb.0:
```

```
; RV64I-NEXT:  slli a0, a0, 32
```

```
; RV64I-NEXT:  srli a0, a0, 32
```

```
; RV64I-NEXT:  li a1, 5
```

```
; RV64I-NEXT:  slli a1, a1, 32
```

```
; RV64I-NEXT:  mul a0, a0, a1
```

```
; RV64I-NEXT:
```

```
    ret
```

```
;
```

```
; RV64ZBA-LABEL: zext_mul21474836480:
```

```
; RV64ZBA:     # %bb.0:
```

```
; RV64ZBA-NEXT: andi a0, a0, -1
```

```
; RV64ZBA-NEXT: sh2add a0, a0, a0
```

```
; RV64ZBA-NEXT: slli a0, a0, 32
```

```
; RV64ZBA-NEXT: ret
```

```
%b = zext i32 %a to i64
```

```
%c = mul i64 %b, 21474836480
```

```
ret i64 %c
```

```
}
```

; We can't use slli.uw becaues the shift amount is more than 31.

; FIXME: The zext.w is unneeded.

```
define i64 @zext_mul38654705664(i32 signext %a) {
```

```
; RV64I-LABEL: zext_mul38654705664:
```

```
; RV64I:      # %bb.0:
```

```
; RV64I-NEXT:  slli a0, a0, 32
```

```
; RV64I-NEXT:  srli a0, a0, 32
```

```
; RV64I-NEXT:  li a1, 9
```

```
; RV64I-NEXT:  slli a1, a1, 32
```

```
; RV64I-NEXT:  mul a0, a0, a1
```

```
; RV64I-NEXT:  ret
```

```
;
```

```
; RV64ZBA-LABEL: zext_mul38654705664:
```

```
; RV64ZBA:     # %bb.0:
```

```
; RV64ZBA-NEXT: andi a0, a0, -1
```

```
; RV64ZBA-NEXT: sh3add a0, a0, a0
```

```
; RV64ZBA-NEXT: slli a0, a0, 32
```

```
; RV64ZBA-NEXT: ret
```

```

%b = zext i32 %a to i64
%c = mul i64 %b, 38654705664
ret i64 %c
}

```

```

define i64 @sh1add_imm(i64 %0) {
; CHECK-LABEL: sh1add_imm:
;
CHECK:    # %bb.0:
; CHECK-NEXT:  slli a0, a0, 1
; CHECK-NEXT:  addi a0, a0, 5
; CHECK-NEXT:  ret
%a = shl i64 %0, 1
%b = add i64 %a, 5
ret i64 %b
}

```

```

define i64 @sh2add_imm(i64 %0) {
; CHECK-LABEL: sh2add_imm:
; CHECK:    # %bb.0:
; CHECK-NEXT:  slli a0, a0, 2
; CHECK-NEXT:  addi a0, a0, -6
; CHECK-NEXT:  ret
%a = shl i64 %0, 2
%b = add i64 %a, -6
ret i64 %b
}

```

```

define i64 @sh3add_imm(i64 %0) {
; CHECK-LABEL: sh3add_imm:
; CHECK:    # %bb.0:
; CHECK-NEXT:  slli a0, a0, 3
; CHECK-NEXT:  addi a0, a0, 7
; CHECK-NEXT:  ret
%a = shl i64 %0, 3
%b = add i64 %a, 7
ret i64 %b
}

```

```

define i64 @sh1adduw_imm(i32 signext %0) {
; RV64I-LABEL: sh1adduw_imm:
; RV64I:    # %bb.0:
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  srli a0, a0, 31
; RV64I-NEXT:  addi a0, a0, 11
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: sh1adduw_imm:

```

```

; RV64ZBA:    # %bb.0:
; RV64ZBA-NEXT:  slli.uw a0, a0, 1
; RV64ZBA-NEXT:  addi a0, a0, 11
; RV64ZBA-NEXT:  ret
%a =
zext i32 %0 to i64
%b = shl i64 %a, 1
%c = add i64 %b, 11
ret i64 %c
}

define i64 @sh2adduw_imm(i32 signext %0) {
; RV64I-LABEL: sh2adduw_imm:
; RV64I:    # %bb.0:
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  srli a0, a0, 30
; RV64I-NEXT:  addi a0, a0, -12
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: sh2adduw_imm:
; RV64ZBA:    # %bb.0:
; RV64ZBA-NEXT:  slli.uw a0, a0, 2
; RV64ZBA-NEXT:  addi a0, a0, -12
; RV64ZBA-NEXT:  ret
%a = zext i32 %0 to i64
%b = shl i64 %a, 2
%c = add i64 %b, -12
ret i64 %c
}

define i64 @sh3adduw_imm(i32 signext %0) {
; RV64I-LABEL: sh3adduw_imm:
; RV64I:    # %bb.0:
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  srli a0, a0, 29
; RV64I-NEXT:  addi a0, a0, 13
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: sh3adduw_imm:
; RV64ZBA:    # %bb.0:
; RV64ZBA-NEXT:  slli.uw a0, a0, 3
; RV64ZBA-NEXT:  addi a0, a0, 13
; RV64ZBA-NEXT:  ret
%a = zext i32 %0 to i64
%b = shl i64 %a, 3
%c = add i64 %b, 13
ret i64 %c
}

```

```

define i64
  @adduw_imm(i32 signext %0) nounwind {
; RV64I-LABEL: adduw_imm:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  srli a0, a0, 32
; RV64I-NEXT:  addi a0, a0, 5
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: adduw_imm:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  zext.w a0, a0
; RV64ZBA-NEXT:  addi a0, a0, 5
; RV64ZBA-NEXT:  ret
  %a = zext i32 %0 to i64
  %b = add i64 %a, 5
  ret i64 %b
}

```

```

define i64 @mul258(i64 %a) {
; CHECK-LABEL: mul258:
; CHECK:      # %bb.0:
; CHECK-NEXT:  li a1, 258
; CHECK-NEXT:  mul a0, a0, a1
; CHECK-NEXT:  ret
  %c = mul i64 %a, 258
  ret i64 %c
}

```

```

define i64 @mul260(i64 %a) {
; CHECK-LABEL: mul260:
; CHECK:      # %bb.0:
; CHECK-NEXT:  li a1, 260
; CHECK-NEXT:  mul a0, a0, a1
; CHECK-NEXT:  ret
  %c = mul i64 %a, 260
  ret i64 %c
}

```

```

define i64 @mul264(i64 %a) {
; CHECK-LABEL: mul264:
; CHECK:      # %bb.0:
; CHECK-NEXT:  li a1, 264
; CHECK-NEXT:  mul a0, a0, a1
; CHECK-NEXT:  ret
  %c = mul i64 %a, 264
  ret i64
}

```

```

%c
}

define i64 @imm_zextw() nounwind {
; RV64I-LABEL: imm_zextw:
; RV64I:      # %bb.0:
; RV64I-NEXT: li a0, 1
; RV64I-NEXT: slli a0, a0, 32
; RV64I-NEXT: addi a0, a0, -2
; RV64I-NEXT: ret
;
; RV64ZBA-LABEL: imm_zextw:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT: li a0, -2
; RV64ZBA-NEXT: zext.w a0, a0
; RV64ZBA-NEXT: ret
ret i64 4294967294 ; -2 in 32 bits.
}

define i64 @mul11(i64 %a) {
; RV64I-LABEL: mul11:
; RV64I:      # %bb.0:
; RV64I-NEXT: li a1, 11
; RV64I-NEXT: mul a0, a0, a1
; RV64I-NEXT: ret
;
; RV64ZBA-LABEL: mul11:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT: sh2add a1, a0, a0
; RV64ZBA-NEXT: sh1add a0, a1, a0
; RV64ZBA-NEXT: ret
%c = mul i64 %a, 11
ret i64 %c
}

define i64 @mul19(i64 %a) {
; RV64I-LABEL: mul19:
; RV64I:      # %bb.0:
; RV64I-NEXT: li a1, 19
; RV64I-NEXT: mul a0, a0, a1
; RV64I-NEXT: ret
;
; RV64ZBA-LABEL: mul19:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT: sh3add a1, a0, a0
; RV64ZBA-NEXT: sh1add a0,
a1, a0
; RV64ZBA-NEXT: ret

```

```
%c = mul i64 %a, 19
```

```
ret i64 %c
```

```
}
```

```
define i64 @mul13(i64 %a) {
```

```
; RV64I-LABEL: mul13:
```

```
; RV64I:    # %bb.0:
```

```
; RV64I-NEXT:  li a1, 13
```

```
; RV64I-NEXT:  mul a0, a0, a1
```

```
; RV64I-NEXT:  ret
```

```
;
```

```
; RV64ZBA-LABEL: mul13:
```

```
; RV64ZBA:    # %bb.0:
```

```
; RV64ZBA-NEXT:  sh1add a1, a0, a0
```

```
; RV64ZBA-NEXT:  sh2add a0, a1, a0
```

```
; RV64ZBA-NEXT:  ret
```

```
%c = mul i64 %a, 13
```

```
ret i64 %c
```

```
}
```

```
define i64 @mul21(i64 %a) {
```

```
; RV64I-LABEL: mul21:
```

```
; RV64I:    # %bb.0:
```

```
; RV64I-NEXT:  li a1, 21
```

```
; RV64I-NEXT:  mul a0, a0, a1
```

```
; RV64I-NEXT:  ret
```

```
;
```

```
; RV64ZBA-LABEL: mul21:
```

```
; RV64ZBA:    # %bb.0:
```

```
; RV64ZBA-NEXT:  sh2add a1, a0, a0
```

```
; RV64ZBA-NEXT:  sh2add a0, a1, a0
```

```
; RV64ZBA-NEXT:  ret
```

```
%c = mul i64 %a, 21
```

```
ret i64 %c
```

```
}
```

```
define i64 @mul37(i64 %a) {
```

```
; RV64I-LABEL: mul37:
```

```
; RV64I:    # %bb.0:
```

```
; RV64I-NEXT:  li a1, 37
```

```
; RV64I-NEXT:  mul a0, a0, a1
```

```
; RV64I-NEXT:  ret
```

```
;
```

```
; RV64ZBA-LABEL: mul37:
```

```
; RV64ZBA:    # %bb.0:
```

```
; RV64ZBA-NEXT:  sh3add a1, a0, a0
```

```
; RV64ZBA-NEXT:
```

```

    sh2add a0, a1, a0
; RV64ZBA-NEXT:  ret
    %c = mul i64 %a, 37
    ret i64 %c
}

define i64 @mul25(i64 %a) {
; RV64I-LABEL: mul25:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a1, 25
; RV64I-NEXT:  mul a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: mul25:
; RV64ZBA:    # %bb.0:
; RV64ZBA-NEXT:  sh1add a1, a0, a0
; RV64ZBA-NEXT:  sh3add a0, a1, a0
; RV64ZBA-NEXT:  ret
    %c = mul i64 %a, 25
    ret i64 %c
}

define i64 @mul41(i64 %a) {
; RV64I-LABEL: mul41:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a1, 41
; RV64I-NEXT:  mul a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: mul41:
; RV64ZBA:    # %bb.0:
; RV64ZBA-NEXT:  sh2add a1, a0, a0
; RV64ZBA-NEXT:  sh3add a0, a1, a0
; RV64ZBA-NEXT:  ret
    %c = mul i64 %a, 41
    ret i64 %c
}

define i64 @mul73(i64 %a) {
; RV64I-LABEL: mul73:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a1, 73
; RV64I-NEXT:  mul a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: mul73:
; RV64ZBA:    # %bb.0:
; RV64ZBA-NEXT:  sh3add

```



```

a1, a0, a0
; RV64ZBA-NEXT:  sh3add a0, a1, a0
; RV64ZBA-NEXT:  ret
%c = mul i64 %a, 73
ret i64 %c
}

```

```

define i64 @mul27(i64 %a) {
; RV64I-LABEL: mul27:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a1, 27
; RV64I-NEXT:  mul a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: mul27:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  sh3add a0, a0, a0
; RV64ZBA-NEXT:  sh1add a0, a0, a0
; RV64ZBA-NEXT:  ret
%c = mul i64 %a, 27
ret i64 %c
}

```

```

define i64 @mul45(i64 %a) {
; RV64I-LABEL: mul45:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a1, 45
; RV64I-NEXT:  mul a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: mul45:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  sh3add a0, a0, a0
; RV64ZBA-NEXT:  sh2add a0, a0, a0
; RV64ZBA-NEXT:  ret
%c = mul i64 %a, 45
ret i64 %c
}

```

```

define i64 @mul81(i64 %a) {
; RV64I-LABEL: mul81:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a1, 81
; RV64I-NEXT:  mul a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: mul81:
; RV64ZBA:      # %bb.0:

```

```

;
RV64ZBA-NEXT:  sh3add a0, a0, a0
; RV64ZBA-NEXT:  sh3add a0, a0, a0
; RV64ZBA-NEXT:  ret
%c = mul i64 %a, 81
ret i64 %c
}

```

```

define i64 @mul4098(i64 %a) {
; RV64I-LABEL: mul4098:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a1, a0, 1
; RV64I-NEXT:  slli a0, a0, 12
; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: mul4098:
; RV64ZBA:    # %bb.0:
; RV64ZBA-NEXT:  slli a1, a0, 12
; RV64ZBA-NEXT:  sh1add a0, a0, a1
; RV64ZBA-NEXT:  ret
%c = mul i64 %a, 4098
ret i64 %c
}

```

```

define i64 @mul4100(i64 %a) {
; RV64I-LABEL: mul4100:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a1, a0, 2
; RV64I-NEXT:  slli a0, a0, 12
; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: mul4100:
; RV64ZBA:    # %bb.0:
; RV64ZBA-NEXT:  slli a1, a0, 12
; RV64ZBA-NEXT:  sh2add a0, a0, a1
; RV64ZBA-NEXT:  ret
%c = mul i64 %a, 4100
ret i64 %c
}

```

```

define i64 @mul4104(i64 %a) {
; RV64I-LABEL: mul4104:
; RV64I:      # %bb.0:
; RV64I-NEXT:
    slli a1, a0, 3
; RV64I-NEXT:  slli a0, a0, 12

```

```

; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: mul4104:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  slli a1, a0, 12
; RV64ZBA-NEXT:  sh3add a0, a0, a1
; RV64ZBA-NEXT:  ret
%c = mul i64 %a, 4104
ret i64 %c
}

define signext i32 @mulw192(i32 signext %a) {
; CHECK-LABEL: mulw192:
; CHECK:      # %bb.0:
; CHECK-NEXT:  li a1, 192
; CHECK-NEXT:  mulw a0, a0, a1
; CHECK-NEXT:  ret
%c = mul i32 %a, 192
ret i32 %c
}

define signext i32 @mulw320(i32 signext %a) {
; CHECK-LABEL: mulw320:
; CHECK:      # %bb.0:
; CHECK-NEXT:  li a1, 320
; CHECK-NEXT:  mulw a0, a0, a1
; CHECK-NEXT:  ret
%c = mul i32 %a, 320
ret i32 %c
}

define signext i32 @mulw576(i32 signext %a) {
; CHECK-LABEL: mulw576:
; CHECK:      # %bb.0:
; CHECK-NEXT:  li a1, 576
; CHECK-NEXT:  mulw a0, a0, a1
; CHECK-NEXT:  ret
%c = mul i32 %a, 576
ret i32 %c
}

define i64 @add4104(i64 %a) {
; RV64I-LABEL: add4104:
; RV64I:
;   # %bb.0:
; RV64I-NEXT:  lui a1, 1
; RV64I-NEXT:  addiw a1, a1, 8

```

```

; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: add4104:
; RV64ZBA:     # %bb.0:
; RV64ZBA-NEXT:  li a1, 1026
; RV64ZBA-NEXT:  sh2add a0, a1, a0
; RV64ZBA-NEXT:  ret
%c = add i64 %a, 4104
ret i64 %c
}

```

```

define i64 @add8208(i64 %a) {
; RV64I-LABEL: add8208:
; RV64I:       # %bb.0:
; RV64I-NEXT:  lui a1, 2
; RV64I-NEXT:  addiw a1, a1, 16
; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: add8208:
; RV64ZBA:     # %bb.0:
; RV64ZBA-NEXT:  li a1, 1026
; RV64ZBA-NEXT:  sh3add a0, a1, a0
; RV64ZBA-NEXT:  ret
%c = add i64 %a, 8208
ret i64 %c
}

```

```

; Make sure we prefer LUI for the 8192 instead of using sh3add.
define signext i32 @add8192_i32(i32 signext %a) {
; CHECK-LABEL: add8192_i32:
; CHECK:       # %bb.0:
; CHECK-NEXT:  lui a1, 2
; CHECK-NEXT:  addw a0, a0, a1
; CHECK-NEXT:  ret
%c = add i32 %a, 8192
ret i32 %c
}

```

```

; Make sure we prefer LUI
for the 8192 instead of using sh3add.
define i64 @add8192(i64 %a) {
; CHECK-LABEL: add8192:
; CHECK:       # %bb.0:
; CHECK-NEXT:  lui a1, 2
; CHECK-NEXT:  add a0, a0, a1
; CHECK-NEXT:  ret

```

```

%c = add i64 %a, 8192
ret i64 %c
}

define signext i32 @addshl32_5_6(i32 signext %a, i32 signext %b) {
; RV64I-LABEL: addshl32_5_6:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a0, a0, 5
; RV64I-NEXT:  slli a1, a1, 6
; RV64I-NEXT:  addw a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: addshl32_5_6:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  sh1add a0, a1, a0
; RV64ZBA-NEXT:  slliw a0, a0, 5
; RV64ZBA-NEXT:  ret
%c = shl i32 %a, 5
%d = shl i32 %b, 6
%e = add i32 %c, %d
ret i32 %e
}

define i64 @addshl64_5_6(i64 %a, i64 %b) {
; RV64I-LABEL: addshl64_5_6:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a0, a0, 5
; RV64I-NEXT:  slli a1, a1, 6
; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: addshl64_5_6:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:
; RV64ZBA-NEXT:  sh1add a0, a1, a0
; RV64ZBA-NEXT:  slli a0, a0, 5
; RV64ZBA-NEXT:  ret
%c = shl i64 %a, 5
%d = shl i64 %b, 6
%e = add i64 %c, %d
ret i64 %e
}

define signext i32 @addshl32_5_7(i32 signext %a, i32 signext %b) {
; RV64I-LABEL: addshl32_5_7:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a0, a0, 5
; RV64I-NEXT:  slli a1, a1, 7

```

```

; RV64I-NEXT:  addw a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: addshl32_5_7:
; RV64ZBA:     # %bb.0:
; RV64ZBA-NEXT:  sh2add a0, a1, a0
; RV64ZBA-NEXT:  slliw a0, a0, 5
; RV64ZBA-NEXT:  ret
%c = shl i32 %a, 5
%d = shl i32 %b, 7
%e = add i32 %c, %d
ret i32 %e
}

```

```

define i64 @addshl64_5_7(i64 %a, i64 %b) {
; RV64I-LABEL: addshl64_5_7:
; RV64I:       # %bb.0:
; RV64I-NEXT:  slli a0, a0, 5
; RV64I-NEXT:  slli a1, a1, 7
; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: addshl64_5_7:
; RV64ZBA:     # %bb.0:
; RV64ZBA-NEXT:  sh2add a0, a1, a0
; RV64ZBA-NEXT:  slli a0, a0, 5
; RV64ZBA-NEXT:  ret
%c
= shl i64 %a, 5
%d = shl i64 %b, 7
%e = add i64 %c, %d
ret i64 %e
}

```

```

define signext i32 @addshl32_5_8(i32 signext %a, i32 signext %b) {
; RV64I-LABEL: addshl32_5_8:
; RV64I:       # %bb.0:
; RV64I-NEXT:  slli a0, a0, 5
; RV64I-NEXT:  slli a1, a1, 8
; RV64I-NEXT:  addw a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: addshl32_5_8:
; RV64ZBA:     # %bb.0:
; RV64ZBA-NEXT:  sh3add a0, a1, a0
; RV64ZBA-NEXT:  slliw a0, a0, 5
; RV64ZBA-NEXT:  ret
%c = shl i32 %a, 5

```

```

%d = shl i32 %b, 8
%e = add i32 %c, %d
ret i32 %e
}

```

```

define i64 @addshl64_5_8(i64 %a, i64 %b) {
; RV64I-LABEL: addshl64_5_8:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a0, a0, 5
; RV64I-NEXT:  slli a1, a1, 8
; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: addshl64_5_8:
; RV64ZBA:    # %bb.0:
; RV64ZBA-NEXT:  sh3add a0, a1, a0
; RV64ZBA-NEXT:  slli a0, a0, 5
; RV64ZBA-NEXT:  ret
%c = shl i64 %a, 5
%d = shl i64 %b, 8
%e = add i64 %c, %d
ret i64 %e
}

```

```

; Make
sure we use sext.h+slli+srli for Zba+Zbb.
; FIXME: The RV64I and Zba only cases can be done with only 3 shifts.

```

```

define zeroext i32 @sext_ashr_zext_i8(i8 %a) nounwind {

```

```

; RV64I-LABEL: sext_ashr_zext_i8:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a0, a0, 24
; RV64I-NEXT:  sraiw a0, a0, 31
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  srli a0, a0, 32
; RV64I-NEXT:  ret
;
; RV64ZBANOZBB-LABEL: sext_ashr_zext_i8:
; RV64ZBANOZBB:    # %bb.0:
; RV64ZBANOZBB-NEXT:  slli a0, a0, 24
; RV64ZBANOZBB-NEXT:  sraiw a0, a0, 31
; RV64ZBANOZBB-NEXT:  zext.w a0, a0
; RV64ZBANOZBB-NEXT:  ret
;
; RV64ZBAZBB-LABEL: sext_ashr_zext_i8:
; RV64ZBAZBB:    # %bb.0:
; RV64ZBAZBB-NEXT:  sext.b a0, a0
; RV64ZBAZBB-NEXT:  sraiw a0, a0, 9
; RV64ZBAZBB-NEXT:  zext.w a0, a0

```

```

; RV64ZBAZBB-NEXT:  ret
%ext = sext i8 %a to i32
%1 = ashr i32 %ext, 9
ret i32 %1
}

; Make sure we use sext.h+slli+srli for Zba+Zbb.
; FIXME: The RV64I and Zba only cases can be done with only 3 shifts.
define
  zeroext i32 @sext_ashr_zext_i16(i16 %a) nounwind {
; RV64I-LABEL: sext_ashr_zext_i16:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a0, a0, 16
; RV64I-NEXT:  sraiw a0, a0, 25
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  srli a0, a0, 32
; RV64I-NEXT:  ret
;
; RV64ZBANOBZBB-LABEL: sext_ashr_zext_i16:
; RV64ZBANOBZBB:  # %bb.0:
; RV64ZBANOBZBB-NEXT:  slli a0, a0, 16
; RV64ZBANOBZBB-NEXT:  sraiw a0, a0, 25
; RV64ZBANOBZBB-NEXT:  zext.w a0, a0
; RV64ZBANOBZBB-NEXT:  ret
;
; RV64ZBAZBB-LABEL: sext_ashr_zext_i16:
; RV64ZBAZBB:  # %bb.0:
; RV64ZBAZBB-NEXT:  slli a0, a0, 48
; RV64ZBAZBB-NEXT:  srai a0, a0, 57
; RV64ZBAZBB-NEXT:  zext.w a0, a0
; RV64ZBAZBB-NEXT:  ret
%ext = sext i16 %a to i32
%1 = ashr i32 %ext, 9
ret i32 %1
}

```

; This the IR you get from InstCombine if take the difference of 2 pointers and  
; cast is to unsigned before using as an index.

```

define signext i16 @sh1adduw_ptrdiff(i64 %diff, ptr %baseptr) {
; RV64I-LABEL: sh1adduw_ptrdiff:
; RV64I:
;   # %bb.0:
; RV64I-NEXT:  li a2, 1
; RV64I-NEXT:  slli a2, a2, 33
; RV64I-NEXT:  addi a2, a2, -2
; RV64I-NEXT:  and a0, a0, a2
; RV64I-NEXT:  add a0, a1, a0
; RV64I-NEXT:  lh a0, 0(a0)

```



```

; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: sh1adduw_ptrdiff:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  srli a0, a0, 1
; RV64ZBA-NEXT:  sh1add.uw a0, a0, a1
; RV64ZBA-NEXT:  lh a0, 0(a0)
; RV64ZBA-NEXT:  ret
%ptrdiff = lshr exact i64 %diff, 1
%cast = and i64 %ptrdiff, 4294967295
%ptr = getelementptr inbounds i16, ptr %baseptr, i64 %cast
%res = load i16, ptr %ptr
ret i16 %res
}

```

```

define signext i32 @sh2adduw_ptrdiff(i64 %diff, ptr %baseptr) {
; RV64I-LABEL: sh2adduw_ptrdiff:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a2, 1
; RV64I-NEXT:  slli a2, a2, 34
; RV64I-NEXT:  addi a2, a2, -4
; RV64I-NEXT:  and a0, a0, a2
; RV64I-NEXT:  add a0, a1, a0
; RV64I-NEXT:  lw a0, 0(a0)
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: sh2adduw_ptrdiff:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:
    srli a0, a0, 2
; RV64ZBA-NEXT:  sh2add.uw a0, a0, a1
; RV64ZBA-NEXT:  lw a0, 0(a0)
; RV64ZBA-NEXT:  ret
%ptrdiff = lshr exact i64 %diff, 2
%cast = and i64 %ptrdiff, 4294967295
%ptr = getelementptr inbounds i32, ptr %baseptr, i64 %cast
%res = load i32, ptr %ptr
ret i32 %res
}

```

```

define i64 @sh3adduw_ptrdiff(i64 %diff, ptr %baseptr) {
; RV64I-LABEL: sh3adduw_ptrdiff:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a2, 1
; RV64I-NEXT:  slli a2, a2, 35
; RV64I-NEXT:  addi a2, a2, -8
; RV64I-NEXT:  and a0, a0, a2
; RV64I-NEXT:  add a0, a1, a0

```

```

; RV64I-NEXT:  ld a0, 0(a0)
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: sh3adduw_ptrdiff:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  srli a0, a0, 3
; RV64ZBA-NEXT:  sh3add.uw a0, a0, a1
; RV64ZBA-NEXT:  ld a0, 0(a0)
; RV64ZBA-NEXT:  ret
%ptrdiff = lshr exact i64 %diff, 3
%cast = and i64 %ptrdiff, 4294967295
%ptr = getelementptr inbounds i64, ptr %baseptr, i64 %cast
%res = load i64, ptr %ptr
ret i64 %res
}

```

```

define signext
i16 @srlw_1_sh1add(ptr %0, i32 signext %1) {
; RV64I-LABEL: srlw_1_sh1add:
; RV64I:      # %bb.0:
; RV64I-NEXT:  srlw a1, a1, 1
; RV64I-NEXT:  slli a1, a1, 1
; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  lh a0, 0(a0)
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: srlw_1_sh1add:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  srlw a1, a1, 1
; RV64ZBA-NEXT:  sh1add a0, a1, a0
; RV64ZBA-NEXT:  lh a0, 0(a0)
; RV64ZBA-NEXT:  ret
%3 = lshr i32 %1, 1
%4 = zext i32 %3 to i64
%5 = getelementptr inbounds i16, ptr %0, i64 %4
%6 = load i16, ptr %5, align 2
ret i16 %6
}

```

```

define i128 @slliw_ptrdiff(i64 %diff, ptr %baseptr) {
; RV64I-LABEL: slliw_ptrdiff:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a2, 1
; RV64I-NEXT:  slli a2, a2, 36
; RV64I-NEXT:  addi a2, a2, -16
; RV64I-NEXT:  and a0, a0, a2
; RV64I-NEXT:  add a1, a1, a0
; RV64I-NEXT:  ld a0, 0(a1)

```

```

; RV64I-NEXT:  ld a1, 8(a1)
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: slliw_ptrdiff:
; RV64ZBA:      # %bb.0:
;
RV64ZBA-NEXT:  srli a0, a0, 4
; RV64ZBA-NEXT:  slli.uw a0, a0, 4
; RV64ZBA-NEXT:  add a1, a1, a0
; RV64ZBA-NEXT:  ld a0, 0(a1)
; RV64ZBA-NEXT:  ld a1, 8(a1)
; RV64ZBA-NEXT:  ret
%ptrdiff = lshr exact i64 %diff, 4
%cast = and i64 %ptrdiff, 4294967295
%ptr = getelementptr inbounds i128, ptr %baseptr, i64 %cast
%res = load i128, ptr %ptr
ret i128 %res
}

```

```

define signext i32 @srliw_2_sh2add(ptr %0, i32 signext %1) {
; RV64I-LABEL: srliw_2_sh2add:
; RV64I:      # %bb.0:
; RV64I-NEXT:  srliw a1, a1, 2
; RV64I-NEXT:  slli a1, a1, 2
; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  lw a0, 0(a0)
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: srliw_2_sh2add:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  srliw a1, a1, 2
; RV64ZBA-NEXT:  sh2add a0, a1, a0
; RV64ZBA-NEXT:  lw a0, 0(a0)
; RV64ZBA-NEXT:  ret
%3 = lshr i32 %1, 2
%4 = zext i32 %3 to i64
%5 = getelementptr inbounds i32, ptr %0, i64 %4
%6 = load i32, ptr %5, align 4
ret i32 %6
}

```

```

define i64 @srliw_3_sh3add(ptr
%0, i32 signext %1) {
; RV64I-LABEL: srliw_3_sh3add:
; RV64I:      # %bb.0:
; RV64I-NEXT:  srliw a1, a1, 3
; RV64I-NEXT:  slli a1, a1, 3
; RV64I-NEXT:  add a0, a0, a1

```

```

; RV64I-NEXT:  ld a0, 0(a0)
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: srlw_3_sh3add:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  srlw a1, a1, 3
; RV64ZBA-NEXT:  sh3add a0, a1, a0
; RV64ZBA-NEXT:  ld a0, 0(a0)
; RV64ZBA-NEXT:  ret
%3 = lshr i32 %1, 3
%4 = zext i32 %3 to i64
%5 = getelementptr inbounds i64, ptr %0, i64 %4
%6 = load i64, ptr %5, align 8
ret i64 %6
}

define signext i32 @srlw_1_sh2add(ptr %0, i32 signext %1) {
; RV64I-LABEL: srlw_1_sh2add:
; RV64I:      # %bb.0:
; RV64I-NEXT:  srlw a1, a1, 1
; RV64I-NEXT:  slli a1, a1, 32
; RV64I-NEXT:  srli a1, a1, 30
; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  lw a0, 0(a0)
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: srlw_1_sh2add:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  srlw a1, a1, 1
; RV64ZBA-NEXT:  sh2add a0, a1, a0
;
; RV64ZBA-NEXT:  lw a0, 0(a0)
; RV64ZBA-NEXT:  ret
%3 = lshr i32 %1, 1
%4 = zext i32 %3 to i64
%5 = getelementptr inbounds i32, ptr %0, i64 %4
%6 = load i32, ptr %5, align 4
ret i32 %6
}

define i64 @srlw_1_sh3add(ptr %0, i32 signext %1) {
; RV64I-LABEL: srlw_1_sh3add:
; RV64I:      # %bb.0:
; RV64I-NEXT:  srlw a1, a1, 1
; RV64I-NEXT:  slli a1, a1, 32
; RV64I-NEXT:  srli a1, a1, 29
; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  ld a0, 0(a0)

```

```

; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: srlw_1_sh3add:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  srlw a1, a1, 1
; RV64ZBA-NEXT:  sh3add a0, a1, a0
; RV64ZBA-NEXT:  ld a0, 0(a0)
; RV64ZBA-NEXT:  ret
%3 = lshr i32 %1, 1
%4 = zext i32 %3 to i64
%5 = getelementptr inbounds i64, ptr %0, i64 %4
%6 = load i64, ptr %5, align 8
ret i64 %6
}

define i64 @srlw_2_sh3add(ptr %0, i32 signext %1) {
; RV64I-LABEL: srlw_2_sh3add:
; RV64I:      # %bb.0:
; RV64I-NEXT:  srlw a1, a1, 2
; RV64I-NEXT:  slli a1, a1, 32
;
; RV64I-NEXT:  srli a1, a1, 29
; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  ld a0, 0(a0)
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: srlw_2_sh3add:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  srlw a1, a1, 2
; RV64ZBA-NEXT:  sh3add a0, a1, a0
; RV64ZBA-NEXT:  ld a0, 0(a0)
; RV64ZBA-NEXT:  ret
%3 = lshr i32 %1, 2
%4 = zext i32 %3 to i64
%5 = getelementptr inbounds i64, ptr %0, i64 %4
%6 = load i64, ptr %5, align 8
ret i64 %6
}

define signext i16 @srlw_2_sh1add(ptr %0, i32 signext %1) {
; RV64I-LABEL: srlw_2_sh1add:
; RV64I:      # %bb.0:
; RV64I-NEXT:  srlw a1, a1, 2
; RV64I-NEXT:  slli a1, a1, 32
; RV64I-NEXT:  srli a1, a1, 31
; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  lh a0, 0(a0)
; RV64I-NEXT:  ret

```

```

;
; RV64ZBA-LABEL: srlw_2_sh1add:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  srlw a1, a1, 2
; RV64ZBA-NEXT:  sh1add a0, a1, a0
; RV64ZBA-NEXT:  lh a0, 0(a0)
; RV64ZBA-NEXT:  ret
%3 = lshr i32 %1, 2
%4 = zext i32 %3 to i64
%5 = getelementptr
inbounds i16, ptr %0, i64 %4
%6 = load i16, ptr %5, align 2
ret i16 %6
}

```

```

define signext i32 @srlw_3_sh2add(ptr %0, i32 signext %1) {
; RV64I-LABEL: srlw_3_sh2add:
; RV64I:      # %bb.0:
; RV64I-NEXT:  srlw a1, a1, 3
; RV64I-NEXT:  slli a1, a1, 32
; RV64I-NEXT:  srli a1, a1, 30
; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  lw a0, 0(a0)
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: srlw_3_sh2add:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  srlw a1, a1, 3
; RV64ZBA-NEXT:  sh2add a0, a1, a0
; RV64ZBA-NEXT:  lw a0, 0(a0)
; RV64ZBA-NEXT:  ret
%3 = lshr i32 %1, 3
%4 = zext i32 %3 to i64
%5 = getelementptr inbounds i32, ptr %0, i64 %4
%6 = load i32, ptr %5, align 4
ret i32 %6
}

```

```

define i64 @srlw_4_sh3add(ptr %0, i32 signext %1) {
; RV64I-LABEL: srlw_4_sh3add:
; RV64I:      # %bb.0:
; RV64I-NEXT:  srlw a1, a1, 4
; RV64I-NEXT:  slli a1, a1, 32
; RV64I-NEXT:  srli a1, a1, 29
; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  ld a0, 0(a0)
; RV64I-NEXT:

```

```

    ret
;
; RV64ZBA-LABEL: srliw_4_sh3add:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT: srliw a1, a1, 4
; RV64ZBA-NEXT: sh3add a0, a1, a0
; RV64ZBA-NEXT: ld a0, 0(a0)
; RV64ZBA-NEXT: ret
%3 = lshr i32 %1, 4
%4 = zext i32 %3 to i64
%5 = getelementptr inbounds i64, ptr %0, i64 %4
%6 = load i64, ptr %5, align 8
ret i64 %6
}

```

```

define signext i32 @srli_1_sh2add(ptr %0, i64 %1) {
; RV64I-LABEL: srli_1_sh2add:
; RV64I:      # %bb.0:
; RV64I-NEXT: slli a1, a1, 1
; RV64I-NEXT: andi a1, a1, -4
; RV64I-NEXT: add a0, a0, a1
; RV64I-NEXT: lw a0, 0(a0)
; RV64I-NEXT: ret
;
; RV64ZBA-LABEL: srli_1_sh2add:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT: srli a1, a1, 1
; RV64ZBA-NEXT: sh2add a0, a1, a0
; RV64ZBA-NEXT: lw a0, 0(a0)
; RV64ZBA-NEXT: ret
%3 = lshr i64 %1, 1
%4 = getelementptr inbounds i32, ptr %0, i64 %3
%5 = load i32, ptr %4, align 4
ret i32 %5
}

```

```

define i64 @srli_2_sh3add(ptr %0, i64 %1) {
; RV64I-LABEL: srli_2_sh3add:
; RV64I:      # %bb.0:
;
; RV64I-NEXT: slli a1, a1, 1
; RV64I-NEXT: andi a1, a1, -8
; RV64I-NEXT: add a0, a0, a1
; RV64I-NEXT: ld a0, 0(a0)
; RV64I-NEXT: ret
;
; RV64ZBA-LABEL: srli_2_sh3add:
; RV64ZBA:      # %bb.0:

```

```

; RV64ZBA-NEXT: srli a1, a1, 2
; RV64ZBA-NEXT: sh3add a0, a1, a0
; RV64ZBA-NEXT: ld a0, 0(a0)
; RV64ZBA-NEXT: ret
%3 = lshr i64 %1, 2
%4 = getelementptr inbounds i64, ptr %0, i64 %3
%5 = load i64, ptr %4, align 8
ret i64 %5
}

define signext i16 @srli_2_sh1add(ptr %0, i64 %1) {
; RV64I-LABEL: srli_2_sh1add:
; RV64I:    # %bb.0:
; RV64I-NEXT: srli a1, a1, 1
; RV64I-NEXT: andi a1, a1, -2
; RV64I-NEXT: add a0, a0, a1
; RV64I-NEXT: lh a0, 0(a0)
; RV64I-NEXT: ret
;
; RV64ZBA-LABEL: srli_2_sh1add:
; RV64ZBA:    # %bb.0:
; RV64ZBA-NEXT: srli a1, a1, 2
; RV64ZBA-NEXT: sh1add a0, a1, a0
; RV64ZBA-NEXT: lh a0, 0(a0)
; RV64ZBA-NEXT: ret
%3 = lshr i64 %1, 2
%4 = getelementptr inbounds i16, ptr %0, i64 %3
%5 = load i16, ptr %4, align
2
ret i16 %5
}

define signext i32 @srli_3_sh2add(ptr %0, i64 %1) {
; RV64I-LABEL: srli_3_sh2add:
; RV64I:    # %bb.0:
; RV64I-NEXT: srli a1, a1, 1
; RV64I-NEXT: andi a1, a1, -4
; RV64I-NEXT: add a0, a0, a1
; RV64I-NEXT: lw a0, 0(a0)
; RV64I-NEXT: ret
;
; RV64ZBA-LABEL: srli_3_sh2add:
; RV64ZBA:    # %bb.0:
; RV64ZBA-NEXT: srli a1, a1, 3
; RV64ZBA-NEXT: sh2add a0, a1, a0
; RV64ZBA-NEXT: lw a0, 0(a0)
; RV64ZBA-NEXT: ret
%3 = lshr i64 %1, 3

```



```

%4 = getelementptr inbounds i32, ptr %0, i64 %3
%5 = load i32, ptr %4, align 4
ret i32 %5
}

```

```

define i64 @srli_4_sh3add(ptr %0, i64 %1) {
; RV64I-LABEL: srli_4_sh3add:
; RV64I:      # %bb.0:
; RV64I-NEXT: srli a1, a1, 1
; RV64I-NEXT: andi a1, a1, -8
; RV64I-NEXT: add a0, a0, a1
; RV64I-NEXT: ld a0, 0(a0)
; RV64I-NEXT: ret
;
; RV64ZBA-LABEL: srli_4_sh3add:
; RV64ZBA:    # %bb.0:
; RV64ZBA-NEXT: srli a1, a1, 4
; RV64ZBA-NEXT: sh3add a0, a1, a0
; RV64ZBA-NEXT: ld a0, 0(a0)
; RV64ZBA-NEXT:
    ret
%3 = lshr i64 %1, 4
%4 = getelementptr inbounds i64, ptr %0, i64 %3
%5 = load i64, ptr %4, align 8
ret i64 %5
}

```

```

define signext i16 @shl_2_sh1add(ptr %0, i32 signext %1) {
; RV64I-LABEL: shl_2_sh1add:
; RV64I:      # %bb.0:
; RV64I-NEXT: slli a1, a1, 2
; RV64I-NEXT: slli a1, a1, 32
; RV64I-NEXT: srli a1, a1, 31
; RV64I-NEXT: add a0, a0, a1
; RV64I-NEXT: lh a0, 0(a0)
; RV64I-NEXT: ret
;
; RV64ZBA-LABEL: shl_2_sh1add:
; RV64ZBA:    # %bb.0:
; RV64ZBA-NEXT: slli a1, a1, 2
; RV64ZBA-NEXT: zext.w a1, a1
; RV64ZBA-NEXT: sh1add a0, a1, a0
; RV64ZBA-NEXT: lh a0, 0(a0)
; RV64ZBA-NEXT: ret
%3 = shl i32 %1, 2
%4 = zext i32 %3 to i64
%5 = getelementptr inbounds i16, ptr %0, i64 %4
%6 = load i16, ptr %5, align 2

```

```

ret i16 %6
}

define signext i32 @shl_16_sh2add(ptr %0, i32 signext %1) {
; RV64I-LABEL: shl_16_sh2add:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a1, a1, 16
; RV64I-NEXT:  slli a1, a1, 32
; RV64I-NEXT:  srli a1, a1, 30
;
; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  lw a0, 0(a0)
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: shl_16_sh2add:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  slli a1, a1, 16
; RV64ZBA-NEXT:  zext.w a1, a1
; RV64ZBA-NEXT:  sh2add a0, a1, a0
; RV64ZBA-NEXT:  lw a0, 0(a0)
; RV64ZBA-NEXT:  ret
%3 = shl i32 %1, 16
%4 = zext i32 %3 to i64
%5 = getelementptr inbounds i32, ptr %0, i64 %4
%6 = load i32, ptr %5, align 4
ret i32 %6
}

define i64 @shl_31_sh3add(ptr %0, i32 signext %1) {
; RV64I-LABEL: shl_31_sh3add:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a1, a1, 31
; RV64I-NEXT:  slli a1, a1, 32
; RV64I-NEXT:  srli a1, a1, 29
; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  ld a0, 0(a0)
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: shl_31_sh3add:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  slli a1, a1, 31
; RV64ZBA-NEXT:  zext.w a1, a1
; RV64ZBA-NEXT:  sh3add a0, a1, a0
; RV64ZBA-NEXT:  ld a0, 0(a0)
; RV64ZBA-NEXT:  ret
%3 = shl i32 %1, 31
%4 = zext i32 %3

```

```

to i64
%5 = getelementptr inbounds i64, ptr %0, i64 %4
%6 = load i64, ptr %5, align 8
ret i64 %6
}

define i64 @pack_i64(i64 %a, i64 %b) nounwind {
; RV64I-LABEL: pack_i64:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  srli a0, a0, 32
; RV64I-NEXT:  slli a1, a1, 32
; RV64I-NEXT:  or a0, a1, a0
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: pack_i64:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  slli a1, a1, 32
; RV64ZBA-NEXT:  add.uw a0, a0, a1
; RV64ZBA-NEXT:  ret
%shl = and i64 %a, 4294967295
%shl1 = shl i64 %b, 32
%or = or i64 %shl1, %shl
ret i64 %or
}

define i64 @pack_i64_2(i32 signext %a, i32 signext %b) nounwind {
; RV64I-LABEL: pack_i64_2:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  srli a0, a0, 32
; RV64I-NEXT:  slli a1, a1, 32
; RV64I-NEXT:  or a0, a1, a0
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: pack_i64_2:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  slli a1, a1, 32
; RV64ZBA-NEXT:  add.uw a0, a0,
a1
; RV64ZBA-NEXT:  ret
%zexta = zext i32 %a to i64
%zextb = zext i32 %b to i64
%shl1 = shl i64 %zextb, 32
%or = or i64 %shl1, %zexta
ret i64 %or
}

```

```

define i64 @pack_i64_3(i32 signext %a, i32 signext %b) nounwind {
; RV64I-LABEL: pack_i64_3:
; RV64I:      # %bb.0:
; RV64I-NEXT:  addi a0, a0, 1
; RV64I-NEXT:  addi a1, a1, 1
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  srli a0, a0, 32
; RV64I-NEXT:  slli a1, a1, 32
; RV64I-NEXT:  or a0, a1, a0
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: pack_i64_3:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  addi a0, a0, 1
; RV64ZBA-NEXT:  addi a1, a1, 1
; RV64ZBA-NEXT:  slli a1, a1, 32
; RV64ZBA-NEXT:  add.uw a0, a0, a1
; RV64ZBA-NEXT:  ret
%adda = add i32 %a, 1
%addb = add i32 %b, 1
%zexta = zext i32 %adda to i64
%zextb = zext i32 %addb to i64
%shl1 = shl i64 %zextb, 32
%or = or i64 %shl1, %zexta
ret i64 %or
}
; RUN: llc -O3 -mtriple=powerpc-unknown-linux-gnu -mcpu=e500 -mattr=spe < %s | FileCheck %s

```

; PowerPC SPE is a rare in-tree target that has the FP\_TO\_SINT node marked  
; as Legal.

```

; Verify that fptosi(42.1) isn't simplified when the rounding mode is
; unknown.
; Verify that no gross errors happen.
; CHECK-LABEL: @f20
; COMMON: cfdctsiz
define i32 @f20(double %a) strictfp {
entry:
%result = call i32 @llvm.experimental.constrained.fptosi.i32.f64(double 42.1,
                                metadata !"fpexcept.strict")
                                strictfp
ret i32 %result
}

```

```

@llvm.fp.env = thread_local global i8 zeroinitializer, section "llvm.metadata"
declare i32 @llvm.experimental.constrained.fptosi.i32.f64(double, metadata)
; NOTE: Assertions have been autogenerated by utils/update_llc_test_checks.py
; RUN: llc -mtriple=riscv64 -mattr=+zbb -verify-machineinstrs < %s \

```

; RUN: -riscv-experimental-rv64-legal-i32 | FileCheck %s -check-prefix=RV64ZBB

declare i32 @llvm.riscv.orc.b.i32(i32)

```
define signext i32 @orc32(i32 signext %a) nounwind {
; RV64ZBB-LABEL: orc32:
; RV64ZBB:      # %bb.0:
; RV64ZBB-NEXT:  orc.b a0, a0
; RV64ZBB-NEXT:  sext.w a0, a0
; RV64ZBB-NEXT:  ret
  %tmp = call i32 @llvm.riscv.orc.b.i32(i32 %a)
  ret i32 %tmp
}
```

```
define zeroext i32 @orc32_zext(i32 zeroext %a) nounwind {
; RV64ZBB-LABEL: orc32_zext:
; RV64ZBB:      # %bb.0:
; RV64ZBB-NEXT:  orc.b a0, a0
; RV64ZBB-NEXT:  ret
  %tmp = call i32 @llvm.riscv.orc.b.i32(i32 %a)
  ret i32 %tmp
}
```

; Second and+or is redundant with the first, make sure we remove them.

```
define signext i32 @orc32_knownbits(i32 signext %a) nounwind {
; RV64ZBB-LABEL: orc32_knownbits:
; RV64ZBB:      # %bb.0:
; RV64ZBB-NEXT:  lui a1, 1044480
; RV64ZBB-NEXT:
  and a0, a0, a1
; RV64ZBB-NEXT:  lui a1, 2048
; RV64ZBB-NEXT:  addi a1, a1, 1
; RV64ZBB-NEXT:  or a0, a0, a1
; RV64ZBB-NEXT:  orc.b a0, a0
; RV64ZBB-NEXT:  sext.w a0, a0
; RV64ZBB-NEXT:  ret
  %tmp = and i32 %a, 4278190080 ; 0xFF000000
  %tmp2 = or i32 %tmp, 8388609 ; 0x800001
  %tmp3 = call i32 @llvm.riscv.orc.b.i32(i32 %tmp2)
  %tmp4 = and i32 %tmp3, 4278190080 ; 0xFF000000
  %tmp5 = or i32 %tmp4, 16711935 ; 0xFF00FF
  ret i32 %tmp5
}
```

declare i64 @llvm.riscv.orc.b.i64(i64)

```
define i64 @orc64(i64 %a) nounwind {
; RV64ZBB-LABEL: orc64:
```

```
; RV64ZBB:    # %bb.0:
; RV64ZBB-NEXT:  orc.b a0, a0
; RV64ZBB-NEXT:  ret
%tmp = call i64 @llvm.riscv.orc.b.i64(i64 %a)
ret i64 %tmp
}
```

; Second and+or is redundant with the first, make sure we remove them.

```
define i64 @orc64_knownbits(i64 %a) nounwind {
; RV64ZBB-LABEL: orc64_knownbits:
; RV64ZBB:    # %bb.0:
; RV64ZBB-NEXT:  lui a1, 65535
; RV64ZBB-NEXT:  slli a1, a1, 12
; RV64ZBB-NEXT:  and a0, a0, a1
;
RV64ZBB-NEXT:  lui a1, 256
; RV64ZBB-NEXT:  addiw a1, a1, 8
; RV64ZBB-NEXT:  slli a2, a1, 42
; RV64ZBB-NEXT:  add a1, a1, a2
; RV64ZBB-NEXT:  or a0, a0, a1
; RV64ZBB-NEXT:  orc.b a0, a0
; RV64ZBB-NEXT:  ret
%tmp = and i64 %a, 1099494850560 ; 0x000000ffff000000
%tmp2 = or i64 %tmp, 4611721202800525320 ; 0x4000200000100008
%tmp3 = call i64 @llvm.riscv.orc.b.i64(i64 %tmp2)
%tmp4 = and i64 %tmp3, 1099494850560 ; 0x000000ffff000000
%tmp5 = or i64 %tmp4, 18374966855153418495 ; 0xff00ff0000ff00ff
ret i64 %tmp5
}
```

; NOTE: Assertions have been autogenerated by utils/update\_analyze\_test\_checks.py

```
; RUN: opt < %s -passes="print<cost-model>" 2>&1 -disable-output -mtriple=x86_64-apple-macosx10.8.0 -
mattr=+avx2 | FileCheck %s --check-prefixes=VEC256,AVX
```

```
; RUN: opt < %s -passes="print<cost-model>" 2>&1 -disable-output -mtriple=x86_64-apple-macosx10.8.0 -
mattr=+avx512vl,+prefer-256-bit | FileCheck %s --check-prefixes=VEC256,AVX512VL256
```

```
; RUN: opt < %s -passes="print<cost-model>" 2>&1 -disable-output -mtriple=x86_64-apple-macosx10.8.0 -
mattr=+avx512vl,-prefer-256-bit | FileCheck %s --check-prefixes=AVX512VL512
```

```
; RUN: opt < %s -passes="print<cost-model>" 2>&1 -disable-output -mtriple=x86_64-apple-macosx10.8.0 -
mattr=+avx512vl,+avx512bw,+avx512dq,+prefer-256-bit | FileCheck %s --check-prefixes=VEC256,SKX256
```

```
; RUN: opt < %s -passes="print<cost-model>" 2>&1 -disable-output -mtriple=x86_64-apple-macosx10.8.0 -
mattr=+avx512vl,+avx512bw,+avx512dq,-prefer-256-bit | FileCheck %s --check-prefixes=SKX512
```

define

```
void @zext256() "min-legal-vector-width"="256" {
```

```
; AVX-LABEL: 'zext256'
```

```
; AVX-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %A = zext <8 x i16> undef to <8 x i64>
```

```
; AVX-NEXT: Cost Model: Found an estimated cost of 5 for instruction: %B = zext <8 x i32> undef to <8 x i64>
```

```
; AVX-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %C = zext <16 x i8> undef to <16 x i32>
```

```
; AVX-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %D = zext <16 x i16> undef to <16 x
```

```

i32>
; AVX-NEXT: Cost Model: Found an estimated cost of 5 for instruction: %E = zext <32 x i8> undef to <32 x i16>
; AVX-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret void
;
; AVX512VL256-LABEL: 'zext256'
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %A = zext <8 x i16> undef to
<8 x i64>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %B = zext <8 x i32> undef to
<8 x i64>
; AVX512VL256-NEXT: Cost
Model: Found an estimated cost of 2 for instruction: %C = zext <16 x i8> undef to <16 x i32>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %D = zext <16 x i16> undef to
<16 x i32>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %E = zext <32 x i8> undef to
<32 x i16>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret void
;
; AVX512VL512-LABEL: 'zext256'
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %A = zext <8 x i16> undef to
<8 x i64>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %B = zext <8 x i32> undef to
<8 x i64>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %C = zext <16 x i8> undef to
<16 x i32>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %D = zext <16 x i16> undef to
<16 x i32>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 3 for instruction:
%E = zext <32 x i8> undef to <32 x i16>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret void
;
; SKX256-LABEL: 'zext256'
; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %A = zext <8 x i16> undef to <8 x
i64>
; SKX256-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %B = zext <8 x i32> undef to <8 x
i64>
; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %C = zext <16 x i8> undef to <16 x
i32>
; SKX256-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %D = zext <16 x i16> undef to <16 x
i32>
; SKX256-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %E = zext <32 x i8> undef to <32 x
i16>
; SKX256-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret void
;
; SKX512-LABEL: 'zext256'
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %A = zext <8 x i16> undef to <8 x
i64>
; SKX512-NEXT: Cost Model: Found an estimated

```

```

cost of 1 for instruction: %B = zext <8 x i32> undef to <8 x i64>
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %C = zext <16 x i8> undef to <16 x i32>
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %D = zext <16 x i16> undef to <16 x i32>
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %E = zext <32 x i8> undef to <32 x i16>
; SKX512-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret void
;
%A = zext <8 x i16> undef to <8 x i64>
%B = zext <8 x i32> undef to <8 x i64>
%C = zext <16 x i8> undef to <16 x i32>
%D = zext <16 x i16> undef to <16 x i32>
%E = zext <32 x i8> undef to <32 x i16>
ret void
}

```

```

define void @zext512() "min-legal-vector-width"="512" {
; AVX-LABEL: 'zext512'
; AVX-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %A = zext <8 x i16> undef to <8 x i64>
; AVX-NEXT: Cost Model: Found an estimated cost of 5 for instruction: %B = zext <8 x i32>
undef to <8 x i64>
; AVX-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %C = zext <16 x i8> undef to <16 x i32>
; AVX-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %D = zext <16 x i16> undef to <16 x i32>
; AVX-NEXT: Cost Model: Found an estimated cost of 5 for instruction: %E = zext <32 x i8> undef to <32 x i16>
; AVX-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret void
;
; AVX512VL256-LABEL: 'zext512'
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %A = zext <8 x i16> undef to
<8 x i64>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %B = zext <8 x i32> undef to
<8 x i64>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %C = zext <16 x i8> undef to
<16 x i32>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %D = zext <16 x i16> undef to
<16 x i32>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost
of 3 for instruction: %E = zext <32 x i8> undef to <32 x i16>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret void
;
; AVX512VL512-LABEL: 'zext512'
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %A = zext <8 x i16> undef to
<8 x i64>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %B = zext <8 x i32> undef to
<8 x i64>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %C = zext <16 x i8> undef to
<16 x i32>

```



```

; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %D = zext <16 x i16> undef to
<16 x i32>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %E = zext <32 x i8> undef to
<32 x i16>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret void
;
; SKX256-LABEL: 'zext512'
; SKX256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %A = zext <8 x i16> undef to <8 x
i64>
; SKX256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %B = zext <8 x i32> undef to <8 x
i64>
; SKX256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %C = zext <16 x i8> undef to <16 x
i32>
; SKX256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %D = zext <16 x i16> undef to <16 x
i32>
; SKX256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %E = zext <32 x i8> undef to <32 x
i16>
; SKX256-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret void
;
; SKX512-LABEL: 'zext512'
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %A = zext <8 x i16> undef to <8 x
i64>
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %B = zext <8 x i32> undef to <8 x
i64>
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %C = zext <16 x i8> undef to <16 x
i32>
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %D = zext <16
x i16> undef to <16 x i32>
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %E = zext <32 x i8> undef to <32 x
i16>
; SKX512-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret void
;
%A = zext <8 x i16> undef to <8 x i64>
%B = zext <8 x i32> undef to <8 x i64>
%C = zext <16 x i8> undef to <16 x i32>
%D = zext <16 x i16> undef to <16 x i32>
%E = zext <32 x i8> undef to <32 x i16>
ret void
}

define void @sext256() "min-legal-vector-width"="256" {
; AVX-LABEL: 'sext256'
; AVX-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %A = sext <8 x i8> undef to <8 x i64>
; AVX-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %B = sext <8 x i16> undef to <8 x i64>
; AVX-NEXT: Cost Model: Found an estimated cost of 5 for instruction: %C = sext <8 x i32> undef to <8 x i64>
; AVX-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %D = sext <16 x i8> undef to <16 x i32>
; AVX-NEXT: Cost Model: Found

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an estimated cost of 3 for instruction: %E = sext <16 x i16> undef to <16 x i32>
; AVX-NEXT: Cost Model: Found an estimated cost of 5 for instruction: %F = sext <32 x i8> undef to <32 x i16>
; AVX-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret void
;
; AVX512VL256-LABEL: 'sext256'
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %A = sext <8 x i8> undef to <8
x i64>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %B = sext <8 x i16> undef to
<8 x i64>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %C = sext <8 x i32> undef to
<8 x i64>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %D = sext <16 x i8> undef to
<16 x i32>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %E = sext <16 x i16> undef to
<16 x i32>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %F = sext <32 x i8> undef
to <32 x i16>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret void
;
; AVX512VL512-LABEL: 'sext256'
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %A = sext <8 x i8> undef to <8
x i64>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %B = sext <8 x i16> undef to
<8 x i64>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %C = sext <8 x i32> undef to
<8 x i64>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %D = sext <16 x i8> undef to
<16 x i32>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %E = sext <16 x i16> undef to
<16 x i32>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %F = sext <32 x i8> undef to
<32 x i16>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret void
;
; SKX256-LABEL: 'sext256'
; SKX256-NEXT: Cost Model: Found an
estimated cost of 2 for instruction: %A = sext <8 x i8> undef to <8 x i64>
; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %B = sext <8 x i16> undef to <8 x
i64>
; SKX256-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %C = sext <8 x i32> undef to <8 x
i64>
; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %D = sext <16 x i8> undef to <16 x
i32>
; SKX256-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %E = sext <16 x i16> undef to <16 x
i32>
; SKX256-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %F = sext <32 x i8> undef to <32 x
i16>
; SKX256-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret void

```

```

;
; SKX512-LABEL: 'sext256'
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %A = sext <8 x i8> undef to <8 x i64>
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %B = sext <8 x i16> undef to <8 x i64>
; SKX512-NEXT: Cost
Model: Found an estimated cost of 1 for instruction: %C = sext <8 x i32> undef to <8 x i64>
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %D = sext <16 x i8> undef to <16 x i32>
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %E = sext <16 x i16> undef to <16 x i32>
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %F = sext <32 x i8> undef to <32 x i16>
; SKX512-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret void
;
%A = sext <8 x i8> undef to <8 x i64>
%B = sext <8 x i16> undef to <8 x i64>
%C = sext <8 x i32> undef to <8 x i64>
%D = sext <16 x i8> undef to <16 x i32>
%E = sext <16 x i16> undef to <16 x i32>
%F = sext <32 x i8> undef to <32 x i16>
ret void
}

```

```

define void @sext512() "min-legal-vector-width"="512" {
; AVX-LABEL: 'sext512'
; AVX-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %A = sext <8 x i8> undef to <8 x i64>
; AVX-NEXT: Cost Model: Found
an estimated cost of 4 for instruction: %B = sext <8 x i16> undef to <8 x i64>
; AVX-NEXT: Cost Model: Found an estimated cost of 5 for instruction: %C = sext <8 x i32> undef to <8 x i64>
; AVX-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %D = sext <16 x i8> undef to <16 x i32>
; AVX-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %E = sext <16 x i16> undef to <16 x i32>
; AVX-NEXT: Cost Model: Found an estimated cost of 5 for instruction: %F = sext <32 x i8> undef to <32 x i16>
; AVX-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret void
;
; AVX512VL256-LABEL: 'sext512'
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %A = sext <8 x i8> undef to <8 x i64>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %B = sext <8 x i16> undef to <8 x i64>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %C = sext <8 x i32> undef to <8 x i64>
; AVX512VL256-NEXT:
Cost Model: Found an estimated cost of 1 for instruction: %D = sext <16 x i8> undef to <16 x i32>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %E = sext <16 x i16> undef to <16 x i32>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %F = sext <32 x i8> undef to <32 x i16>

```

```

; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret void
;
; AVX512VL512-LABEL: 'sext512'
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %A = sext <8 x i8> undef to <8
x i64>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %B = sext <8 x i16> undef to
<8 x i64>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %C = sext <8 x i32> undef to
<8 x i64>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %D = sext <16 x i8> undef to
<16 x i32>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost
of 1 for instruction: %E = sext <16 x i16> undef to <16 x i32>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %F = sext <32 x i8> undef to
<32 x i16>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret void
;
; SKX256-LABEL: 'sext512'
; SKX256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %A = sext <8 x i8> undef to <8 x i64>
; SKX256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %B = sext <8 x i16> undef to <8 x
i64>
; SKX256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %C = sext <8 x i32> undef to <8 x
i64>
; SKX256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %D = sext <16 x i8> undef to <16 x
i32>
; SKX256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %E = sext <16 x i16> undef to <16 x
i32>
; SKX256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %F = sext <32 x i8> undef to <32 x
i16>
; SKX256-NEXT: Cost
Model: Found an estimated cost of 0 for instruction: ret void
;
; SKX512-LABEL: 'sext512'
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %A = sext <8 x i8> undef to <8 x i64>
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %B = sext <8 x i16> undef to <8 x
i64>
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %C = sext <8 x i32> undef to <8 x
i64>
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %D = sext <16 x i8> undef to <16 x
i32>
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %E = sext <16 x i16> undef to <16 x
i32>
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %F = sext <32 x i8> undef to <32 x
i16>
; SKX512-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret void
;
%A = sext <8 x i8> undef to <8 x i64>
%B = sext <8 x i16> undef to <8 x i64>

```

```

%C = sext <8 x i32> undef to <8 x i64>
%D = sext <16 x i8>
undef to <16 x i32>
%E = sext <16 x i16> undef to <16 x i32>
%F = sext <32 x i8> undef to <32 x i16>
ret void
}

define void @trunc256() "min-legal-vector-width"="256" {
; VEC256-LABEL: 'trunc256'
; VEC256-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %A = trunc <8 x i64> undef to <8 x
i32>
; VEC256-NEXT: Cost Model: Found an estimated cost of 10 for instruction: %B = trunc <8 x i64> undef to <8 x
i16>
; VEC256-NEXT: Cost Model: Found an estimated cost of 8 for instruction: %C = trunc <8 x i64> undef to <8 x
i8>
; VEC256-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %D = trunc <16 x i32> undef to <16 x
i16>
; VEC256-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %E = trunc <16 x i32> undef to <16 x
i8>
; VEC256-NEXT: Cost Model: Found an estimated cost of 5 for instruction: %F = trunc <32 x i16> undef to <32 x
i8>
; VEC256-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret void
;
; AVX512VL512-LABEL: 'trunc256'
;
AVX512VL512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %A = trunc <8 x i64> undef to
<8 x i32>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %B = trunc <8 x i64> undef to
<8 x i16>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %C = trunc <8 x i64> undef to
<8 x i8>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %D = trunc <16 x i32> undef
to <16 x i16>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %E = trunc <16 x i32> undef to
<16 x i8>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 8 for instruction: %F = trunc <32 x i16> undef to
<32 x i8>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret void
;
; SKX512-LABEL: 'trunc256'
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %A = trunc <8 x i64> undef to <8 x
i32>
; SKX512-NEXT: Cost Model: Found an estimated
cost of 2 for instruction: %B = trunc <8 x i64> undef to <8 x i16>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %C = trunc <8 x i64> undef to <8 x
i8>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %D = trunc <16 x i32> undef to <16 x

```

```

i16>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %E = trunc <16 x i32> undef to <16 x
i8>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %F = trunc <32 x i16> undef to <32 x
i8>
; SKX512-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret void
;
%A = trunc <8 x i64> undef to <8 x i32>
%B = trunc <8 x i64> undef to <8 x i16>
%C = trunc <8 x i64> undef to <8 x i8>
%D = trunc <16 x i32> undef to <16 x i16>
%E = trunc <16 x i32> undef to <16 x i8>
%F = trunc <32 x i16> undef to <32 x i8>
ret void
}

```

```

define i32 @zext256_vXi1() "min-legal-vector-width"="256" {
; AVX-LABEL: 'zext256_vXi1'
; AVX-NEXT: Cost Model: Found
an estimated cost of 1 for instruction: %V2i64 = zext <2 x i1> undef to <2 x i64>
; AVX-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %V4i64 = zext <4 x i1> undef to <4 x
i64>
; AVX-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %V8i64 = zext <8 x i1> undef to <8 x
i64>
; AVX-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V2i32 = zext <2 x i1> undef to <2 x
i32>
; AVX-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V4i32 = zext <4 x i1> undef to <4 x
i32>
; AVX-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %V8i32 = zext <8 x i1> undef to <8 x
i32>
; AVX-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %V16i32 = zext <16 x i1> undef to <16 x
i32>
; AVX-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V2i16 = zext <2 x i1> undef to <2 x
i16>
; AVX-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V4i16 = zext <4 x i1> undef to <4 x
i16>
; AVX-NEXT:
Cost Model: Found an estimated cost of 1 for instruction: %V8i16 = zext <8 x i1> undef to <8 x i16>
; AVX-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V16i16 = zext <16 x i1> undef to <16 x
i16>
; AVX-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %V32i16 = zext <32 x i1> undef to <32 x
i16>
; AVX-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V2i8 = zext <2 x i1> undef to <2 x i8>
; AVX-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V4i8 = zext <4 x i1> undef to <4 x i8>
; AVX-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V8i8 = zext <8 x i1> undef to <8 x i8>
; AVX-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V16i8 = zext <16 x i1> undef to <16 x
i8>
; AVX-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V32i8 = zext <32 x i1> undef to <32 x

```

```

i8>
; AVX-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V64i8 = zext <64 x i1> undef
to <64 x i8>
; AVX-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret i32 undef
;
; AVX512VL256-LABEL: 'zext256_vXi1'
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V2i64 = zext <2 x i1> undef
to <2 x i64>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V4i64 = zext <4 x i1> undef
to <4 x i64>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 5 for instruction: %V8i64 = zext <8 x i1> undef
to <8 x i64>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V2i32 = zext <2 x i1> undef
to <2 x i32>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V4i32 = zext <4 x i1> undef
to <4 x i32>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V8i32 = zext <8 x i1> undef
to <8 x i32>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %V16i32 = zext <16 x i1>
undef to <16 x i32>
; AVX512VL256-NEXT:
Cost Model: Found an estimated cost of 5 for instruction: %V2i16 = zext <2 x i1> undef to <2 x i16>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 5 for instruction: %V4i16 = zext <4 x i1> undef
to <4 x i16>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 5 for instruction: %V8i16 = zext <8 x i1> undef
to <8 x i16>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 12 for instruction: %V16i16 = zext <16 x i1>
undef to <16 x i16>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 24 for instruction: %V32i16 = zext <32 x i1>
undef to <32 x i16>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 6 for instruction: %V2i8 = zext <2 x i1> undef to
<2 x i8>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 6 for instruction: %V4i8 = zext <4 x i1> undef to
<4 x i8>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 6 for instruction: %V8i8 = zext <8 x i1> undef to
<8 x i8>
; AVX512VL256-NEXT: Cost Model: Found an estimated
cost of 12 for instruction: %V16i8 = zext <16 x i1> undef to <16 x i8>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 25 for instruction: %V32i8 = zext <32 x i1>
undef to <32 x i8>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 50 for instruction: %V64i8 = zext <64 x i1>
undef to <64 x i8>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret i32 undef
;
; AVX512VL512-LABEL: 'zext256_vXi1'
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V2i64 = zext <2 x i1> undef
to <2 x i64>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V4i64 = zext <4 x i1> undef

```

to <4 x i64>

; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V8i64 = zext <8 x i1> undef to <8 x i64>

; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V2i32 = zext <2 x i1> undef to <2 x i32>

; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V4i32 = zext <4 x i1> undef to <4 x i32>

; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V8i32 = zext <8 x i1> undef to <8 x i32>

; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V16i32 = zext <16 x i1> undef to <16 x i32>

; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %V2i16 = zext <2 x i1> undef to <2 x i16>

; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %V4i16 = zext <4 x i1> undef to <4 x i16>

; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %V8i16 = zext <8 x i1> undef to <8 x i16>

; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %V16i16 = zext <16 x i1> undef to <16 x i16>

; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 9 for instruction: %V32i16 = zext <32 x i1> undef to <32 x i16>

; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %V2i8 = zext <2 x i1> undef to <2 x i8>

; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %V4i8 = zext <4 x i1> undef to <4 x i8>

; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %V8i8 = zext <8 x i1> undef to <8 x i8>

; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %V16i8 = zext <16 x i1> undef to <16 x i8>

; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 9 for instruction: %V32i8 = zext <32 x i1> undef to <32 x i8>

; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 19 for instruction: %V64i8 = zext <64 x i1> undef to <64 x i8>

; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret i32 undef

;

; SKX256-LABEL: 'zext256\_vXi1'

; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V2i64 = zext <2 x i1> undef to <2 x i64>

; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V4i64 = zext <4 x i1> undef to <4 x i64>

;

SKX256-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %V8i64 = zext <8 x i1> undef to <8 x i64>

; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V2i32 = zext <2 x i1> undef to <2 x i32>

; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V4i32 = zext <4 x i1> undef to <4 x i32>

; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V8i32 = zext <8 x i1> undef to <8 x i32>



```

i32>
; SKX256-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %V16i32 = zext <16 x i1> undef to
<16 x i32>
; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V2i16 = zext <2 x i1> undef to <2 x
i16>
; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V4i16 = zext <4 x i1> undef to <4 x
i16>
; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V8i16 = zext <8 x i1> undef to <8 x
i16>
; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction:
%V16i16 = zext <16 x i1> undef to <16 x i16>
; SKX256-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %V32i16 = zext <32 x i1> undef to
<32 x i16>
; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V2i8 = zext <2 x i1> undef to <2 x
i8>
; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V4i8 = zext <4 x i1> undef to <4 x
i8>
; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V8i8 = zext <8 x i1> undef to <8 x
i8>
; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V16i8 = zext <16 x i1> undef to <16
x i8>
; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V32i8 = zext <32 x i1> undef to <32
x i8>
; SKX256-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %V64i8 = zext <64 x i1> undef to <64
x i8>
; SKX256-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret i32 undef
;
; SKX512-LABEL: 'zext256_vXi1'
; SKX512-NEXT: Cost
Model: Found an estimated cost of 2 for instruction: %V2i64 = zext <2 x i1> undef to <2 x i64>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V4i64 = zext <4 x i1> undef to <4 x
i64>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V8i64 = zext <8 x i1> undef to <8 x
i64>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V2i32 = zext <2 x i1> undef to <2 x
i32>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V4i32 = zext <4 x i1> undef to <4 x
i32>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V8i32 = zext <8 x i1> undef to <8 x
i32>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V16i32 = zext <16 x i1> undef to
<16 x i32>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V2i16 = zext <2 x i1> undef to <2 x
i16>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V4i16 = zext
<4 x i1> undef to <4 x i16>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V8i16 = zext <8 x i1> undef to <8 x
i16>

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```

; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V16i16 = zext <16 x i1> undef to
<16 x i16>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V32i16 = zext <32 x i1> undef to
<32 x i16>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V2i8 = zext <2 x i1> undef to <2 x
i8>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V4i8 = zext <4 x i1> undef to <4 x
i8>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V8i8 = zext <8 x i1> undef to <8 x
i8>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V16i8 = zext <16 x i1> undef to <16
x i8>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V32i8 = zext <32 x i1> undef to <32
x i8>
; SKX512-NEXT: Cost Model: Found an estimated
cost of 2 for instruction: %V64i8 = zext <64 x i1> undef to <64 x i8>
; SKX512-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret i32 undef
;
%V2i64 = zext <2 x i1> undef to <2 x i64>
%V4i64 = zext <4 x i1> undef to <4 x i64>
%V8i64 = zext <8 x i1> undef to <8 x i64>

%V2i32 = zext <2 x i1> undef to <2 x i32>
%V4i32 = zext <4 x i1> undef to <4 x i32>
%V8i32 = zext <8 x i1> undef to <8 x i32>
%V16i32 = zext <16 x i1> undef to <16 x i32>

%V2i16 = zext <2 x i1> undef to <2 x i16>
%V4i16 = zext <4 x i1> undef to <4 x i16>
%V8i16 = zext <8 x i1> undef to <8 x i16>
%V16i16 = zext <16 x i1> undef to <16 x i16>
%V32i16 = zext <32 x i1> undef to <32 x i16>

%V2i8 = zext <2 x i1> undef to <2 x i8>
%V4i8 = zext <4 x i1> undef to <4 x i8>
%V8i8 = zext <8 x i1> undef to <8 x i8>
%V16i8 = zext <16 x i1> undef to <16 x i8>
%V32i8 = zext <32 x i1> undef to <32 x i8>
%V64i8 = zext <64 x i1> undef to <64 x i8>

ret i32 undef
}

define i32 @sext256_vXi1()
"min-legal-vector-width"="256" {
; AVX-LABEL: 'sext256_vXi1'
; AVX-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %I64 = sext i1 undef to i64
; AVX-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V2i64 = sext <2 x i1> undef to <2 x

```

```

i64>
; AVX-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %V4i64 = sext <4 x i1> undef to <4 x
i64>
; AVX-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %V8i64 = sext <8 x i1> undef to <8 x
i64>
; AVX-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %I32 = sext i1 undef to i32
; AVX-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V2i32 = sext <2 x i1> undef to <2 x
i32>
; AVX-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V4i32 = sext <4 x i1> undef to <4 x
i32>
; AVX-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %V8i32 = sext <8 x i1> undef to <8 x
i32>
; AVX-NEXT: Cost Model: Found an estimated cost
of 4 for instruction: %V16i32 = sext <16 x i1> undef to <16 x i32>
; AVX-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %I16 = sext i1 undef to i16
; AVX-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V2i16 = sext <2 x i1> undef to <2 x
i16>
; AVX-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V4i16 = sext <4 x i1> undef to <4 x
i16>
; AVX-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V8i16 = sext <8 x i1> undef to <8 x
i16>
; AVX-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V16i16 = sext <16 x i1> undef to <16 x
i16>
; AVX-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %V32i16 = sext <32 x i1> undef to <32 x
i16>
; AVX-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %I8 = sext i1 undef to i8
; AVX-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V2i8 = sext <2 x i1> undef to <2 x i8>
; AVX-NEXT: Cost Model: Found an estimated cost of 2 for
instruction: %V4i8 = sext <4 x i1> undef to <4 x i8>
; AVX-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V8i8 = sext <8 x i1> undef to <8 x i8>
; AVX-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V16i8 = sext <16 x i1> undef to <16 x
i8>
; AVX-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V32i8 = sext <32 x i1> undef to <32 x
i8>
; AVX-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %V64i8 = sext <64 x i1> undef to <64 x
i8>
; AVX-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret i32 undef
;
; AVX512VL256-LABEL: 'sext256_vXi1'
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %I64 = sext i1 undef to i64
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V2i64 = sext <2 x i1> undef
to <2 x i64>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V4i64 = sext <4 x i1> undef
to <4 x i64>
; AVX512VL256-NEXT:
Cost Model: Found an estimated cost of 3 for instruction: %V8i64 = sext <8 x i1> undef to <8 x i64>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %I32 = sext i1 undef to i32
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V2i32 = sext <2 x i1> undef

```

```

to <2 x i32>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V4i32 = sext <4 x i1> undef
to <4 x i32>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V8i32 = sext <8 x i1> undef
to <8 x i32>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V16i32 = sext <16 x i1>
undef to <16 x i32>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %I16 = sext i1 undef to i16
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %V2i16 = sext <2 x i1> undef
to <2 x i16>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 4 for instruction:
%V4i16 = sext <4 x i1> undef to <4 x i16>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %V8i16 = sext <8 x i1> undef
to <8 x i16>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 10 for instruction: %V16i16 = sext <16 x i1>
undef to <16 x i16>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 20 for instruction: %V32i16 = sext <32 x i1>
undef to <32 x i16>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %I8 = sext i1 undef to i8
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 5 for instruction: %V2i8 = sext <2 x i1> undef to
<2 x i8>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 5 for instruction: %V4i8 = sext <4 x i1> undef to
<4 x i8>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 5 for instruction: %V8i8 = sext <8 x i1> undef to
<8 x i8>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 10 for instruction: %V16i8 = sext <16 x i1>
undef to <16 x i8>
;
AVX512VL256-NEXT: Cost Model: Found an estimated cost of 21 for instruction: %V32i8 = sext <32 x i1>
undef to <32 x i8>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 42 for instruction: %V64i8 = sext <64 x i1>
undef to <64 x i8>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret i32 undef
;
; AVX512VL512-LABEL: 'sext256_vXi1'
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %I64 = sext i1 undef to i64
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V2i64 = sext <2 x i1> undef
to <2 x i64>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V4i64 = sext <4 x i1> undef
to <4 x i64>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V8i64 = sext <8 x i1> undef
to <8 x i64>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %I32 = sext i1 undef to i32
; AVX512VL512-NEXT: Cost Model: Found an estimated
cost of 1 for instruction: %V2i32 = sext <2 x i1> undef to <2 x i32>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V4i32 = sext <4 x i1> undef
to <4 x i32>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V8i32 = sext <8 x i1> undef

```

to <8 x i32>

; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V16i32 = sext <16 x i1> undef to <16 x i32>

; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %I16 = sext i1 undef to i16

; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %V2i16 = sext <2 x i1> undef to <2 x i16>

; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %V4i16 = sext <4 x i1> undef to <4 x i16>

; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %V8i16 = sext <8 x i1> undef to <8 x i16>

; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %V16i16 = sext <16 x i1> undef to <16 x i16>

; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 7 for instruction: %V32i16 = sext <32 x i1> undef to <32 x i16>

; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %I8 = sext i1 undef to i8

; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %V2i8 = sext <2 x i1> undef to <2 x i8>

; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %V4i8 = sext <4 x i1> undef to <4 x i8>

; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %V8i8 = sext <8 x i1> undef to <8 x i8>

; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %V16i8 = sext <16 x i1> undef to <16 x i8>

; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 7 for instruction: %V32i8 = sext <32 x i1> undef to <32 x i8>

; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 15 for instruction: %V64i8 = sext <64 x i1> undef to <64 x i8>

; AVX512VL512-NEXT:  
Cost Model: Found an estimated cost of 0 for instruction: ret i32 undef

;

; SKX256-LABEL: 'sext256\_vXi1'

; SKX256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %I64 = sext i1 undef to i64

; SKX256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V2i64 = sext <2 x i1> undef to <2 x i64>

; SKX256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V4i64 = sext <4 x i1> undef to <4 x i64>

; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V8i64 = sext <8 x i1> undef to <8 x i64>

; SKX256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %I32 = sext i1 undef to i32

; SKX256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V2i32 = sext <2 x i1> undef to <2 x i32>

; SKX256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V4i32 = sext <4 x i1> undef to <4 x i32>

; SKX256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V8i32 = sext <8 x i1> undef to <8 x i32>

; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V16i32 = sext <16 x i1> undef to <16 x i32>

; SKX256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %I16 = sext i1 undef to i16

```

; SKX256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V2i16 = sext <2 x i1> undef to <2 x
i16>
; SKX256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V4i16 = sext <4 x i1> undef to <4 x
i16>
; SKX256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V8i16 = sext <8 x i1> undef to <8 x
i16>
; SKX256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V16i16 = sext <16 x i1> undef to
<16 x i16>
; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V32i16 = sext <32 x i1> undef to
<32 x i16>
; SKX256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %I8 = sext i1 undef to i8
; SKX256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V2i8
= sext <2 x i1> undef to <2 x i8>
; SKX256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V4i8 = sext <4 x i1> undef to <4 x
i8>
; SKX256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V8i8 = sext <8 x i1> undef to <8 x
i8>
; SKX256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V16i8 = sext <16 x i1> undef to <16
x i8>
; SKX256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V32i8 = sext <32 x i1> undef to <32
x i8>
; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V64i8 = sext <64 x i1> undef to <64
x i8>
; SKX256-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret i32 undef
;
; SKX512-LABEL: 'sext256_vXi1'
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %I64 = sext i1 undef to i64
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V2i64 = sext <2 x i1> undef to <2 x
i64>
; SKX512-NEXT: Cost Model: Found an estimated
cost of 1 for instruction: %V4i64 = sext <4 x i1> undef to <4 x i64>
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V8i64 = sext <8 x i1> undef to <8 x
i64>
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %I32 = sext i1 undef to i32
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V2i32 = sext <2 x i1> undef to <2 x
i32>
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V4i32 = sext <4 x i1> undef to <4 x
i32>
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V8i32 = sext <8 x i1> undef to <8 x
i32>
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V16i32 = sext <16 x i1> undef to
<16 x i32>
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %I16 = sext i1 undef to i16
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V2i16 = sext <2 x i1> undef to <2 x
i16>
; SKX512-NEXT: Cost Model:
Found an estimated cost of 1 for instruction: %V4i16 = sext <4 x i1> undef to <4 x i16>
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V8i16 = sext <8 x i1> undef to <8 x

```

```

i16>
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V16i16 = sext <16 x i1> undef to
<16 x i16>
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V32i16 = sext <32 x i1> undef to
<32 x i16>
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %I8 = sext i1 undef to i8
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V2i8 = sext <2 x i1> undef to <2 x
i8>
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V4i8 = sext <4 x i1> undef to <4 x
i8>
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V8i8 = sext <8 x i1> undef to <8 x
i8>
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V16i8 = sext <16 x i1> undef to <16
x i8>
;
SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V32i8 = sext <32 x i1> undef to <32
x i8>
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V64i8 = sext <64 x i1> undef to <64
x i8>
; SKX512-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret i32 undef
;
%i64 = sext i1 undef to i64
%V2i64 = sext <2 x i1> undef to <2 x i64>
%V4i64 = sext <4 x i1> undef to <4 x i64>
%V8i64 = sext <8 x i1> undef to <8 x i64>

%i32 = sext i1 undef to i32
%V2i32 = sext <2 x i1> undef to <2 x i32>
%V4i32 = sext <4 x i1> undef to <4 x i32>
%V8i32 = sext <8 x i1> undef to <8 x i32>
%V16i32 = sext <16 x i1> undef to <16 x i32>

%i16 = sext i1 undef to i16
%V2i16 = sext <2 x i1> undef to <2 x i16>
%V4i16 = sext <4 x i1> undef to <4 x i16>
%V8i16 = sext <8 x i1> undef to <8 x i16>
%V16i16 = sext <16 x i1> undef to <16 x i16>
%V32i16 = sext <32 x i1> undef to <32 x i16>

%i8 = sext i1 undef to i8
%V2i8 = sext <2
x i1> undef to <2 x i8>
%V4i8 = sext <4 x i1> undef to <4 x i8>
%V8i8 = sext <8 x i1> undef to <8 x i8>
%V16i8 = sext <16 x i1> undef to <16 x i8>
%V32i8 = sext <32 x i1> undef to <32 x i8>
%V64i8 = sext <64 x i1> undef to <64 x i8>

```

```
ret i32 undef
}
```

```
define i32 @trunc_vXi1() "min-legal-vector-width"="256" {
; AVX-LABEL: 'trunc_vXi1'
; AVX-NEXT: Cost Model: Found an estimated cost of 0 for instruction: %V2i64 = trunc <2 x i64> undef to <2 x
i1>
; AVX-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %V4i64 = trunc <4 x i64> undef to <4 x
i1>
; AVX-NEXT: Cost Model: Found an estimated cost of 9 for instruction: %V8i64 = trunc <8 x i64> undef to <8 x
i1>
; AVX-NEXT: Cost Model: Found an estimated cost of 11 for instruction: %V16i64 = trunc <16 x i64> undef to
<16 x i1>
; AVX-NEXT: Cost Model: Found an estimated cost of 0 for instruction: %V32i64 = trunc <32 x i64> undef to <32
x i1>
; AVX-NEXT: Cost Model: Found an estimated cost of 0 for instruction: %V64i64
= trunc <64 x i64> undef to <64 x i1>
; AVX-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V2i32 = trunc <2 x i32> undef to <2 x
i1>
; AVX-NEXT: Cost Model: Found an estimated cost of 0 for instruction: %V4i32 = trunc <4 x i32> undef to <4 x
i1>
; AVX-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V8i32 = trunc <8 x i32> undef to <8 x
i1>
; AVX-NEXT: Cost Model: Found an estimated cost of 8 for instruction: %V16i32 = trunc <16 x i32> undef to <16
x i1>
; AVX-NEXT: Cost Model: Found an estimated cost of 0 for instruction: %V32i32 = trunc <32 x i32> undef to <32
x i1>
; AVX-NEXT: Cost Model: Found an estimated cost of 0 for instruction: %V64i32 = trunc <64 x i32> undef to <64
x i1>
; AVX-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V2i16 = trunc <2 x i16> undef to <2 x
i1>
; AVX-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V4i16 = trunc <4 x i16> undef to <4 x
i1>
; AVX-NEXT: Cost Model: Found an estimated
cost of 0 for instruction: %V8i16 = trunc <8 x i16> undef to <8 x i1>
; AVX-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %V16i16 = trunc <16 x i16> undef to <16
x i1>
; AVX-NEXT: Cost Model: Found an estimated cost of 0 for instruction: %V32i16 = trunc <32 x i16> undef to <32
x i1>
; AVX-NEXT: Cost Model: Found an estimated cost of 0 for instruction: %V64i16 = trunc <64 x i16> undef to <64
x i1>
; AVX-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V2i8 = trunc <2 x i8> undef to <2 x i1>
; AVX-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V4i8 = trunc <4 x i8> undef to <4 x i1>
; AVX-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V8i8 = trunc <8 x i8> undef to <8 x i1>
; AVX-NEXT: Cost Model: Found an estimated cost of 0 for instruction: %V16i8 = trunc <16 x i8> undef to <16 x
i1>
; AVX-NEXT: Cost Model: Found an estimated cost of 0 for instruction: %V32i8 = trunc <32 x i8> undef to <32 x
i1>
```



```

; AVX-NEXT:
  Cost Model: Found an estimated cost of 0 for instruction: %V64i8 = trunc <64 x i8> undef to <64 x i1>
; AVX-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret i32 undef
;
; AVX512VL256-LABEL: 'trunc_vXi1'
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V2i64 = trunc <2 x i64>
undef to <2 x i1>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V4i64 = trunc <4 x i64>
undef to <4 x i1>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 9 for instruction: %V8i64 = trunc <8 x i64>
undef to <8 x i1>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 11 for instruction: %V16i64 = trunc <16 x i64>
undef to <16 x i1>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 0 for instruction: %V32i64 = trunc <32 x i64>
undef to <32 x i1>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 0 for instruction: %V64i64 = trunc <64 x i64>
undef to <64 x i1>
; AVX512VL256-NEXT: Cost Model:
  Found an estimated cost of 2 for instruction: %V2i32 = trunc <2 x i32> undef to <2 x i1>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V4i32 = trunc <4 x i32>
undef to <4 x i1>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V8i32 = trunc <8 x i32>
undef to <8 x i1>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %V16i32 = trunc <16 x i32>
undef to <16 x i1>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 8 for instruction: %V32i32 = trunc <32 x i32>
undef to <32 x i1>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 16 for instruction: %V64i32 = trunc <64 x i32>
undef to <64 x i1>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %V2i16 = trunc <2 x i16>
undef to <2 x i1>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %V4i16 = trunc <4 x i16>
undef to <4 x i1>
; AVX512VL256-NEXT: Cost Model: Found an
  estimated cost of 3 for instruction: %V8i16 = trunc <8 x i16> undef to <8 x i1>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 8 for instruction: %V16i16 = trunc <16 x i16>
undef to <16 x i1>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 16 for instruction: %V32i16 = trunc <32 x i16>
undef to <32 x i1>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 32 for instruction: %V64i16 = trunc <64 x i16>
undef to <64 x i1>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %V2i8 = trunc <2 x i8> undef
to <2 x i1>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %V4i8 = trunc <4 x i8> undef
to <4 x i1>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %V8i8 = trunc <8 x i8> undef
to <8 x i1>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 8 for instruction: %V16i8 = trunc <16 x i8>

```

```

undef to <16 x i1>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of
0 for instruction: %V32i8 = trunc <32 x i8> undef to <32 x i1>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 0 for instruction: %V64i8 = trunc <64 x i8>
undef to <64 x i1>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret i32 undef
;
; AVX512VL512-LABEL: 'trunc_vXi1'
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V2i64 = trunc <2 x i64>
undef to <2 x i1>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V4i64 = trunc <4 x i64>
undef to <4 x i1>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V8i64 = trunc <8 x i64>
undef to <8 x i1>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 11 for instruction: %V16i64 = trunc <16 x i64>
undef to <16 x i1>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 0 for instruction: %V32i64 = trunc <32 x i64>
undef to <32 x i1>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 0 for instruction:
%V64i64 = trunc <64 x i64> undef to <64 x i1>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V2i32 = trunc <2 x i32>
undef to <2 x i1>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V4i32 = trunc <4 x i32>
undef to <4 x i1>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V8i32 = trunc <8 x i32>
undef to <8 x i1>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V16i32 = trunc <16 x i32>
undef to <16 x i1>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %V32i32 = trunc <32 x i32>
undef to <32 x i1>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 8 for instruction: %V64i32 = trunc <64 x i32>
undef to <64 x i1>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %V2i16 = trunc <2 x i16>
undef to <2 x i1>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 3 for instruction:
%V4i16 = trunc <4 x i16> undef to <4 x i1>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %V8i16 = trunc <8 x i16>
undef to <8 x i1>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %V16i16 = trunc <16 x i16>
undef to <16 x i1>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 0 for instruction: %V32i16 = trunc <32 x i16>
undef to <32 x i1>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 0 for instruction: %V64i16 = trunc <64 x i16>
undef to <64 x i1>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %V2i8 = trunc <2 x i8> undef
to <2 x i1>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %V4i8 = trunc <4 x i8> undef
to <4 x i1>

```

```

; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %V8i8 = trunc <8 x i8> undef
to <8 x i1>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %V16i8 = trunc <16 x
i8> undef to <16 x i1>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 0 for instruction: %V32i8 = trunc <32 x i8>
undef to <32 x i1>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 0 for instruction: %V64i8 = trunc <64 x i8>
undef to <64 x i1>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret i32 undef
;
; SKX256-LABEL: 'trunc_vXi1'
; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V2i64 = trunc <2 x i64> undef to <2
x i1>
; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V4i64 = trunc <4 x i64> undef to <4
x i1>
; SKX256-NEXT: Cost Model: Found an estimated cost of 9 for instruction: %V8i64 = trunc <8 x i64> undef to <8
x i1>
; SKX256-NEXT: Cost Model: Found an estimated cost of 11 for instruction: %V16i64 = trunc <16 x i64> undef to
<16 x i1>
; SKX256-NEXT: Cost Model: Found an estimated cost of 0 for instruction: %V32i64 = trunc <32 x i64> undef to
<32 x i1>
; SKX256-NEXT:
Cost Model: Found an estimated cost of 0 for instruction: %V64i64 = trunc <64 x i64> undef to <64 x i1>
; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V2i32 = trunc <2 x i32> undef to <2
x i1>
; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V4i32 = trunc <4 x i32> undef to <4
x i1>
; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V8i32 = trunc <8 x i32> undef to <8
x i1>
; SKX256-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %V16i32 = trunc <16 x i32> undef to
<16 x i1>
; SKX256-NEXT: Cost Model: Found an estimated cost of 0 for instruction: %V32i32 = trunc <32 x i32> undef to
<32 x i1>
; SKX256-NEXT: Cost Model: Found an estimated cost of 0 for instruction: %V64i32 = trunc <64 x i32> undef to
<64 x i1>
; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V2i16 = trunc <2 x i16> undef to <2
x i1>
; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction:
%V4i16 = trunc <4 x i16> undef to <4 x i1>
; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V8i16 = trunc <8 x i16> undef to <8
x i1>
; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V16i16 = trunc <16 x i16> undef to
<16 x i1>
; SKX256-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %V32i16 = trunc <32 x i16> undef to
<32 x i1>
; SKX256-NEXT: Cost Model: Found an estimated cost of 8 for instruction: %V64i16 = trunc <64 x i16> undef to
<64 x i1>
; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V2i8 = trunc <2 x i8> undef to <2 x

```

```

i1>
; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V4i8 = trunc <4 x i8> undef to <4 x
i1>
; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V8i8 = trunc <8 x i8> undef to <8 x
i1>
; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V16i8 = trunc <16 x i8> undef to
<16 x i1>
; SKX256-NEXT:
Cost Model: Found an estimated cost of 2 for instruction: %V32i8 = trunc <32 x i8> undef to <32 x i1>
; SKX256-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %V64i8 = trunc <64 x i8> undef to
<64 x i1>
; SKX256-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret i32 undef
;
; SKX512-LABEL: 'trunc_vXi1'
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V2i64 = trunc <2 x i64> undef to <2
x i1>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V4i64 = trunc <4 x i64> undef to <4
x i1>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V8i64 = trunc <8 x i64> undef to <8
x i1>
; SKX512-NEXT: Cost Model: Found an estimated cost of 11 for instruction: %V16i64 = trunc <16 x i64> undef to
<16 x i1>
; SKX512-NEXT: Cost Model: Found an estimated cost of 0 for instruction: %V32i64 = trunc <32 x i64> undef to
<32 x i1>
; SKX512-NEXT: Cost Model: Found an estimated cost of 0 for instruction:
%V64i64 = trunc <64 x i64> undef to <64 x i1>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V2i32 = trunc <2 x i32> undef to <2
x i1>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V4i32 = trunc <4 x i32> undef to <4
x i1>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V8i32 = trunc <8 x i32> undef to <8
x i1>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V16i32 = trunc <16 x i32> undef to
<16 x i1>
; SKX512-NEXT: Cost Model: Found an estimated cost of 0 for instruction: %V32i32 = trunc <32 x i32> undef to
<32 x i1>
; SKX512-NEXT: Cost Model: Found an estimated cost of 0 for instruction: %V64i32 = trunc <64 x i32> undef to
<64 x i1>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V2i16 = trunc <2 x i16> undef to <2
x i1>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V4i16 = trunc <4 x i16> undef to <4
x i1>
;
SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V8i16 = trunc <8 x i16> undef to <8
x i1>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V16i16 = trunc <16 x i16> undef to
<16 x i1>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V32i16 = trunc <32 x i16> undef to

```

```

<32 x i1>
; SKX512-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %V64i16 = trunc <64 x i16> undef to
<64 x i1>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V2i8 = trunc <2 x i8> undef to <2 x
i1>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V4i8 = trunc <4 x i8> undef to <4 x
i1>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V8i8 = trunc <8 x i8> undef to <8 x
i1>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V16i8 = trunc <16 x i8> undef to
<16 x i1>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for
instruction: %V32i8 = trunc <32 x i8> undef to <32 x i1>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V64i8 = trunc <64 x i8> undef to
<64 x i1>
; SKX512-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret i32 undef
;
%V2i64 = trunc <2 x i64> undef to <2 x i1>
%V4i64 = trunc <4 x i64> undef to <4 x i1>
%V8i64 = trunc <8 x i64> undef to <8 x i1>
%V16i64 = trunc <16 x i64> undef to <16 x i1>
%V32i64 = trunc <32 x i64> undef to <32 x i1>
%V64i64 = trunc <64 x i64> undef to <64 x i1>

%V2i32 = trunc <2 x i32> undef to <2 x i1>
%V4i32 = trunc <4 x i32> undef to <4 x i1>
%V8i32 = trunc <8 x i32> undef to <8 x i1>
%V16i32 = trunc <16 x i32> undef to <16 x i1>
%V32i32 = trunc <32 x i32> undef to <32 x i1>
%V64i32 = trunc <64 x i32> undef to <64 x i1>

%V2i16 = trunc <2 x i16> undef to <2 x i1>
%V4i16 = trunc <4 x i16> undef to <4 x i1>
%V8i16 = trunc <8 x i16> undef to <8 x i1>
%V16i16 = trunc <16 x i16> undef to
<16 x i1>
%V32i16 = trunc <32 x i16> undef to <32 x i1>
%V64i16 = trunc <64 x i16> undef to <64 x i1>

%V2i8 = trunc <2 x i8> undef to <2 x i1>
%V4i8 = trunc <4 x i8> undef to <4 x i1>
%V8i8 = trunc <8 x i8> undef to <8 x i1>
%V16i8 = trunc <16 x i8> undef to <16 x i1>
%V32i8 = trunc <32 x i8> undef to <32 x i1>
%V64i8 = trunc <64 x i8> undef to <64 x i1>

ret i32 undef
}

```

```
; NOTE: Assertions have been autogenerated by utils/update_llc_test_checks.py
; RUN: llc -mtriple=riscv64 -mattr=+m -verify-machineinstrs < %s \
; RUN: -riscv-experimental-rv64-legal-i32 | FileCheck %s -check-prefix=RV64
```

```
;
; Get the actual value of the overflow bit.
;
define zeroext i1 @saddo1.i32(i32 signext %v1, i32 signext %v2, ptr %res) {
; RV64-LABEL: saddo1.i32:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  addw a3, a0, a1
; RV64-NEXT:  slt a0, a3, a0
; RV64-NEXT:  slti a1, a1, 0
; RV64-NEXT:  xor a0, a1, a0
; RV64-NEXT:  sw a3, 0(a2)
; RV64-NEXT:  ret
entry:
  %t = call {i32, i1} @llvm.sadd.with.overflow.i32(i32 %v1, i32 %v2)
  %val = extractvalue {i32, i1} %t, 0
  %obit = extractvalue {i32, i1} %t, 1
  store i32 %val, ptr %res
  ret i1 %obit
}
```

```
; Test the immediate version.
define zeroext i1 @saddo2.i32(i32 signext %v1, ptr %res) {
; RV64-LABEL: saddo2.i32:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  addiw a2, a0, 4
; RV64-NEXT:  slt a0, a2, a0
; RV64-NEXT:
  sw a2, 0(a1)
; RV64-NEXT:  ret
entry:
  %t = call {i32, i1} @llvm.sadd.with.overflow.i32(i32 %v1, i32 4)
  %val = extractvalue {i32, i1} %t, 0
  %obit = extractvalue {i32, i1} %t, 1
  store i32 %val, ptr %res
  ret i1 %obit
}
```

```
; Test negative immediates.
define zeroext i1 @saddo3.i32(i32 signext %v1, ptr %res) {
; RV64-LABEL: saddo3.i32:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  addiw a2, a0, -4
; RV64-NEXT:  slt a0, a2, a0
; RV64-NEXT:  xori a0, a0, 1
```

```

; RV64-NEXT:  sw a2, 0(a1)
; RV64-NEXT:  ret
entry:
%t = call {i32, i1} @llvm.sadd.with.overflow.i32(i32 %v1, i32 -4)
%val = extractvalue {i32, i1} %t, 0
%obit = extractvalue {i32, i1} %t, 1
store i32 %val, ptr %res
ret i1 %obit
}

; Test immediates that are too large to be encoded.
define zeroext i1 @saddo4.i32(i32 signext %v1, ptr %res) {
; RV64-LABEL: saddo4.i32:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  lui a2, 4096
; RV64-NEXT:  addi a2, a2, -1
; RV64-NEXT:  addw a2, a0, a2
; RV64-NEXT:  slt
a0, a2, a0
; RV64-NEXT:  sw a2, 0(a1)
; RV64-NEXT:  ret
entry:
%t = call {i32, i1} @llvm.sadd.with.overflow.i32(i32 %v1, i32 16777215)
%val = extractvalue {i32, i1} %t, 0
%obit = extractvalue {i32, i1} %t, 1
store i32 %val, ptr %res
ret i1 %obit
}

define zeroext i1 @saddo1.i64(i64 %v1, i64 %v2, ptr %res) {
; RV64-LABEL: saddo1.i64:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  add a3, a0, a1
; RV64-NEXT:  slt a0, a3, a0
; RV64-NEXT:  slti a1, a1, 0
; RV64-NEXT:  xor a0, a1, a0
; RV64-NEXT:  sd a3, 0(a2)
; RV64-NEXT:  ret
entry:
%t = call {i64, i1} @llvm.sadd.with.overflow.i64(i64 %v1, i64 %v2)
%val = extractvalue {i64, i1} %t, 0
%obit = extractvalue {i64, i1} %t, 1
store i64 %val, ptr %res
ret i1 %obit
}

define zeroext i1 @saddo2.i64(i64 %v1, ptr %res) {
; RV64-LABEL: saddo2.i64:

```

```

; RV64:    # %bb.0: # %entry
; RV64-NEXT:  addi a2, a0, 4
; RV64-NEXT:  slt a0, a2, a0
; RV64-NEXT:  sd a2, 0(a1)
; RV64-NEXT:  ret
entry:
%t = call {i64, i1}
@llvm.sadd.with.overflow.i64(i64 %v1, i64 4)
%val = extractvalue {i64, i1} %t, 0
%obit = extractvalue {i64, i1} %t, 1
store i64 %val, ptr %res
ret i1 %obit
}

define zeroext i1 @saddo3.i64(i64 %v1, ptr %res) {
; RV64-LABEL: saddo3.i64:
; RV64:    # %bb.0: # %entry
; RV64-NEXT:  addi a2, a0, -4
; RV64-NEXT:  slt a0, a2, a0
; RV64-NEXT:  xori a0, a0, 1
; RV64-NEXT:  sd a2, 0(a1)
; RV64-NEXT:  ret
entry:
%t = call {i64, i1} @llvm.sadd.with.overflow.i64(i64 %v1, i64 -4)
%val = extractvalue {i64, i1} %t, 0
%obit = extractvalue {i64, i1} %t, 1
store i64 %val, ptr %res
ret i1 %obit
}

define zeroext i1 @uaddo.i32(i32 signext %v1, i32 signext %v2, ptr %res) {
; RV64-LABEL: uaddo.i32:
; RV64:    # %bb.0: # %entry
; RV64-NEXT:  addw a1, a0, a1
; RV64-NEXT:  sltu a0, a1, a0
; RV64-NEXT:  sw a1, 0(a2)
; RV64-NEXT:  ret
entry:
%t = call {i32, i1} @llvm.uadd.with.overflow.i32(i32 %v1, i32 %v2)
%val = extractvalue {i32, i1} %t, 0
%obit = extractvalue {i32,
i1} %t, 1
store i32 %val, ptr %res
ret i1 %obit
}

define zeroext i1 @uaddo.i32.constant(i32 signext %v1, ptr %res) {
; RV64-LABEL: uaddo.i32.constant:

```



```

; RV64:    # %bb.0: # %entry
; RV64-NEXT:  addiw a2, a0, -2
; RV64-NEXT:  sltu a0, a2, a0
; RV64-NEXT:  sw a2, 0(a1)
; RV64-NEXT:  ret
entry:
%t = call {i32, i1} @llvm.uadd.with.overflow.i32(i32 %v1, i32 -2)
%val = extractvalue {i32, i1} %t, 0
%obit = extractvalue {i32, i1} %t, 1
store i32 %val, ptr %res
ret i1 %obit
}

define zeroext i1 @uaddo.i32.constant_one(i32 signext %v1, ptr %res) {
; RV64-LABEL: uaddo.i32.constant_one:
; RV64:    # %bb.0: # %entry
; RV64-NEXT:  addiw a2, a0, 1
; RV64-NEXT:  seqz a0, a2
; RV64-NEXT:  sw a2, 0(a1)
; RV64-NEXT:  ret
entry:
%t = call {i32, i1} @llvm.uadd.with.overflow.i32(i32 %v1, i32 1)
%val = extractvalue {i32, i1} %t, 0
%obit = extractvalue {i32, i1} %t, 1
store i32 %val, ptr %res
ret i1 %obit
}

define zeroext i1 @uaddo.i64(i64 %v1, i64 %v2, ptr
%res) {
; RV64-LABEL: uaddo.i64:
; RV64:    # %bb.0: # %entry
; RV64-NEXT:  add a1, a0, a1
; RV64-NEXT:  sltu a0, a1, a0
; RV64-NEXT:  sd a1, 0(a2)
; RV64-NEXT:  ret
entry:
%t = call {i64, i1} @llvm.uadd.with.overflow.i64(i64 %v1, i64 %v2)
%val = extractvalue {i64, i1} %t, 0
%obit = extractvalue {i64, i1} %t, 1
store i64 %val, ptr %res
ret i1 %obit
}

define zeroext i1 @uaddo.i64.constant_one(i64 %v1, ptr %res) {
; RV64-LABEL: uaddo.i64.constant_one:
; RV64:    # %bb.0: # %entry
; RV64-NEXT:  addi a2, a0, 1

```

```

; RV64-NEXT: seqz a0, a2
; RV64-NEXT: sd a2, 0(a1)
; RV64-NEXT: ret
entry:
%t = call {i64, i1} @llvm.uadd.with.overflow.i64(i64 %v1, i64 1)
%val = extractvalue {i64, i1} %t, 0
%obit = extractvalue {i64, i1} %t, 1
store i64 %val, ptr %res
ret i1 %obit
}

define zeroext i1 @ssubo1.i32(i32 signext %v1, i32 signext %v2, ptr %res) {
; RV64-LABEL: ssubo1.i32:
; RV64:    # %bb.0: # %entry
; RV64-NEXT: sgtz a3, a1
; RV64-NEXT: subw a1,
a0, a1
; RV64-NEXT: slt a0, a1, a0
; RV64-NEXT: xor a0, a3, a0
; RV64-NEXT: sw a1, 0(a2)
; RV64-NEXT: ret
entry:
%t = call {i32, i1} @llvm.ssub.with.overflow.i32(i32 %v1, i32 %v2)
%val = extractvalue {i32, i1} %t, 0
%obit = extractvalue {i32, i1} %t, 1
store i32 %val, ptr %res
ret i1 %obit
}

define zeroext i1 @ssubo2.i32(i32 signext %v1, ptr %res) {
; RV64-LABEL: ssubo2.i32:
; RV64:    # %bb.0: # %entry
; RV64-NEXT: addiw a2, a0, 4
; RV64-NEXT: slt a0, a2, a0
; RV64-NEXT: sw a2, 0(a1)
; RV64-NEXT: ret
entry:
%t = call {i32, i1} @llvm.ssub.with.overflow.i32(i32 %v1, i32 -4)
%val = extractvalue {i32, i1} %t, 0
%obit = extractvalue {i32, i1} %t, 1
store i32 %val, ptr %res
ret i1 %obit
}

define zeroext i1 @ssubo.i64(i64 %v1, i64 %v2, ptr %res) {
; RV64-LABEL: ssubo.i64:
; RV64:    # %bb.0: # %entry
; RV64-NEXT: sgtz a3, a1

```

```

; RV64-NEXT:  sub a1, a0, a1
; RV64-NEXT:  slt a0, a1, a0
; RV64-NEXT:  xor a0, a3, a0
; RV64-NEXT:  sd a1,
0(a2)
; RV64-NEXT:  ret
entry:
%t = call {i64, i1} @llvm.ssub.with.overflow.i64(i64 %v1, i64 %v2)
%val = extractvalue {i64, i1} %t, 0
%obit = extractvalue {i64, i1} %t, 1
store i64 %val, ptr %res
ret i1 %obit
}

define zeroext i1 @usubo.i32(i32 signext %v1, i32 signext %v2, ptr %res) {
; RV64-LABEL: usubo.i32:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  subw a1, a0, a1
; RV64-NEXT:  sltu a0, a0, a1
; RV64-NEXT:  sw a1, 0(a2)
; RV64-NEXT:  ret
entry:
%t = call {i32, i1} @llvm.usub.with.overflow.i32(i32 %v1, i32 %v2)
%val = extractvalue {i32, i1} %t, 0
%obit = extractvalue {i32, i1} %t, 1
store i32 %val, ptr %res
ret i1 %obit
}

define zeroext i1 @usubo.i32.constant.rhs(i32 signext %v1, ptr %res) {
; RV64-LABEL: usubo.i32.constant.rhs:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  addiw a2, a0, 2
; RV64-NEXT:  sltu a0, a0, a2
; RV64-NEXT:  sw a2, 0(a1)
; RV64-NEXT:  ret
entry:
%t = call {i32, i1} @llvm.usub.with.overflow.i32(i32 %v1, i32 -2)

%val = extractvalue {i32, i1} %t, 0
%obit = extractvalue {i32, i1} %t, 1
store i32 %val, ptr %res
ret i1 %obit
}

define zeroext i1 @usubo.i32.constant.lhs(i32 signext %v1, ptr %res) {
; RV64-LABEL: usubo.i32.constant.lhs:
; RV64:      # %bb.0: # %entry

```

```

; RV64-NEXT:  li a2, -2
; RV64-NEXT:  subw a2, a2, a0
; RV64-NEXT:  addi a0, a2, 1
; RV64-NEXT:  seqz a0, a0
; RV64-NEXT:  sw a2, 0(a1)
; RV64-NEXT:  ret
entry:
%t = call {i32, i1} @llvm.usub.with.overflow.i32(i32 -2, i32 %v1)
%val = extractvalue {i32, i1} %t, 0
%obit = extractvalue {i32, i1} %t, 1
store i32 %val, ptr %res
ret i1 %obit
}

define zeroext i1 @usubo.i64(i64 %v1, i64 %v2, ptr %res) {
; RV64-LABEL: usubo.i64:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  sub a1, a0, a1
; RV64-NEXT:  sltu a0, a0, a1
; RV64-NEXT:  sd a1, 0(a2)
; RV64-NEXT:  ret
entry:
%t = call {i64, i1} @llvm.usub.with.overflow.i64(i64 %v1, i64 %v2)
%val = extractvalue {i64, i1} %t, 0
%obit = extractvalue {i64, i1} %t,
1
store i64 %val, ptr %res
ret i1 %obit
}

define zeroext i1 @smulo.i32(i32 signext %v1, i32 signext %v2, ptr %res) {
; RV64-LABEL: smulo.i32:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  mul a1, a0, a1
; RV64-NEXT:  srai a0, a1, 32
; RV64-NEXT:  sraiw a3, a1, 31
; RV64-NEXT:  xor a0, a0, a3
; RV64-NEXT:  snez a0, a0
; RV64-NEXT:  sw a1, 0(a2)
; RV64-NEXT:  ret
entry:
%t = call {i32, i1} @llvm.smul.with.overflow.i32(i32 %v1, i32 %v2)
%val = extractvalue {i32, i1} %t, 0
%obit = extractvalue {i32, i1} %t, 1
store i32 %val, ptr %res
ret i1 %obit
}

```

```

define zeroext i1 @smulo2.i32(i32 signext %v1, ptr %res) {
; RV64-LABEL: smulo2.i32:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  li a2, 13
; RV64-NEXT:  mul a2, a0, a2
; RV64-NEXT:  srai a0, a2, 32
; RV64-NEXT:  sraiw a3, a2, 31
; RV64-NEXT:  xor a0, a0, a3
; RV64-NEXT:  snez a0, a0
; RV64-NEXT:  sw a2, 0(a1)
; RV64-NEXT:  ret
entry:
%t = call {i32, i1} @llvm.smul.with.overflow.i32(i32 %v1, i32
13)
%val = extractvalue {i32, i1} %t, 0
%obit = extractvalue {i32, i1} %t, 1
store i32 %val, ptr %res
ret i1 %obit
}

```

```

define zeroext i1 @smulo.i64(i64 %v1, i64 %v2, ptr %res) {
; RV64-LABEL: smulo.i64:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  mulh a3, a0, a1
; RV64-NEXT:  mul a1, a0, a1
; RV64-NEXT:  srai a0, a1, 63
; RV64-NEXT:  xor a0, a3, a0
; RV64-NEXT:  snez a0, a0
; RV64-NEXT:  sd a1, 0(a2)
; RV64-NEXT:  ret
entry:
%t = call {i64, i1} @llvm.smul.with.overflow.i64(i64 %v1, i64 %v2)
%val = extractvalue {i64, i1} %t, 0
%obit = extractvalue {i64, i1} %t, 1
store i64 %val, ptr %res
ret i1 %obit
}

```

```

define zeroext i1 @smulo2.i64(i64 %v1, ptr %res) {
; RV64-LABEL: smulo2.i64:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  li a2, 13
; RV64-NEXT:  mulh a3, a0, a2
; RV64-NEXT:  mul a2, a0, a2
; RV64-NEXT:  srai a0, a2, 63
; RV64-NEXT:  xor a0, a3, a0
; RV64-NEXT:  snez a0, a0
; RV64-NEXT:  sd a2, 0(a1)

```

```

; RV64-NEXT:  ret
entry:
%t = call
{i64, i1} @llvm.smul.with.overflow.i64(i64 %v1, i64 13)
%val = extractvalue {i64, i1} %t, 0
%obit = extractvalue {i64, i1} %t, 1
store i64 %val, ptr %res
ret i1 %obit
}

define zeroext i1 @umulo.i32(i32 signext %v1, i32 signext %v2, ptr %res) {
; RV64-LABEL: umulo.i32:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  slli a1, a1, 32
; RV64-NEXT:  slli a0, a0, 32
; RV64-NEXT:  mulhu a1, a0, a1
; RV64-NEXT:  srai a0, a1, 32
; RV64-NEXT:  snez a0, a0
; RV64-NEXT:  sw a1, 0(a2)
; RV64-NEXT:  ret
entry:
%t = call {i32, i1} @llvm.umul.with.overflow.i32(i32 %v1, i32 %v2)
%val = extractvalue {i32, i1} %t, 0
%obit = extractvalue {i32, i1} %t, 1
store i32 %val, ptr %res
ret i1 %obit
}

define zeroext i1 @umulo2.i32(i32 signext %v1, ptr %res) {
; RV64-LABEL: umulo2.i32:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  li a2, 13
; RV64-NEXT:  slli a2, a2, 32
; RV64-NEXT:  slli a0, a0, 32
; RV64-NEXT:  mulhu a2, a0, a2
; RV64-NEXT:  srli a0, a2, 32
; RV64-NEXT:
; RV64-NEXT:  snez a0, a0
; RV64-NEXT:  sw a2, 0(a1)
; RV64-NEXT:  ret
entry:
%t = call {i32, i1} @llvm.umul.with.overflow.i32(i32 %v1, i32 13)
%val = extractvalue {i32, i1} %t, 0
%obit = extractvalue {i32, i1} %t, 1
store i32 %val, ptr %res
ret i1 %obit
}

```

```

; Similar to umulo.i32, but storing the overflow and returning the result.
define signext i32 @umulo3.i32(i32 signext %0, i32 signext %1, ptr %2) {
; RV64-LABEL: umulo3.i32:
; RV64:      # %bb.0:
; RV64-NEXT:  slli a1, a1, 32
; RV64-NEXT:  slli a0, a0, 32
; RV64-NEXT:  mulhu a0, a0, a1
; RV64-NEXT:  srai a1, a0, 32
; RV64-NEXT:  snez a1, a1
; RV64-NEXT:  sext.w a0, a0
; RV64-NEXT:  sw a1, 0(a2)
; RV64-NEXT:  ret
%4 = tail call { i32, i1 } @llvm.umul.with.overflow.i32(i32 %0, i32 %1)
%5 = extractvalue { i32, i1 } %4, 1
%6 = extractvalue { i32, i1 } %4, 0
%7 = zext i1 %5 to i32
store i32 %7, ptr %2, align 4
ret i32 %6
}

```

```

define zeroext i1 @umulo.i64(i64 %v1, i64 %v2, ptr %res) {
; RV64-LABEL: umulo.i64:
;
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  mulhu a3, a0, a1
; RV64-NEXT:  snez a3, a3
; RV64-NEXT:  mul a0, a0, a1
; RV64-NEXT:  sd a0, 0(a2)
; RV64-NEXT:  mv a0, a3
; RV64-NEXT:  ret
entry:
%t = call {i64, i1} @llvm.umul.with.overflow.i64(i64 %v1, i64 %v2)
%val = extractvalue {i64, i1} %t, 0
%obit = extractvalue {i64, i1} %t, 1
store i64 %val, ptr %res
ret i1 %obit
}

```

```

define zeroext i1 @umulo2.i64(i64 %v1, ptr %res) {
; RV64-LABEL: umulo2.i64:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  li a3, 13
; RV64-NEXT:  mulhu a2, a0, a3
; RV64-NEXT:  snez a2, a2
; RV64-NEXT:  mul a0, a0, a3
; RV64-NEXT:  sd a0, 0(a1)
; RV64-NEXT:  mv a0, a2
; RV64-NEXT:  ret

```

```

entry:
    %t = call {i64, i1} @llvm.umul.with.overflow.i64(i64 %v1, i64 13)
    %val = extractvalue {i64, i1} %t, 0
    %obit = extractvalue {i64, i1} %t, 1
    store i64 %val, ptr %res
    ret i1 %obit
}

;
; Check the use of the overflow bit in combination with a select instruction.
;
define i32 @saddo.select.i32(i32
    signext %v1, i32 signext %v2) {
; RV64-LABEL: saddo.select.i32:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  addw a2, a0, a1
; RV64-NEXT:  slt a2, a2, a0
; RV64-NEXT:  slti a3, a1, 0
; RV64-NEXT:  bne a3, a2, .LBB28_2
; RV64-NEXT:  # %bb.1: # %entry
; RV64-NEXT:  mv a0, a1
; RV64-NEXT:  .LBB28_2: # %entry
; RV64-NEXT:  ret
entry:
    %t = call {i32, i1} @llvm.sadd.with.overflow.i32(i32 %v1, i32 %v2)
    %obit = extractvalue {i32, i1} %t, 1
    %ret = select i1 %obit, i32 %v1, i32 %v2
    ret i32 %ret
}

define i1 @saddo.not.i32(i32 signext %v1, i32 signext %v2) {
; RV64-LABEL: saddo.not.i32:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  addw a2, a0, a1
; RV64-NEXT:  slt a0, a2, a0
; RV64-NEXT:  slti a1, a1, 0
; RV64-NEXT:  xor a0, a1, a0
; RV64-NEXT:  xori a0, a0, 1
; RV64-NEXT:  ret
entry:
    %t = call {i32, i1} @llvm.sadd.with.overflow.i32(i32 %v1, i32 %v2)
    %obit = extractvalue {i32, i1} %t, 1
    %ret = xor i1 %obit, true
    ret i1 %ret
}

define i64 @saddo.select.i64(i64

```



```

    %v1, i64 %v2) {
; RV64-LABEL: saddo.select.i64:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  add a2, a0, a1
; RV64-NEXT:  slt a2, a2, a0
; RV64-NEXT:  slti a3, a1, 0
; RV64-NEXT:  bne a3, a2, .LBB30_2
; RV64-NEXT:  # %bb.1: # %entry
; RV64-NEXT:  mv a0, a1
; RV64-NEXT:  .LBB30_2: # %entry
; RV64-NEXT:  ret
entry:
    %t = call {i64, i1} @llvm.sadd.with.overflow.i64(i64 %v1, i64 %v2)
    %obit = extractvalue {i64, i1} %t, 1
    %ret = select i1 %obit, i64 %v1, i64 %v2
    ret i64 %ret
}

```

```

define i1 @saddo.not.i64(i64 %v1, i64 %v2) {
; RV64-LABEL: saddo.not.i64:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  add a2, a0, a1
; RV64-NEXT:  slt a0, a2, a0
; RV64-NEXT:  slti a1, a1, 0
; RV64-NEXT:  xor a0, a1, a0
; RV64-NEXT:  xori a0, a0, 1
; RV64-NEXT:  ret
entry:
    %t = call {i64, i1} @llvm.sadd.with.overflow.i64(i64 %v1, i64 %v2)
    %obit = extractvalue {i64, i1} %t, 1
    %ret = xor i1 %obit, true
    ret i1 %ret
}

```

```

define i32 @uaddo.select.i32(i32 signext %v1,
    i32 signext %v2) {
; RV64-LABEL: uaddo.select.i32:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  addw a2, a0, a1
; RV64-NEXT:  bltu a2, a0, .LBB32_2
; RV64-NEXT:  # %bb.1: # %entry
; RV64-NEXT:  mv a0, a1
; RV64-NEXT:  .LBB32_2: # %entry
; RV64-NEXT:  ret
entry:
    %t = call {i32, i1} @llvm.uadd.with.overflow.i32(i32 %v1, i32 %v2)
    %obit = extractvalue {i32, i1} %t, 1
    %ret = select i1 %obit, i32 %v1, i32 %v2

```

```

ret i32 %ret
}

define i1 @uaddo.not.i32(i32 signext %v1, i32 signext %v2) {
; RV64-LABEL: uaddo.not.i32:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  addw a1, a0, a1
; RV64-NEXT:  sltu a0, a1, a0
; RV64-NEXT:  xori a0, a0, 1
; RV64-NEXT:  ret
entry:
%t = call {i32, i1} @llvm.uadd.with.overflow.i32(i32 %v1, i32 %v2)
%obit = extractvalue {i32, i1} %t, 1
%ret = xor i1 %obit, true
ret i1 %ret
}

define i64 @uaddo.select.i64(i64 %v1, i64 %v2) {
; RV64-LABEL: uaddo.select.i64:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  add a2, a0, a1
; RV64-NEXT:
; RV64-NEXT:  bltu a2, a0, .LBB34_2
; RV64-NEXT:  # %bb.1: # %entry
; RV64-NEXT:  mv a0, a1
; RV64-NEXT:  .LBB34_2: # %entry
; RV64-NEXT:  ret
entry:
%t = call {i64, i1} @llvm.uadd.with.overflow.i64(i64 %v1, i64 %v2)
%obit = extractvalue {i64, i1} %t, 1
%ret = select i1 %obit, i64 %v1, i64 %v2
ret i64 %ret
}

define i1 @uaddo.not.i64(i64 %v1, i64 %v2) {
; RV64-LABEL: uaddo.not.i64:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  add a1, a0, a1
; RV64-NEXT:  sltu a0, a1, a0
; RV64-NEXT:  xori a0, a0, 1
; RV64-NEXT:  ret
entry:
%t = call {i64, i1} @llvm.uadd.with.overflow.i64(i64 %v1, i64 %v2)
%obit = extractvalue {i64, i1} %t, 1
%ret = xor i1 %obit, true
ret i1 %ret
}

```

```

define i32 @ssubo.select.i32(i32 signext %v1, i32 signext %v2) {
; RV64-LABEL: ssubo.select.i32:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  sgtz a2, a1
; RV64-NEXT:  subw a3, a0, a1
; RV64-NEXT:  slt a3, a3, a0
; RV64-NEXT:  bne a2, a3, .LBB36_2
; RV64-NEXT:  # %bb.1: # %entry
; RV64-NEXT:  mv a0,
a1
; RV64-NEXT:  .LBB36_2: # %entry
; RV64-NEXT:  ret
entry:
%t = call {i32, i1} @llvm.ssub.with.overflow.i32(i32 %v1, i32 %v2)
%obit = extractvalue {i32, i1} %t, 1
%ret = select i1 %obit, i32 %v1, i32 %v2
ret i32 %ret
}

```

```

define i1 @ssubo.not.i32(i32 signext %v1, i32 signext %v2) {
; RV64-LABEL: ssubo.not.i32:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  sgtz a2, a1
; RV64-NEXT:  subw a1, a0, a1
; RV64-NEXT:  slt a0, a1, a0
; RV64-NEXT:  xor a0, a2, a0
; RV64-NEXT:  xori a0, a0, 1
; RV64-NEXT:  ret
entry:
%t = call {i32, i1} @llvm.ssub.with.overflow.i32(i32 %v1, i32 %v2)
%obit = extractvalue {i32, i1} %t, 1
%ret = xor i1 %obit, true
ret i1 %ret
}

```

```

define i64 @ssubo.select.i64(i64 %v1, i64 %v2) {
; RV64-LABEL: ssubo.select.i64:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  sgtz a2, a1
; RV64-NEXT:  sub a3, a0, a1
; RV64-NEXT:  slt a3, a3, a0
; RV64-NEXT:  bne a2, a3, .LBB38_2
; RV64-NEXT:  # %bb.1: # %entry
; RV64-NEXT:  mv a0, a1
; RV64-NEXT:
.LBB38_2: # %entry
; RV64-NEXT:  ret
entry:

```

```

%t = call {i64, i1} @llvm.ssub.with.overflow.i64(i64 %v1, i64 %v2)
%obit = extractvalue {i64, i1} %t, 1
%ret = select i1 %obit, i64 %v1, i64 %v2
ret i64 %ret
}

```

```

define i1 @ssub.not.i64(i64 %v1, i64 %v2) {
; RV64-LABEL: ssub.not.i64:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  sgtz a2, a1
; RV64-NEXT:  sub a1, a0, a1
; RV64-NEXT:  slt a0, a1, a0
; RV64-NEXT:  xor a0, a2, a0
; RV64-NEXT:  xori a0, a0, 1
; RV64-NEXT:  ret
entry:
%t = call {i64, i1} @llvm.ssub.with.overflow.i64(i64 %v1, i64 %v2)
%obit = extractvalue {i64, i1} %t, 1
%ret = xor i1 %obit, true
ret i1 %ret
}

```

```

define i32 @usubo.select.i32(i32 signext %v1, i32 signext %v2) {
; RV64-LABEL: usubo.select.i32:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  subw a2, a0, a1
; RV64-NEXT:  bltu a0, a2, .LBB40_2
; RV64-NEXT:  # %bb.1: # %entry
; RV64-NEXT:  mv a0, a1
; RV64-NEXT:  .LBB40_2: # %entry
; RV64-NEXT:  ret
entry:
%t = call {i32, i1} @llvm.usub.with.overflow.i32(i32
%v1, i32 %v2)
%obit = extractvalue {i32, i1} %t, 1
%ret = select i1 %obit, i32 %v1, i32 %v2
ret i32 %ret
}

```

```

define i1 @usubo.not.i32(i32 signext %v1, i32 signext %v2) {
; RV64-LABEL: usubo.not.i32:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  subw a1, a0, a1
; RV64-NEXT:  sltu a0, a0, a1
; RV64-NEXT:  xori a0, a0, 1
; RV64-NEXT:  ret
entry:
%t = call {i32, i1} @llvm.usub.with.overflow.i32(i32 %v1, i32 %v2)

```

```

%obit = extractvalue {i32, i1} %t, 1
%ret = xor i1 %obit, true
ret i1 %ret
}

define i64 @usubo.select.i64(i64 %v1, i64 %v2) {
; RV64-LABEL: usubo.select.i64:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  sub a2, a0, a1
; RV64-NEXT:  bltu a0, a2, .LBB42_2
; RV64-NEXT:  # %bb.1: # %entry
; RV64-NEXT:  mv a0, a1
; RV64-NEXT:  .LBB42_2: # %entry
; RV64-NEXT:  ret
entry:
%t = call {i64, i1} @llvm.usub.with.overflow.i64(i64 %v1, i64 %v2)
%obit = extractvalue {i64, i1} %t, 1
%ret = select i1 %obit, i64 %v1, i64 %v2
ret i64 %ret
}

define
i1 @usubo.not.i64(i64 %v1, i64 %v2) {
; RV64-LABEL: usubo.not.i64:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  sub a1, a0, a1
; RV64-NEXT:  sltu a0, a0, a1
; RV64-NEXT:  xori a0, a0, 1
; RV64-NEXT:  ret
entry:
%t = call {i64, i1} @llvm.usub.with.overflow.i64(i64 %v1, i64 %v2)
%obit = extractvalue {i64, i1} %t, 1
%ret = xor i1 %obit, true
ret i1 %ret
}

define i32 @smulo.select.i32(i32 signext %v1, i32 signext %v2) {
; RV64-LABEL: smulo.select.i32:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  mul a2, a0, a1
; RV64-NEXT:  srai a3, a2, 32
; RV64-NEXT:  sraiw a2, a2, 31
; RV64-NEXT:  bne a3, a2, .LBB44_2
; RV64-NEXT:  # %bb.1: # %entry
; RV64-NEXT:  mv a0, a1
; RV64-NEXT:  .LBB44_2: # %entry
; RV64-NEXT:  ret
entry:

```

```

%t = call {i32, i1} @llvm.smul.with.overflow.i32(i32 %v1, i32 %v2)
%obit = extractvalue {i32, i1} %t, 1
%ret = select i1 %obit, i32 %v1, i32 %v2
ret i32 %ret
}

```

```

define i1 @smulo.not.i32(i32 signext %v1, i32 signext %v2) {
; RV64-LABEL:
smulo.not.i32:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  mul a0, a0, a1
; RV64-NEXT:  srai a1, a0, 32
; RV64-NEXT:  sraiw a0, a0, 31
; RV64-NEXT:  xor a0, a1, a0
; RV64-NEXT:  snez a0, a0
; RV64-NEXT:  xori a0, a0, 1
; RV64-NEXT:  ret
entry:
%t = call {i32, i1} @llvm.smul.with.overflow.i32(i32 %v1, i32 %v2)
%obit = extractvalue {i32, i1} %t, 1
%ret = xor i1 %obit, true
ret i1 %ret
}

```

```

define i64 @smulo.select.i64(i64 %v1, i64 %v2) {
; RV64-LABEL: smulo.select.i64:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  mulh a2, a0, a1
; RV64-NEXT:  mul a3, a0, a1
; RV64-NEXT:  srai a3, a3, 63
; RV64-NEXT:  bne a2, a3, .LBB46_2
; RV64-NEXT:  # %bb.1: # %entry
; RV64-NEXT:  mv a0, a1
; RV64-NEXT:  .LBB46_2: # %entry
; RV64-NEXT:  ret
entry:
%t = call {i64, i1} @llvm.smul.with.overflow.i64(i64 %v1, i64 %v2)
%obit = extractvalue {i64, i1} %t, 1
%ret = select i1 %obit, i64 %v1, i64 %v2
ret i64 %ret
}

```

```

define i1 @smulo.not.i64(i64 %v1, i64 %v2) {
; RV64-LABEL:
smulo.not.i64:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  mulh a2, a0, a1
; RV64-NEXT:  mul a0, a0, a1

```

```

; RV64-NEXT:  srai a0, a0, 63
; RV64-NEXT:  xor a0, a2, a0
; RV64-NEXT:  snez a0, a0
; RV64-NEXT:  xori a0, a0, 1
; RV64-NEXT:  ret

entry:
%t = call {i64, i1} @llvm.smul.with.overflow.i64(i64 %v1, i64 %v2)
%obit = extractvalue {i64, i1} %t, 1
%ret = xor i1 %obit, true
ret i1 %ret
}

```

```

define i32 @umulo.select.i32(i32 signext %v1, i32 signext %v2) {
; RV64-LABEL: umulo.select.i32:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  slli a2, a1, 32
; RV64-NEXT:  slli a3, a0, 32
; RV64-NEXT:  mulhu a2, a3, a2
; RV64-NEXT:  srai a2, a2, 32
; RV64-NEXT:  bnez a2, .LBB48_2
; RV64-NEXT: # %bb.1: # %entry
; RV64-NEXT:  mv a0, a1
; RV64-NEXT: .LBB48_2: # %entry
; RV64-NEXT:  ret

entry:
%t = call {i32, i1} @llvm.umul.with.overflow.i32(i32 %v1, i32 %v2)
%obit = extractvalue {i32, i1} %t, 1
%ret = select i1 %obit, i32 %v1, i32 %v2
ret i32 %ret
}

```

```

define
i1 @umulo.not.i32(i32 signext %v1, i32 signext %v2) {
; RV64-LABEL: umulo.not.i32:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  slli a1, a1, 32
; RV64-NEXT:  slli a0, a0, 32
; RV64-NEXT:  mulhu a0, a0, a1
; RV64-NEXT:  srai a0, a0, 32
; RV64-NEXT:  snez a0, a0
; RV64-NEXT:  xori a0, a0, 1
; RV64-NEXT:  ret

entry:
%t = call {i32, i1} @llvm.umul.with.overflow.i32(i32 %v1, i32 %v2)
%obit = extractvalue {i32, i1} %t, 1
%ret = xor i1 %obit, true
ret i1 %ret
}

```

```

define i64 @umulo.select.i64(i64 %v1, i64 %v2) {
; RV64-LABEL: umulo.select.i64:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  mulhu a2, a0, a1
; RV64-NEXT:  bnez a2, .LBB50_2
; RV64-NEXT:  # %bb.1: # %entry
; RV64-NEXT:  mv a0, a1
; RV64-NEXT:  .LBB50_2: # %entry
; RV64-NEXT:  ret
entry:
%t = call {i64, i1} @llvm.umul.with.overflow.i64(i64 %v1, i64 %v2)
%obit = extractvalue {i64, i1} %t, 1
%ret = select i1 %obit, i64 %v1, i64 %v2
ret i64 %ret
}

```

```

define i1 @umulo.not.i64(i64 %v1, i64 %v2)
{
; RV64-LABEL: umulo.not.i64:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  mulhu a0, a0, a1
; RV64-NEXT:  snez a0, a0
; RV64-NEXT:  xori a0, a0, 1
; RV64-NEXT:  ret
entry:
%t = call {i64, i1} @llvm.umul.with.overflow.i64(i64 %v1, i64 %v2)
%obit = extractvalue {i64, i1} %t, 1
%ret = xor i1 %obit, true
ret i1 %ret
}

```

```

;
; Check the use of the overflow bit in combination with a branch instruction.
;

```

```

define zeroext i1 @saddo.br.i32(i32 signext %v1, i32 signext %v2) {
; RV64-LABEL: saddo.br.i32:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  addw a2, a0, a1
; RV64-NEXT:  slt a0, a2, a0
; RV64-NEXT:  slti a1, a1, 0
; RV64-NEXT:  beq a1, a0, .LBB52_2
; RV64-NEXT:  # %bb.1: # %overflow
; RV64-NEXT:  li a0, 0
; RV64-NEXT:  ret
; RV64-NEXT:  .LBB52_2: # %continue
; RV64-NEXT:  li a0, 1

```



```

; RV64-NEXT:  ret
entry:
%t = call {i32, i1} @llvm.sadd.with.overflow.i32(i32 %v1, i32 %v2)
%val = extractvalue {i32, i1} %t, 0
%obit = extractvalue {i32, i1} %t, 1
br i1
%obit, label %overflow, label %continue

overflow:
ret i1 false

continue:
ret i1 true
}

```

```

define zeroext i1 @saddo.br.i64(i64 %v1, i64 %v2) {
; RV64-LABEL: saddo.br.i64:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  add a2, a0, a1
; RV64-NEXT:  slt a0, a2, a0
; RV64-NEXT:  slti a1, a1, 0
; RV64-NEXT:  beq a1, a0, .LBB53_2
; RV64-NEXT: # %bb.1: # %overflow
; RV64-NEXT:  li a0, 0
; RV64-NEXT:  ret
; RV64-NEXT: .LBB53_2: # %continue
; RV64-NEXT:  li a0, 1
; RV64-NEXT:  ret
entry:
%t = call {i64, i1} @llvm.sadd.with.overflow.i64(i64 %v1, i64 %v2)
%val = extractvalue {i64, i1} %t, 0
%obit = extractvalue {i64, i1} %t, 1
br i1 %obit, label %overflow, label %continue

overflow:
ret i1 false

continue:
ret i1 true
}

```

```

define zeroext i1 @uaddo.br.i32(i32 %v1, i32 %v2) {
; RV64-LABEL: uaddo.br.i32:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  addw a1, a0, a1
; RV64-NEXT:  sext.w a0, a0
; RV64-NEXT:  bgeu a1, a0, .LBB54_2
; RV64-NEXT: # %bb.1: # %overflow

```

```

;
RV64-NEXT:  li a0, 0
; RV64-NEXT:  ret
; RV64-NEXT: .LBB54_2: # %continue
; RV64-NEXT:  li a0, 1
; RV64-NEXT:  ret
entry:
%t = call {i32, i1} @llvm.uadd.with.overflow.i32(i32 %v1, i32 %v2)
%val = extractvalue {i32, i1} %t, 0
%obit = extractvalue {i32, i1} %t, 1
br i1 %obit, label %overflow, label %continue

overflow:
ret i1 false

continue:
ret i1 true
}

```

```

define zeroext i1 @uaddo.br.i64(i64 %v1, i64 %v2) {
; RV64-LABEL: uaddo.br.i64:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  add a1, a0, a1
; RV64-NEXT:  bgeu a1, a0, .LBB55_2
; RV64-NEXT: # %bb.1: # %overflow
; RV64-NEXT:  li a0, 0
; RV64-NEXT:  ret
; RV64-NEXT: .LBB55_2: # %continue
; RV64-NEXT:  li a0, 1
; RV64-NEXT:  ret
entry:
%t = call {i64, i1} @llvm.uadd.with.overflow.i64(i64 %v1, i64 %v2)
%val = extractvalue {i64, i1} %t, 0
%obit = extractvalue {i64, i1} %t, 1
br i1 %obit, label %overflow, label %continue

overflow:
ret i1 false

continue:
ret i1 true
}

```

```

define zeroext i1 @ssubo.br.i32(i32
signext %v1, i32 signext %v2) {
; RV64-LABEL: ssubo.br.i32:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  sgtz a2, a1

```

```

; RV64-NEXT:   subw a1, a0, a1
; RV64-NEXT:   slt a0, a1, a0
; RV64-NEXT:   beq a2, a0, .LBB56_2
; RV64-NEXT:   # %bb.1: # %overflow
; RV64-NEXT:   li a0, 0
; RV64-NEXT:   ret
; RV64-NEXT:   .LBB56_2: # %continue
; RV64-NEXT:   li a0, 1
; RV64-NEXT:   ret
entry:
%t = call {i32, i1} @llvm.ssub.with.overflow.i32(i32 %v1, i32 %v2)
%val = extractvalue {i32, i1} %t, 0
%obit = extractvalue {i32, i1} %t, 1
br i1 %obit, label %overflow, label %continue

```

```

overflow:
ret i1 false

```

```

continue:
ret i1 true
}

```

```

define zeroext i1 @ssubo.br.i64(i64 %v1, i64 %v2) {
; RV64-LABEL: ssubo.br.i64:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:   sgtz a2, a1
; RV64-NEXT:   sub a1, a0, a1
; RV64-NEXT:   slt a0, a1, a0
; RV64-NEXT:   beq a2, a0, .LBB57_2
; RV64-NEXT:   # %bb.1: # %overflow
; RV64-NEXT:   li a0, 0
; RV64-NEXT:   ret
; RV64-NEXT:   .LBB57_2: # %continue
;
RV64-NEXT:   li a0, 1
; RV64-NEXT:   ret
entry:
%t = call {i64, i1} @llvm.ssub.with.overflow.i64(i64 %v1, i64 %v2)
%val = extractvalue {i64, i1} %t, 0
%obit = extractvalue {i64, i1} %t, 1
br i1 %obit, label %overflow, label %continue

```

```

overflow:
ret i1 false

```

```

continue:
ret i1 true
}

```

```

define zeroext i1 @usubo.br.i32(i32 signext %v1, i32 signext %v2) {
; RV64-LABEL: usubo.br.i32:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  subw a1, a0, a1
; RV64-NEXT:  bgeu a0, a1, .LBB58_2
; RV64-NEXT:  # %bb.1: # %overflow
; RV64-NEXT:  li a0, 0
; RV64-NEXT:  ret
; RV64-NEXT: .LBB58_2: # %continue
; RV64-NEXT:  li a0, 1
; RV64-NEXT:  ret
entry:
%t = call {i32, i1} @llvm.usub.with.overflow.i32(i32 %v1, i32 %v2)
%val = extractvalue {i32, i1} %t, 0
%obit = extractvalue {i32, i1} %t, 1
br i1 %obit, label %overflow, label %continue

overflow:
ret i1 false

continue:
ret i1 true
}

```

```

define zeroext i1 @usubo.br.i64(i64 %v1, i64 %v2) {
; RV64-LABEL: usubo.br.i64:
;
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  sub a1, a0, a1
; RV64-NEXT:  bgeu a0, a1, .LBB59_2
; RV64-NEXT:  # %bb.1: # %overflow
; RV64-NEXT:  li a0, 0
; RV64-NEXT:  ret
; RV64-NEXT: .LBB59_2: # %continue
; RV64-NEXT:  li a0, 1
; RV64-NEXT:  ret
entry:
%t = call {i64, i1} @llvm.usub.with.overflow.i64(i64 %v1, i64 %v2)
%val = extractvalue {i64, i1} %t, 0
%obit = extractvalue {i64, i1} %t, 1
br i1 %obit, label %overflow, label %continue

overflow:
ret i1 false

continue:
ret i1 true

```

```

}

define zeroext i1 @smulo.br.i32(i32 signext %v1, i32 signext %v2) {
; RV64-LABEL: smulo.br.i32:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  mul a0, a0, a1
; RV64-NEXT:  srai a1, a0, 32
; RV64-NEXT:  sraiw a0, a0, 31
; RV64-NEXT:  beq a1, a0, .LBB60_2
; RV64-NEXT:  # %bb.1: # %overflow
; RV64-NEXT:  li a0, 0
; RV64-NEXT:  ret
; RV64-NEXT: .LBB60_2: # %continue
; RV64-NEXT:  li a0, 1
; RV64-NEXT:  ret
entry:
%t = call {i32, i1} @llvm.smul.with.overflow.i32(i32
%v1, i32 %v2)
%val = extractvalue {i32, i1} %t, 0
%obit = extractvalue {i32, i1} %t, 1
br i1 %obit, label %overflow, label %continue

overflow:
ret i1 false

continue:
ret i1 true
}

```

```

define zeroext i1 @smulo.br.i64(i64 %v1, i64 %v2) {
; RV64-LABEL: smulo.br.i64:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  mulh a2, a0, a1
; RV64-NEXT:  mul a0, a0, a1
; RV64-NEXT:  srai a0, a0, 63
; RV64-NEXT:  beq a2, a0, .LBB61_2
; RV64-NEXT:  # %bb.1: # %overflow
; RV64-NEXT:  li a0, 0
; RV64-NEXT:  ret
; RV64-NEXT: .LBB61_2: # %continue
; RV64-NEXT:  li a0, 1
; RV64-NEXT:  ret
entry:
%t = call {i64, i1} @llvm.smul.with.overflow.i64(i64 %v1, i64 %v2)
%val = extractvalue {i64, i1} %t, 0
%obit = extractvalue {i64, i1} %t, 1
br i1 %obit, label %overflow, label %continue

```

```

overflow:
ret i1 false

continue:
ret i1 true
}

define zeroext i1 @smulo2.br.i64(i64 %v1) {
; RV64-LABEL: smulo2.br.i64:
; RV64:      # %bb.0: # %entry
; RV64-NEXT: li a1, -13
; RV64-NEXT:
    mulh a2, a0, a1
; RV64-NEXT: mul a0, a0, a1
; RV64-NEXT: srai a0, a0, 63
; RV64-NEXT: beq a2, a0, .LBB62_2
; RV64-NEXT: # %bb.1: # %overflow
; RV64-NEXT: li a0, 0
; RV64-NEXT: ret
; RV64-NEXT: .LBB62_2: # %continue
; RV64-NEXT: li a0, 1
; RV64-NEXT: ret
entry:
    %t = call {i64, i1} @llvm.smul.with.overflow.i64(i64 %v1, i64 -13)
    %val = extractvalue {i64, i1} %t, 0
    %obit = extractvalue {i64, i1} %t, 1
    br i1 %obit, label %overflow, label %continue

overflow:
ret i1 false

continue:
ret i1 true
}

define zeroext i1 @umulo.br.i32(i32 signext %v1, i32 signext %v2) {
; RV64-LABEL: umulo.br.i32:
; RV64:      # %bb.0: # %entry
; RV64-NEXT: slli a1, a1, 32
; RV64-NEXT: slli a0, a0, 32
; RV64-NEXT: mulhu a0, a0, a1
; RV64-NEXT: srai a0, a0, 32
; RV64-NEXT: beqz a0, .LBB63_2
; RV64-NEXT: # %bb.1: # %overflow
; RV64-NEXT: li a0, 0
; RV64-NEXT: ret
; RV64-NEXT: .LBB63_2: # %continue
; RV64-NEXT: li a0, 1

```

```

; RV64-NEXT:  ret
entry:
%t = call
{i32, i1} @llvm.umul.with.overflow.i32(i32 %v1, i32 %v2)
%val = extractvalue {i32, i1} %t, 0
%obit = extractvalue {i32, i1} %t, 1
br i1 %obit, label %overflow, label %continue

overflow:
ret i1 false

continue:
ret i1 true
}

define zeroext i1 @umulo.br.i64(i64 %v1, i64 %v2) {
; RV64-LABEL: umulo.br.i64:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  mulhu a0, a0, a1
; RV64-NEXT:  beqz a0, .LBB64_2
; RV64-NEXT: # %bb.1: # %overflow
; RV64-NEXT:  li a0, 0
; RV64-NEXT:  ret
; RV64-NEXT: .LBB64_2: # %continue
; RV64-NEXT:  li a0, 1
; RV64-NEXT:  ret
entry:
%t = call {i64, i1} @llvm.umul.with.overflow.i64(i64 %v1, i64 %v2)
%val = extractvalue {i64, i1} %t, 0
%obit = extractvalue {i64, i1} %t, 1
br i1 %obit, label %overflow, label %continue

overflow:
ret i1 false

continue:
ret i1 true
}

define zeroext i1 @umulo2.br.i64(i64 %v1) {
; RV64-LABEL: umulo2.br.i64:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  add a1, a0, a0
; RV64-NEXT:  bgeu a1, a0,
.LBB65_2
; RV64-NEXT: # %bb.1: # %overflow
; RV64-NEXT:  li a0, 0
; RV64-NEXT:  ret

```

```

; RV64-NEXT: .LBB65_2: # %continue
; RV64-NEXT:  li a0, 1
; RV64-NEXT:  ret
entry:
%t = call {i64, i1} @llvm.umul.with.overflow.i64(i64 %v1, i64 2)
%val = extractvalue {i64, i1} %t, 0
%obit = extractvalue {i64, i1} %t, 1
br i1 %obit, label %overflow, label %continue

overflow:
ret i1 false

continue:
ret i1 true
}

define zeroext i1 @uaddo.i64.constant(i64 %v1, ptr %res) {
; RV64-LABEL: uaddo.i64.constant:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  addi a2, a0, 2
; RV64-NEXT:  sltu a0, a2, a0
; RV64-NEXT:  sd a2, 0(a1)
; RV64-NEXT:  ret
entry:
%t = call {i64, i1} @llvm.uadd.with.overflow.i64(i64 %v1, i64 2)
%val = extractvalue {i64, i1} %t, 0
%obit = extractvalue {i64, i1} %t, 1
store i64 %val, ptr %res
ret i1 %obit
}

define zeroext i1 @uaddo.i64.constant_2048(i64 %v1, ptr %res) {
; RV64-LABEL: uaddo.i64.constant_2048:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:
    addi a2, a0, 2047
; RV64-NEXT:  addi a2, a2, 1
; RV64-NEXT:  sltu a0, a2, a0
; RV64-NEXT:  sd a2, 0(a1)
; RV64-NEXT:  ret
entry:
%t = call {i64, i1} @llvm.uadd.with.overflow.i64(i64 %v1, i64 2048)
%val = extractvalue {i64, i1} %t, 0
%obit = extractvalue {i64, i1} %t, 1
store i64 %val, ptr %res
ret i1 %obit
}

```



```

define zeroext i1 @uaddo.i64.constant_2049(i64 %v1, ptr %res) {
; RV64-LABEL: uaddo.i64.constant_2049:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  addi a2, a0, 2047
; RV64-NEXT:  addi a2, a2, 2
; RV64-NEXT:  sltu a0, a2, a0
; RV64-NEXT:  sd a2, 0(a1)
; RV64-NEXT:  ret
entry:
%t = call {i64, i1} @llvm.uadd.with.overflow.i64(i64 %v1, i64 2049)
%val = extractvalue {i64, i1} %t, 0
%obit = extractvalue {i64, i1} %t, 1
store i64 %val, ptr %res
ret i1 %obit
}

```

```

define i64 @uaddo.i64.constant_setcc_on_overflow_flag(ptr %p) {
; RV64-LABEL: uaddo.i64.constant_setcc_on_overflow_flag:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  ld a1, 0(a0)
;
; RV64-NEXT:  addi a0, a1, 2
; RV64-NEXT:  bltu a0, a1, .LBB69_2
; RV64-NEXT:  # %bb.1: # %IfOverflow
; RV64-NEXT:  li a0, 0
; RV64-NEXT:  .LBB69_2: # %IfNoOverflow
; RV64-NEXT:  ret
entry:
%v1 = load i64, ptr %p
%t = call {i64, i1} @llvm.uadd.with.overflow.i64(i64 %v1, i64 2)
%val = extractvalue {i64, i1} %t, 0
%obit = extractvalue {i64, i1} %t, 1
br i1 %obit, label %IfNoOverflow, label %IfOverflow
IfOverflow:
ret i64 0
IfNoOverflow:
ret i64 %val
}

```

```

declare {i32, i1} @llvm.sadd.with.overflow.i32(i32, i32) nounwind readnone
declare {i64, i1} @llvm.sadd.with.overflow.i64(i64, i64) nounwind readnone
declare {i32, i1} @llvm.uadd.with.overflow.i32(i32, i32) nounwind readnone
declare {i64, i1} @llvm.uadd.with.overflow.i64(i64, i64) nounwind readnone
declare {i32, i1} @llvm.ssub.with.overflow.i32(i32, i32) nounwind readnone
declare {i64, i1} @llvm.ssub.with.overflow.i64(i64, i64) nounwind readnone
declare {i32, i1} @llvm.usub.with.overflow.i32(i32, i32) nounwind readnone
declare

```

```

{i64, i1} @llvm.usub.with.overflow.i64(i64, i64) nounwind readnone
declare {i32, i1} @llvm.smul.with.overflow.i32(i32, i32) nounwind readnone
declare {i64, i1} @llvm.smul.with.overflow.i64(i64, i64) nounwind readnone
declare {i32, i1} @llvm.umul.with.overflow.i32(i32, i32) nounwind readnone
declare {i64, i1} @llvm.umul.with.overflow.i64(i64, i64) nounwind readnone
; NOTE: Assertions have been autogenerated by utils/update_llc_test_checks.py
; RUN: llc -mtriple=riscv64 -mattr=+zbc -verify-machineinstrs < %s \
; RUN: -riscv-experimental-rv64-legal-i32 | FileCheck %s -check-prefix=RV64ZBC

```

```

declare i64 @llvm.riscv.clmulr.i64(i64 %a, i64 %b)

```

```

define i64 @clmul64r(i64 %a, i64 %b) nounwind {
; RV64ZBC-LABEL: clmul64r:
; RV64ZBC:      # %bb.0:
; RV64ZBC-NEXT:  clmulr a0, a0, a1
; RV64ZBC-NEXT:  ret
    %tmp = call i64 @llvm.riscv.clmulr.i64(i64 %a, i64 %b)
    ret i64 %tmp
}

```

```

declare i32 @llvm.riscv.clmulr.i32(i32 %a, i32 %b)

```

```

define signext i32 @clmul32r(i32 signext %a, i32 signext %b) nounwind {
; RV64ZBC-LABEL: clmul32r:
; RV64ZBC:      # %bb.0:
; RV64ZBC-NEXT:  slli a1, a1, 32
; RV64ZBC-NEXT:  slli a0, a0, 32
; RV64ZBC-NEXT:  clmulr a0, a0, a1
; RV64ZBC-NEXT:  srai a0, a0, 32
; RV64ZBC-NEXT:  ret
    %tmp = call i32 @llvm.riscv.clmulr.i32(i32 %a, i32 %b)
    ret i32 %tmp
}

```

; FIXME: We could avoid the slli instructions by using clmul+srli+sext.w since

; the inputs are zero extended.

```

define signext i32 @clmul32r_zext(i32 zeroext %a, i32 zeroext %b) nounwind {
; RV64ZBC-LABEL: clmul32r_zext:
; RV64ZBC:      # %bb.0:
; RV64ZBC-NEXT:  slli a1, a1, 32
; RV64ZBC-NEXT:  slli a0, a0, 32
; RV64ZBC-NEXT:  clmulr a0, a0, a1
; RV64ZBC-NEXT:  srai a0, a0, 32
; RV64ZBC-NEXT:  ret
    %tmp = call i32 @llvm.riscv.clmulr.i32(i32 %a, i32 %b)
    ret i32 %tmp
}

```

```
; NOTE: Assertions have been autogenerated by utils/update_llc_test_checks.py
; RUN: llc -mtriple=riscv64 -verify-machineinstrs < %s \
; RUN: -riscv-experimental-rv64-legal-i32 | FileCheck -check-prefix=RV64I %s
; RUN: llc -mtriple=riscv64 -mattr=+m -verify-machineinstrs < %s \
; RUN: -riscv-experimental-rv64-legal-i32 | FileCheck -check-prefix=RV64IM %s
```

```
define i32 @udiv(i32 %a, i32 %b) nounwind {
; RV64I-LABEL: udiv:
; RV64I:      # %bb.0:
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  srli a0, a0, 32
; RV64I-NEXT:  slli a1, a1, 32
; RV64I-NEXT:  srli a1, a1, 32
; RV64I-NEXT:  call __udivdi3
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
;
; RV64IM-LABEL: udiv:
; RV64IM:      # %bb.0:
; RV64IM-NEXT:  divuw a0, a0, a1
; RV64IM-NEXT:  ret
    %1 = udiv i32 %a, %b
    ret i32 %1
}
```

```
define i32 @udiv_constant(i32 %a) nounwind {
; RV64I-LABEL:
    udiv_constant:
; RV64I:      # %bb.0:
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  srli a0, a0, 32
; RV64I-NEXT:  li a1, 5
; RV64I-NEXT:  call __udivdi3
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
;
; RV64IM-LABEL: udiv_constant:
; RV64IM:      # %bb.0:
; RV64IM-NEXT:  slli a0, a0, 32
; RV64IM-NEXT:  lui a1, 838861
; RV64IM-NEXT:  addi a1, a1, -819
; RV64IM-NEXT:  slli a1, a1, 32
```

```
; RV64IM-NEXT: mulhu a0, a0, a1
; RV64IM-NEXT: srli a0, a0, 34
; RV64IM-NEXT: ret
%1 = udiv i32 %a, 5
ret i32 %1
}
```

```
define i32 @udiv_pow2(i32 %a) nounwind {
; RV64I-LABEL: udiv_pow2:
; RV64I:    # %bb.0:
; RV64I-NEXT: srliw a0, a0, 3
; RV64I-NEXT: ret
;
; RV64IM-LABEL: udiv_pow2:
; RV64IM:    # %bb.0:
; RV64IM-NEXT: srliw a0, a0, 3
; RV64IM-NEXT: ret
%1 = udiv i32 %a, 8
ret i32 %1
}
```

```
define i32 @udiv_constant_lhs(i32
%a) nounwind {
; RV64I-LABEL: udiv_constant_lhs:
; RV64I:    # %bb.0:
; RV64I-NEXT: addi sp, sp, -16
; RV64I-NEXT: sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT: slli a0, a0, 32
; RV64I-NEXT: srli a1, a0, 32
; RV64I-NEXT: li a0, 10
; RV64I-NEXT: call __udivdi3
; RV64I-NEXT: ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT: addi sp, sp, 16
; RV64I-NEXT: ret
;
; RV64IM-LABEL: udiv_constant_lhs:
; RV64IM:    # %bb.0:
; RV64IM-NEXT: li a1, 10
; RV64IM-NEXT: divuw a0, a1, a0
; RV64IM-NEXT: ret
%1 = udiv i32 10, %a
ret i32 %1
}
```

```
define i64 @udiv64(i64 %a, i64 %b) nounwind {
; RV64I-LABEL: udiv64:
; RV64I:    # %bb.0:
; RV64I-NEXT: tail __udivdi3
```

```

;
; RV64IM-LABEL: udiv64:
; RV64IM:    # %bb.0:
; RV64IM-NEXT:  divu a0, a0, a1
; RV64IM-NEXT:  ret
%1 = udiv i64 %a, %b
ret i64 %1
}

define i64 @udiv64_constant(i64 %a) nounwind {
; RV64I-LABEL: udiv64_constant:
; RV64I:    # %bb.0:
; RV64I-NEXT:  li a1, 5
; RV64I-NEXT:
    tail __udivdi3
;
; RV64IM-LABEL: udiv64_constant:
; RV64IM:    # %bb.0:
; RV64IM-NEXT:  lui a1, 838861
; RV64IM-NEXT:  addiw a1, a1, -819
; RV64IM-NEXT:  slli a2, a1, 32
; RV64IM-NEXT:  add a1, a1, a2
; RV64IM-NEXT:  mulhu a0, a0, a1
; RV64IM-NEXT:  srli a0, a0, 2
; RV64IM-NEXT:  ret
%1 = udiv i64 %a, 5
ret i64 %1
}

define i64 @udiv64_constant_lhs(i64 %a) nounwind {
; RV64I-LABEL: udiv64_constant_lhs:
; RV64I:    # %bb.0:
; RV64I-NEXT:  mv a1, a0
; RV64I-NEXT:  li a0, 10
; RV64I-NEXT:  tail __udivdi3
;
; RV64IM-LABEL: udiv64_constant_lhs:
; RV64IM:    # %bb.0:
; RV64IM-NEXT:  li a1, 10
; RV64IM-NEXT:  divu a0, a1, a0
; RV64IM-NEXT:  ret
%1 = udiv i64 10, %a
ret i64 %1
}

define i8 @udiv8(i8 %a, i8 %b) nounwind {
; RV64I-LABEL: udiv8:
; RV64I:    # %bb.0:

```

```

; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  andi a0, a0, 255
; RV64I-NEXT:  andi a1, a1, 255
; RV64I-NEXT:  call
__udivdi3
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
;
; RV64IM-LABEL: udiv8:
; RV64IM:      # %bb.0:
; RV64IM-NEXT: andi a1, a1, 255
; RV64IM-NEXT: andi a0, a0, 255
; RV64IM-NEXT: divuw a0, a0, a1
; RV64IM-NEXT: ret
%1 = udiv i8 %a, %b
ret i8 %1
}

```

```

define i8 @udiv8_constant(i8 %a) nounwind {
; RV64I-LABEL: udiv8_constant:
; RV64I:      # %bb.0:
; RV64I-NEXT: addi sp, sp, -16
; RV64I-NEXT: sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT: andi a0, a0, 255
; RV64I-NEXT: li a1, 5
; RV64I-NEXT: call __udivdi3
; RV64I-NEXT: ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT: addi sp, sp, 16
; RV64I-NEXT: ret
;
; RV64IM-LABEL: udiv8_constant:
; RV64IM:      # %bb.0:
; RV64IM-NEXT: andi a0, a0, 255
; RV64IM-NEXT: li a1, 205
; RV64IM-NEXT: mul a0, a0, a1
; RV64IM-NEXT: srliw a0, a0, 10
; RV64IM-NEXT: ret
%1 = udiv i8 %a, 5
ret i8 %1
}

```

```

define i8 @udiv8_pow2(i8 %a) nounwind
{
; RV64I-LABEL: udiv8_pow2:
; RV64I:      # %bb.0:
; RV64I-NEXT: slli a0, a0, 56

```

```

; RV64I-NEXT:  srli a0, a0, 59
; RV64I-NEXT:  ret
;
; RV64IM-LABEL: udiv8_pow2:
; RV64IM:      # %bb.0:
; RV64IM-NEXT:  slli a0, a0, 56
; RV64IM-NEXT:  srli a0, a0, 59
; RV64IM-NEXT:  ret
%1 = udiv i8 %a, 8
ret i8 %1
}

define i8 @udiv8_constant_lhs(i8 %a) nounwind {
; RV64I-LABEL: udiv8_constant_lhs:
; RV64I:      # %bb.0:
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  andi a1, a0, 255
; RV64I-NEXT:  li a0, 10
; RV64I-NEXT:  call __udivdi3
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
;
; RV64IM-LABEL: udiv8_constant_lhs:
; RV64IM:      # %bb.0:
; RV64IM-NEXT:  andi a0, a0, 255
; RV64IM-NEXT:  li a1, 10
; RV64IM-NEXT:  divuw a0, a1, a0
; RV64IM-NEXT:  ret
%1 = udiv i8 10, %a
ret i8 %1
}

define i16 @udiv16(i16 %a, i16 %b) nounwind {
; RV64I-LABEL: udiv16:
;
; RV64I:      # %bb.0:
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  lui a2, 16
; RV64I-NEXT:  addiw a2, a2, -1
; RV64I-NEXT:  and a0, a0, a2
; RV64I-NEXT:  and a1, a1, a2
; RV64I-NEXT:  call __udivdi3
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret

```

```

;
; RV64IM-LABEL: udiv16:
; RV64IM:    # %bb.0:
; RV64IM-NEXT:  lui a2, 16
; RV64IM-NEXT:  addi a2, a2, -1
; RV64IM-NEXT:  and a1, a1, a2
; RV64IM-NEXT:  and a0, a0, a2
; RV64IM-NEXT:  divuw a0, a0, a1
; RV64IM-NEXT:  ret
%1 = udiv i16 %a, %b
ret i16 %1
}

define i16 @udiv16_constant(i16 %a) nounwind {
; RV64I-LABEL: udiv16_constant:
; RV64I:    # %bb.0:
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  slli a0, a0, 48
; RV64I-NEXT:  srli a0, a0, 48
; RV64I-NEXT:  li a1, 5
; RV64I-NEXT:  call __udivdi3
; RV64I-NEXT:  ld ra, 8(sp)
# 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
;
; RV64IM-LABEL: udiv16_constant:
; RV64IM:    # %bb.0:
; RV64IM-NEXT:  lui a1, 52429
; RV64IM-NEXT:  slli a1, a1, 4
; RV64IM-NEXT:  slli a0, a0, 48
; RV64IM-NEXT:  mulhu a0, a0, a1
; RV64IM-NEXT:  srliw a0, a0, 18
; RV64IM-NEXT:  ret
%1 = udiv i16 %a, 5
ret i16 %1
}

define i16 @udiv16_pow2(i16 %a) nounwind {
; RV64I-LABEL: udiv16_pow2:
; RV64I:    # %bb.0:
; RV64I-NEXT:  slli a0, a0, 48
; RV64I-NEXT:  srli a0, a0, 51
; RV64I-NEXT:  ret
;
; RV64IM-LABEL: udiv16_pow2:
; RV64IM:    # %bb.0:

```



```

; RV64IM-NEXT:  slli a0, a0, 48
; RV64IM-NEXT:  srli a0, a0, 51
; RV64IM-NEXT:  ret
%1 = udiv i16 %a, 8
ret i16 %1
}

define i16 @udiv16_constant_lhs(i16 %a) nounwind {
; RV64I-LABEL: udiv16_constant_lhs:
; RV64I:        # %bb.0:
; RV64I-NEXT:   addi sp, sp, -16
; RV64I-NEXT:   sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:   slli a0, a0, 48
; RV64I-NEXT:   srli a1, a0, 48
; RV64I-NEXT:
    li a0, 10
; RV64I-NEXT:   call __udivdi3
; RV64I-NEXT:   ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT:   addi sp, sp, 16
; RV64I-NEXT:   ret
;
; RV64IM-LABEL: udiv16_constant_lhs:
; RV64IM:       # %bb.0:
; RV64IM-NEXT:  slli a0, a0, 48
; RV64IM-NEXT:  srli a0, a0, 48
; RV64IM-NEXT:  li a1, 10
; RV64IM-NEXT:  divuw a0, a1, a0
; RV64IM-NEXT:  ret
%1 = udiv i16 10, %a
ret i16 %1
}

define i32 @sdiv(i32 %a, i32 %b) nounwind {
; RV64I-LABEL: sdiv:
; RV64I:       # %bb.0:
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  sext.w a0, a0
; RV64I-NEXT:  sext.w a1, a1
; RV64I-NEXT:  call __divdi3
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
;
; RV64IM-LABEL: sdiv:
; RV64IM:      # %bb.0:
; RV64IM-NEXT:  divw a0, a0, a1
; RV64IM-NEXT:  ret

```

```

%1 = sdiv i32 %a, %b
ret i32 %1
}

define i32 @sdiv_constant(i32 %a) nounwind {
; RV64I-LABEL: sdiv_constant:
;
RV64I:    # %bb.0:
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  sext.w a0, a0
; RV64I-NEXT:  li a1, 5
; RV64I-NEXT:  call __divdi3
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
;
; RV64IM-LABEL: sdiv_constant:
; RV64IM:    # %bb.0:
; RV64IM-NEXT:  sext.w a0, a0
; RV64IM-NEXT:  lui a1, 419430
; RV64IM-NEXT:  addiw a1, a1, 1639
; RV64IM-NEXT:  mul a0, a0, a1
; RV64IM-NEXT:  srli a1, a0, 63
; RV64IM-NEXT:  srai a0, a0, 33
; RV64IM-NEXT:  addw a0, a0, a1
; RV64IM-NEXT:  ret
%1 = sdiv i32 %a, 5
ret i32 %1
}

```

```

define i32 @sdiv_pow2(i32 %a) nounwind {
; RV64I-LABEL: sdiv_pow2:
; RV64I:    # %bb.0:
; RV64I-NEXT:  sraiw a1, a0, 31
; RV64I-NEXT:  srliw a1, a1, 29
; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  sraiw a0, a0, 3
; RV64I-NEXT:  ret
;
; RV64IM-LABEL: sdiv_pow2:
; RV64IM:    # %bb.0:
; RV64IM-NEXT:  sraiw a1, a0,
31
; RV64IM-NEXT:  srliw a1, a1, 29
; RV64IM-NEXT:  add a0, a0, a1
; RV64IM-NEXT:  sraiw a0, a0, 3
; RV64IM-NEXT:  ret

```

```

%1 = sdiv i32 %a, 8
ret i32 %1
}

define i32 @sdiv_pow2_2(i32 %a) nounwind {
; RV64I-LABEL: sdiv_pow2_2:
; RV64I:      # %bb.0:
; RV64I-NEXT:  sraiw a1, a0, 31
; RV64I-NEXT:  srlw a1, a1, 16
; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  sraiw a0, a0, 16
; RV64I-NEXT:  ret
;
; RV64IM-LABEL: sdiv_pow2_2:
; RV64IM:      # %bb.0:
; RV64IM-NEXT:  sraiw a1, a0, 31
; RV64IM-NEXT:  srlw a1, a1, 16
; RV64IM-NEXT:  add a0, a0, a1
; RV64IM-NEXT:  sraiw a0, a0, 16
; RV64IM-NEXT:  ret
%1 = sdiv i32 %a, 65536
ret i32 %1
}

define i32 @sdiv_constant_lhs(i32 %a) nounwind {
; RV64I-LABEL: sdiv_constant_lhs:
; RV64I:      # %bb.0:
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  sext.w a1, a0
; RV64I-NEXT:  li a0, -10
; RV64I-NEXT:  call __divdi3
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded
Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
;
; RV64IM-LABEL: sdiv_constant_lhs:
; RV64IM:      # %bb.0:
; RV64IM-NEXT:  li a1, -10
; RV64IM-NEXT:  divw a0, a1, a0
; RV64IM-NEXT:  ret
%1 = sdiv i32 -10, %a
ret i32 %1
}

define i64 @sdiv64(i64 %a, i64 %b) nounwind {
; RV64I-LABEL: sdiv64:

```

```

; RV64I:    # %bb.0:
; RV64I-NEXT:  tail __divdi3
;
; RV64IM-LABEL: sdiv64:
; RV64IM:    # %bb.0:
; RV64IM-NEXT:  div a0, a0, a1
; RV64IM-NEXT:  ret
%1 = sdiv i64 %a, %b
ret i64 %1
}

```

```

define i64 @sdiv64_constant(i64 %a) nounwind {
; RV64I-LABEL: sdiv64_constant:
; RV64I:    # %bb.0:
; RV64I-NEXT:  li a1, 5
; RV64I-NEXT:  tail __divdi3
;
; RV64IM-LABEL: sdiv64_constant:
; RV64IM:    # %bb.0:
; RV64IM-NEXT:  lui a1, %hi(.LCPI21_0)
; RV64IM-NEXT:  ld a1, %lo(.LCPI21_0)(a1)
; RV64IM-NEXT:  mulh a0, a0, a1
; RV64IM-NEXT:  srli a1, a0, 63
; RV64IM-NEXT:  srai a0, a0, 1
; RV64IM-NEXT:  add a0, a0, a1
; RV64IM-NEXT:  ret
%1 = sdiv i64 %a,
5
ret i64 %1
}

```

```

define i64 @sdiv64_constant_lhs(i64 %a) nounwind {
; RV64I-LABEL: sdiv64_constant_lhs:
; RV64I:    # %bb.0:
; RV64I-NEXT:  mv a1, a0
; RV64I-NEXT:  li a0, 10
; RV64I-NEXT:  tail __divdi3
;
; RV64IM-LABEL: sdiv64_constant_lhs:
; RV64IM:    # %bb.0:
; RV64IM-NEXT:  li a1, 10
; RV64IM-NEXT:  div a0, a1, a0
; RV64IM-NEXT:  ret
%1 = sdiv i64 10, %a
ret i64 %1
}

```

; Although this sdiv has two sexti32 operands, it shouldn't compile to divw on

; RV64M as that wouldn't produce the correct result for e.g. INT\_MIN/-1.

```
define i64 @sdiv64_sext_operands(i32 %a, i32 %b) nounwind {
; RV64I-LABEL: sdiv64_sext_operands:
; RV64I:      # %bb.0:
; RV64I-NEXT: sext.w a0, a0
; RV64I-NEXT: sext.w a1, a1
; RV64I-NEXT: tail __divdi3
;
; RV64IM-LABEL: sdiv64_sext_operands:
; RV64IM:     # %bb.0:
; RV64IM-NEXT: sext.w a0, a0
; RV64IM-NEXT: sext.w a1, a1
; RV64IM-NEXT: div a0, a0, a1
; RV64IM-NEXT: ret
%1 = sext i32 %a to i64
%2 = sext i32 %b to
i64
%3 = sdiv i64 %1, %2
ret i64 %3
}
```

```
define i8 @sdiv8(i8 %a, i8 %b) nounwind {
; RV64I-LABEL: sdiv8:
; RV64I:      # %bb.0:
; RV64I-NEXT: addi sp, sp, -16
; RV64I-NEXT: sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT: slli a1, a1, 24
; RV64I-NEXT: sraiw a1, a1, 24
; RV64I-NEXT: slli a0, a0, 24
; RV64I-NEXT: sraiw a0, a0, 24
; RV64I-NEXT: call __divdi3
; RV64I-NEXT: ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT: addi sp, sp, 16
; RV64I-NEXT: ret
;
; RV64IM-LABEL: sdiv8:
; RV64IM:     # %bb.0:
; RV64IM-NEXT: slli a1, a1, 24
; RV64IM-NEXT: sraiw a1, a1, 24
; RV64IM-NEXT: slli a0, a0, 24
; RV64IM-NEXT: sraiw a0, a0, 24
; RV64IM-NEXT: divw a0, a0, a1
; RV64IM-NEXT: ret
%1 = sdiv i8 %a, %b
ret i8 %1
}
```

```

define i8 @sdiv8_constant(i8 %a) nounwind {
; RV64I-LABEL: sdiv8_constant:
; RV64I:      # %bb.0:
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  slli a0, a0, 24
; RV64I-NEXT:
    sraiw a0, a0, 24
; RV64I-NEXT:  li a1, 5
; RV64I-NEXT:  call __divdi3
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
;
; RV64IM-LABEL: sdiv8_constant:
; RV64IM:      # %bb.0:
; RV64IM-NEXT:  slli a0, a0, 24
; RV64IM-NEXT:  sraiw a0, a0, 24
; RV64IM-NEXT:  li a1, 103
; RV64IM-NEXT:  mul a0, a0, a1
; RV64IM-NEXT:  sraiw a1, a0, 9
; RV64IM-NEXT:  slli a0, a0, 48
; RV64IM-NEXT:  srli a0, a0, 63
; RV64IM-NEXT:  addw a0, a1, a0
; RV64IM-NEXT:  ret
    %1 = sdiv i8 %a, 5
    ret i8 %1
}

```

```

define i8 @sdiv8_pow2(i8 %a) nounwind {
; RV64I-LABEL: sdiv8_pow2:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a1, a0, 24
; RV64I-NEXT:  sraiw a1, a1, 24
; RV64I-NEXT:  slli a1, a1, 49
; RV64I-NEXT:  srli a1, a1, 61
; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  slli a0, a0, 24
; RV64I-NEXT:  sraiw a0, a0, 27
; RV64I-NEXT:  ret
;
; RV64IM-LABEL: sdiv8_pow2:
; RV64IM:      # %bb.0:
; RV64IM-NEXT:  slli a1, a0,
    24
; RV64IM-NEXT:  sraiw a1, a1, 24
; RV64IM-NEXT:  slli a1, a1, 49
; RV64IM-NEXT:  srli a1, a1, 61

```

```

; RV64IM-NEXT:  add a0, a0, a1
; RV64IM-NEXT:  slli a0, a0, 24
; RV64IM-NEXT:  sraiw a0, a0, 27
; RV64IM-NEXT:  ret
%1 = sdiv i8 %a, 8
ret i8 %1
}

define i8 @sdiv8_constant_lhs(i8 %a) nounwind {
; RV64I-LABEL: sdiv8_constant_lhs:
; RV64I:      # %bb.0:
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  slli a0, a0, 24
; RV64I-NEXT:  sraiw a1, a0, 24
; RV64I-NEXT:  li a0, -10
; RV64I-NEXT:  call __divdi3
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
;
; RV64IM-LABEL: sdiv8_constant_lhs:
; RV64IM:      # %bb.0:
; RV64IM-NEXT:  slli a0, a0, 24
; RV64IM-NEXT:  sraiw a0, a0, 24
; RV64IM-NEXT:  li a1, -10
; RV64IM-NEXT:  divw a0, a1, a0
; RV64IM-NEXT:  ret
%1 = sdiv i8 -10, %a
ret i8 %1
}

define i16 @sdiv16(i16 %a, i16 %b) nounwind {
; RV64I-LABEL:
sdiv16:
; RV64I:      # %bb.0:
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  slli a1, a1, 16
; RV64I-NEXT:  sraiw a1, a1, 16
; RV64I-NEXT:  slli a0, a0, 16
; RV64I-NEXT:  sraiw a0, a0, 16
; RV64I-NEXT:  call __divdi3
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
;
; RV64IM-LABEL: sdiv16:

```

```

; RV64IM:    # %bb.0:
; RV64IM-NEXT:  slli a1, a1, 16
; RV64IM-NEXT:  sraiw a1, a1, 16
; RV64IM-NEXT:  slli a0, a0, 16
; RV64IM-NEXT:  sraiw a0, a0, 16
; RV64IM-NEXT:  divw a0, a0, a1
; RV64IM-NEXT:  ret
%1 = sdiv i16 %a, %b
ret i16 %1
}

```

```

define i16 @sdiv16_constant(i16 %a) nounwind {
; RV64I-LABEL: sdiv16_constant:
; RV64I:    # %bb.0:
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  slli a0, a0, 16
; RV64I-NEXT:  sraiw a0, a0, 16
; RV64I-NEXT:  li a1, 5
; RV64I-NEXT:  call __divdi3
; RV64I-NEXT:
    ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
;
; RV64IM-LABEL: sdiv16_constant:
; RV64IM:    # %bb.0:
; RV64IM-NEXT:  slli a0, a0, 16
; RV64IM-NEXT:  sraiw a0, a0, 16
; RV64IM-NEXT:  lui a1, 6
; RV64IM-NEXT:  addi a1, a1, 1639
; RV64IM-NEXT:  mul a0, a0, a1
; RV64IM-NEXT:  srliw a1, a0, 31
; RV64IM-NEXT:  sraiw a0, a0, 17
; RV64IM-NEXT:  addw a0, a0, a1
; RV64IM-NEXT:  ret
%1 = sdiv i16 %a, 5
ret i16 %1
}

```

```

define i16 @sdiv16_pow2(i16 %a) nounwind {
; RV64I-LABEL: sdiv16_pow2:
; RV64I:    # %bb.0:
; RV64I-NEXT:  slli a1, a0, 16
; RV64I-NEXT:  sraiw a1, a1, 16
; RV64I-NEXT:  slli a1, a1, 33
; RV64I-NEXT:  srli a1, a1, 61
; RV64I-NEXT:  add a0, a0, a1

```



```

; RV64I-NEXT:  slli a0, a0, 16
; RV64I-NEXT:  sraiw a0, a0, 19
; RV64I-NEXT:  ret
;
; RV64IM-LABEL: sdiv16_pow2:
; RV64IM:      # %bb.0:
; RV64IM-NEXT:  slli a1, a0, 16
; RV64IM-NEXT:  sraiw a1, a1, 16
; RV64IM-NEXT:  slli a1, a1, 33
;
; RV64IM-NEXT:  srli a1, a1, 61
; RV64IM-NEXT:  add a0, a0, a1
; RV64IM-NEXT:  slli a0, a0, 16
; RV64IM-NEXT:  sraiw a0, a0, 19
; RV64IM-NEXT:  ret
%1 = sdiv i16 %a, 8
ret i16 %1
}

define i16 @sdiv16_constant_lhs(i16 %a) nounwind {
; RV64I-LABEL: sdiv16_constant_lhs:
; RV64I:      # %bb.0:
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  slli a0, a0, 16
; RV64I-NEXT:  sraiw a1, a0, 16
; RV64I-NEXT:  li a0, -10
; RV64I-NEXT:  call __divdi3
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
;
; RV64IM-LABEL: sdiv16_constant_lhs:
; RV64IM:      # %bb.0:
; RV64IM-NEXT:  slli a0, a0, 16
; RV64IM-NEXT:  sraiw a0, a0, 16
; RV64IM-NEXT:  li a1, -10
; RV64IM-NEXT:  divw a0, a1, a0
; RV64IM-NEXT:  ret
%1 = sdiv i16 -10, %a
ret i16 %1
}

; RUN: opt %s -passes=inline -S | FileCheck %s

define internal void @innerSmall() "min-legal-vector-width"="128" {
  ret void
}

```

```

define internal void @innerLarge() "min-legal-vector-width"="512" {
  ret void
}

define internal void @innerNoAttribute() {
  ret void
}

; We should not add an attribute during inlining. No attribute means unknown.
; Inlining doesn't change the fact that we don't know anything about this
; function.
define void @outerNoAttribute() {
  call void @innerLarge()
  ret void
}

define void @outerConflictingAttributeSmall() "min-legal-vector-width"="128" {
  call void @innerLarge()
  ret void
}

define void @outerConflictingAttributeLarge() "min-legal-vector-width"="512" {
  call void @innerSmall()
  ret void
}

```

; We should remove the attribute after inlining since the callee's  
; vector width requirements are unknown.

```

define void @outerAttribute() "min-legal-vector-width"="128" {
  call void @innerNoAttribute()
  ret void
}

```

```

; CHECK: define void @outerNoAttribute()
{
; CHECK: define void @outerConflictingAttributeSmall() #0
; CHECK: define void @outerConflictingAttributeLarge() #0
; CHECK: define void @outerAttribute() {
; CHECK: attributes #0 = { "min-legal-vector-width"="512" }
LLVM System Interface Library

```

-----

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; RUN: opt -mtriple=aarch64-linux-gnu -mattr=+sve -passes=sanitize-masked-mem-intrin -S < %s | FileCheck %s

; Testing that masked scatters operating on scalable vectors that are

; packed in SVE registers are not scalarized.

```
; CHECK-LABEL: @masked_scatter_nxv4i32(  
; CHECK: call void @llvm.masked.scatter.nxv4i32  
define void @masked_scatter_nxv4i32(<vscale x 4 x i32> %data, <vscale x 4 x ptr> %ptrs, <vscale x 4 x i1>  
%masks) {  
    call void @llvm.masked.scatter.nxv4i32(<vscale x 4 x i32> %data, <vscale x 4 x ptr> %ptrs, i32 0, <vscale x 4 x  
i1> %masks)  
    ret void  
}
```

; Testing that masked scatters operating on scalable vectors of FP  
; data that is packed in SVE registers are not scalarized.

```
; CHECK-LABEL: @masked_scatter_nxv2f64(  
; CHECK: call void @llvm.masked.scatter.nxv2f64  
define void @masked_scatter_nxv2f64(<vscale x 2 x double> %data, <vscale x 2 x ptr> %ptrs, <vscale x 2 x i1>  
%masks) {  
    call void @llvm.masked.scatter.nxv2f64(<vscale x 2 x double> %data, <vscale x 2 x ptr> %ptrs,  
i32 0, <vscale x 2 x i1> %masks)  
    ret void  
}
```

; Testing that masked scatters operating on scalable vectors of FP  
; data that is unpacked in SVE registers are not scalarized.

```
; CHECK-LABEL: @masked_scatter_nxv2f16(  
; CHECK: call void @llvm.masked.scatter.nxv2f16  
define void @masked_scatter_nxv2f16(<vscale x 2 x half> %data, <vscale x 2 x ptr> %ptrs, <vscale x 2 x i1>  
%masks) {  
    call void @llvm.masked.scatter.nxv2f16(<vscale x 2 x half> %data, <vscale x 2 x ptr> %ptrs, i32 0, <vscale x 2 x  
i1> %masks)  
    ret void  
}
```

; Testing that masked scatters operating on 64-bit fixed vectors are  
; scalarized because NEON doesn't have support for masked scatter  
; instructions.

```
; CHECK-LABEL: @masked_scatter_v2f32(  
; CHECK-NOT: @llvm.masked.scatter.v2f32(  
define void @masked_scatter_v2f32(<2 x float> %data, <2 x ptr> %ptrs, <2 x i1> %masks) {  
    call void @llvm.masked.scatter.v2f32(<2 x float> %data, <2 x ptr> %ptrs, i32 0, <2 x i1> %masks)  
    ret void  
}
```

; Testing that masked scatters operating on 128-bit

fixed vectors are  
; scalarized because NEON doesn't have support for masked scatter  
; instructions and because we are not targeting fixed width SVE.

```
; CHECK-LABEL: @masked_scatter_v4i32(  
; CHECK-NOT: @llvm.masked.scatter.v4i32(  
define void @masked_scatter_v4i32(<4 x i32> %data, <4 x ptr> %ptrs, <4 x i1> %masks) {  
    call void @llvm.masked.scatter.v4i32(<4 x i32> %data, <4 x ptr> %ptrs, i32 0, <4 x i1> %masks)  
    ret void  
}
```

```
declare void @llvm.masked.scatter.nxv4i32(<vscale x 4 x i32> %data, <vscale x 4 x ptr> %ptrs, i32 %align,  
<vscale x 4 x i1> %masks)  
declare void @llvm.masked.scatter.nxv2f64(<vscale x 2 x double> %data, <vscale x 2 x ptr> %ptrs, i32 %align,  
<vscale x 2 x i1> %masks)  
declare void @llvm.masked.scatter.nxv2f16(<vscale x 2 x half> %data, <vscale x 2 x ptr> %ptrs, i32 %align,  
<vscale x 2 x i1> %masks)  
declare void @llvm.masked.scatter.v2f32(<2 x float> %data, <2 x ptr> %ptrs, i32 %align, <2 x i1> %masks)  
declare void @llvm.masked.scatter.v4i32(<4 x i32> %data, <4 x  
    ptr> %ptrs, i32 %align, <4 x i1> %masks)  
; NOTE: Assertions have been autogenerated by utils/update_llc_test_checks.py  
; RUN: llc -mtriple=riscv64 -verify-machineinstrs < %s \  
; RUN: -riscv-experimental-rv64-legal-i32 | FileCheck -check-prefix=RV64I %s
```

; Check indexed and unindexed, sext, zext and anyext loads

```
define dso_local i64 @lb(ptr %a) nounwind {  
; RV64I-LABEL: lb:  
; RV64I:      # %bb.0:  
; RV64I-NEXT: lb a1, 1(a0)  
; RV64I-NEXT: lbu zero, 0(a0)  
; RV64I-NEXT: mv a0, a1  
; RV64I-NEXT: ret  
%1 = getelementptr i8, ptr %a, i32 1  
%2 = load i8, ptr %1  
%3 = sext i8 %2 to i64  
; the unused load will produce an anyext for selection  
%4 = load volatile i8, ptr %a  
ret i64 %3  
}
```

```
define dso_local i64 @lh(ptr %a) nounwind {  
; RV64I-LABEL: lh:  
; RV64I:      # %bb.0:  
; RV64I-NEXT: lh a1, 4(a0)  
; RV64I-NEXT: lh zero, 0(a0)  
; RV64I-NEXT: mv a0, a1  
; RV64I-NEXT: ret
```

```

%1 = getelementptr i16, ptr %a, i32 2
%2 = load i16, ptr %1
%3 = sext i16 %2 to i64
; the unused load will produce an anyext for selection
%4 = load volatile i16, ptr %a
ret i64 %3
}

```

```

define dso_local i64 @lw(ptr %a) nounwind {
; RV64I-LABEL: lw:
; RV64I:      # %bb.0:
; RV64I-NEXT: lw a1, 12(a0)
; RV64I-NEXT: lw zero, 0(a0)
; RV64I-NEXT: mv a0, a1
; RV64I-NEXT: ret
%1 = getelementptr i32, ptr %a, i32 3
%2 = load i32, ptr %1
%3 = sext i32 %2 to i64
; the unused load will produce an anyext for selection
%4 = load volatile i32, ptr %a
ret i64 %3
}

```

```

define dso_local i64 @lbu(ptr %a) nounwind {
; RV64I-LABEL: lbu:
; RV64I:      # %bb.0:
; RV64I-NEXT: lbu a1, 4(a0)
; RV64I-NEXT: lbu a0, 0(a0)
; RV64I-NEXT: add a0, a1, a0
; RV64I-NEXT: ret
%1 = getelementptr i8, ptr %a, i32 4
%2 = load i8, ptr %1
%3 = zext i8 %2 to i64
%4 = load volatile i8, ptr %a
%5 = zext i8 %4 to i64
%6 = add i64 %3, %5
ret i64 %6
}

```

```

define dso_local i64 @lhu(ptr %a) nounwind {
; RV64I-LABEL: lhu:
; RV64I:      # %bb.0:
; RV64I-NEXT: lhu a1, 10(a0)
; RV64I-NEXT: lhu a0, 0(a0)
; RV64I-NEXT:
    add a0, a1, a0
; RV64I-NEXT: ret
%1 = getelementptr i16, ptr %a, i32 5

```

```

%2 = load i16, ptr %1
%3 = zext i16 %2 to i64
%4 = load volatile i16, ptr %a
%5 = zext i16 %4 to i64
%6 = add i64 %3, %5
ret i64 %6
}

define dso_local i64 @lwu(ptr %a) nounwind {
; RV64I-LABEL: lwu:
; RV64I:      # %bb.0:
; RV64I-NEXT:  lwu a1, 24(a0)
; RV64I-NEXT:  lwu a0, 0(a0)
; RV64I-NEXT:  add a0, a1, a0
; RV64I-NEXT:  ret
%1 = getelementptr i32, ptr %a, i32 6
%2 = load i32, ptr %1
%3 = zext i32 %2 to i64
%4 = load volatile i32, ptr %a
%5 = zext i32 %4 to i64
%6 = add i64 %3, %5
ret i64 %6
}

```

; 64-bit loads and stores

```

define dso_local i64 @ld(ptr %a) nounwind {
; RV64I-LABEL: ld:
; RV64I:      # %bb.0:
; RV64I-NEXT:  ld a1, 80(a0)
; RV64I-NEXT:  ld zero, 0(a0)
; RV64I-NEXT:  mv a0, a1
; RV64I-NEXT:  ret
%1 = getelementptr i64, ptr %a, i32 10
%2 = load i64, ptr %1
%3 = load volatile i64, ptr %a
ret i64 %2
}

```

```

define dso_local void @sd(ptr %a, i64 %b)
nounwind {
; RV64I-LABEL: sd:
; RV64I:      # %bb.0:
; RV64I-NEXT:  sd a1, 0(a0)
; RV64I-NEXT:  sd a1, 88(a0)
; RV64I-NEXT:  ret
store i64 %b, ptr %a
%1 = getelementptr i64, ptr %a, i32 11

```

```

store i64 %b, ptr %1
ret void
}

; Check load and store to an i1 location
define dso_local i64 @load_sext_zext_anyext_i1(ptr %a) nounwind {
; RV64I-LABEL: load_sext_zext_anyext_i1:
; RV64I:      # %bb.0:
; RV64I-NEXT:  lbu a1, 1(a0)
; RV64I-NEXT:  lbu a2, 2(a0)
; RV64I-NEXT:  lbu zero, 0(a0)
; RV64I-NEXT:  sub a0, a2, a1
; RV64I-NEXT:  ret
; sextload i1
%1 = getelementptr i1, ptr %a, i32 1
%2 = load i1, ptr %1
%3 = sext i1 %2 to i64
; zextload i1
%4 = getelementptr i1, ptr %a, i32 2
%5 = load i1, ptr %4
%6 = zext i1 %5 to i64
%7 = add i64 %3, %6
; extload i1 (anyext). Produced as the load is unused.
%8 = load volatile i1, ptr %a
ret i64 %7
}

define dso_local i16 @load_sext_zext_anyext_i1_i16(ptr %a) nounwind {
; RV64I-LABEL: load_sext_zext_anyext_i1_i16:
;
; RV64I:      # %bb.0:
; RV64I-NEXT:  lbu a1, 1(a0)
; RV64I-NEXT:  lbu a2, 2(a0)
; RV64I-NEXT:  lbu zero, 0(a0)
; RV64I-NEXT:  subw a0, a2, a1
; RV64I-NEXT:  ret
; sextload i1
%1 = getelementptr i1, ptr %a, i32 1
%2 = load i1, ptr %1
%3 = sext i1 %2 to i16
; zextload i1
%4 = getelementptr i1, ptr %a, i32 2
%5 = load i1, ptr %4
%6 = zext i1 %5 to i16
%7 = add i16 %3, %6
; extload i1 (anyext). Produced as the load is unused.
%8 = load volatile i1, ptr %a
ret i16 %7
}

```

```

}

; Check load and store to a global
@G = dso_local global i64 0

define dso_local i64 @ld_sd_global(i64 %a) nounwind {
; RV64I-LABEL: ld_sd_global:
; RV64I:      # %bb.0:
; RV64I-NEXT:  lui a2, %hi(G)
; RV64I-NEXT:  ld a1, %lo(G)(a2)
; RV64I-NEXT:  addi a3, a2, %lo(G)
; RV64I-NEXT:  sd a0, %lo(G)(a2)
; RV64I-NEXT:  ld zero, 72(a3)
; RV64I-NEXT:  sd a0, 72(a3)
; RV64I-NEXT:  mv a0, a1
; RV64I-NEXT:  ret
%1 = load volatile i64, ptr @G
store i64 %a, ptr @G
%2 = getelementptr
i64, ptr @G, i64 9
%3 = load volatile i64, ptr %2
store i64 %a, ptr %2
ret i64 %1
}

define i64 @lw_near_local(ptr %a) {
; RV64I-LABEL: lw_near_local:
; RV64I:      # %bb.0:
; RV64I-NEXT:  addi a0, a0, 2047
; RV64I-NEXT:  ld a0, 9(a0)
; RV64I-NEXT:  ret
%1 = getelementptr inbounds i64, ptr %a, i64 257
%2 = load volatile i64, ptr %1
ret i64 %2
}

define void @st_near_local(ptr %a, i64 %b) {
; RV64I-LABEL: st_near_local:
; RV64I:      # %bb.0:
; RV64I-NEXT:  addi a0, a0, 2047
; RV64I-NEXT:  sd a1, 9(a0)
; RV64I-NEXT:  ret
%1 = getelementptr inbounds i64, ptr %a, i64 257
store i64 %b, ptr %1
ret void
}

define i64 @lw_sw_near_local(ptr %a, i64 %b) {

```



```

; RV64I-LABEL: lw_sw_near_local:
; RV64I:    # %bb.0:
; RV64I-NEXT:  addi a2, a0, 2047
; RV64I-NEXT:  ld a0, 9(a2)
; RV64I-NEXT:  sd a1, 9(a2)
; RV64I-NEXT:  ret
%1 = getelementptr inbounds i64, ptr %a, i64 257
%2 = load volatile i64, ptr %1
store i64 %b, ptr %1
ret i64 %2
}

```

```

define
i64 @lw_far_local(ptr %a) {
; RV64I-LABEL: lw_far_local:
; RV64I:    # %bb.0:
; RV64I-NEXT:  lui a1, 8
; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  ld a0, -8(a0)
; RV64I-NEXT:  ret
%1 = getelementptr inbounds i64, ptr %a, i64 4095
%2 = load volatile i64, ptr %1
ret i64 %2
}

```

```

define void @st_far_local(ptr %a, i64 %b) {
; RV64I-LABEL: st_far_local:
; RV64I:    # %bb.0:
; RV64I-NEXT:  lui a2, 8
; RV64I-NEXT:  add a0, a0, a2
; RV64I-NEXT:  sd a1, -8(a0)
; RV64I-NEXT:  ret
%1 = getelementptr inbounds i64, ptr %a, i64 4095
store i64 %b, ptr %1
ret void
}

```

```

define i64 @lw_sw_far_local(ptr %a, i64 %b) {
; RV64I-LABEL: lw_sw_far_local:
; RV64I:    # %bb.0:
; RV64I-NEXT:  lui a2, 8
; RV64I-NEXT:  add a2, a0, a2
; RV64I-NEXT:  ld a0, -8(a2)
; RV64I-NEXT:  sd a1, -8(a2)
; RV64I-NEXT:  ret
%1 = getelementptr inbounds i64, ptr %a, i64 4095
%2 = load volatile i64, ptr %1
store i64 %b, ptr %1
}

```

```
ret i64 %2
}
```

```
; Make sure we don't fold the addiw
into the load offset. The sign extend of the
; addiw is required.
```

```
define i64 @lw_really_far_local(ptr %a) {
; RV64I-LABEL: lw_really_far_local:
; RV64I:      # %bb.0:
; RV64I-NEXT: lui a1, 524288
; RV64I-NEXT: addiw a1, a1, -2048
; RV64I-NEXT: add a0, a0, a1
; RV64I-NEXT: ld a0, 0(a0)
; RV64I-NEXT: ret
%1 = getelementptr inbounds i64, ptr %a, i64 268435200
%2 = load volatile i64, ptr %1
ret i64 %2
}
```

```
; Make sure we don't fold the addiw into the store offset. The sign extend of
; the addiw is required.
```

```
define void @st_really_far_local(ptr %a, i64 %b) {
; RV64I-LABEL: st_really_far_local:
; RV64I:      # %bb.0:
; RV64I-NEXT: lui a2, 524288
; RV64I-NEXT: addiw a2, a2, -2048
; RV64I-NEXT: add a0, a0, a2
; RV64I-NEXT: sd a1, 0(a0)
; RV64I-NEXT: ret
%1 = getelementptr inbounds i64, ptr %a, i64 268435200
store i64 %b, ptr %1
ret void
}
```

```
; Make sure we don't fold the addiw into the load/store offset. The sign extend
; of the addiw is required.
```

```
define
i64 @lw_sw_really_far_local(ptr %a, i64 %b) {
; RV64I-LABEL: lw_sw_really_far_local:
; RV64I:      # %bb.0:
; RV64I-NEXT: lui a2, 524288
; RV64I-NEXT: addiw a2, a2, -2048
; RV64I-NEXT: add a2, a0, a2
; RV64I-NEXT: ld a0, 0(a2)
; RV64I-NEXT: sd a1, 0(a2)
; RV64I-NEXT: ret
%1 = getelementptr inbounds i64, ptr %a, i64 268435200
%2 = load volatile i64, ptr %1
```

```

store i64 %b, ptr %1
ret i64 %2
}

```

```
%struct.quux = type { i32, [0 x i8] }
```

```

; Make sure we don't remove the addi and fold the C from
; (add (addi FrameIndex, C), X) into the store address.
; FrameIndex cannot be the operand of an ADD. We must keep the ADDI.
define void @addi_fold_crash(i64 %arg) nounwind {
; RV64I-LABEL: addi_fold_crash:
; RV64I:      # %bb.0: # %bb
; RV64I-NEXT: addi sp, sp, -16
; RV64I-NEXT: sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT: addi a1, sp, 4
; RV64I-NEXT: add a0, a1, a0
; RV64I-NEXT: sb zero, 0(a0)
; RV64I-NEXT: mv a0, a1
; RV64I-NEXT: call snork
; RV64I-NEXT:
    ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT: addi sp, sp, 16
; RV64I-NEXT: ret
bb:
%tmp = alloca %struct.quux, align 8
%tmp1 = getelementptr inbounds %struct.quux, ptr %tmp, i64 0, i32 1
%tmp2 = getelementptr inbounds %struct.quux, ptr %tmp, i64 0, i32 1, i64 %arg
store i8 0, ptr %tmp2, align 1
call void @snork(ptr %tmp1)
ret void
}

```

```

declare void @snork(ptr)
; NOTE: Assertions have been autogenerated by utils/update_test_checks.py UTC_ARGS: --function-signature --
scrub-attributes
; RUN: opt -S -passes=argpromotion < %s | FileCheck %s
; Test that we only promote arguments when the caller/callee have compatible
; function attributes.

```

```
target triple = "x86_64-unknown-linux-gnu"
```

```

; This should promote
define internal fastcc void @callee_avx512_legal512_prefer512_call_avx512_legal512_prefer512(ptr %arg, ptr
readonly %arg1) #0 {
; CHECK-LABEL: define {{{^@}+}}@callee_avx512_legal512_prefer512_call_avx512_legal512_prefer512
; CHECK-SAME: (ptr [[ARG:%.*]], <8 x i64> [[ARG1_VAL:%.*]])
; CHECK-NEXT: bb:
; CHECK-NEXT: store <8 x i64> [[ARG1_VAL]], ptr [[ARG]]

```

```

; CHECK-NEXT:  ret void
;
bb:
  %tmp = load <8 x i64>, ptr %arg1
  store <8 x i64> %tmp, ptr %arg
  ret void
}

define void @avx512_legal512_prefer512_call_avx512_legal512_prefer512(ptr %arg) #0 {
; CHECK-LABEL: define {{^@}+}}@avx512_legal512_prefer512_call_avx512_legal512_prefer512
; CHECK-SAME:
  (ptr [[ARG:%.*]])
; CHECK-NEXT: bb:
; CHECK-NEXT:  [[TMP:%.*]] = alloca <8 x i64>, align 32
; CHECK-NEXT:  [[TMP2:%.*]] = alloca <8 x i64>, align 32
; CHECK-NEXT:  call void @llvm.memset.p0.i64(ptr align 32 [[TMP]], i8 0, i64 32, i1 false)
; CHECK-NEXT:  [[TMP_VAL:%.*]] = load <8 x i64>, ptr [[TMP]]
; CHECK-NEXT:  call fastcc void @callee_avx512_legal512_prefer512_call_avx512_legal512_prefer512(ptr
[[TMP2]], <8 x i64> [[TMP_VAL]])
; CHECK-NEXT:  [[TMP4:%.*]] = load <8 x i64>, ptr [[TMP2]], align 32
; CHECK-NEXT:  store <8 x i64> [[TMP4]], ptr [[ARG]], align 2
; CHECK-NEXT:  ret void
;
bb:
  %tmp = alloca <8 x i64>, align 32
  %tmp2 = alloca <8 x i64>, align 32
  call void @llvm.memset.p0.i64(ptr align 32 %tmp, i8 0, i64 32, i1 false)
  call fastcc void @callee_avx512_legal512_prefer512_call_avx512_legal512_prefer512(ptr %tmp2, ptr %tmp)
  %tmp4 = load <8 x i64>, ptr %tmp2, align 32
  store <8 x i64> %tmp4, ptr %arg, align 2
  ret void
}

; This should promote
define
  internal fastcc void @callee_avx512_legal512_prefer256_call_avx512_legal512_prefer256(ptr %arg, ptr readonly
%arg1) #1 {
; CHECK-LABEL: define {{^@}+}}@callee_avx512_legal512_prefer256_call_avx512_legal512_prefer256
; CHECK-SAME: (ptr [[ARG:%.*]], <8 x i64> [[ARG1_VAL:%.*]])
; CHECK-NEXT: bb:
; CHECK-NEXT:  store <8 x i64> [[ARG1_VAL]], ptr [[ARG]]
; CHECK-NEXT:  ret void
;
bb:
  %tmp = load <8 x i64>, ptr %arg1
  store <8 x i64> %tmp, ptr %arg
  ret void
}

```

```

define void @avx512_legal512_prefer256_call_avx512_legal512_prefer256(ptr %arg) #1 {
; CHECK-LABEL: define {{^@+}}@avx512_legal512_prefer256_call_avx512_legal512_prefer256
; CHECK-SAME: (ptr [[ARG:%.*]])
; CHECK-NEXT: bb:
; CHECK-NEXT: [[TMP:%.*]] = alloca <8 x i64>, align 32
; CHECK-NEXT: [[TMP2:%.*]] = alloca <8 x i64>, align 32
; CHECK-NEXT: call void @llvm.memset.p0.i64(ptr align 32 [[TMP]], i8 0, i64 32, i1 false)
; CHECK-NEXT: [[TMP_VAL:%.*]] = load <8 x i64>, ptr [[TMP]]
; CHECK-NEXT: call fastcc
  void @callee_avx512_legal512_prefer256_call_avx512_legal512_prefer256(ptr [[TMP2]], <8 x i64>
[[TMP_VAL]])
; CHECK-NEXT: [[TMP4:%.*]] = load <8 x i64>, ptr [[TMP2]], align 32
; CHECK-NEXT: store <8 x i64> [[TMP4]], ptr [[ARG]], align 2
; CHECK-NEXT: ret void
;
bb:
  %tmp = alloca <8 x i64>, align 32
  %tmp2 = alloca <8 x i64>, align 32
  call void @llvm.memset.p0.i64(ptr align 32 %tmp, i8 0, i64 32, i1 false)
  call fastcc void @callee_avx512_legal512_prefer256_call_avx512_legal512_prefer256(ptr %tmp2, ptr %tmp)
  %tmp4 = load <8 x i64>, ptr %tmp2, align 32
  store <8 x i64> %tmp4, ptr %arg, align 2
  ret void
}

; This should promote
define internal fastcc void @callee_avx512_legal512_prefer512_call_avx512_legal512_prefer256(ptr %arg, ptr
readonly %arg1) #1 {
; CHECK-LABEL: define {{^@+}}@callee_avx512_legal512_prefer512_call_avx512_legal512_prefer256
; CHECK-SAME: (ptr [[ARG:%.*]], <8 x i64> [[ARG1_VAL:%.*]])
; CHECK-NEXT: bb:
; CHECK-NEXT: store <8 x i64> [[ARG1_VAL]],
  ptr [[ARG]]
; CHECK-NEXT: ret void
;
bb:
  %tmp = load <8 x i64>, ptr %arg1
  store <8 x i64> %tmp, ptr %arg
  ret void
}

define void @avx512_legal512_prefer512_call_avx512_legal512_prefer256(ptr %arg) #0 {
; CHECK-LABEL: define {{^@+}}@avx512_legal512_prefer512_call_avx512_legal512_prefer256
; CHECK-SAME: (ptr [[ARG:%.*]])
; CHECK-NEXT: bb:
; CHECK-NEXT: [[TMP:%.*]] = alloca <8 x i64>, align 32
; CHECK-NEXT: [[TMP2:%.*]] = alloca <8 x i64>, align 32

```

```

; CHECK-NEXT: call void @llvm.memset.p0.i64(ptr align 32 [[TMP]], i8 0, i64 32, i1 false)
; CHECK-NEXT: [[TMP_VAL:%.*]] = load <8 x i64>, ptr [[TMP]]
; CHECK-NEXT: call fastcc void @callee_avx512_legal512_prefer512_call_avx512_legal512_prefer256(ptr
[[TMP2]], <8 x i64> [[TMP_VAL]])
; CHECK-NEXT: [[TMP4:%.*]] = load <8 x i64>, ptr [[TMP2]], align 32
; CHECK-NEXT: store <8 x i64> [[TMP4]], ptr [[ARG]], align 2
; CHECK-NEXT: ret void
;
bb:
%tmp = alloca <8 x i64>, align 32
%tmp2 = alloca <8 x i64>, align
32
call void @llvm.memset.p0.i64(ptr align 32 %tmp, i8 0, i64 32, i1 false)
call fastcc void @callee_avx512_legal512_prefer512_call_avx512_legal512_prefer256(ptr %tmp2, ptr %tmp)
%tmp4 = load <8 x i64>, ptr %tmp2, align 32
store <8 x i64> %tmp4, ptr %arg, align 2
ret void
}

```

; This should promote

```

define internal fastcc void @callee_avx512_legal512_prefer256_call_avx512_legal512_prefer512(ptr %arg, ptr
readonly %arg1) #0 {
; CHECK-LABEL: define {{^@+}}@callee_avx512_legal512_prefer256_call_avx512_legal512_prefer512
; CHECK-SAME: (ptr [[ARG:%.*]], <8 x i64> [[ARG1_VAL:%.*]])
; CHECK-NEXT: bb:
; CHECK-NEXT: store <8 x i64> [[ARG1_VAL]], ptr [[ARG]]
; CHECK-NEXT: ret void
;
bb:
%tmp = load <8 x i64>, ptr %arg1
store <8 x i64> %tmp, ptr %arg
ret void
}

```

```

define void @avx512_legal512_prefer256_call_avx512_legal512_prefer512(ptr %arg) #1 {
; CHECK-LABEL: define {{^@+}}@avx512_legal512_prefer256_call_avx512_legal512_prefer512
; CHECK-SAME: (ptr [[ARG:%.*]])
; CHECK-NEXT:
bb:
; CHECK-NEXT: [[TMP:%.*]] = alloca <8 x i64>, align 32
; CHECK-NEXT: [[TMP2:%.*]] = alloca <8 x i64>, align 32
; CHECK-NEXT: call void @llvm.memset.p0.i64(ptr align 32 [[TMP]], i8 0, i64 32, i1 false)
; CHECK-NEXT: [[TMP_VAL:%.*]] = load <8 x i64>, ptr [[TMP]]
; CHECK-NEXT: call fastcc void @callee_avx512_legal512_prefer256_call_avx512_legal512_prefer512(ptr
[[TMP2]], <8 x i64> [[TMP_VAL]])
; CHECK-NEXT: [[TMP4:%.*]] = load <8 x i64>, ptr [[TMP2]], align 32
; CHECK-NEXT: store <8 x i64> [[TMP4]], ptr [[ARG]], align 2
; CHECK-NEXT: ret void

```

```
;
bb:
%tmp = alloca <8 x i64>, align 32
%tmp2 = alloca <8 x i64>, align 32
call void @llvm.memset.p0.i64(ptr align 32 %tmp, i8 0, i64 32, i1 false)
call fastcc void @callee_avx512_legal512_prefer256_call_avx512_legal512_prefer512(ptr %tmp2, ptr %tmp)
%tmp4 = load <8 x i64>, ptr %tmp2, align 32
store <8 x i64> %tmp4, ptr %arg, align 2
ret void
}
```

; This should not promote

```
define internal fastcc void @callee_avx512_legal256_prefer256_call_avx512_legal512_prefer256(ptr
%arg, ptr readonly %arg1) #1 {
; CHECK-LABEL: define {{^(^@)+}}@callee_avx512_legal256_prefer256_call_avx512_legal512_prefer256
; CHECK-SAME: (ptr [[ARG:%.*]], ptr readonly [[ARG1:%.*]])
; CHECK-NEXT: bb:
; CHECK-NEXT: [[TMP:%.*]] = load <8 x i64>, ptr [[ARG1]]
; CHECK-NEXT: store <8 x i64> [[TMP]], ptr [[ARG]]
; CHECK-NEXT: ret void
;
bb:
%tmp = load <8 x i64>, ptr %arg1
store <8 x i64> %tmp, ptr %arg
ret void
}
```

```
define void @avx512_legal256_prefer256_call_avx512_legal512_prefer256(ptr %arg) #2 {
; CHECK-LABEL: define {{^(^@)+}}@avx512_legal256_prefer256_call_avx512_legal512_prefer256
; CHECK-SAME: (ptr [[ARG:%.*]])
; CHECK-NEXT: bb:
; CHECK-NEXT: [[TMP:%.*]] = alloca <8 x i64>, align 32
; CHECK-NEXT: [[TMP2:%.*]] = alloca <8 x i64>, align 32
; CHECK-NEXT: call void @llvm.memset.p0.i64(ptr align 32 [[TMP]], i8 0, i64 32, i1 false)
; CHECK-NEXT: call fastcc void @callee_avx512_legal256_prefer256_call_avx512_legal512_prefer256(ptr
[[TMP2]], ptr [[TMP]])
; CHECK-NEXT: [[TMP4:%.*]] = load <8 x i64>, ptr [[TMP2]], align 32
; CHECK-NEXT: store <8 x i64> [[TMP4]], ptr [[ARG]], align 2
; CHECK-NEXT: ret void
;
bb:
%tmp = alloca <8 x i64>, align 32
%tmp2 = alloca <8 x i64>, align 32
call void @llvm.memset.p0.i64(ptr align 32 %tmp, i8 0, i64 32, i1 false)
call fastcc void @callee_avx512_legal256_prefer256_call_avx512_legal512_prefer256(ptr %tmp2, ptr %tmp)
%tmp4 = load <8 x i64>, ptr %tmp2, align 32
store <8 x i64> %tmp4, ptr %arg, align 2
ret void
}
```

```
}
```

```
; This should not promote
```

```
define internal fastcc void @callee_avx512_legal512_prefer256_call_avx512_legal256_prefer256(ptr %arg, ptr  
readonly %arg1) #2 {  
; CHECK-LABEL: define {{{^@}+}}@callee_avx512_legal512_prefer256_call_avx512_legal256_prefer256  
; CHECK-SAME: (ptr [[ARG:%.*]], ptr readonly [[ARG1:%.*]])  
; CHECK-NEXT: bb:  
; CHECK-NEXT: [[TMP:%.*]] = load <8 x i64>, ptr [[ARG1]]  
; CHECK-NEXT: store <8 x i64>  
[[TMP]], ptr [[ARG]]  
; CHECK-NEXT: ret void  
;  
bb:  
%tmp = load <8 x i64>, ptr %arg1  
store <8 x i64> %tmp, ptr %arg  
ret void  
}
```

```
define void @avx512_legal512_prefer256_call_avx512_legal256_prefer256(ptr %arg) #1 {  
; CHECK-LABEL: define {{{^@}+}}@avx512_legal512_prefer256_call_avx512_legal256_prefer256  
; CHECK-SAME: (ptr [[ARG:%.*]])  
; CHECK-NEXT: bb:  
; CHECK-NEXT: [[TMP:%.*]] = alloca <8 x i64>, align 32  
; CHECK-NEXT: [[TMP2:%.*]] = alloca <8 x i64>, align 32  
; CHECK-NEXT: call void @llvm.memset.p0.i64(ptr align 32 [[TMP]], i8 0, i64 32, i1 false)  
; CHECK-NEXT: call fastcc void @callee_avx512_legal512_prefer256_call_avx512_legal256_prefer256(ptr  
[[TMP2]], ptr [[TMP]])  
; CHECK-NEXT: [[TMP4:%.*]] = load <8 x i64>, ptr [[TMP2]], align 32  
; CHECK-NEXT: store <8 x i64> [[TMP4]], ptr [[ARG]], align 2  
; CHECK-NEXT: ret void  
;  
bb:  
%tmp = alloca <8 x i64>, align 32  
%tmp2 = alloca <8 x i64>, align 32  
call void @llvm.memset.p0.i64(ptr align 32 %tmp, i8 0, i64  
32, i1 false)  
call fastcc void @callee_avx512_legal512_prefer256_call_avx512_legal256_prefer256(ptr %tmp2, ptr %tmp)  
%tmp4 = load <8 x i64>, ptr %tmp2, align 32  
store <8 x i64> %tmp4, ptr %arg, align 2  
ret void  
}
```

```
; This should promote
```

```
define internal fastcc void @callee_avx2_legal256_prefer256_call_avx2_legal512_prefer256(ptr %arg, ptr readonly  
%arg1) #3 {  
; CHECK-LABEL: define {{{^@}+}}@callee_avx2_legal256_prefer256_call_avx2_legal512_prefer256  
; CHECK-SAME: (ptr [[ARG:%.*]], <8 x i64> [[ARG1_VAL:%.*]])
```



```

; CHECK-NEXT: bb:
; CHECK-NEXT: store <8 x i64> [[ARG1_VAL]], ptr [[ARG]]
; CHECK-NEXT: ret void
;
bb:
%tmp = load <8 x i64>, ptr %arg1
store <8 x i64> %tmp, ptr %arg
ret void
}

define void @avx2_legal256_prefer256_call_avx2_legal512_prefer256(ptr %arg) #4 {
; CHECK-LABEL: define {{^[^@]+}}@avx2_legal256_prefer256_call_avx2_legal512_prefer256
; CHECK-SAME: (ptr [[ARG:%.*]])
; CHECK-NEXT: bb:
; CHECK-NEXT: [[TMP:%.*]] = alloca <8 x i64>, align 32
; CHECK-NEXT:
[[TMP2:%.*]] = alloca <8 x i64>, align 32
; CHECK-NEXT: call void @llvm.memset.p0.i64(ptr align 32 [[TMP]], i8 0, i64 32, i1 false)
; CHECK-NEXT: [[TMP_VAL:%.*]] = load <8 x i64>, ptr [[TMP]]
; CHECK-NEXT: call fastcc void @callee_avx2_legal256_prefer256_call_avx2_legal512_prefer256(ptr
[[TMP2]], <8 x i64> [[TMP_VAL]])
; CHECK-NEXT: [[TMP4:%.*]] = load <8 x i64>, ptr [[TMP2]], align 32
; CHECK-NEXT: store <8 x i64> [[TMP4]], ptr [[ARG]], align 2
; CHECK-NEXT: ret void
;
bb:
%tmp = alloca <8 x i64>, align 32
%tmp2 = alloca <8 x i64>, align 32
call void @llvm.memset.p0.i64(ptr align 32 %tmp, i8 0, i64 32, i1 false)
call fastcc void @callee_avx2_legal256_prefer256_call_avx2_legal512_prefer256(ptr %tmp2, ptr %tmp)
%tmp4 = load <8 x i64>, ptr %tmp2, align 32
store <8 x i64> %tmp4, ptr %arg, align 2
ret void
}

; This should promote
define internal fastcc void @callee_avx2_legal512_prefer256_call_avx2_legal256_prefer256(ptr %arg, ptr readonly
%arg1) #4 {
;
CHECK-LABEL: define {{^[^@]+}}@callee_avx2_legal512_prefer256_call_avx2_legal256_prefer256
; CHECK-SAME: (ptr [[ARG:%.*]], <8 x i64> [[ARG1_VAL:%.*]])
; CHECK-NEXT: bb:
; CHECK-NEXT: store <8 x i64> [[ARG1_VAL]], ptr [[ARG]]
; CHECK-NEXT: ret void
;
bb:
%tmp = load <8 x i64>, ptr %arg1
store <8 x i64> %tmp, ptr %arg

```

```

ret void
}

define void @avx2_legal512_prefer256_call_avx2_legal256_prefer256(ptr %arg) #3 {
; CHECK-LABEL: define {{{^@}+}}@avx2_legal512_prefer256_call_avx2_legal256_prefer256
; CHECK-SAME: (ptr [[ARG:%.*]])
; CHECK-NEXT: bb:
; CHECK-NEXT: [[TMP:%.*]] = alloca <8 x i64>, align 32
; CHECK-NEXT: [[TMP2:%.*]] = alloca <8 x i64>, align 32
; CHECK-NEXT: call void @llvm.memset.p0.i64(ptr align 32 [[TMP]], i8 0, i64 32, i1 false)
; CHECK-NEXT: [[TMP_VAL:%.*]] = load <8 x i64>, ptr [[TMP]]
; CHECK-NEXT: call fastcc void @callee_avx2_legal512_prefer256_call_avx2_legal256_prefer256(ptr
[[TMP2]], <8 x i64> [[TMP_VAL]])
; CHECK-NEXT: [[TMP4:%.*]] = load
<8 x i64>, ptr [[TMP2]], align 32
; CHECK-NEXT: store <8 x i64> [[TMP4]], ptr [[ARG]], align 2
; CHECK-NEXT: ret void
;
bb:
%tmp = alloca <8 x i64>, align 32
%tmp2 = alloca <8 x i64>, align 32
call void @llvm.memset.p0.i64(ptr align 32 %tmp, i8 0, i64 32, i1 false)
call fastcc void @callee_avx2_legal512_prefer256_call_avx2_legal256_prefer256(ptr %tmp2, ptr %tmp)
%tmp4 = load <8 x i64>, ptr %tmp2, align 32
store <8 x i64> %tmp4, ptr %arg, align 2
ret void
}

```

; If the arguments are scalar, its ok to promote.

```

define internal i32 @scalar_callee_avx512_legal256_prefer256_call_avx512_legal512_prefer256(ptr %X, ptr %Y)
#2 {
; CHECK-LABEL: define
{{{^@}+}}@scalar_callee_avx512_legal256_prefer256_call_avx512_legal512_prefer256
; CHECK-SAME: (i32 [[X_VAL:%.*]], i32 [[Y_VAL:%.*]])
; CHECK-NEXT: [[C:%.*]] = add i32 [[X_VAL]], [[Y_VAL]]
; CHECK-NEXT: ret i32 [[C]]
;
%A = load i32, ptr %X
%B = load i32, ptr %Y
%C = add i32 %A, %B
ret i32 %C
}

```

```

define i32 @scalar_avx512_legal256_prefer256_call_avx512_legal512_prefer256(ptr
%B) #2 {
; CHECK-LABEL: define {{{^@}+}}@scalar_avx512_legal256_prefer256_call_avx512_legal512_prefer256
; CHECK-SAME: (ptr [[B:%.*]])
; CHECK-NEXT: [[A:%.*]] = alloca i32

```

```

; CHECK-NEXT: store i32 1, ptr [[A]]
; CHECK-NEXT: [[A_VAL:%.*]] = load i32, ptr [[A]]
; CHECK-NEXT: [[B_VAL:%.*]] = load i32, ptr [[B]]
; CHECK-NEXT: [[C:%.*]] = call i32
@scalar_callee_avx512_legal256_prefer256_call_avx512_legal512_prefer256(i32 [[A_VAL]], i32 [[B_VAL]])
; CHECK-NEXT: ret i32 [[C]]
;
%A = alloca i32
store i32 1, ptr %A
%C = call i32 @scalar_callee_avx512_legal256_prefer256_call_avx512_legal512_prefer256(ptr %A, ptr %B)
ret i32 %C
}

; If the arguments are scalar, its ok to promote.
define internal i32 @scalar_callee_avx512_legal512_prefer256_call_avx512_legal256_prefer256(ptr %X, ptr %Y)
#2 {
; CHECK-LABEL: define
{{{^@+}}}@scalar_callee_avx512_legal512_prefer256_call_avx512_legal256_prefer256
; CHECK-SAME: (i32 [[X_VAL:%.*]],
i32 [[Y_VAL:%.*]])
; CHECK-NEXT: [[C:%.*]] = add i32 [[X_VAL]], [[Y_VAL]]
; CHECK-NEXT: ret i32 [[C]]
;
%A = load i32, ptr %X
%B = load i32, ptr %Y
%C = add i32 %A, %B
ret i32 %C
}

define i32 @scalar_avx512_legal512_prefer256_call_avx512_legal256_prefer256(ptr %B) #2 {
; CHECK-LABEL: define {{{^@+}}}@scalar_avx512_legal512_prefer256_call_avx512_legal256_prefer256
; CHECK-SAME: (ptr [[B:%.*]])
; CHECK-NEXT: [[A:%.*]] = alloca i32
; CHECK-NEXT: store i32 1, ptr [[A]]
; CHECK-NEXT: [[A_VAL:%.*]] = load i32, ptr [[A]]
; CHECK-NEXT: [[B_VAL:%.*]] = load i32, ptr [[B]]
; CHECK-NEXT: [[C:%.*]] = call i32
@scalar_callee_avx512_legal512_prefer256_call_avx512_legal256_prefer256(i32 [[A_VAL]], i32 [[B_VAL]])
; CHECK-NEXT: ret i32 [[C]]
;
%A = alloca i32
store i32 1, ptr %A
%C = call i32 @scalar_callee_avx512_legal512_prefer256_call_avx512_legal256_prefer256(ptr %A, ptr %B)
ret i32 %C
}

; Function Attrs: argmemonly nounwind
declare void @llvm.memset.p0.i64(ptr

```

nocapture writeonly, i8, i64, i1) #5

```
attributes #0 = { inlinehint norecurse nounwind uwtable "target-features"="+avx512vl" "min-legal-vector-width"="512" "prefer-vector-width"="512" }
attributes #1 = { inlinehint norecurse nounwind uwtable "target-features"="+avx512vl" "min-legal-vector-width"="512" "prefer-vector-width"="256" }
attributes #2 = { inlinehint norecurse nounwind uwtable "target-features"="+avx512vl" "min-legal-vector-width"="256" "prefer-vector-width"="256" }
attributes #3 = { inlinehint norecurse nounwind uwtable "target-features"="+avx2" "min-legal-vector-width"="512" "prefer-vector-width"="256" }
attributes #4 = { inlinehint norecurse nounwind uwtable "target-features"="+avx2" "min-legal-vector-width"="256" "prefer-vector-width"="256" }
attributes #5 = { argmemonly nounwind }
; NOTE: Assertions have been autogenerated by utils/update_llc_test_checks.py
; RUN: llc -mtriple=riscv64 -mattr=+zbc -verify-machineinstrs < %s \
; RUN: -riscv-experimental-rv64-legal-i32 | FileCheck %s -check-prefix=RV64ZBC-ZBKC
; RUN: llc -mtriple=riscv64 -mattr=+zbbc -verify-machineinstrs < %s \
; RUN: -riscv-experimental-rv64-legal-i32 | FileCheck %s -check-prefix=RV64ZBC-ZBKC
```

```
declare i64 @llvm.riscv.clmul.i64(i64 %a, i64 %b)
```

```
define i64 @clmul64(i64 %a, i64 %b) nounwind {
; RV64ZBC-ZBKC-LABEL: clmul64:
; RV64ZBC-ZBKC:      # %bb.0:
; RV64ZBC-ZBKC-NEXT:  clmul a0, a0, a1
; RV64ZBC-ZBKC-NEXT:  ret
  %tmp = call i64 @llvm.riscv.clmul.i64(i64 %a, i64 %b)
  ret i64 %tmp
}
```

```
declare i64 @llvm.riscv.clmulh.i64(i64 %a, i64 %b)
```

```
define i64 @clmul64h(i64 %a, i64 %b) nounwind {
; RV64ZBC-ZBKC-LABEL: clmul64h:
; RV64ZBC-ZBKC:      # %bb.0:
; RV64ZBC-ZBKC-NEXT:  clmulh a0, a0, a1
; RV64ZBC-ZBKC-NEXT:  ret
  %tmp = call i64 @llvm.riscv.clmulh.i64(i64 %a, i64 %b)
  ret i64 %tmp
}
```

```
declare
```

```
i32 @llvm.riscv.clmul.i32(i32 %a, i32 %b)
```

```
define signext i32 @clmul32(i32 signext %a, i32 signext %b) nounwind {
; RV64ZBC-ZBKC-LABEL: clmul32:
; RV64ZBC-ZBKC:      # %bb.0:
; RV64ZBC-ZBKC-NEXT:  clmul a0, a0, a1
```

```

; RV64ZBC-ZBKC-NEXT:  sext.w a0, a0
; RV64ZBC-ZBKC-NEXT:  ret
%tmp = call i32 @llvm.riscv.clmul.i32(i32 %a, i32 %b)
ret i32 %tmp
}

declare i32 @llvm.riscv.clmulh.i32(i32 %a, i32 %b)

define signext i32 @clmul32h(i32 signext %a, i32 signext %b) nounwind {
; RV64ZBC-ZBKC-LABEL: clmul32h:
; RV64ZBC-ZBKC:      # %bb.0:
; RV64ZBC-ZBKC-NEXT:  slli a1, a1, 32
; RV64ZBC-ZBKC-NEXT:  slli a0, a0, 32
; RV64ZBC-ZBKC-NEXT:  clmulh a0, a0, a1
; RV64ZBC-ZBKC-NEXT:  srai a0, a0, 32
; RV64ZBC-ZBKC-NEXT:  ret
%tmp = call i32 @llvm.riscv.clmulh.i32(i32 %a, i32 %b)
ret i32 %tmp
}

; FIXME: We could avoid the slli instructions by using clmul+srai since the
; inputs are zero extended.
define signext i32 @clmul32h_zext(i32 zeroext %a, i32 zeroext %b) nounwind {
;
; RV64ZBC-ZBKC-LABEL: clmul32h_zext:
; RV64ZBC-ZBKC:      # %bb.0:
; RV64ZBC-ZBKC-NEXT:  slli a1, a1, 32
; RV64ZBC-ZBKC-NEXT:  slli a0, a0, 32
; RV64ZBC-ZBKC-NEXT:  clmulh a0, a0, a1
; RV64ZBC-ZBKC-NEXT:  srai a0, a0, 32
; RV64ZBC-ZBKC-NEXT:  ret
%tmp = call i32 @llvm.riscv.clmulh.i32(i32 %a, i32 %b)
ret i32 %tmp
}

static_library("BSD-Archive") {
  output_name = "lldbPluginObjectContainerBSDArchive"
  configs += [ "//llvm/utils/gn/build:lldb_code" ]
  deps = [
    "//lldb/source/Core",
    "//lldb/source/Host",
    "//lldb/source/Symbol",
    "//llvm/lib/Support",
  ]
  sources = [ "ObjectContainerBSDArchive.cpp" ]
}

; RUN: opt -mtriple=aarch64-linux-gnu -mattr=+sve -passes=sanitize-masked-mem-intrin -S < %s | FileCheck %s

; Testing that masked gathers operating on scalable vectors that are

```

; packed in SVE registers are not scalarized.

```
; CHECK-LABEL: @masked_gather_nxv4i32(  
; CHECK: call <vscale x 4 x i32> @llvm.masked.gather.nxv4i32  
define <vscale x 4 x i32> @masked_gather_nxv4i32(<vscale x 4 x ptr> %ld, <vscale x 4 x i1> %masks, <vscale x 4  
x i32> %passthru) {  
    %res = call <vscale x 4 x i32> @llvm.masked.gather.nxv4i32(<vscale x 4 x ptr> %ld, i32 0, <vscale x 4 x i1>  
    %masks, <vscale x 4 x i32> %passthru)  
    ret <vscale x 4 x i32> %res  
}
```

; Testing that masked gathers operating on scalable vectors of FP data  
; that is packed in SVE registers are not scalarized.

```
; CHECK-LABEL: @masked_gather_nxv2f64(  
; CHECK: call <vscale x 2 x double> @llvm.masked.gather.nxv2f64  
define <vscale x 2 x double> @masked_gather_nxv2f64(<vscale x 2 x ptr> %ld, <vscale x 2 x i1> %masks, <vscale  
x 2 x double> %passthru)  
{  
    %res = call <vscale x 2 x double> @llvm.masked.gather.nxv2f64(<vscale x 2 x ptr> %ld, i32 0, <vscale x 2 x i1>  
    %masks, <vscale x 2 x double> %passthru)  
    ret <vscale x 2 x double> %res  
}
```

; Testing that masked gathers operating on scalable vectors of FP data  
; that is unpacked in SVE registers are not scalarized.

```
; CHECK-LABEL: @masked_gather_nxv2f16(  
; CHECK: call <vscale x 2 x half> @llvm.masked.gather.nxv2f16  
define <vscale x 2 x half> @masked_gather_nxv2f16(<vscale x 2 x ptr> %ld, <vscale x 2 x i1> %masks, <vscale x  
2 x half> %passthru) {  
    %res = call <vscale x 2 x half> @llvm.masked.gather.nxv2f16(<vscale x 2 x ptr> %ld, i32 0, <vscale x 2 x i1>  
    %masks, <vscale x 2 x half> %passthru)  
    ret <vscale x 2 x half> %res  
}
```

; Testing that masked gathers operating on 64-bit fixed vectors are  
; scalarized because NEON doesn't have support for masked gather  
; instructions.

```
; CHECK-LABEL: @masked_gather_v2f32(  
; CHECK-NOT: @llvm.masked.gather.v2f32(  
define <2 x float> @masked_gather_v2f32(<2  
x ptr> %ld, <2 x i1> %masks, <2 x float> %passthru) {  
    %res = call <2 x float> @llvm.masked.gather.v2f32(<2 x ptr> %ld, i32 0, <2 x i1> %masks, <2 x float> %passthru)  
    ret <2 x float> %res  
}
```

```

; Testing that masked gathers operating on 128-bit fixed vectors are
; scalarized because NEON doesn't have support for masked gather
; instructions and because we are not targeting fixed width SVE.

; CHECK-LABEL: @masked_gather_v4i32(
; CHECK-NOT: @llvm.masked.gather.v4i32(
define <4 x i32> @masked_gather_v4i32(<4 x ptr> %ld, <4 x i1> %masks, <4 x i32> %passthru) {
    %res = call <4 x i32> @llvm.masked.gather.v4i32(<4 x ptr> %ld, i32 0, <4 x i1> %masks, <4 x i32> %passthru)
    ret <4 x i32> %res
}

declare <vscale x 4 x i32> @llvm.masked.gather.nxv4i32(<vscale x 4 x ptr> %ptrs, i32 %align, <vscale x 4 x i1>
%.masks, <vscale x 4 x i32> %passthru)
declare <vscale x 2 x double> @llvm.masked.gather.nxv2f64(<vscale x 2 x ptr> %ptrs, i32 %align, <vscale x 2 x
i1> %masks, <vscale x 2 x double>
%passthru)
declare <vscale x 2 x half> @llvm.masked.gather.nxv2f16(<vscale x 2 x ptr> %ptrs, i32 %align, <vscale x 2 x i1>
%.masks, <vscale x 2 x half> %passthru)
declare <2 x float> @llvm.masked.gather.v2f32(<2 x ptr> %ptrs, i32 %align, <2 x i1> %masks, <2 x float>
%passthru)
declare <4 x i32> @llvm.masked.gather.v4i32(<4 x ptr> %ptrs, i32 %align, <4 x i1> %masks, <4 x i32> %passthru)

```

## 1.89 curl-zsh-completion 8.12.1-r1

### 1.89.1 Available under license :

```

# Maintainer: psykose <alice@ayaya.dev>
pkgname=cargo-license
pkgver=0.5.1
pkgrel=1
pkgdesc="Cargo subcommand to see license of dependencies"
url="https://github.com/onur/cargo-license"
arch="all !s390x !riscv64" # rust
license="MIT"
makedepends="cargo"
source="$pkgname-$pkgver.tar.gz::https://crates.io/api/v1/crates/cargo-license/$pkgver/download"

```

```

prepare() {
    default_prepare

    cargo fetch --target="$CTARGET" --locked
}

build() {
    cargo build --release --frozen
}

```

```

check() {
    cargo test --frozen
}

package() {
    install -Dm755 target/release/cargo-license -t "$pkgdir"/usr/bin
}

sha512sums="
4d8d430df91c6aac53d2305d3125eae492324e85c4db29d33d452b3848f33a55088e71247c6c72c6a62f4e924a374a
115bf14b4f398e7950b9eb52415f2244 cargo-license-0.5.1.tar.gz
"

```

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 Parts Copyright (c) 1991 by Paul King  
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 The text rotation code in w\_rottext.c was written by Alan Richardson.  
 The above copyright notice holds for this work as well.

Parts Copyright (c) 1994 by Anthony Dekker  
 The Kohonen neural network code for color optimization was written by Anthony Dekker.

Parts Copyright (c) 1995 by C. Blanc and C. Schlick  
 The X-Spline code was written Carole Blanc (blanc@labri.u-bordeaux.fr) and Christophe Schlick (schlick@labri.u-bordeaux.fr) starting from an initial implementation done by C. Feuille, S. Grosbois, L. Maziere and L. Minihot as a student practice (Universite Bordeaux, France). For additional information about X-splines, see:

"X-Splines: A Spline Model Designed for the End User" by C. Blanc and C. Schlick, Proceedings of SIGGRAPH'95  
<http://dept-info.labri.u-bordeaux.fr/~schlick/DOC/sig1.html>

```

# Automatically generated by apkbuild-cpan, template 1
# Contributor: Valery Kartel <valery.kartel@gmail.com>
# Maintainer: Valery Kartel <valery.kartel@gmail.com>
pkgname=perl-bsd-resource
_pkgreal=BSD-Resource
pkgver=1.2911
pkgrel=7

```



```

pkgdesc="Perl extension implements the BSD process resource limit functions"
url="https://metacpan.org/release/BSD-Resource"
arch="all"
license="GPL-1.0-or-later OR Artistic-1.0-Perl"
makedepends="perl-dev"
subpackages="$pkgname-doc"
source="https://cpan.metacpan.org/authors/id/J/JH/JHI/${_pkgreal}-${pkgver}.tar.gz"

buildddir="${srcdir}/${_pkgreal}-${pkgver}"

prepare() {
    default_prepare

    export CFLAGS=$(perl -MConfig -E 'say $Config{ccflags}')
    PERL_MM_USE_DEFAULT=1 perl Makefile.PL INSTALLDIRS=vendor
}

build() {
    export CFLAGS=$(perl -MConfig -E 'say $Config{ccflags}')
    make
}

check() {
    make test
}

package() {
    make DESTDIR="$pkgdir" install
    find "$pkgdir" \( -name perllocal.pod -o -name .packlist \) -delete
}

sha512sums="d0032d41c7c0468ed1c6d8f57b885f6cb97a5039d754c8cb60b2067daedaf53bd15fb6561a3d0f828df16
dfa5417f663b8065ba65f4fea16dc9262728b3b6b85
    BSD-Resource-1.2911.tar.gz"
# Contributor: Dhruvin Gandhi <contact@dhruvin.dev>
# Maintainer: Patrycja Rosa <alpine@ptrcnull.me>
pkgname=py3-license-expression
_pkgname=license-expression
pkgver=30.1.0
pkgrel=1
pkgdesc="Library to parse, compare, simplify and normalize license expressions"
url="https://github.com/nexB/license-expression"
arch="noarch"
license="Apache-2.0"
depends="python3 py3-boolean.py"
makedepends="py3-setuptools py3-setuptools_scm py3-gpep517 py3-wheel"
checkdepends="py3-pytest py3-pytest-xdist"
subpackages="$pkgname-pyc"

```

```
source="https://files.pythonhosted.org/packages/source/l/${_pkgname}/${_pkgname}-${pkgver}.tar.gz"
```

```
builddir="$srcdir/${_pkgname}-${pkgver}"
```

```
build() {  
  gpep517 build-wheel \  
    --wheel-dir dist \  
    --output-fd 3 3>&1 >&2  
}
```

```
check() {  
  python3 -m venv --clear --without-pip --system-site-packages testenv  
  testenv/bin/python3 -m installer dist/*.whl  
  testenv/bin/python3 -m pytest  
}
```

```
package() {  
  python3 -m installer -d "$pkgdir" \  
    dist/*.whl  
}
```

```
sha512sums="
```

```
8d05a04a2b753be1a50d58b622d9493948f0c70d834ee871e2814a1fcbdab6177a10733d6f1a8a19bd9cb741e2b5fe6e  
dc73e8d15fb61f952283aa8053fc7090
```

```
  license-expression-30.1.0.tar.gz
```

```
"
```

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# 1.90 apk-tools-zsh-completion 2.14.6-r3

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- c) You must cause the whole of the work to be licensed at no charge to all third parties under the terms of this License.
- d) If a facility in the modified Library refers to a function or a table of data to be supplied by an application program that uses the facility, other than as an argument passed when the facility is invoked, then you must make a good faith effort to ensure that, in the event an application does not supply such function or table, the facility still operates, and performs whatever part of its purpose remains meaningful.

(For example, a function in a library to compute square roots has a purpose that is entirely well-defined independent of the application. Therefore, Subsection 2d requires that any application-supplied function or table used by this function must be optional: if the application does not supply it, the square root function must still compute square roots.)

These requirements apply to the modified work as a whole. If identifiable sections of that work are not derived from the Library, and can be reasonably considered independent and separate works in themselves,

then this License, and its terms, do not apply to those sections when you distribute them as separate works. But when you distribute the same sections as part of a whole which is a work based on the Library, the distribution of the whole must be on the terms of this License, whose permissions for other licensees extend to the entire whole, and thus to each and every part regardless of who wrote it.

Thus, it is not the intent of this section to claim rights or contest your rights to work written entirely by you; rather, the intent is to exercise the right to control the distribution of derivative or collective works based on the Library.

In addition, mere aggregation of another work not based on the Library

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Once this change is made in a given copy, it is irreversible for that copy, so the ordinary GNU General Public License applies to all subsequent copies and derivative works made from that copy.

This option is useful when you wish to copy part of the code of the Library into a program that is not a library.

4. You may copy and distribute the Library (or a portion or derivative of it, under Section 2) in object code or executable form under the terms of Sections 1 and 2 above provided that you accompany it with the complete corresponding machine-readable source code, which must be distributed under the terms of Sections 1 and 2 above on a medium customarily used for software interchange.

If distribution of object code is made by offering access to copy from a designated place, then offering equivalent access to copy the source code from the same place satisfies the requirement to distribute the source code, even though third parties are not compelled to copy the source along with the object code.

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Section 6 states terms for distribution of such executables.

When a "work that uses the Library" uses material from a header file that is part of the Library, the object code for the work may be a derivative work of the Library even though the source code is not. Whether this is true is especially significant if the work can be linked without the Library, or if the work is itself a library. The threshold for this to be true is not precisely defined by law.

If such an object file uses only numerical parameters, data structure layouts and accessors, and small macros and small inline functions (ten lines or less in length), then the use of the object file is unrestricted, regardless of whether it is legally a derivative work. (Executables containing this object code plus portions of the Library will still fall under Section 6.)

Otherwise, if the work is a derivative of the Library, you may distribute the object code for the work under the terms of Section 6. Any executables containing that work also fall under Section 6, whether or not they are linked directly with the Library itself.

6. As an exception to the Sections above, you may also combine or link a "work that uses the Library" with the Library to produce a work containing portions of the Library, and distribute that work under terms of your choice, provided that the terms permit modification of the work for the customer's own use and reverse engineering for debugging such modifications.

You must give prominent notice with each copy of the work that the Library is used in it and that the Library and its use are covered by this License. You must supply a copy of this License. If the work during execution displays copyright notices, you must include the copyright notice for the Library among them, as well as a reference directing the user to the copy of this License. Also, you must do one of these things:

- a) Accompany the work with the complete corresponding machine-readable source code for the Library including whatever changes were used in the work (which must be distributed under Sections 1 and 2 above); and, if the work is an executable linked with the Library, with the complete machine-readable "work that uses the Library", as object code and/or source code, so that the user can modify the Library and then relink to produce a modified executable containing the modified Library. (It is understood that the user who changes the contents of definitions files in the Library will not necessarily be able to recompile the application to use the modified definitions.)

- b) Use a suitable shared library mechanism for linking with the Library. A suitable mechanism is one that (1) uses at run time a copy of the library already present on the user's computer system, rather than copying library functions into the executable, and (2) will operate properly with a modified version of the library, if the user installs one, as long as the modified version is interface-compatible with the version that the work was made with.
- c) Accompany the work with a written offer, valid for at least three years, to give the same user the materials specified in Subsection 6a, above, for a charge no more than the cost of performing this distribution.
- d) If distribution of the work is made by offering access to copy from a designated place, offer equivalent access to copy the above specified materials from the same place.
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Sections above.

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<one line to give the library's name and a brief idea of what it does.>  
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Also add information on how to contact you by electronic and paper mail.

You should also  
get your employer (if you work as a programmer) or your  
school, if any, to sign a "copyright disclaimer" for the library, if  
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Yoyodyne, Inc., hereby disclaims all copyright interest in the  
library `Frob' (a library for tweaking knobs) written by James Random Hacker.

<signature of Ty Coon>, 1 April 1990  
Ty Coon, President of Vice

That's all there is to it!  
\*uganda.txt\* For Vim version 9.1. Last change: 2024 Aug 14

VIM REFERENCE MANUAL by Bram Moolenaar

\*uganda\* \*Uganda\* \*copying\* \*copyright\* \*license\*  
SUMMARY  
\*iccf\* \*ICCF\*

Vim is Charityware. You can use and copy it as much as you like, but you are  
encouraged to make a donation for needy children in Uganda. Please see |kcc|  
below or visit the ICCF web site, available at these URLs:

<https://iccf-holland.org/>  
<https://www.vim.org/iccf/>  
<https://www.iccf.nl/>

You can also sponsor the development of Vim, see |sponsor|. The money goes to  
Uganda anyway.

The Open Publication License applies to the Vim documentation, see  
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=== begin of license ===

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II) It is allowed to distribute a modified (or extended) version of Vim, including executables and/or source code, when the following four conditions are met:

- 1) This license text must be included unmodified.
- 2) The modified Vim must be distributed in one of the following five ways:
  - a) If you make changes to Vim yourself, you must clearly describe in the distribution how to contact you. When the maintainer asks you (in any way) for a copy of the modified Vim you distributed, you must make your changes, including source code, available to the maintainer without fee. The maintainer reserves the right to include your changes in the official version of Vim. What the maintainer will do with your changes and under what license they will be distributed is negotiable. If there has been no negotiation then this license, or a later version,

also applies to your changes.

The current maintainers are listed here: <https://github.com/orgs/vim/people>.

If this changes it will be announced in appropriate places (most likely [vim.sf.net](http://vim.sf.net), [www.vim.org](http://www.vim.org) and/or [comp.editors](http://comp.editors)). When it is completely impossible to contact the maintainer, the obligation to send him your changes ceases. Once the maintainer has confirmed that he has received your changes they will not have to be sent again.

- b) If you have received a modified Vim that was distributed as mentioned under a) you are allowed to further distribute it unmodified, as mentioned at I). If you make additional changes the text under a) applies to those changes.

- c) Provide all the changes, including source code, with every copy of the modified Vim you distribute. This may be done in the form of a context diff. You can choose what license to use for new code you add. The changes and their license must not restrict others from making

their own changes to the official version of Vim.

- d) When you have a modified Vim which includes changes as mentioned under c), you can distribute it without the source code for the changes if the following three conditions are met:

- The license that applies to the changes permits you to distribute the changes to the Vim maintainer without fee or restriction, and

permits the Vim maintainer to include the changes in the official version of Vim without fee or restriction.

- You keep the changes for at least three years after last distributing the corresponding modified Vim. When the maintainer or someone who you distributed the modified Vim to asks you (in any way) for the changes within this period, you must make them available to him.
- You clearly describe in the distribution how to contact you. This contact information must remain valid for at least three years after last distributing the corresponding modified

Vim, or as long

as possible.

e) When the GNU General Public License (GPL) applies to the changes, you can distribute the modified Vim under the GNU GPL version 2 or any later version.

- 3) A message must be added, at least in the output of the ":version" command and in the intro screen, such that the user of the modified Vim is able to see that it was modified. When distributing as mentioned under 2)e) adding the message is only required for as far as this does not conflict with the license used for the changes.
- 4) The contact information as required under 2)a) and 2)d) must not be removed or changed, except that the person himself can make corrections.

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If the number of changes is small (e.g., a modified Makefile) e-mailing a context diff will do. The e-mail address to be used is  
<maintainer@vim.org>

IV) It is not allowed to remove this license from the distribution of the Vim sources, parts of it or from a modified version. You may use this license for previous Vim releases instead of the license that they came with, at your option.

=== end of license ===

Note:

- If you are happy with Vim, please express that by reading the rest of this file and consider helping needy children in Uganda.
- If you want to support further Vim development consider becoming a [sponsor]. The money goes to Uganda anyway.

- According to Richard Stallman the Vim license is GNU GPL compatible. A few minor changes have been made since he checked it, but that should not make a difference.
- If you link Vim with a library that goes under the GNU GPL, this limits further distribution to the GNU GPL. Also when you didn't actually change anything in Vim.
- Once a change is included that goes under the GNU GPL, this forces all further changes to also be made under the GNU GPL or a compatible license.
- If you distribute a modified version of Vim, you can include your name and contact information with the "--with-modified-by" configure argument or the MODIFIED\_BY define.

=====

Kibaale Children's Centre \*kcc\* \*Kibaale\* \*charity\*

Kibaale Children's Centre (KCC) is located in Kibaale, a small town in the south of Uganda, near Tanzania, in East Africa. The area is known as Rakai District. The population is mostly farmers. Although people are poor, there usually is enough food. But this district is suffering from AIDS more than any other part of the world. Some say that it started there. Estimations are that in the past 10 to 30% of the Ugandans are infected with HIV. Because parents die, there are many orphans. In this district about 60,000 children have lost one or both parents, out of a population of 350,000. Although AIDS is now mostly under control, the problems are still continuing.

The children need a lot of help. The KCC is working hard to provide the needy with food, medical care and education. Food and medical care to keep them healthy now, and education so that they can take care of themselves in the future. KCC works on a Christian base, but help is given to children of any religion.

The key to solving the problems in this area is education. This has been neglected in the past years with president Idi Amin and the following civil wars. Now that the government is stable again, the children and parents have to learn how to take care of themselves and how to avoid infections. There is also help for people who are ill and hungry, but the primary goal is to prevent people from getting ill and to teach them how to grow healthy food.

Most of the orphans are living in an extended family. An uncle or older sister is taking care of them. Because these families are big and the income (if any) is low, a child is lucky if it gets healthy food. Clothes, medical care and schooling is beyond its reach. To help these needy children, a

sponsorship program was put into place. A child can be financially adopted. For a few dollars a month KCC sees to it that the child gets indispensable items, is healthy, goes to school and KCC takes care of anything else that needs to be done for the child and the family that supports it.

Besides helping the child directly, the environment where the child grows up needs to be improved. KCC helps schools to improve their teaching methods. There is a demonstration school at the centre and teacher trainings are given. Health workers are being trained, hygiene education is carried out and households are stimulated to build a proper latrine. I helped setting up a production site for cement slabs. These are used to build a good latrine. They are sold below cost price.

There is a clinic at the project, which provides children and their family medical help. Since 2020 a maternity ward was added and 24/7 service is available. When needed, transport to a hospital is offered. Immunization programs are carried out and help is provided when an epidemic is breaking out (measles and cholera have been a problem).

*\*donate\**

Summer 1994 to summer 1995 I spent a whole year at the centre, working as a volunteer. I have helped to expand the centre and worked in the area of water and sanitation. I learned that the help that the KCC provides really helps. When I came back to Holland, I wanted to continue supporting KCC. To do this I'm raising funds and organizing the sponsorship program. Please consider one of these possibilities:

1. Sponsor a child in primary school: 17 euro a month (or more).
2. Sponsor a child in secondary school: 25 euro a month (or more).
3. Sponsor the clinic:  
Any amount a month or quarter
4. A one-time donation

Compared with other organizations that do child sponsorship the amounts are very low. This is because the money goes directly to the centre. Less than 5% is used for administration. This is possible because this is a small organization that works with volunteers. If you would like to sponsor a child, you should have the intention to do this for at least one year.

How do you know that the money will be spent right? First of all you have my personal guarantee as the author of Vim. I trust the people that are working at the centre, I know them personally. Furthermore, the centre has been co-sponsored and inspected by World Vision, Save the Children Fund and is now under the supervision of Pacific Academy Outreach Society. The centre is visited about once a year to check the progress (at our own cost). I have visited the centre myself many times, starting in 1993. The visit reports are on the ICCF web site.

If you have  
any further questions, send e-mail: <Bram@vim.org>.

The address of the centre is:  
Kibaale Children's Centre  
p.o. box 1658  
Masaka, Uganda, East Africa

Sending money:    \*iccf-donations\*

Check the ICCF web site for the latest information! See |iccf| for the URL.

USA: The methods mentioned below can be used.  
If you must send a check send it to our Canadian partner:  
<https://www.kuwasha.net/>

Canada: Contact Kuwasha in Surrey, Canada. They take care of the  
Canadian sponsors for the children in Kibaale. Kuwasha  
forwards 100% of the money to the project in Uganda. You can  
send them a one time donation directly.  
Look on their site for information about sponsorship:  
<https://www.kuwasha.net/>  
If you make a donation to Kuwasha you will receive a tax  
receipt which can be submitted with your tax return.

Holland: Transfer to the account of "Stichting ICCF Holland" in  
Amersfoort. This will allow for tax deduction if you live in  
Holland. ING bank, IBAN: NL95  
INGB 0004 5487 74

Germany: It is possible to make donations that allow for a tax return.  
Check the ICCF web site for the latest information:  
<https://iccf-holland.org/germany.html>

Europe: Use a bank transfer if possible. See "Others" below for the  
swift code and IBAN number.  
Any other method should work. Ask for information about  
sponsorship.

Credit Card: You can use PayPal to send money with a Credit card. This is  
the most widely used Internet based payment system. It's  
really simple to use. Use this link to find more info:  
[https://www.paypal.com/en\\_US/mrb/pal=XAC62PML3GF8Q](https://www.paypal.com/en_US/mrb/pal=XAC62PML3GF8Q)  
The e-mail address for sending the money to is:  
[Bram@iccf-holland.org](mailto:Bram@iccf-holland.org)

Others: Transfer to this account if possible:

ING bank: IBAN: NL95 INGB 0004 5487 74  
Swift code: INGBNL2A  
under the name "stichting ICCF Holland", Amersfoort  
Checks are not accepted.

vim:tw=78:ts=8:noet:ft=help:norl:

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  - e) When the GNU General Public License (GPL) applies to the changes, you can distribute the modified Vim under the GNU GPL version 2 or any later version.
- 3) A message must be added, at least in the output of the ":version" command and in the intro screen, such that the user of the modified Vim is able to see that it was modified. When distributing as mentioned under 2)e) adding the message is only required for as far as this does not conflict with the license used for the changes.
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## 1.92 vim-common 9.1.1105-r0

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<signature of Ty Coon>, 1 April 1990  
Ty Coon, President of Vice

That's all there is to it!  
\*uganda.txt\* For Vim version 9.1. Last change: 2024 Aug 14

VIM REFERENCE MANUAL by Bram Moolenaar

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SUMMARY  
\*iccf\* \*ICCF\*

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encouraged to make a donation for needy children in Uganda. Please see |kcc|  
below or visit the ICCF web site, available at these URLs:

<https://iccf-holland.org/>  
<https://www.vim.org/iccf/>  
<https://www.iccf.nl/>

You can also sponsor the development of Vim, see |sponsor|. The money goes to  
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examples and Vim scripts.

II) It is allowed to distribute a modified (or extended) version of Vim,



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also applies to your changes.

The current maintainers are listed here: <https://github.com/orgs/vim/people>.

If this changes it will be announced in appropriate places (most likely [vim.sf.net](http://vim.sf.net), [www.vim.org](http://www.vim.org) and/or [comp.editors](http://comp.editors)). When it is completely impossible to contact the maintainer, the obligation to send him your changes ceases. Once the maintainer has confirmed that he has received your changes they will not have to be sent again.

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- You clearly describe in the distribution how to contact you. This contact information must remain valid for at least three years after last distributing the corresponding modified

Vim, or as long  
as possible.

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If the number of changes is small (e.g., a modified Makefile) e-mailing a context diff will do. The e-mail address to be used is  
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=== end of license ===

Note:

- If you are happy with Vim, please express that by reading the rest of this file and consider helping needy children in Uganda.
- If you want to support further Vim development consider becoming a [sponsor]. The money goes to Uganda anyway.
- According to Richard Stallman the Vim license is GNU GPL compatible. A few minor changes have been made since he checked it, but that should not make a difference.
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- Once a change is included that goes under the GNU GPL, this forces all further changes to also be made under the GNU GPL or a compatible license.
- If you distribute a modified version of Vim, you can include your name and

contact information with the "--with-modified-by" configure argument or the MODIFIED\_BY define.

=====

Kibaale Children's Centre \*kcc\* \*Kibaale\* \*charity\*

Kibaale Children's Centre (KCC) is located in Kibaale, a small town in the south of Uganda, near Tanzania, in East Africa. The area is known as Rakai District. The population is mostly farmers. Although people are poor, there usually is enough food. But this district is suffering from AIDS more than any other part of the world. Some say that it started there. Estimations are that in the past 10 to 30% of the Ugandans are infected with HIV. Because parents die, there are many orphans. In this district about 60,000 children have lost one or both parents, out of a population of 350,000. Although AIDS is now mostly under control, the problems are still continuing.

The children need a lot of help. The KCC is working hard to provide the needy with food, medical care and education. Food and medical care to keep them healthy now, and education so that they can take care of themselves in the future. KCC works on a Christian base, but help is given to children of any religion.

The key to solving the problems in this area is education. This has been neglected in the past years with president Idi Amin and the following civil wars. Now that the government is stable again, the children and parents have to learn how to take care of themselves and how to avoid infections. There is also help for people who are ill and hungry, but the primary goal is to prevent people from getting ill and to teach them how to grow healthy food.

Most of the orphans are living in an extended family. An uncle or older sister is taking care of them. Because these families are big and the income (if any) is low, a child is lucky if it gets healthy food. Clothes, medical care and schooling is beyond its reach. To help these needy children, a sponsorship program was put into place. A child can be financially adopted. For a few dollars a month KCC sees to it that the child gets indispensable items, is healthy, goes to school and KCC takes care of anything else that needs to be done for the child and the family that supports it.

Besides helping the child directly, the environment where the child grows up needs to be improved. KCC helps schools to improve their teaching methods. There is a demonstration school at the centre and teacher trainings are given. Health workers are being trained, hygiene education is carried out and households are stimulated to build a proper latrine. I helped setting up a production site for cement slabs. These are used to build a good latrine. They are sold below cost price.

There is a clinic at the project, which provides children and their family medical help. Since 2020 a maternity ward was added and 24/7 service is available. When needed, transport to a hospital is offered. Immunization programs are carried out and help is provided when an epidemic is breaking out (measles and cholera have been a problem).

*\*donate\**

Summer 1994 to summer 1995 I spent a whole year at the centre, working as a volunteer. I have helped to expand the centre and worked in the area of water and sanitation. I learned that the help that the KCC provides really helps. When I came back to Holland, I wanted to continue supporting KCC. To do this I'm raising funds and organizing the sponsorship program. Please consider one of these possibilities:

1. Sponsor a child in primary school: 17 euro a month (or more).
2. Sponsor a child in secondary school: 25 euro a month (or more).
3. Sponsor the clinic:  
Any amount a month or quarter
4. A one-time donation

Compared with other organizations that do child sponsorship the amounts are very low. This is because the money goes directly to the centre. Less than 5% is used for administration. This is possible because this is a small organization that works with volunteers. If you would like to sponsor a child, you should have the intention to do this for at least one year.

How do you know that the money will be spent right? First of all you have my personal guarantee as the author of Vim. I trust the people that are working at the centre, I know them personally. Furthermore, the centre has been co-sponsored and inspected by World Vision, Save the Children Fund and is now under the supervision of Pacific Academy Outreach Society. The centre is visited about once a year to check the progress (at our own cost). I have visited the centre myself many times, starting in 1993. The visit reports are on the ICCF web site.

If you have  
any further questions, send e-mail: <Bram@vim.org>.

The address of the centre is:  
Kibaale Children's Centre  
p.o. box 1658  
Masaka, Uganda, East Africa

Sending money: *\*iccf-donations\**

Check the ICCF web site for the latest information! See [|iccf|](#) for the URL.

USA: The methods mentioned below can be used.

If you must send a check send it to our Canadian partner:

<https://www.kuwasha.net/>

Canada: Contact Kuwasha in Surrey, Canada. They take care of the Canadian sponsors for the children in Kibaale. Kuwasha forwards 100% of the money to the project in Uganda. You can send them a one time donation directly.

Look on their site for information about sponsorship:

<https://www.kuwasha.net/>

If you make a donation to Kuwasha you will receive a tax receipt which can be submitted with your tax return.

Holland: Transfer to the account of "Stichting ICCF Holland" in Amersfoort. This will allow for tax deduction if you live in Holland. ING bank, IBAN: NL95 INGB 0004 5487 74

Germany: It is possible to make donations that allow for a tax return. Check the ICCF web site for the latest information:  
<https://iccf-holland.org/germany.html>

Europe: Use a bank transfer if possible. See "Others" below for the swift code and IBAN number.  
Any other method should work. Ask for information about sponsorship.

Credit Card: You can use PayPal to send money with a Credit card. This is the most widely used Internet based payment system. It's really simple to use. Use this link to find more info:  
[https://www.paypal.com/en\\_US/mrb/pal=XAC62PML3GF8Q](https://www.paypal.com/en_US/mrb/pal=XAC62PML3GF8Q)  
The e-mail address for sending the money to is:  
[Bram@iccf-holland.org](mailto:Bram@iccf-holland.org)

Others: Transfer to this account if possible:  
ING bank: IBAN: NL95 INGB 0004 5487 74  
Swift code: INGBNL2A  
under the name "stichting ICCF Holland", Amersfoort  
Checks are not accepted.

vim:tw=78:ts=8:noet:ft=help:norl:

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## 1.93 python3-pyc 3.12.10-r1

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#### A. HISTORY OF THE SOFTWARE

=====

Python was created in the early 1990s by Guido van Rossum at Stichting Mathematisch Centrum (CWI, see <https://www.cwi.nl>) in the Netherlands as a successor of a language called ABC. Guido remains Python's principal author, although it includes many contributions from others.

In 1995, Guido continued his work on Python at the Corporation for National Research Initiatives (CNRI, see <https://www.cnri.reston.va.us>) in Reston, Virginia where he released several versions of the software.

In May 2000, Guido and the Python core development team moved to BeOpen.com to form the BeOpen PythonLabs team. In October of the same year, the PythonLabs team moved to Digital Creations, which became Zope Corporation. In 2001, the Python Software Foundation (PSF, see <https://www.python.org/psf/>) was formed, a non-profit organization created specifically to own Python-related Intellectual Property. Zope Corporation was a sponsoring member of the PSF.

All

Python releases are Open Source (see <https://opensource.org> for the Open Source Definition). Historically, most, but not all, Python releases have also been GPL-compatible; the table below summarizes the various releases.

| Release        | Derived from | Year      | Owner | GPL-compatible? (1) |
|----------------|--------------|-----------|-------|---------------------|
| 0.9.0 thru 1.2 |              | 1991-1995 | CWI   | yes                 |

|                |           |           |            |         |
|----------------|-----------|-----------|------------|---------|
| 1.3 thru 1.5.2 | 1.2       | 1995-1999 | CNRI       | yes     |
| 1.6            | 1.5.2     | 2000      | CNRI       | no      |
| 2.0            | 1.6       | 2000      | BeOpen.com | no      |
| 1.6.1          | 1.6       | 2001      | CNRI       | yes (2) |
| 2.1            | 2.0+1.6.1 | 2001      | PSF        | no      |
| 2.0.1          | 2.0+1.6.1 | 2001      | PSF        | yes     |
| 2.1.1          | 2.1+2.0.1 | 2001      | PSF        | yes     |
| 2.1.2          | 2.1.1     | 2002      | PSF        | yes     |
| 2.1.3          | 2.1.2     | 2002      | PSF        | yes     |
| 2.2 and above  | 2.1.1     | 2001-now  |            |         |
| PSF            |           |           |            | yes     |

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```
# Automatically generated by apkbuild-cpan, template 1
# Contributor: Valery Kartel <valery.kartel@gmail.com>
# Maintainer: Valery Kartel <valery.kartel@gmail.com>
pkgname=perl-bsd-resource
_pkgreal=BSD-Resource
pkgver=1.2911
pkgrel=4
pkgdesc="Perl extension implements the BSD process resource limit functions"
url="https://metacpan.org/release/BSD-Resource"
arch="all"
license="GPL-1.0-or-later OR Artistic-1.0-Perl"
makedepends="perl-dev"
subpackages="$pkgname-doc"
source="https://cpan.metacpan.org/authors/id/J/JH/JHI/${_pkgreal}-${pkgver}.tar.gz"

builddir="$srcdir/${_pkgreal}-${pkgver}"

prepare() {
    default_prepare

    export CFLAGS=$(perl -MConfig -E 'say $Config{ccflags}')
    PERL_MM_USE_DEFAULT=1 perl Makefile.PL INSTALLDIRS=vendor
}

build() {
    export CFLAGS=$(perl -MConfig -E 'say $Config{ccflags}')
    make
}
```

```
check() {  
    make test  
}
```

```
package() {  
    make DESTDIR="$pkgdir" install  
    find "$pkgdir" \( -name perllocal.pod -o -name .packlist \) -delete  
}
```

```
sha512sums="d0032d41c7c0468ed1c6d8f57b885f6cb97a5039d754c8cb60b2067daedaf53bd15fb6561a3d0f828df16  
dfa5417f663b8065ba65f4fea16dc9262728b3b6b85
```

```
BSD-Resource-1.2911.tar.gz"
```

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## 1.94 python3-pycache-pyc0 3.12.10-r1

### 1.94.1 Available under license :

```
# Contributor: Fabian Affolter <fabian@affolter-engineering.ch>
# Maintainer: Fabian Affolter <fabian@affolter-engineering.ch>
pkgname=py3-flake8-copyright
_pkgname=flake8-copyright
pkgver=0.2.2
pkgrel=1
pkgdesc="Extension for flake8 which checks for copyrights"
options="!check" # No testsuite
url="https://github.com/savoirfairelinux/flake8-copyright"
arch="noarch"
license="MIT"
depends="py3-flake8 py3-setuptools"
source="https://files.pythonhosted.org/packages/source/${_pkgname:0:1}/${_pkgname}/${_pkgname}-${pkgver}.tar.gz"
builddir="$srcdir"/$_pkgname-$pkgver

replaces="py-flake8-copyright" # Backwards compatibility
provides="py-flake8-copyright=$pkgver-r$pkgrel" # Backwards compatibility

build() {
    python3 setup.py build
}

package() {
    python3 setup.py install --prefix=/usr --root="$pkgdir"
}

sha512sums="8ade49f386e67d14e4b826946b947454cf2502ff249a9ab1d359f61fa42ebc2b17dd465708894cf82ffd15
3f0be1bed746464220d40d9d4dc1b07940ec280f28 flake8-copyright-0.2.2.tar.gz"
```

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In 1995, Guido continued his work on Python at the Corporation for National Research Initiatives (CNRI, see <https://www.cnri.reston.va.us>) in Reston, Virginia where he released several versions of the software.

In May 2000, Guido and the Python core development team moved to BeOpen.com to form the BeOpen PythonLabs team. In October of the same year, the PythonLabs team moved to Digital Creations, which became Zope Corporation. In 2001, the Python Software Foundation (PSF, see <https://www.python.org/psf/>) was formed, a non-profit organization created specifically to own Python-related Intellectual Property. Zope Corporation was a sponsoring member of the PSF.

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| 1.3 thru 1.5.2 | 1.2          | 1995-1999 | CNRI       | yes                 |
| 1.6            | 1.5.2        | 2000      | CNRI       | no                  |
| 2.0            | 1.6          | 2000      | BeOpen.com | no                  |
| 1.6.1          | 1.6          | 2001      | CNRI       | yes (2)             |
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|               |           |          |     |     |
|---------------|-----------|----------|-----|-----|
| 2.0.1         | 2.0+1.6.1 | 2001     | PSF | yes |
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| 2.1.2         | 2.1.1     | 2002     | PSF | yes |
| 2.1.3         | 2.1.2     | 2002     | PSF | yes |
| 2.2 and above | 2.1.1     | 2001-now |     |     |
| PSF           |           |          |     | yes |

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```
# Automatically generated by apkbuild-cpan, template 1
# Contributor: Valery Kartel <valery.kartel@gmail.com>
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pkgname=perl-bsd-resource
_pkgreal=BSD-Resource
pkgver=1.2911
pkgrel=4
pkgdesc="Perl extension implements the BSD process resource limit functions"
url="https://metacpan.org/release/BSD-Resource"
arch="all"
license="GPL-1.0-or-later OR Artistic-1.0-Perl"
makedepends="perl-dev"
subpackages="$pkgname-doc"
source="https://cpan.metacpan.org/authors/id/J/JH/JHI/${_pkgreal}-${pkgver}.tar.gz"

builddir="$srcdir/${_pkgreal}-${pkgver}"

prepare() {
    default_prepare

    export CFLAGS=$(perl -MConfig -E 'say $Config{ccflags}')
    PERL_MM_USE_DEFAULT=1 perl Makefile.PL INSTALLDIRS=vendor
}

build() {
    export CFLAGS=$(perl -MConfig -E 'say $Config{ccflags}')
    make
}

check() {
    make test
}
```

```
package() {  
  make DESTDIR="$pkgdir" install  
  find "$pkgdir" \( -name perllocal.pod -o -name .packlist \) -delete  
}
```

sha512sums="d0032d41c7c0468ed1c6d8f57b885f6cb97a5039d754c8cb60b2067daedaf53bd15fb6561a3d0f828df16  
dfa5417f663b8065ba65f4fea16dc9262728b3b6b85

BSD-Resource-1.2911.tar.gz"

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## 1.95 pyc 3.12.10-r1

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```
# Contributor: Fabian Affolter <fabian@affolter-engineering.ch>
# Maintainer: Fabian Affolter <fabian@affolter-engineering.ch>
pkgname=py3-flake8-copyright
_pkgname=flake8-copyright
pkgver=0.2.2
pkgrel=1
pkgdesc="Extension for flake8 which checks for copyrights"
options="!check" # No testsuite
url="https://github.com/savoirfairelinux/flake8-copyright"
arch="noarch"
license="MIT"
depends="py3-flake8 py3-setuptools"
source="https://files.pythonhosted.org/packages/source/${_pkgname:0:1}/${_pkgname}/${_pkgname}-${pkgver}.tar.gz"
builddir="$srcdir"/$_pkgname-$pkgver

replaces="py-flake8-copyright" # Backwards compatibility
provides="py-flake8-copyright=${pkgver}-r${pkgrel}" # Backwards compatibility

build() {
    python3 setup.py build
}

package() {
    python3 setup.py install --prefix=/usr --root="$pkgdir"
}

sha512sums="8ade49f386e67d14e4b826946b947454cf2502ff249a9ab1d359f61fa42ebc2b17dd465708894cf82ffd15
3f0be1bed746464220d40d9d4dc1b07940ec280f28 flake8-copyright-0.2.2.tar.gz"
```

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principal author, although it includes many contributions from others.

In 1995, Guido continued his work on Python at the Corporation for National Research Initiatives (CNRI, see <https://www.cnri.reston.va.us>) in Reston, Virginia where he released several versions of the software.

In May 2000, Guido and the Python core development team moved to BeOpen.com to form the BeOpen PythonLabs team. In October of the same year, the PythonLabs team moved to Digital Creations, which became Zope Corporation. In 2001, the Python Software Foundation (PSF, see <https://www.python.org/psf/>) was formed, a non-profit organization created specifically to own Python-related Intellectual Property. Zope Corporation was a sponsoring member of the PSF.

All

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| Release        | Derived from | Year      | Owner      | GPL-compatible? (1) |
|----------------|--------------|-----------|------------|---------------------|
| 0.9.0 thru 1.2 |              | 1991-1995 | CWI        | yes                 |
| 1.3 thru 1.5.2 | 1.2          | 1995-1999 | CNRI       | yes                 |
| 1.6            | 1.5.2        | 2000      | CNRI       | no                  |
| 2.0            | 1.6          | 2000      | BeOpen.com | no                  |
| 1.6.1          | 1.6          | 2001      | CNRI       | yes (2)             |
| 2.1            | 2.0+1.6.1    | 2001      | PSF        | no                  |
| 2.0.1          | 2.0+1.6.1    | 2001      | PSF        | yes                 |
| 2.1.1          | 2.1+2.0.1    | 2001      | PSF        | yes                 |
| 2.1.2          | 2.1.1        | 2002      | PSF        | yes                 |
| 2.1.3          | 2.1.2        | 2002      | PSF        | yes                 |
| 2.2 and above  | 2.1.1        | 2001-now  |            |                     |
| PSF            | yes          |           |            |                     |

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Python was created in the early 1990s by Guido van Rossum at Stichting Mathematisch Centrum (CWI, see <https://www.cwi.nl>) in the Netherlands

as a successor of a language called ABC. Guido remains Python's principal author, although it includes many contributions from others.

In 1995, Guido continued his work on Python at the Corporation for National Research Initiatives (CNRI, see <https://www.cnri.reston.va.us>) in Reston, Virginia where he released several versions of the software.

In May 2000, Guido and the Python core development team moved to BeOpen.com to form the BeOpen PythonLabs team. In October of the same year, the PythonLabs team moved to Digital Creations, which became Zope Corporation. In 2001, the Python Software Foundation (PSF, see <https://www.python.org/psf/>) was formed, a non-profit organization created specifically to own Python-related Intellectual Property. Zope Corporation was a sponsoring member of the PSF.

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| 1.6            | 1.5.2        | 2000      | CNRI       | no                  |
| 2.0            | 1.6          | 2000      | BeOpen.com | no                  |
| 1.6.1          | 1.6          | 2001      | CNRI       | yes (2)             |
| 2.1            | 2.0+1.6.1    | 2001      | PSF        | no                  |
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| 2.1.1          | 2.1+2.0.1    | 2001      | PSF        | yes                 |
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include/bsd/vis.h  
man/bitstring.3bsd  
man/errc.3bsd  
man/explicit\_bzero.3bsd  
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man/unvis.3bsd  
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src/getbsize.c  
src/heapsort.c  
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src/arc4random\_uniform.c  
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src/getentropy\_solaris.c  
src/getentropy\_win.c  
src/readpassphrase.c  
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Version 2, June 1991

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## 1.102 alpine-keys 2.5-r0

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# Maintainer: Natanael Copa <ncopa@alpinelinux.org>

pkgname=alpine-keys

pkgver=2.5

pkgrel=0

pkgdesc="Public keys for Alpine Linux packages"

url="https://alpinelinux.org"

# we install arch specific keys to /etc so we cannot do arch=noarch

arch="all"

license="MIT"

replaces="alpine-base"

## 1.103 python-requests 2.32.3

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Requests

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## 1.104 bcc 0.32.0-r0

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Upstream-Name: bcc

Source: <https://github.com/iovisor/bcc>

Files: \*

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```
cmd/krb5/iprop/iprop.x
cmd/krb5/iprop/iprop_hdr.h
cmd/krb5/kadmin/server/ipropd_svc.c
cmd/krb5/kproplog/kproplog.c
cmd/krb5/slave/kpropd_rpc.c
lib/gss_mechs/mech_krb5/et/kdb5_err.c
lib/gss_mechs/mech_spnego/mech/gssapiP_spnego.h
lib/gss_mechs/mech_spnego/mech/spnego_mech.c
lib/krb5/kadm5/kadm_host_srv_names.c
lib/krb5/kdb/kdb_convert.c
lib/krb5/kdb/kdb_hdr.h
lib/krb5/kdb/kdb_log.c
lib/krb5/kdb/kdb_log.h
lib/libgss/g_accept_sec_context.c
lib/libgss/g_acquire_cred.c
lib/libgss/g_canon_name.c
lib/libgss/g_compare_name.c
lib/libgss/g_context_time.c
lib/libgss/g_delete_sec_context.c
lib/libgss/g_dsp_name.c
lib/libgss/g_dsp_status.c
lib/libgss/g_dup_name.c
lib/libgss/g_exp_sec_context.c
lib/libgss/g_export_name.c
```

lib/libgss/g\_glue.c  
lib/libgss/g\_imp\_name.c  
lib/libgss/g\_imp\_sec\_context.c  
lib/libgss/g\_init\_sec\_context.c  
lib/libgss/g\_initialize.c  
lib/libgss/g\_inquire\_context.c  
lib/libgss/g\_inquire\_cred.c  
lib/libgss/g\_inquire\_names.c  
lib/libgss/g\_process\_context.c  
lib/libgss/g\_rel\_buffer.c  
lib/libgss/g\_rel\_cred.c  
lib/libgss/g\_rel\_name.c  
lib/libgss/g\_rel\_oid\_set.c  
lib/libgss/g\_seal.c  
lib/libgss/g\_sign.c  
lib/libgss/g\_store\_cred.c  
lib/libgss/g\_unseal.c  
lib/libgss/g\_userok.c  
lib/libgss/g\_utils.c  
lib/libgss/g\_verify.c  
lib/libgss/gssd\_pname\_to\_uid.c  
uts/common/gssapi/include/gssapi\_err\_generic.h  
uts/common/gssapi/include/mechglueP.h

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lib/gssapi/mechglue/g\_accept\_sec\_context.c  
lib/gssapi/mechglue/g\_acquire\_cred.c  
lib/gssapi/mechglue/g\_canon\_name.c  
lib/gssapi/mechglue/g\_compare\_name.c  
lib/gssapi/mechglue/g\_context\_time.c  
lib/gssapi/mechglue/g\_delete\_sec\_context.c  
lib/gssapi/mechglue/g\_dsp\_name.c  
lib/gssapi/mechglue/g\_dsp\_status.c  
lib/gssapi/mechglue/g\_dup\_name.c  
lib/gssapi/mechglue/g\_exp\_sec\_context.c  
lib/gssapi/mechglue/g\_export\_name.c  
lib/gssapi/mechglue/g\_glue.c  
lib/gssapi/mechglue/g\_imp\_name.c  
lib/gssapi/mechglue/g\_imp\_sec\_context.c  
lib/gssapi/mechglue/g\_init\_sec\_context.c  
lib/gssapi/mechglue/g\_initialize.c  
lib/gssapi/mechglue/g\_inquire\_context.c  
lib/gssapi/mechglue/g\_inquire\_cred.c  
lib/gssapi/mechglue/g\_inquire\_names.c  
lib/gssapi/mechglue/g\_process\_context.c  
lib/gssapi/mechglue/g\_rel\_buffer.c  
lib/gssapi/mechglue/g\_rel\_cred.c  
lib/gssapi/mechglue/g\_rel\_name.c  
lib/gssapi/mechglue/g\_rel\_oid\_set.c  
lib/gssapi/mechglue/g\_seal.c  
lib/gssapi/mechglue/g\_sign.c  
lib/gssapi/mechglue/g\_store\_cred.c  
lib/gssapi/mechglue/g\_unseal.c  
lib/gssapi/mechglue/g\_userok.c  
lib/gssapi/mechglue/g\_utils.c  
lib/gssapi/mechglue/g\_verify.c  
lib/gssapi/mechglue/gssd\_pname\_to\_uid.c  
lib/gssapi/mechglue/mglueP.h  
lib/gssapi/mechglue/oid\_ops.c  
lib/gssapi/spnego/gssapiP\_spnego.h  
lib/gssapi/spnego/spnego\_mech.c

and the initial implementation of incremental propagation,

including  
the following new or changed files:

include/iprof\_hdr.h  
kadmin/server/iprof\_svc.c  
lib/kdb/iprof.x  
lib/kdb/kdb\_convert.c  
lib/kdb/kdb\_log.c  
lib/kdb/kdb\_log.h  
lib/krb5/error\_tables/kdb5\_err.et  
kprop/kpropd\_rpc.c  
kprop/kproplog.c

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pkgname=bsd-compat-headers

pkgver=0.7.2

pkgrel=6

pkgdesc="BSD compatibility headers (cdefs, queue, tree)"

url="https://gitlab.alpinelinux.org/alpine/aports"

arch="noarch"

license="BSD-2-Clause AND BSD-3-Clause"

source="

cdefs.h

queue.h

tree.h

"

builddir="\$srcdir"

options="!check" # just headers

package() {

mkdir -p "\$pkgdir"

install -Dm644 -t "\$pkgdir"/usr/include/sys \

cdefs.h queue.h tree.h

}

sha512sums="

37c8fc73c7aea7b490f7850927e2bb91d12137c9e59e22c084146d515696dbc7973b5de92f4c987ba080dd2502ba8312

7006442c3f019b6447a620c0cae73178 cdefs.h

2f0d5e6e4dc3350285cf17009265dddcbe12431c111868eea39bc8cb038ab7c1f2acacbb21735c4e9d4a1fd106a8fc0f86

11ea33987d4faba37dde5ce6da0750 queue.h

d9ac210d81feb8ad2655bc80fb065d3fe20ae4417b32b4a1711e6738a4870140005c13373b5d1846ef3ce5ae6da45f2da

cef2092881eded0a2e94f6a07752ef3 tree.h

"

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"X-Splines: A Spline Model Designed for the End User" by C. Blanc and C. Schlick, Proceedings of SIGGRAPH'95

<http://dept-info.labri.u-bordeaux.fr/~schlick/DOC/sig1.html>

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# Contributor: Valery Kartel <valery.kartel@gmail.com>

# Maintainer: Celeste <cielesti@protonmail.com>

maintainer="Celeste <cielesti@protonmail.com>"

pkgname=perl-bsd-resource

pkgver=1.2911

pkgrel=10

#\_pkgreal is used by apkbuild-cpan to find modules at MetaCpan

\_pkgreal=BSD-Resource

pkgdesc="Perl extension implements the BSD process resource limit functions"

url="https://metacpan.org/release/BSD-Resource/"

arch="all"

license="Artistic-2.0 OR LGPL-2.0"

depends="perl"

makedepends="perl-dev"

subpackages="\$pkgname-doc"

source="https://cpan.metacpan.org/authors/id/J/JH/JHI/BSD-Resource-\$pkgver.tar.gz"

builddir="\$srcdir/\$\_pkgreal-\$pkgver"

```
build() {  
    export CFLAGS=$(perl -MConfig -E 'say $Config{ccflags}')
```

PERL\_MM\_USE\_DEFAULT=1 perl -I. Makefile.PL \

INSTALLDIRS=vendor \

NO\_PACKLIST=1 \

NO\_PERLLOCAL=1

make

}

```

check() {
    export CFLAGS=$(perl -MConfig -E 'say $Config{ccflags}')
    make test
}

package() {
    make DESTDIR="$pkgdir" install
}

sha512sums="
d0032d41c7c0468ed1c6d8f57b885f6cb97a5039d754c8cb60b2067daedaf53bd15fb6561a3d0f828df16dfa5417f663b
8065ba65f4fea16dc9262728b3b6b85
    BSD-Resource-1.2911.tar.gz
"

# Maintainer: fossdd <fossdd@pwned.life>
pkgname=cargo-license
pkgver=0.6.1
pkgrel=1
pkgdesc="Cargo subcommand to see license of dependencies"
url="https://github.com/onur/cargo-license"
arch="all"
license="MIT"
makedepends="cargo cargo-auditable"
source="$pkgname-$pkgver.tar.gz::https://crates.io/api/v1/crates/cargo-license/$pkgver/download"

prepare() {
    default_prepare

    cargo fetch --target="$CTARGET" --locked
}

build() {
    cargo auditable build --release --frozen
}

check() {
    cargo test --frozen
}

package() {
    install -Dm755 target/release/cargo-license -t "$pkgdir"/usr/bin
}

sha512sums="
36215145e79965be090ae2f5ce6f5eb208465eb67a94c26bed1fe70a131c46c6dc35695e30852759b7366883fbc3caf00
272d796ac634f0a5e1d49232b6b29d5 cargo-license-0.6.1.tar.gz
"

```

```

# Contributor: Maxim Karasev <begs@disroot.org>
# Maintainer: mio <miyopan@e.email>
pkgname=bsd-games
pkgver=3.3
pkgrel=2
pkgdesc="traditional text mode games from BSD"
url="https://bsd-games.sourceforge.io/"
arch="all"
license="BSD-3-Clause"
install="$pkgname.post-install"
makedepends="ncurses-dev coreutils" # configure causes busybox expr error
subpackages="$pkgname-doc"
source="https://sourceforge.net/projects/bsd-games/files/bsd-games-$pkgver.tar.gz
0001-bsd-games-scores-dir.patch
"

options="!check" # no tests

build() {
# some GNU autoconf options are ignored, but it works
./configure \
--build=$CBUILD \
--host=$CHOST \
--prefix=/usr \
--sysconfdir=/etc \
--mandir=/usr/share/man \
--scoredir=/usr/share/$pkgname
make
}

package() {
make DESTDIR="$pkgdir" install
install -Dm644 LICENSE "$pkgdir"/usr/share/licenses/bsd-games/LICENSE
}

sha512sums="
aaf36d09d4fe68514a5c279063d7e77a9a9a84c447037cba974b29faa07eb80c2aab2379d0699c196b5c27ffe1b2bb2c6
8d3390143e0e62d5e3d210ccfb61294
bsd-games-3.3.tar.gz
e1def0d4835a877242c4173fae862e278a7858738e0bacacbb045a42bcabec2aa7c72d000bbd2421ce35fe66cdc1f52c0
577b7e278029ca5ed50f7aab22319f6 0001-bsd-games-scores-dir.patch
"

Vintage Dreams Waves v 2.0. for Creative Labs' AWE Soundcards
(EMU Soundfont 2 Format)

```

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[vintagedreamworks@hotmail.com](mailto:vintagedreamworks@hotmail.com)

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<https://analoguesque.x10host.com/>

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\*

\* Optimised ANSI C code for the Rijndael cipher (now AES)

\*

\* @author Vincent Rijmen <vincent.rijmen@esat.kuleuven.ac.be>

\* @author Antoon Bosselaers <antoon.bosselaers@esat.kuleuven.ac.be>

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You may modify your copy or copies of the Library or any portion of it, thus forming a work based on the Library, and copy and distribute such modifications or work under the terms of Section 1 above, provided that you also meet all of these conditions:

@enumerate a

@item

The modified work must itself be a software library.

@item

You must cause the files modified to carry prominent notices stating that you changed the files and the date of any change.

@item

You must

cause the whole of the work to be licensed at no charge to all third parties under the terms of this License.

@item

If a facility in the modified Library refers to a function or a

table of data to be supplied by an application program that uses the facility, other than as an argument passed when the facility is invoked, then you must make a good faith effort to ensure that, in the event an application does not supply such function or table, the facility still operates, and performs whatever part of its purpose remains meaningful.

(For example, a function in a library to compute square roots has a purpose that is entirely well-defined independent of the application. Therefore, Subsection 2d requires that any application-supplied function or table used by this function must be optional: if the application does not supply it, the square root function must still compute square roots.)

@end enumerate

These requirements apply to the modified work as a whole. If identifiable sections

of that work are not derived from the Library, and can be reasonably considered independent and separate works in themselves, then this License, and its terms, do not apply to those sections when you distribute them as separate works. But when you distribute the same sections as part of a whole which is a work based on the Library, the distribution of the whole must be on the terms of this License, whose permissions for other licensees extend to the entire whole, and thus to each and every part regardless of who wrote it.

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@item

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If distribution of object code is made by offering access to copy from a designated place, then offering equivalent access to copy the source code from the same place satisfies the requirement to distribute the source code, even though third parties are not compelled to copy the source along with the object code.

@item

A program that contains no derivative of any portion of the Library, but is designed to work with the Library by being compiled or linked with it, is called a ``work that uses the Library''. Such a work, in isolation, is not a derivative work of the Library, and therefore falls outside the scope of this License.

However, linking a ``work that uses the Library'' with the Library creates an executable that is a derivative of the Library (because it contains portions of the Library), rather than a ``work that uses the library''. The executable is therefore covered by this License. Section 6 states terms for distribution of such executables.

When a ``work that uses the Library'' uses material from a header file that is part of the Library, the object code for the work may be a derivative work of the Library even though the source code is not. Whether this is true is especially significant if the work can be linked without the Library, or if the work is itself a library. The threshold for this to be true is not precisely defined by law.

If such an object file uses only numerical parameters, data structure layouts and accessors, and small macros and small inline functions (ten lines or less in length), then the use of the object file is unrestricted, regardless of whether it is legally a derivative work. (Executables containing this object code plus portions of the

Library will still fall under Section 6.)

Otherwise,

if the work is a derivative of the Library, you may distribute the object code for the work under the terms of Section 6. Any executables containing that work also fall under Section 6, whether or not they are linked directly with the Library itself.

@item

As an exception to the Sections above, you may also combine or link a ``work that uses the Library" with the Library to produce a work containing portions of the Library, and distribute that work under terms of your choice, provided that the terms permit modification of the work for the customer's own use and reverse engineering for debugging such modifications.

You must give prominent notice with each copy of the work that the Library is used in it and that the Library and its use are covered by this License. You must supply a copy of this License. If the work during execution displays copyright notices, you must include the copyright notice for the Library among them, as well as a reference directing the user to the copy of this License. Also, you must do one of these things:

@enumerate a

@item

Accompany the work with the complete corresponding machine-readable source code for the Library including whatever changes were used in the work (which must be distributed under Sections 1 and 2 above); and, if the work is an executable linked with the Library, with the complete machine-readable ``work that uses the Library", as object code and/or source code, so that the user can modify the Library and then relink to produce a modified executable containing the modified Library. (It is understood that the user who changes the contents of definitions files in the Library will not necessarily be able to recompile the application to use the modified definitions.)

@item

Use a suitable shared library mechanism for linking with the Library. A suitable mechanism is one that (1) uses at run time a copy of the library already present on the user's computer system, rather than copying library functions into the executable, and (2) will operate properly with a modified version of the library, if the user installs one, as long as the modified version is interface-compatible with the version that the work was made with.

@item

Accompany the work with a written offer, valid for at least three years, to give the same user the materials specified in Subsection 6a, above, for a charge no more than the cost of performing this distribution.

@item

If distribution of the work is made by offering access to copy from a designated place, offer equivalent access to copy the above specified materials from the same place.

@item

Verify that the user has already received a copy of these materials or that you have already sent this user a copy.

@end enumerate

For an executable, the required form of the ``work that uses the Library" must include any data and utility programs needed for reproducing the executable from it. However, as a special exception, the materials to be distributed need not include anything that is normally distributed (in either source or binary form) with the major components (compiler, kernel, and so on) of the operating system on which the executable runs, unless that component itself accompanies the executable.

It may happen that this requirement contradicts the license restrictions of other proprietary libraries that do not normally accompany the operating system. Such a contradiction means you cannot use both them and the Library together in an executable that you distribute.

@item

You may place library facilities that are a work based on the Library side-by-side in a single library together with other library facilities not covered by this License, and distribute such a combined library, provided that the separate distribution of the work based on the Library and of the other library facilities is otherwise permitted, and provided that you do these two things:

@enumerate a

@item

Accompany the combined library with a copy of the same work based on the Library,  
uncombined with any other library facilities. This must be distributed under the terms of the Sections above.



@item

Give prominent notice with the combined library of the fact that part of it is a work based on the Library, and explaining where to find the accompanying uncombined form of the same work.

@end enumerate

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@end enumerate

@subheading END OF TERMS AND CONDITIONS

@page

@subheading How to Apply These Terms to Your New Libraries

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To apply these terms, attach the following notices to the library. It is

safest to attach them to the start of each source  
file to most effectively  
convey the exclusion of warranty; and each file should have at least the  
``copyright" line and a pointer to where the full notice is found.

```
@smallexample
@var{one line to give the library's name and an idea of what it does.}
Copyright (C) @var{year} @var{name of author}
```

This library is free software; you can redistribute it and/or modify it  
under the terms of the GNU Lesser General Public License as published by  
the Free Software Foundation; either version 2.1 of the License, or (at  
your option) any later version.

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You should have received a copy of the GNU Lesser General Public  
License along with this library; if not, write to the Free Software  
Foundation, Inc., 51 Franklin Street, Fifth Floor, Boston, MA 02110-1301,  
USA.

```
@end
smallexample
```

Also add information on how to contact you by electronic and paper mail.

You should also get your employer (if you work as a programmer) or your  
school, if any, to sign a ``copyright disclaimer" for the library, if  
necessary. Here is a sample; alter the names:

```
@smallexample
Yoyodyne, Inc., hereby disclaims all copyright interest in the library
`Frob' (a library for tweaking knobs) written by James Random Hacker.
```

```
@var{signature of Ty Coon}, 1 April 1990
Ty Coon, President of Vice
@end smallexample
```

That's all there is to it!  
The libasprintf package is under the LGPL, see file COPYING.LIB.  
This subpackage is under the GPL, see file COPYING in the toplevel directory.  
@c The GNU General Public License.  
@center Version 2, June 1991

```
@c This file is intended to be included within another document,
@c hence no sectioning command or @node.
```

@display

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The precise terms and conditions for copying, distribution and modification follow.

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@enumerate 0

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@item

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@enumerate a

@item

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@item

You must cause any work that you distribute or publish, that in whole or in part contains or is derived from the Program or any part thereof, to be licensed as a whole at no charge to all third parties under the terms of this License.

@item

If the modified program normally reads commands interactively when run, you must cause it, when started running for such interactive use in the most ordinary way, to print or display an announcement including an appropriate copyright notice and a notice that there is no warranty (or else, saying that you provide a warranty) and that users may redistribute the program under these conditions, and telling the user how to view a copy of this License. (Exception: if the Program itself is interactive but does not normally print such an announcement, your work based on the Program is not required to print an announcement.)

@end enumerate

These requirements apply to the modified work as a whole. If

identifiable sections of that work are not derived from the Program, and can be reasonably considered independent and separate works in themselves, then this License, and its terms, do not apply to those sections when you distribute them as separate works. But when you distribute the same sections as part of a whole which is a work based on the Program, the distribution of the whole must be on the terms of this License, whose permissions for other licensees extend to the entire whole, and thus to each and every part regardless of who wrote it.

Thus, it is not the intent of this section to claim rights or contest your rights to work written entirely by you; rather, the intent is to exercise the right to control the distribution of derivative or collective works based on the Program.

In addition, mere aggregation of another work not based on the Program

with the Program (or with a work based on the Program) on a volume of a storage or distribution medium does not bring the other work under the scope of this License.

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You may copy and distribute the Program (or a work based on it, under Section 2) in object code or executable form under the terms of Sections 1 and 2 above provided that you also do one of the following:

@enumerate a

@item

Accompany it with the complete corresponding machine-readable source code, which must be distributed under the terms of Sections 1 and 2 above on a medium customarily used for software interchange; or,

@item

Accompany it with a written offer, valid for at least three years, to give any third party, for a charge no more than your cost of physically performing source distribution, a complete machine-readable copy of the corresponding source code, to be distributed under the terms of Sections 1 and 2 above on a medium customarily used for software interchange; or,

@item

Accompany it with the information you received as to the offer to distribute corresponding source code. (This alternative is allowed only for noncommercial distribution and only if you received the program in object code or executable form with such an offer, in accord with Subsection b above.)

@end enumerate

The source code for a work means the preferred form of the work for making modifications to it. For an executable work, complete source code means all the source code for all modules it contains, plus any associated interface definition files, plus the scripts used to control compilation and installation of the executable. However, as a special exception, the source code distributed need not include anything that is normally distributed (in either source or binary form) with the major components (compiler, kernel, and so on) of the operating system on which the executable runs, unless that component itself accompanies the executable.

If distribution of executable or object code is made by offering access to copy from a designated place, then offering equivalent access to copy the source code from the same place counts



as  
distribution of the source code, even though third parties are not  
compelled to copy the source along with the object code.

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Each

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@iftex  
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@end iftex  
@ifinfo  
@center  
NO WARRANTY

@end ifinfo

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@end enumerate

@iftex  
@heading END OF TERMS AND CONDITIONS  
@end iftex  
@ifinfo  
@center END OF TERMS AND CONDITIONS

@end ifinfo

@page  
@heading Appendix: How to Apply These Terms to Your New Programs

If you develop a new program, and you want it to be of the greatest possible use to the public, the best way to achieve this is to make it free software which everyone can redistribute and change under these terms.

To do so, attach the following notices to the program. It is safest to attach them to the start of each source file to most effectively convey the exclusion of warranty; and each file should have at least the ``copyright" line and a pointer to where the full notice is found.

```
@smallexample
@var{one line to give the program's name
and a brief idea of what it does.}
Copyright (C) @var{yyyy} @var{name of author}
```

This program is free software; you can redistribute it and/or modify it under the terms of the GNU General Public License as published by the Free Software Foundation; either version 2 of the License, or (at your option) any later version.

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You should have received a copy of the GNU General Public License along with this program; if not, write to the Free Software Foundation, Inc., 51 Franklin Street, Fifth Floor, Boston, MA 02110-1301, USA.  
@end smallexample

Also add information on how to contact you by electronic and paper mail.

If the program is interactive, make it output a short notice like this when it starts in an interactive mode:

```
@smallexample
Gnomovision version
69, Copyright (C) @var{year} @var{name of author}
Gnomovision comes with ABSOLUTELY NO WARRANTY; for details type `show w'.
This is free software, and you are welcome to redistribute it
under certain conditions; type `show c' for details.
@end smallexample
```

The hypothetical commands @samp{show w} and @samp{show c} should show the appropriate parts of the General Public License. Of course, the commands you use may be called something other than @samp{show w} and @samp{show c}; they could even be mouse-clicks or menu items---whatever suits your program.

You should also get your employer (if you work as a programmer) or your school, if any, to sign a ``copyright disclaimer" for the program, if necessary. Here is a sample; alter the names:

@example

Yoyodyne, Inc., hereby disclaims all copyright interest in the program  
`Gnomovision' (which makes passes at compilers) written by James Hacker.

@var{signature of Ty Coon}, 1 April 1989

Ty Coon, President of Vice

@end example

This General

Public License does not permit incorporating your program into proprietary programs. If your program is a subroutine library, you may consider it more useful to permit linking proprietary applications with the library. If this is what you want to do, use the GNU Lesser General Public License instead of this License.

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Version 2.1, February 1999

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## 1.111 libpsl 0.21.5-r3

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./configure && make

~~~~

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> ~~~  
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## 1.113 heimdal 18.0.2

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The

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AES in libcrypto

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rijndael-alg-fst.c

@version 3.0 (December 2000)

Optimised ANSI C code for the Rijndael cipher (now AES)

@author Vincent Rijmen <vincent.rijmen@esat.kuleuven.ac.be>

@author Antoon Bosselaers <antoon.bosselaers@esat.kuleuven.ac.be>

@author Paulo Barreto <paulo.barreto@terra.com.br>

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DES core in libcrypto

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D3DES (V5.09) -

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Thanks to: Dan Hoey for his excellent Initial and Inverse permutation code; Jim Gillogly & Phil Karn for the DES key schedule code; Dennis Ferguson, Eric Young and Dana How for comparing notes; and Ray Lau, for humouring me on.

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lib/hcrypto/test\_dh.c

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```
# -*- perl -*-
```

```
$testlist = [  
  # This specific test fails on OpenBSD because the .pcap file uses DLT_RAW,  
  # which OpenBSD treats as DLT_LOOP.  
  {  
    config_unset => 'IS_OPENBSD',  
    name => 'heap-overflow-1',  
    input => 'heap-overflow-1.pcap',  
    output => 'heap-overflow-1.out',  
    args => '-v'  
  },  
];  
  
1;
```

# 1.115 apr-util 1.6.3-r1

## 1.115.1 Available under license :

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```
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When a program is linked with a library, whether statically or using a shared library, the combination of the two is legally speaking a combined work, a derivative of the original library. The ordinary General Public License therefore permits such linking only if the entire combination fits its criteria of freedom. The Lesser General Public License permits more lax criteria for linking other code with the library.

We call this license the "Lesser" General Public License because it does Less to protect the user's freedom than the ordinary General Public License. It also provides other free software developers Less of an advantage over competing non-free programs. These disadvantages are the reason we use the ordinary General Public License for many libraries. However, the Lesser license provides advantages in certain special circumstances.

For example, on rare occasions, there may be a special need to encourage the widest possible use of a certain library, so that it becomes a de-facto standard. To achieve this, non-free programs must be allowed to use the library. A more frequent case is that a free library does the same job as widely used non-free libraries. In this case, there is little to gain by limiting the free library to free software only, so we use the Lesser General Public License.

In other cases, permission to use a particular library in non-free programs enables a greater number of people to use a large body of free software. For example, permission to use the GNU C Library in non-free programs enables many more people to use the whole GNU operating system, as well as its variant, the GNU/Linux operating system.

Although the Lesser General Public License is Less protective of the users' freedom, it does ensure that the user of a program that is linked with the Library has the freedom and the wherewithal to run that program using a modified version of the Library.

The precise terms and conditions for copying, distribution and modification follow. Pay close attention to the difference between a "work based on the library" and a "work that uses the library". The former contains code derived from the library, whereas the latter must be combined with the library in order to run.

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The "Library", below, refers to any such software library or work which has been distributed under these terms. A "work based on the Library" means either the Library or any derivative work under copyright law: that is to say, a work containing the Library or a portion of it, either verbatim or with modifications and/or translated straightforwardly into another language. (Hereinafter, translation is included without limitation in the term "modification".)

"Source code" for a work means the preferred form of the work for making modifications to it. For a library, complete source code means all the source code for all modules it contains, plus any associated interface definition files, plus the scripts used to control compilation and installation of the library.

Activities other than copying, distribution and modification are not covered by this License; they are outside its scope. The act of running a program using the Library is not restricted, and output from such a program is covered only if its contents constitute a work based on the Library (independent of the use of the Library in a tool for writing it). Whether that is true depends on what the Library does and what the program that uses the Library does.

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- b) You must cause the files modified to carry prominent notices stating that you changed the files and the date of any change.
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(For example, a function in a library to compute square roots has a purpose that is entirely well-defined independent of the application. Therefore, Subsection 2d requires that any application-supplied function or table used by this function must be optional: if the application does not supply it, the square root function must still compute square roots.)

These requirements apply to the modified work as a whole. If identifiable sections of that work are not derived from the Library, and can be reasonably considered independent and separate works in themselves, then this License, and its terms, do not apply to those sections when you distribute them as separate works. But when you distribute the same sections as part of a whole which is a work based on the Library, the distribution of the whole must be on the terms of this License, whose permissions for other licensees extend to the entire whole, and thus to each and every part regardless of who wrote it.

Thus, it is not the intent of this section to claim rights or contest your rights to work written entirely by you; rather, the intent is to exercise the right to control the distribution of derivative or collective works based on the Library.

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This option is useful when you wish to copy part of the code of the Library into a program that is not a library.

4. You may copy and distribute the Library (or a portion or derivative of it, under Section 2) in object code or executable form under the terms of Sections 1 and 2 above provided that you accompany it with the complete corresponding machine-readable source code, which must be distributed under the terms of Sections 1 and 2 above on a medium customarily used for software interchange.

If distribution of object code is made by offering access to copy from a designated place, then offering equivalent access to copy the source code from the same place satisfies the requirement to distribute the source code, even though third parties are not compelled to copy the source along with the object code.

5. A program that contains no derivative of any portion of the Library, but is designed to work with the Library by being compiled or linked with it, is called a "work that uses the Library". Such a work, in isolation, is not a derivative work of the Library, and therefore falls outside the scope of this License.

However, linking a "work that uses the Library" with the Library creates an executable that is a derivative of the Library (because it contains portions of the Library), rather than a "work that uses the library". The executable is therefore covered by this License. Section 6 states terms for distribution of such executables.

When a "work that uses the Library" uses material from a header file that is part of the Library, the object code for the work may be a derivative work of the Library even though the source code is not. Whether this is true is especially significant if the work can be linked without the Library, or if the work is itself a library. The threshold for this to be true is not precisely defined by law.

If such an object file uses only numerical parameters, data structure layouts and accessors, and small macros and small inline functions (ten lines or less in length), then the use of the object file is unrestricted, regardless of whether it is legally a derivative work. (Executables containing this object code plus portions of the

Library will still fall under Section 6.)

Otherwise, if the work is a derivative of the Library, you may distribute the

object code for the work under the terms of Section 6.

Any executables containing that work also fall under Section 6, whether or not they are linked directly with the Library itself.

6. As an exception to the Sections above, you may also combine or link a "work that uses the Library" with the Library to produce a work containing portions of the Library, and distribute that work under terms of your choice, provided that the terms permit modification of the work for the customer's own use and reverse engineering for debugging such modifications.

You must give prominent notice with each copy of the work that the Library is used in it and that the Library and its use are covered by this License. You must supply a copy of this License. If the work during execution displays copyright notices, you must include the copyright notice for the Library among them, as well as a reference directing the user to the copy of this License. Also, you must do one of these things:

a) Accompany

the work with the complete corresponding

machine-readable source code for the Library including whatever changes were used in the work (which must be distributed under Sections 1 and 2 above); and, if the work is an executable linked with the Library, with the complete machine-readable "work that uses the Library", as object code and/or source code, so that the user can modify the Library and then relink to produce a modified executable containing the modified Library. (It is understood that the user who changes the contents of definitions files in the Library will not necessarily be able to recompile the application to use the modified definitions.)

b) Use a suitable shared library mechanism for linking with the

Library. A suitable mechanism is one that (1) uses at run time a copy of the library already present on the user's computer system, rather than copying library functions into the executable, and (2) will operate

properly with a modified version of the library, if

the user installs one, as long as the modified version is interface-compatible with the version that the work was made with.

c) Accompany the work with a written offer, valid for at

least three years, to give the same user the materials specified in Subsection 6a, above, for a charge no more

than the cost of performing this distribution.

d) If distribution of the work is made by offering access to copy from a designated place, offer equivalent access to copy the above specified materials from the same place.

e) Verify that the user has already received a copy of these materials or that you have already sent this user a copy.

For an executable, the required form of the "work that uses the Library" must include any data and utility programs needed for reproducing the executable from it. However, as a special exception, the materials to be distributed need not include anything that is normally

distributed (in either source or binary form) with the major components (compiler, kernel, and so on) of the operating system on which the executable runs, unless that component itself accompanies the executable.

It may happen that this requirement contradicts the license restrictions of other proprietary libraries that do not normally accompany the operating system. Such a contradiction means you cannot use both them and the Library together in an executable that you distribute.

7. You may place library facilities that are a work based on the Library side-by-side in a single library together with other library facilities not covered by this License, and distribute such a combined library, provided that the separate distribution of the work based on the Library and of the other library facilities is otherwise permitted, and provided that you do these two things:

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That's all there is to it!

# 1.121 libgcrypt 1.10.3-r1

## 1.121.1 Available under license :

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Some devices are designed to deny users access to install or run modified versions of the software inside them, although the manufacturer can do so. This is fundamentally incompatible with the aim of protecting users' freedom to change the software. The systematic pattern of such abuse occurs in the area of products for individuals to use, which is precisely where it is most unacceptable. Therefore, we have designed this version of the GPL to prohibit the practice for those products. If such problems arise substantially in other domains, we stand ready to extend this provision to those domains in future versions of the GPL, as needed to protect the freedom of users.

Finally, every program is threatened constantly by software patents. States should not allow patents to restrict development and use of software on general-purpose computers, but in those that do, we wish to avoid the special danger that patents applied to a free program could make it effectively proprietary. To prevent this, the GPL assures that patents cannot be used to render the program non-free.

The precise terms and conditions for copying, distribution and modification follow.

## TERMS AND CONDITIONS

### 0. Definitions.

"This License" refers to version 3 of the GNU General Public License.

"Copyright" also means copyright-like laws that apply to other kinds of works, such as semiconductor masks.

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To

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To "convey" a work means any kind of propagation that enables other parties to make or receive copies. Mere interaction with a user through a computer network, with no transfer of a copy, is not conveying.

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#### 1. Source Code.

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A "Standard Interface" means an interface that either is an official standard defined by a recognized standards body, or, in the case of interfaces specified for a particular programming language, one that is widely used among developers working in that language.

The "System Libraries" of an executable work include anything, other than

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The "Corresponding Source" for a work in object code form means all the source code needed to generate, install, and (for an executable work) run the object code and to modify the work, including scripts to control those activities. However, it does not include the work's System Libraries, or general-purpose tools or generally available free programs which are used unmodified in performing those activities but which are not part of the work. For example, Corresponding Source includes interface definition files associated with source files for the work, and the source code for shared libraries and dynamically linked subprograms that the work is specifically designed to require, such as by intimate data communication or control flow between those subprograms and other parts of the work.

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written offer, valid for at least three years and valid for as long as you offer spare parts or customer support for that product

model, to give anyone who possesses the object code either (1) a copy of the Corresponding Source for all the software in the product that is covered by this License, on a durable physical medium customarily used for software interchange, for a price no more than your reasonable cost of physically performing this conveying of source, or (2) access to copy the Corresponding Source from a network server at no charge.

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e) Convey the object code using peer-to-peer transmission, provided you inform other peers where the object code and Corresponding Source of the work are being offered to the general public at no charge under subsection 6d.

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```
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From network\_io/unix/inet\_ntop.c, network\_io/unix/inet\_pton.c:

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From dso/aix/dso.c:

\* Based on libdl (dlfcn.c/dlfcn.h) which is

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From strings/apr\_strnatcmp.c,  
include/apr\_strings.h:

strnatcmp.c -- Perform 'natural order' comparisons of strings in C.  
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From  
strings/apr\_snprintf.c:

```
*  
* cvt - IEEE floating point formatting routines.  
*   Derived from UNIX V7, Copyright(C) Caldera International Inc.  
*
```

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## 1.131 socat 1.8.0.3-r0

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## 1.135.1 Available under license :

- \* Original author: Roland Schemers <schemers@stanford.edu>
- \* IPv6 Support: Jeroen Massar <jeroen@unfix.org / jeroen@ipng.nl>
- \* Improved main loop: David Schweikert <david@schweikert.ch>
- \* Debian Merge, TOS settings: Tobi Oetiker <tobi@oetiker.ch>
- \* Bugfixes, byte order & senseful seq.-numbers: Stephan Fuhrmann (stephan.fuhrmann AT 1und1.de)
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In 1995, Guido continued his work on Python at the Corporation for National Research Initiatives (CNRI, see <http://www.cnri.reston.va.us>) in Reston, Virginia where he released several versions of the software.

In May 2000, Guido and the Python core development team moved to BeOpen.com to form the BeOpen PythonLabs team. In October of the same

year, the PythonLabs team moved to Digital Creations (now Zope Corporation, see <http://www.zope.com>). In 2001, the Python Software Foundation (PSF, see <http://www.python.org/psf/>) was formed, a non-profit organization created specifically to own Python-related Intellectual Property. Zope Corporation is a sponsoring member of the PSF.

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| 2.0            | 1.6          | 2000      | BeOpen.com | no                  |
| 1.6.1          | 1.6          | 2001      | CNRI       | yes (2)             |
| 2.1            | 2.0+1.6.1    | 2001      | PSF        | no                  |
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| 2.1.1          | 2.1+2.0.1    | 2001      | PSF        | yes                 |
| 2.2            | 2.1.1        | 2001      | PSF        | yes                 |
| 2.1.2          | 2.1.1        | 2002      | PSF        | yes                 |
| 2.1.3          |              |           |            |                     |
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| 2.3            | 2.2.2        | 2002-2003 | PSF        | yes                 |
| 2.3.1          | 2.3          | 2002-2003 | PSF        | yes                 |
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| 2.3.4          | 2.3.3        | 2004      | PSF        | yes                 |
| 2.3.5          | 2.3.4        | 2005      | PSF        | yes                 |
| 2.4            | 2.3          | 2004      | PSF        | yes                 |
| 2.4.1          | 2.4          | 2005      | PSF        | yes                 |
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| 2.4.4          | 2.4.3        | 2006      | PSF        | yes                 |
| 2.5            | 2.4          | 2006      | PSF        | yes                 |
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| 2.5.2          | 2.5.1        | 2008      | PSF        | yes                 |
| 2.5.3          | 2.5.2        | 2008      | PSF        | yes                 |
| 2.6            | 2.5          | 2008      | PSF        | yes                 |
| 2.6.1          | 2.6          | 2008      | PSF        | yes                 |

|       |       |      |     |     |
|-------|-------|------|-----|-----|
| 2.6.2 | 2.6.1 | 2009 | PSF | yes |
| 2.6.3 | 2.6.2 | 2009 | PSF | yes |
| 2.6.4 | 2.6.3 | 2009 | PSF | yes |
| 2.6.5 | 2.6.4 | 2010 | PSF | yes |
| 3.0   | 2.6   | 2008 | PSF | yes |
| 3.0.1 | 3.0   | 2009 | PSF | yes |
| 3.1   | 3.0.1 | 2009 | PSF | yes |
| 3.1.1 | 3.1   | 2009 | PSF | yes |
| 3.1.2 | 3.1   | 2010 | PSF | yes |
| 3.2   | 3.1   | 2010 | PSF | yes |

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| 1.3 thru 1.5.2 | 1.2          | 1995-1999 | CNRI       | yes                 |
| 1.6            | 1.5.2        | 2000      | CNRI       | no                  |
| 2.0            | 1.6          | 2000      | BeOpen.com | no                  |
| 1.6.1          | 1.6          | 2001      | CNRI       | yes (2)             |
| 2.1            | 2.0+1.6.1    | 2001      | PSF        | no                  |
| 2.0.1          | 2.0+1.6.1    | 2001      | PSF        | yes                 |
| 2.1.1          | 2.1+2.0.1    | 2001      | PSF        | yes                 |
| 2.1.2          | 2.1.1        | 2002      | PSF        | yes                 |
| 2.1.3          | 2.1.2        | 2002      | PSF        | yes                 |
| 2.2 and above  | 2.1.1        | 2001-now  |            |                     |
| PSF            | yes          |           |            |                     |

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## 1.141 tmux 3.5a-r0

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Upstream-Name: liblz4

Upstream-Contact: Yann Collet <Cyan4973@github.com>

Source: <https://github.com/lz4/lz4>

Files: \*

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ipvsadm - Version 1.14 - 11th January 2001

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This version of ipvsadm requires IPVS module v0.0.5 for kernel 2.4 or later. Check out the Linux Virtual Server Project home page on the World Wide Web:

<http://www.LinuxVirtualServer.org/>

or

<http://www.Linux-VS.org/>

for the most recent information and original sources about ipvsadm.

To make, make sure your Linux kernel is already patched with IPVS and "make menuconfig" or "make xconfig" to setup the right compiling options, see the README of the virtual server patch for detail, then simply type  
make  
in the source directory.

Install to your liking. We suggest the following pathnames:

/sbin/ipvsadm

/usr/man/man8/ipvsadm.8

This will be done automatically when calling  
make install  
in the  
source directory.

Wensong Zhang <[wensong@linuxvirtualserver.org](mailto:wensong@linuxvirtualserver.org)>

---

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## 1.148 bash 5.2.37-r0

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```
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* C implementation based on the original Perl and shell versions
*
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pkgver=20241121
pkgrel=1
pkgdesc="Common CA certificates PEM files from Mozilla"
url="https://www.mozilla.org/en-US/about/governance/policies/security-group/certs/"
arch="all"
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## 1.153 lua 5.4.7-r0

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```
@Ci{$Id: manual.of $}  
@C{[(-----}  
@manual{
```

```
@sect1{@title{Introduction}
```

Lua is a powerful, efficient, lightweight, embeddable scripting language. It supports procedural programming, object-oriented programming, functional programming, data-driven programming, and data description.

Lua combines simple procedural syntax with powerful data description constructs based on associative arrays and extensible semantics.

Lua is dynamically typed, runs by interpreting bytecode with a register-based virtual machine, and has automatic memory management with a generational garbage collection, making it ideal for configuration, scripting, and rapid prototyping.

Lua is implemented as a library, written in @emphx{clean C}, the common subset of @N{standard C} and C++.

The Lua distribution includes a host program called @id{lua}, which uses the Lua library to offer a complete, standalone Lua interpreter, for interactive or batch use.

Lua is intended to be used both as a powerful, lightweight, embeddable scripting language for any program that needs one, and as a powerful but lightweight and efficient stand-alone language.

As an extension language, Lua has no notion of a @Q{main} program: it works @emph{embedded} in a host client,

called the `@emph{embedding program}` or simply the `@emphx{host}`.  
(Frequently, this host is the stand-alone `@id{lua}` program.)  
The host program can invoke functions to execute a piece of Lua code,  
can write and read Lua variables,  
and can register `@N{C functions}` to be called by Lua code.  
Through the use of `@N{C functions}`, Lua can be augmented to cope with  
a wide range of different domains,  
thus creating customized programming languages sharing a syntactical framework.

Lua is free software,  
and is provided as usual with no guarantees,  
as stated in its license.  
The implementation described in this manual is available  
at  
Lua's official web site, `@id{www.lua.org}`.

Like any other reference manual,  
this document is dry in places.  
For a discussion of the decisions behind the design of Lua,  
see the technical papers available at Lua's web site.  
For a detailed introduction to programming in Lua,  
see Roberto's book, `@emphx{Programming in Lua}`.

}

`@C{-----}`  
`@sect1{basic| @title{Basic Concepts}`

`@simplesect{`

This section describes the basic concepts of the language.

}

`@sect2{TypesSec| @title{Values and Types}`

Lua is a dynamically typed language.  
This means that  
variables do not have types; only values do.  
There are no type definitions in the language.  
All values carry their own type.

All values in Lua are first-class values.  
This means that all values can be stored in variables,  
passed as arguments to other functions, and returned as results.

There are eight `@x{basic types}` in Lua:

@def{nil}, @def{boolean}, @def{number},  
@def{string},  
@def{function}, @def{userdata},  
@def{thread}, and @def{table}.

The type @emph{nil} has one single value, @nil,  
whose main property is to be different from any other value;  
it often represents the absence of a useful value.

The type @emph{boolean} has two values, @false and @true.

Both @nil and @false make a condition false;  
they are collectively called @def{false values}.

Any other value makes a condition true.

Despite its name,

@false is frequently used as an alternative to @nil,  
with the key difference that @false behaves  
like a regular value in a table,  
while a @nil in a table represents an absent key.

The type @emph{number} represents both  
integer numbers and real (floating-point) numbers,  
using two @x{subtypes}: @def{integer} and @def{float}.  
Standard Lua uses 64-bit integers and double-precision (64-bit) floats,  
but you can also compile Lua so that it  
uses 32-bit integers and/or single-precision (32-bit) floats.  
The option with 32 bits for both integers and floats  
is particularly  
attractive  
for small machines and embedded systems.  
(See macro @id{LUA\_32BITS} in file @id{luaconf.h}.)

Unless stated otherwise,  
any overflow when manipulating integer values @def{wrap around},  
according to the usual rules of two-complement arithmetic.  
(In other words,  
the actual result is the unique representable integer  
that is equal modulo  $2^M$  to the mathematical result,  
where  $M$  is the number of bits of the integer type.)

Lua has explicit rules about when each subtype is used,  
but it also converts between them automatically as needed @see{coercion}.  
Therefore,  
the programmer may choose to mostly ignore the difference  
between integers and floats  
or to assume complete control over the representation of each number.

The type @emph{string} represents immutable sequences of bytes.  
@index{eight-bit clean}  
Lua is 8-bit clean:  
strings can contain any 8-bit value,

including `@x{embedded zeros}` (`@Char{\\0}`).

Lua is also encoding-agnostic;  
it makes no assumptions about the contents  
of a string.

The length of any string in Lua must fit in a Lua integer.

Lua can call (and manipulate) functions written in Lua and  
functions written in C `@see{functioncall}`.

Both are represented by the type `@emph{function}`.

The type `@emph{userdata}` is provided to allow arbitrary `@N{C data}` to  
be stored in Lua variables.

A userdata value represents a block of raw memory.

There are two kinds of userdata:

`@emphx{full userdata}`,  
which is an object with a block of memory managed by Lua,  
and `@emphx{light userdata}`,  
which is simply a `@N{C pointer}` value.

Userdata has no predefined operations in Lua,  
except assignment and identity test.

By using `@emph{metatables}`,  
the programmer can define operations for full userdata values  
`@see{metatable}`.

Userdata values cannot be created or modified in Lua,  
only through the `@N{C API}`.

This guarantees the integrity of data owned by  
the host program and `@N{C libraries}`.

The type `@def{thread}` represents independent threads of execution  
and it is used to  
implement coroutines `@see{coroutine}`.

Lua threads are not related to operating-system threads.

Lua supports coroutines on all systems,  
even those that do not support threads natively.

The type `@emph{table}` implements `@x{associative arrays}`,  
that is, `@x{arrays}` that can have as indices not only numbers,  
but any Lua value except `@nil` and `@x{NaN}`.

(`@emphx{Not a Number}` is a special floating-point value  
used by the `@x{IEEE 754}` standard to represent  
undefined numerical results, such as `@T{0/0}`.)

Tables can be `@emph{heterogeneous}`;  
that is, they can contain values of all types (except `@nil`).

Any key associated to the value `@nil` is not considered part of the table.  
Conversely, any key that is not part of a table has  
an associated value `@nil`.

Tables are the sole data-structuring mechanism in Lua;

they can be used to represent ordinary arrays, lists, symbol tables, sets, records, graphs, trees, etc. To represent `@x{records}`, Lua uses the field name as an index. The language supports this representation by providing `@id{a.name}` as syntactic sugar for `@T{a["name"]}`. There are several convenient ways to create tables in Lua `@see{tableconstructor}`.

Like indices, the values of table fields can be of any type. In particular, because functions are first-class values, table fields can contain functions. Thus tables can also carry `@emph{methods}` `@see{func-def}`.

The indexing of tables follows the definition of raw equality in the language. The expressions `@T{a[i]}` and `@T{a[j]}` denote the same table element if and only if `@id{i}` and `@id{j}` are raw equal (that is, equal without metamethods). In particular, floats with integral values are equal to their respective integers (e.g., `@T{1.0 == 1}`). To avoid ambiguities, any float used as a key that is equal to an integer is converted to that integer. For instance, if you write `@T{a[2.0] = true}`, the actual key inserted into the table will be the integer `@T{2}`.

Tables, functions, threads, and (full) userdata values are `@emph{objects}`: variables do not actually `@emph{contain}` these values, only `@emph{references}` to them. Assignment, parameter passing, and function returns always manipulate references to such values; these operations do not imply any kind of copy.

The library function `@Lid{type}` returns a string describing the type of a given value `@seeF{type}`.

}

`@sect2{globalenv| @title{Environments and the Global Environment}`

As we will discuss further in `@refsec{variables}` and `@refsec{assignment}`,

any reference to a free name  
(that is, a name not bound to any declaration) `@id{var}`  
is syntactically translated to `@T{_ENV.var}`.  
Moreover, every chunk is compiled in the scope of  
an external local variable named `@id{_ENV}` `@see{chunks}`,  
so `@id{_ENV}` itself is never a free name in a chunk.

Despite the existence of this external `@id{_ENV}` variable and  
the translation of free names,  
`@id{_ENV}` is a completely regular name.

In particular,  
you can define new variables and parameters with that name.

Each reference to a free  
name uses the `@id{_ENV}` that is  
visible at that point in the program,  
following the usual visibility rules of Lua `@see{visibility}`.

Any table used as the value of `@id{_ENV}` is called an `@def{environment}`.

Lua keeps a distinguished environment called the `@def{global environment}`.  
This value is kept at a special index in the C registry `@see{registry}`.  
In Lua, the global variable `@Lid{G}` is initialized with this same value.  
(`@Lid{G}` is never used internally,  
so changing its value will affect only your own code.)

When Lua loads a chunk,  
the default value for its `@id{_ENV}` variable  
is the global environment `@seeF{load}`.  
Therefore, by default,  
free names in Lua code refer to entries in the global environment  
and, therefore, they are also called `@def{global variables}`.  
Moreover, all standard libraries are loaded in the global environment  
and some functions there operate on that environment.  
You can use `@Lid{load}` (or `@Lid{loadfile}`)  
to load a chunk with a different environment.  
(In C,  
you have to load the chunk and then change the value  
of its first upvalue; see `@See{lua_setupvalue}`.)

}

`@sect2{error| @title{Error Handling}}`

Several operations in Lua can `@emph{raise}` an error.  
An error interrupts the normal flow of the program,  
which can continue by `@emph{catching}` the error.

Lua code can explicitly raise an error by calling the

@Lid{error} function.  
(This function never returns.)

To catch errors in Lua,  
you can do a @def{protected call},  
using @Lid{pcall} (or @Lid{xpcall}).  
The function @Lid{pcall} calls a given function in @def{protected mode}.  
Any error while running the function stops its execution,  
and control returns immediately to @id{pcall},  
which returns a status code.

Because Lua is an embedded extension language,  
Lua code starts running by a call  
from @N{C code} in the host program.  
(When you use Lua standalone,  
the @id{lua} application is the host program.)  
Usually, this call is protected;  
so, when an otherwise unprotected error occurs during  
the compilation  
or execution of a Lua chunk,  
control returns to the host,  
which can take appropriate measures,  
such as printing an error message.

Whenever there is an error,  
an @def{error object}  
is propagated with information about the error.  
Lua itself only generates errors whose error object is a string,  
but programs can generate errors with  
any value as the error object.  
It is up to the Lua program or its host to handle such error objects.  
For historical reasons,  
an error object is often called an @def{error message},  
even though it does not have to be a string.

When you use @Lid{xpcall} (or @Lid{lua\_pcall}, in C)  
you can give a @def{message handler}  
to be called in case of errors.  
This function is called with the original error object  
and returns a new error object.  
It is called before the error unwinds the stack,  
so that it can gather more information about the error,  
for instance by inspecting the stack and creating a stack traceback.  
This message handler is still protected by the  
protected call;  
so, an error inside the message handler  
will call the message handler again.



If this loop goes on for too long,  
Lua breaks it and returns an appropriate message.  
The message handler is called only for regular runtime errors.  
It is not called for memory-allocation errors  
nor for errors while running finalizers or other message handlers.

Lua also offers a system of `warnings` `warn`.  
Unlike errors, warnings do not interfere  
in any way with program execution.  
They typically only generate a message to the user,  
although this behavior can be adapted from C `lua_setwarnf`.

}

`metatable` | `Metatables and Metamethods`

Every value in Lua can have a `metatable`.  
This `metatable` is an ordinary Lua table  
that defines the behavior of the original value  
under certain events.  
You can change several aspects of the behavior  
of a value by setting specific fields in its metatable.  
For instance, when a non-numeric value is the operand of an addition,  
Lua  
checks for a function in the field `__add` of the value's metatable.  
If it finds one,  
Lua calls this function to perform the addition.

The key for each event in a metatable is a string  
with the event name prefixed by two underscores;  
the corresponding value is called a `metavalue`.  
For most events, the metavalue must be a function,  
which is then called a `metamethod`.  
In the previous example, the key is the string `__add`  
and the metamethod is the function that performs the addition.  
Unless stated otherwise,  
a metamethod can in fact be any `callable value`,  
which is either a function or a value with a `__call` metamethod.

You can query the metatable of any value  
using the `getmetatable` function.  
Lua queries metamethods in metatables using a raw access `rawget`.

You can replace the metatable of tables  
using the `setmetatable` function.  
You cannot change the metatable of other types from Lua code,  
except by using the `debuglib` debug library.

## Tables

and full userdata have individual metatables,  
although multiple tables and userdata can share their metatables.  
Values of all other types share one single metatable per type;  
that is, there is one single metatable for all numbers,  
one for all strings, etc.  
By default, a value has no metatable,  
but the string library sets a metatable for the string type @see{strlib}.

A detailed list of operations controlled by metatables is given next.  
Each event is identified by its corresponding key.  
By convention, all metatable keys used by Lua are composed by  
two underscores followed by lowercase Latin letters.

@description{

@item{@idx{\_\_add}}|  
the addition (@T{+}) operation.  
If any operand for an addition is not a number,  
Lua will try to call a metamethod.  
It starts by checking the first operand (even if it is a number);  
if that operand does not define a metamethod for @idx{\_\_add},  
then Lua will check the second operand.  
If Lua can find a metamethod,  
it calls the metamethod with the two  
operands as arguments,  
and the result of the call  
(adjusted to one value)  
is the result of the operation.  
Otherwise, if no metamethod is found,  
Lua raises an error.  
}

@item{@idx{\_\_sub}}|  
the subtraction (@T{-}) operation.  
Behavior similar to the addition operation.  
}

@item{@idx{\_\_mul}}|  
the multiplication (@T{\*}) operation.  
Behavior similar to the addition operation.  
}

@item{@idx{\_\_div}}|  
the division (@T{/}) operation.  
Behavior similar to the addition operation.  
}

@item{@idx{\_\_mod}}|  
the modulo ( $@T\{\%\}$ ) operation.  
Behavior similar to the addition operation.  
}

@item{@idx{\_\_pow}}|  
the exponentiation ( $@T\{\wedge\}$ ) operation.  
Behavior similar to the addition operation.  
}

@item{@idx{\_\_unm}}|  
the negation (unary  $@T\{-\}$ ) operation.  
Behavior similar to the addition operation.  
}

@item{@idx{\_\_idiv}}|  
the floor division ( $@T\{/\}$ ) operation.  
Behavior similar to the addition operation.  
}

@item{@idx{\_\_band}}|  
the bitwise AND ( $@T\{\&\}$ ) operation.  
Behavior similar to the addition operation,  
except that Lua will  
try a metamethod  
if any operand is neither an integer  
nor a float coercible to an integer @see{coercion}.  
}

@item{@idx{\_\_bor}}|  
the bitwise OR ( $@T\{|\}$ ) operation.  
Behavior similar to the bitwise AND operation.  
}

@item{@idx{\_\_bxor}}|  
the bitwise exclusive OR (binary  $@T\{\sim\}$ ) operation.  
Behavior similar to the bitwise AND operation.  
}

@item{@idx{\_\_bnot}}|  
the bitwise NOT (unary  $@T\{\sim\}$ ) operation.  
Behavior similar to the bitwise AND operation.  
}

@item{@idx{\_\_shl}}|  
the bitwise left shift ( $@T\{<<\}$ ) operation.  
Behavior similar to the bitwise AND operation.  
}

@item{@idx{\_\_shr}|  
the bitwise right shift (@T{>>}) operation.  
Behavior similar to the bitwise AND operation.  
}

@item{@idx{\_\_concat}|  
the concatenation (@T{..}) operation.  
Behavior similar to the addition operation,  
except that Lua will try a metamethod  
if any operand is neither a string nor a number  
(which is always coercible to a string).  
}

@item{@idx{\_\_len}|  
the length (@T{#}) operation.  
If the object is not a string,  
Lua will try its  
metamethod.  
If there is a metamethod,  
Lua calls it with the object as argument,  
and the result of the call  
(always adjusted to one value)  
is the result of the operation.  
If there is no metamethod but the object is a table,  
then Lua uses the table length operation @see{len-op}.  
Otherwise, Lua raises an error.  
}

@item{@idx{\_\_eq}|  
the equal (@T{==}) operation.  
Behavior similar to the addition operation,  
except that Lua will try a metamethod only when the values  
being compared are either both tables or both full userdata  
and they are not primitively equal.  
The result of the call is always converted to a boolean.  
}

@item{@idx{\_\_lt}|  
the less than (@T{<}) operation.  
Behavior similar to the addition operation,  
except that Lua will try a metamethod only when the values  
being compared are neither both numbers nor both strings.  
Moreover, the result of the call is always converted to a boolean.  
}

@item{@idx{\_\_le}|  
the less equal (@T{<=}) operation.

Behavior similar to the less than operation.

}

@item{@idx{\_\_index}|

The

indexing access operation @T{table[key]}.

This event happens when @id{table} is not a table or

when @id{key} is not present in @id{table}.

The metavalue is looked up in the metatable of @id{table}.

The metavalue for this event can be either a function, a table,  
or any value with an @idx{\_\_index} metavalue.

If it is a function,

it is called with @id{table} and @id{key} as arguments,

and the result of the call

(adjusted to one value)

is the result of the operation.

Otherwise,

the final result is the result of indexing this metavalue with @id{key}.

This indexing is regular, not raw,

and therefore can trigger another @idx{\_\_index} metavalue.

}

@item{@idx{\_\_newindex}|

The indexing assignment @T{table[key] = value}.

Like the index event,

this event happens when @id{table} is not a table or

when @id{key} is not present in @id{table}.

The metavalue is looked up in the metatable of @id{table}.

Like with indexing,

the metavalue for this event can be either a function,

a table,

or any value with an @idx{\_\_newindex} metavalue.

If it is a function,

it is called with @id{table}, @id{key}, and @id{value} as arguments.

Otherwise,

Lua repeats the indexing assignment over this metavalue

with the same key and value.

This assignment is regular, not raw,

and therefore can trigger another @idx{\_\_newindex} metavalue.

Whenever a @idx{\_\_newindex} metavalue is invoked,

Lua does not perform the primitive assignment.

If needed,

the metamethod itself can call @Lid{rawset}

to do the assignment.

}

```

@item{@idx{__call}|
The call operation @T{func(args)}.
This event happens when Lua tries to call a non-function value
(that is, @id{func} is not a function).
The metamethod is looked up in @id{func}.
If present,
the metamethod is called with @id{func} as its first argument,
followed by the arguments of the original call (@id{args}).
All results of the call
are the results of the operation.
This is the only metamethod that allows multiple results.
}

}

```

In addition to  
the previous list,  
the interpreter also respects the following keys in metatables:

```

@idx{__gc} @see{finalizers},
@idx{__close} @see{to-be-closed},
@idx{__mode} @see{weak-table},
and @idx{__name}.

```

(The entry @idx{\_\_name},  
when it contains a string,  
may be used by @Lid{tostring} and in error messages.)

For the unary operators (negation, length, and bitwise NOT),  
the metamethod is computed and called with a dummy second operand,  
equal to the first one.

This extra operand is only to simplify Lua's internals  
(by making these operators behave like a binary operation)  
and may be removed in future versions.

For most uses this extra operand is irrelevant.

Because metatables are regular tables,  
they can contain arbitrary fields,  
not only the event names defined above.

Some functions in the standard library  
(e.g., @Lid{tostring})  
use other fields in metatables for their own purposes.

It is a good practice to add all needed metamethods to a table  
before setting it as a metatable of some object.

In  
particular, the @idx{\_\_gc} metamethod works only when this order  
is followed @see{finalizers}.

It is also a good practice to set the metatable of an object

right after its creation.

}

@sect2{GC| @title{Garbage Collection}

@simplesect{

Lua performs automatic memory management.

This means that

you do not have to worry about allocating memory for new objects  
or freeing it when the objects are no longer needed.

Lua manages memory automatically by running

a @def{garbage collector} to collect all @emph{dead} objects.

All memory used by Lua is subject to automatic management:

strings, tables, userdata, functions, threads, internal structures, etc.

An object is considered @def{dead}

as soon as the collector can be sure the object

will not be accessed again in the normal execution of the program.

(@Q{Normal execution} here excludes finalizers,

which can resurrect dead objects @see{finalizers},

and excludes also operations using the debug library.)

Note that the time when the collector can

be sure that an object

is dead may not coincide with the programmer's expectations.

The only guarantees are that Lua will not collect an object

that may still be accessed in the normal execution of the program,

and it will eventually collect an object

that is inaccessible from Lua.

(Here,

@emph{inaccessible from Lua} means that neither a variable nor  
another live object refer to the object.)

Because Lua has no knowledge about @N{C code},

it never collects objects accessible through the registry @see{registry},

which includes the global environment @see{globalenv}.

The garbage collector (GC) in Lua can work in two modes:

incremental and generational.

The default GC mode with the default parameters

are adequate for most uses.

However, programs that waste a large proportion of their time  
allocating and freeing memory can benefit from other settings.

Keep in mind that the GC behavior is non-portable

both across platforms and across different Lua releases;

therefore, optimal settings

are also non-portable.

You can change the GC mode and parameters by calling

`@Lid{lua_gc} @N{in C}`

or `@Lid{collectgarbage}` in Lua.

You can also use these functions to control the collector directly (e.g., to stop and restart it).

}

`@sect3{incmode| @title{Incremental Garbage Collection}`

In incremental mode,

each GC cycle performs a mark-and-sweep collection in small steps interleaved with the program's execution.

In this mode,

the collector uses three numbers to control its garbage-collection cycles:

the `@def{garbage-collector pause}`,

the `@def{garbage-collector step multiplier}`,

and the `@def{garbage-collector step size}`.

The garbage-collector pause

controls how long the collector waits before starting a new cycle.

The collector starts a new cycle when the use of memory hits `@M{n%}` of the use after the previous collection.

Larger values make the collector less aggressive.

Values equal to or less than 100 mean the collector will not wait to start a new cycle.

A value of 200 means that

the collector waits for the total memory in use to double before starting a new cycle.

The default value is 200; the maximum value is 1000.

The garbage-collector step multiplier

controls the speed of the collector relative to memory allocation,

that is,

how many elements it marks or sweeps for each kilobyte of memory allocated.

Larger values make the collector more aggressive but also increase the size of each incremental step.

You should not use values less than 100,

because they make the collector too slow and can result in the collector never finishing a cycle.

The default value is 100; the maximum value is 1000.

The garbage-collector step size controls the

size of each incremental step,



specifically how many bytes the interpreter allocates before performing a step.

This parameter is logarithmic:

A value of `@M{n}` means the interpreter will allocate `@M{2@sp{n}}` bytes between steps and perform equivalent work during the step.

A large value (e.g., 60) makes the collector a stop-the-world (non-incremental) collector.

The default value is 13, which means steps of approximately `@N{8 Kbytes}`.

}

`@sect3{genmode| @title{Generational Garbage Collection}`

In generational mode, the collector does frequent `@emph{minor}` collections, which traverses only objects recently created. If after a minor collection the use of memory is still above a limit, the collector does a stop-the-world `@emph{major}` collection, which traverses all objects. The generational mode uses two parameters: the `@def{minor multiplier}` and the `@def{the major multiplier}`.

The minor multiplier controls the frequency of minor collections. For a minor multiplier `@M{x}`, a new minor collection will be done when memory grows `@M{x%}` larger than the memory in use after the previous major collection. For instance, for a multiplier of 20, the collector will do a minor collection when the use of memory gets 20% larger than the use after the previous major collection. The default value is 20; the maximum value is 200.

The major multiplier controls the frequency of major collections. For a major multiplier `@M{x}`, a new major collection will be done when memory grows `@M{x%}` larger than the memory in use after the previous major collection. For instance, for a multiplier of 100, the collector will do a major collection when the use of memory gets larger than twice the use after the previous collection. The default value is 100; the maximum value is 1000.

}

`@sect3{finalizers| @title{Garbage-Collection Metamethods}`

You can set garbage-collector metamethods for tables and, using the `@N{C API}`, for full userdata `@see{metatable}`.

These metamethods, called `@def{finalizers}`, are called when the garbage collector detects that the corresponding table or userdata is dead.

Finalizers allow you to coordinate Lua's garbage collection with external resource management such as closing files, network or database connections, or freeing your own memory.

For an object (table or userdata) to be finalized when collected, you

must `@emph{mark}` it for finalization.

`@index{mark (for finalization)}`

You mark an object for finalization when you set its metatable and the metatable has a `@idx{__gc}` metamethod.

Note that if you set a metatable without a `@idx{__gc}` field and later create that field in the metatable, the object will not be marked for finalization.

When a marked object becomes dead, it is not collected immediately by the garbage collector.

Instead, Lua puts it in a list.

After the collection,

Lua goes through that list.

For each object in the list,

it checks the object's `@idx{__gc}` metamethod:

If it is present,

Lua calls it with the object as its single argument.

At the end of each garbage-collection cycle,

the finalizers are called in

the reverse order that the objects were marked for finalization, among those collected in that cycle;

that is, the first finalizer to be called is the one associated with the object marked last in the program.

The execution of each finalizer may occur at any point during

the execution of the regular code.

Because the object being collected must still be used by the finalizer, that object (and other objects accessible only through it)

must be `@emph{resurrected}` by `Lua.@index{resurrection}`

Usually, this resurrection is transient,

and the object memory is freed in the next garbage-collection cycle.

However, if the finalizer stores the object in some global place

(e.g., a global variable),  
then the resurrection is permanent.  
Moreover, if the finalizer marks a finalizing object for finalization again,  
its finalizer will be called again in the next cycle where the  
object is dead.  
In any case,  
the object memory is freed only in a GC cycle where  
the object is dead and not marked for finalization.

When you close a state `@seeF{lua_close}`,  
Lua calls the finalizers of all objects marked for finalization,  
following the reverse order that they were marked.  
If any finalizer marks objects for collection during that phase,  
these marks have no effect.

Finalizers  
cannot yield nor run the garbage collector.  
Because they can run in unpredictable times,  
it is good practice to restrict each finalizer  
to the minimum necessary to properly release  
its associated resource.

Any error while running a finalizer generates a warning;  
the error is not propagated.

}

`@sect3{weak-table| @title{Weak Tables}`

A `@def{weak table}` is a table whose elements are  
`@def{weak references}`.  
A weak reference is ignored by the garbage collector.  
In other words,  
if the only references to an object are weak references,  
then the garbage collector will collect that object.

A weak table can have weak keys, weak values, or both.  
A table with weak values allows the collection of its values,  
but prevents the collection of its keys.  
A table with both weak keys and weak values allows the collection of  
both keys and values.  
In any case, if either the key or the value is collected,  
the whole pair is removed from the table.  
The weakness of a table is controlled by the  
`@idx{__mode}`  
field of its metatable.  
This metavalue, if present, must be one of the following strings:  
`@St{k}`, for a table with weak keys;

@St{v}, for a table with weak values;  
or @St{kv}, for a table with both weak keys and values.

A table with weak keys and strong values  
is also called an @def{ephemeron table}.

In an ephemeron table,  
a value is considered reachable only if its key is reachable.

In particular,  
if the only reference to a key comes through its value,  
the pair is removed.

Any change in the weakness of a table may take effect only  
at the next collect cycle.

In particular, if you change the weakness to a stronger mode,  
Lua may still collect some items from that table  
before the change takes effect.

Only objects that have an explicit construction  
are removed from weak tables.

Values, such as numbers and @x{light @N{C functions}},  
are not subject to garbage collection,  
and therefore are not removed from weak tables  
(unless their associated values are collected).

Although strings  
are subject to garbage collection,  
they do not have an explicit construction and  
their equality is by value;  
they behave more like values than like objects.  
Therefore, they are not removed from weak tables.

Resurrected objects  
(that is, objects being finalized  
and objects accessible only through objects being finalized)  
have a special behavior in weak tables.

They are removed from weak values before running their finalizers,  
but are removed from weak keys only in the next collection  
after running their finalizers, when such objects are actually freed.

This behavior allows the finalizer to access properties  
associated with the object through weak tables.

If a weak table is among the resurrected objects in a collection cycle,  
it may not be properly cleared until the next cycle.

}

}

@sect2{coroutine| @title{Coroutines}}

Lua supports coroutines,  
also called `@emphx{collaborative multithreading}`.  
A coroutine in Lua represents an independent thread of execution.  
Unlike threads in multithread  
systems, however,  
a coroutine only suspends its execution by explicitly calling  
a `yield` function.

You create a coroutine by calling `@Lid{coroutine.create}`.  
Its sole argument is a function  
that is the main function of the coroutine.  
The `@id{create}` function only creates a new coroutine and  
returns a handle to it (an object of type `@emph{thread}`);  
it does not start the coroutine.

You execute a coroutine by calling `@Lid{coroutine.resume}`.  
When you first call `@Lid{coroutine.resume}`,  
passing as its first argument  
a thread returned by `@Lid{coroutine.create}`,  
the coroutine starts its execution by  
calling its main function.  
Extra arguments passed to `@Lid{coroutine.resume}` are passed  
as arguments to that function.  
After the coroutine starts running,  
it runs until it terminates or `@emph{yields}`.

A coroutine can terminate its execution in two ways:  
normally, when its main function returns  
(explicitly or implicitly, after the last instruction);  
and abnormally, if there is an unprotected  
error.  
In case of normal termination,  
`@Lid{coroutine.resume}` returns `@true`,  
plus any values returned by the coroutine main function.  
In case of errors, `@Lid{coroutine.resume}` returns `@false`  
plus the error object.  
In this case, the coroutine does not unwind its stack,  
so that it is possible to inspect it after the error  
with the debug API.

A coroutine yields by calling `@Lid{coroutine.yield}`.  
When a coroutine yields,  
the corresponding `@Lid{coroutine.resume}` returns immediately,  
even if the yield happens inside nested function calls  
(that is, not in the main function,  
but in a function directly or indirectly called by the main function).  
In the case of a yield, `@Lid{coroutine.resume}` also returns `@true`,

plus any values passed to `@Lid{coroutine.yield}`.  
The next time you resume the same coroutine,  
it continues its execution from the point where it yielded,  
with the call to `@Lid{coroutine.yield}` returning any extra  
arguments passed to `@Lid{coroutine.resume}`.

Like `@Lid{coroutine.create}`,  
the  
`@Lid{coroutine.wrap}` function also creates a coroutine,  
but instead of returning the coroutine itself,  
it returns a function that, when called, resumes the coroutine.  
Any arguments passed to this function  
go as extra arguments to `@Lid{coroutine.resume}`.  
`@Lid{coroutine.wrap}` returns all the values returned by `@Lid{coroutine.resume}`,  
except the first one (the boolean error code).  
Unlike `@Lid{coroutine.resume}`,  
the function created by `@Lid{coroutine.wrap}`  
propagates any error to the caller.  
In this case,  
the function also closes the coroutine `@seeF{coroutine.close}`.

As an example of how coroutines work,  
consider the following code:

```
@verbatim{
function foo (a)
  print("foo", a)
  return coroutine.yield(2*a)
end

co = coroutine.create(function (a,b)
  print("co-body", a, b)
  local r = foo(a+1)
  print("co-body", r)
  local r, s = coroutine.yield(a+b, a-b)
  print("co-body", r, s)
  return b, "end"
end)

print("main", coroutine.resume(co, 1, 10))
print("main", coroutine.resume(co,
  "r"))
print("main", coroutine.resume(co, "x", "y"))
print("main", coroutine.resume(co, "x", "y"))
}
```

When you run it, it produces the following output:

```
@verbatim{
co-body 1    10
foo    2
```

```

main  true  4
co-body r
main  true  11  -9
co-body x    y
main  true  10  end
main  false  cannot resume dead coroutine
}

```

You can also create and manipulate coroutines through the C API:  
 see functions `@Lid{lua_newthread}`, `@Lid{lua_resume}`,  
 and `@Lid{lua_yield}`.

```

}

```

```

}

```

```

@C{-----}
@sect1{language| @title{The Language}

```

```

@simplesect{

```

This section describes the lexis, the syntax, and the semantics of Lua.  
 In other words,  
 this section describes  
 which tokens are valid,  
 how they can be combined,  
 and what their combinations mean.

Language constructs will be explained using the usual extended BNF notation,  
 in which

`@N{@bnfrep{@rep{a}}` means 0 or more `@rep{a}`'s, and  
`@N{@bnfopt{@rep{a}}` means an  
 optional `@rep{a}`.

Non-terminals are shown like `@bnfNter{non-terminal}`,

keywords are shown like `@rw{kword}`,

and other terminal symbols are shown like `@bnfter{=}`.

The complete syntax of Lua can be found in `@refsec{BNF}`  
 at the end of this manual.

```

}

```

```

@sect2{lexical| @title{Lexical Conventions}

```

Lua is a `@x{free-form}` language.

It ignores spaces and comments between lexical elements (`@x{tokens}`),  
 except as delimiters between two tokens.

In source code,

Lua recognizes as spaces the standard ASCII whitespace characters space, form feed, newline, carriage return, horizontal tab, and vertical tab.

@def{Names}

(also called @def{identifiers})

in Lua can be any string of Latin letters,

Arabic-Indic digits, and underscores,

not beginning with a digit and

not being a reserved word.

Identifiers are used to name variables, table fields, and labels.

The following @def{keywords} are reserved

and cannot be used as names:

@index{reserved words}

@verbatim{

and break do else elseif

end

false for function goto if in

local nil not or repeat return

then true until while

}

Lua is a case-sensitive language:

@id{and} is a reserved word, but @id{And} and @id{AND}

are two different, valid names.

As a convention,

programs should avoid creating

names that start with an underscore followed by

one or more uppercase letters (such as @Lid{\_VERSION}).

The following strings denote other @x{tokens}:

@verbatim{

+ - \* / % ^ #

& ~ | << >> //

== ~= <= >= < > =

( ) { } [ ] ::

; : , . .. ...

}

A @def{short literal string}

can be delimited by matching single or double quotes,

and can contain the following C-like escape sequences:

@Char{\a} (bell),

@Char{\b} (backspace),

@Char{\f} (form feed),

@Char{\n} (newline),

@Char{\r} (carriage return),



`@Char{t}` (horizontal tab),  
`@Char{v}` (vertical tab),  
`@Char{\\}` (backslash),  
`@Char{"}`  
 (quotation mark [double quote]),  
 and `@Char{'}` (apostrophe [single quote]).  
 A backslash followed by a line break  
 results in a newline in the string.  
 The escape sequence `@Char{z}` skips the following span  
 of whitespace characters,  
 including line breaks;  
 it is particularly useful to break and indent a long literal string  
 into multiple lines without adding the newlines and spaces  
 into the string contents.  
 A short literal string cannot contain unescaped line breaks  
 nor escapes not forming a valid escape sequence.

We can specify any byte in a short literal string,  
 including `@x{embedded zeros}`,  
 by its numeric value.  
 This can be done  
 with the escape sequence `@T{x@rep{XX}}`,  
 where `@rep{XX}` is a sequence of exactly two hexadecimal digits,  
 or with the escape sequence `@T{@rep{ddd}}`,  
 where `@rep{ddd}` is a sequence of up to three decimal digits.  
 (Note that if a decimal escape sequence is to be followed by a digit,  
 it must be expressed using exactly three digits.)

The `@x{UTF-8}` encoding  
 of a `@x{Unicode}` character  
 can be inserted in a literal string with  
 the escape sequence `@T{u{@rep{XXX}}}`  
 (with mandatory enclosing braces),  
 where `@rep{XXX}` is a sequence of one or more hexadecimal digits  
 representing the character code point.  
 This code point can be any value less than `@M{2@sp{31}}`.  
 (Lua uses the original UTF-8 specification here,  
 which is not restricted to valid Unicode code points.)

Literal strings can also be defined using a long format  
 enclosed by `@def{long brackets}`.  
 We define an `@def{opening long bracket of level @rep{n}}` as an opening  
 square bracket followed by `@rep{n}` equal signs followed by another  
 opening square bracket.  
 So, an opening long bracket of `@N{level 0}` is written as `@T{[[, @C{]]}`  
 an opening long bracket of `@N{level 1}` is written as `@T{[=[, @C{]]}`  
 and so on.  
 A `@emph{closing long bracket}` is defined similarly;

for instance,  
 a closing long bracket of @N{level 4} is written as @C{[[ @T{]===}]}.  
 A @def{long literal} starts with an opening long bracket  
 of any level and  
 ends at the first closing long bracket of the same level.  
 It can contain any text except a closing bracket of the same level.  
 Literals in this bracketed form can run for several lines,  
 do not interpret any escape sequences,  
 and ignore long brackets of any other level.  
 Any kind of end-of-line sequence  
 (carriage return, newline, carriage return followed by newline,  
 or newline followed by carriage return)  
 is converted to a simple newline.  
 When the opening long bracket is immediately followed by a newline,  
 the newline is not included in the string.

As an example, in a system using ASCII  
 (in which @Char{a} is coded @N{as 97},  
 newline is coded @N{as 10}, and @Char{1} is coded @N{as 49}),  
 the five literal strings below denote the same string:

```
@verbatim{
a = 'alo\n123"'
a = "alo\n123\'"
a = "\97lo\10\04923"
a = [[alo
123"]]
a = [==[
alo
123"]==]
}
```

Any byte in a literal string not  
 explicitly affected by the previous rules represents itself.  
 However, Lua opens files for  
 parsing in text mode,  
 and the system's file functions may have problems with  
 some control characters.  
 So, it is safer to represent  
 binary data as a quoted literal with  
 explicit escape sequences for the non-text characters.

A @def{numeric constant} (or @def{numeral})  
 can be written with an optional fractional part  
 and an optional decimal exponent,  
 marked by a letter @Char{e} or @Char{E}.  
 Lua also accepts @x{hexadecimal constants},  
 which start with @T{0x} or @T{0X}.  
 Hexadecimal constants also accept an optional fractional part

plus an optional binary exponent,  
marked by a letter `@Char{p}` or `@Char{P}` and written in decimal.  
(For instance, `@T{0x1.fp10}` denotes 1984,  
which is `@M{0x1f / 16}` multiplied by `@M{2@sp{10}}.`)

A numeric constant with a radix point or an exponent  
denotes a float;  
otherwise,  
if its value fits in an integer or it is a hexadecimal constant,  
it denotes an integer;  
otherwise (that is, a decimal integer numeral that overflows),  
it denotes a float.

Hexadecimal numerals

with neither a radix point nor an exponent  
always denote an integer value;  
if the value overflows, it `@emph{wraps around}`  
to fit into a valid integer.

Examples of valid integer constants are

```
@verbatim{
3 345 0xff 0xBEBADA
}
```

Examples of valid float constants are

```
@verbatim{
3.0 3.1416 314.16e-2 0.31416E1 34e1
0x0.1E 0xA23p-4 0X1.921FB54442D18P+1
}
```

A `@def{comment}` starts with a double hyphen (`@T{--}`)  
anywhere outside a string.

If the text immediately after `@T{--}` is not an opening long bracket,  
the comment is a `@def{short comment}`,  
which runs until the end of the line.

Otherwise, it is a `@def{long comment}`,  
which runs until the corresponding closing long bracket.

```
}
```

```
@sect2{variables| @title{Variables}}
```

Variables are places that store values.

There are three kinds of variables in Lua:

global variables, local variables, and table fields.

A single name can denote a global variable or a local variable  
(or a function's formal parameter,  
which is a particular kind of

local variable):

```
@Produc{
@producname{var}@producbody{@bnfNter{Name}}
}
@bnfNter{Name} denotes identifiers @see{lexical}.
```

Any variable name is assumed to be global unless explicitly declared as a local @see{localvar}.

@x{Local variables} are @emph{lexically scoped}:  
local variables can be freely accessed by functions  
defined inside their scope @see{visibility}.

Before the first assignment to a variable, its value is @nil.

Square brackets are used to index a table:

```
@Produc{
@producname{var}@producbody{prefixexp @bnfter{[] exp @bnfter{[]}}
}
```

The meaning of accesses to table fields can be changed via metatables @see{metatable}.

The syntax @id{var.Name} is just syntactic sugar for

```
@T{var["Name"]}:
@Produc{
@producname{var}@producbody{prefixexp @bnfter{.} @bnfNter{Name}}
}
```

An access to a global variable @id{x}  
is equivalent to @id{\_ENV.x}.

Due to the way that chunks are compiled,  
the variable @id{\_ENV} itself is never global @see{globalenv}.

```
}
```

```
@sect2{stats| @title{Statements}}
```

```
@simplesect{
```

Lua

supports an almost conventional set of @x{statements},  
similar to those in other conventional languages.

This set includes

blocks, assignments, control structures, function calls,  
and variable declarations.

```
}
```

```
@sect3{@title{Blocks}}
```

A `@x{block}` is a list of statements,

which are executed sequentially:

```
@Produc{
@producname{block}@producbody{@bnfrep{stat}}
}
```

Lua has `@def{empty statements}`

that allow you to separate statements with semicolons,

start a block with a semicolon

or write two semicolons in sequence:

```
@Produc{
@producname{stat}@producbody{@bnfter{;}}
}
```

Both function calls and assignments

can start with an open parenthesis.

This possibility leads to an ambiguity in Lua's grammar.

Consider the following fragment:

```
@verbatim{
a = b + c
(print or io.write)('done')
}
```

The grammar could see this fragment in two ways:

```
@verbatim{
a = b + c(print or io.write)('done')
```

```

a = b + c; (print or io.write)('done')
}
```

The current parser always sees such constructions

in the first way,

interpreting

the open parenthesis

as the start of the arguments to a call.

To avoid this ambiguity,

it is a good practice to always precede with a semicolon

statements that start with a parenthesis:

```
@verbatim{
;(print or io.write)('done')
}
```

A block can be explicitly delimited to produce a single statement:

```
@Produc{
@producname{stat}@producbody{@Rw{do} block @Rw{end}}
}
```

Explicit blocks are useful

to control the scope of variable declarations.

Explicit blocks are also sometimes used to

add a `@Rw{return}` statement in the middle

of another block @see{control}.

}

@sect3{chunks| @title{Chunks}}

The unit of compilation of Lua is called a @def{chunk}.

Syntactically,

a chunk is simply a block:

```
@Produc{
@producname{chunk}@producbody{block}
}
```

Lua handles a chunk as the body of an anonymous function  
with a variable number of arguments

@see{func-def}.

As such, chunks can define local variables,  
receive arguments, and return values.

Moreover, such anonymous function is compiled as in the  
scope of

an external local variable called @id{\_ENV} @see{globalenv}.

The resulting function always has @id{\_ENV} as its only external variable,  
even if it does not use that variable.

A chunk can be stored in a file or in a string inside the host program.

To execute a chunk,

Lua first @emph{loads} it,

precompiling the chunk's code into instructions for a virtual machine,

and then Lua executes the compiled code

with an interpreter for the virtual machine.

Chunks can also be precompiled into binary form;

see the program @idx{luac} and the function @Lid{string.dump} for details.

Programs in source and compiled forms are interchangeable;

Lua automatically detects the file type and acts accordingly @seeF{load}.

}

@sect3{assignment| @title{Assignment}}

Lua allows @x{multiple assignments}.

Therefore, the syntax for assignment

defines a list of variables on the left side

and a list of expressions on the right side.

The elements in both lists are separated by commas:

```
@Produc{
@producname{stat}@producbody{varlist
```

```

@bnfter{=} explist}
@producname{varlist}@producbody{var @bnfrep{@bnfter{,} var}}
@producname{explist}@producbody{exp @bnfrep{@bnfter{,} exp}}
}

```

Expressions are discussed in @See{expressions}.

Before the assignment,  
the list of values is @emph{adjusted} to the length of  
the list of variables @see{multires}.

If a variable is both assigned and read  
inside a multiple assignment,  
Lua ensures that all reads get the value of the variable  
before the assignment.

Thus the code

```

@verbatim{
i = 3
i, a[i] = i+1, 20
}

```

sets @T{a[3]} to 20, without affecting @T{a[4]}  
because the @id{i} in @T{a[i]} is evaluated (to 3)  
before it is @N{assigned 4}.

Similarly, the line

```

@verbatim{
x, y = y, x
}

```

exchanges the values of @id{x} and @id{y},  
and

```

@verbatim{
x, y, z = y, z, x
}

```

cyclically permutes the values of @id{x}, @id{y}, and @id{z}.

Note that this guarantee covers only accesses  
syntactically inside the assignment statement.

If a function or a metamethod called during the assignment  
changes

the value of a variable,

Lua gives no guarantees about the order of that access.

An assignment to a global name @T{x = val}

is equivalent to the assignment

```
@T{_ENV.x = val} @see{globalenv}.
```

The meaning of assignments to table fields and  
global variables (which are actually table fields, too)  
can be changed via metatables @see{metatable}.

}

@sect3{control| @title{Control Structures}

The control structures

@Rw{if}, @Rw{while}, and @Rw{repeat} have the usual meaning and familiar syntax:

@index{while-do statement}

@index{repeat-until statement}

@index{if-then-else statement}

@Produc{

@producname{stat}@producbody{@Rw{while} exp @Rw{do} block @Rw{end}}

@producname{stat}@producbody{@Rw{repeat} block @Rw{until} exp}

@producname{stat}@producbody{@Rw{if} exp @Rw{then} block

@bnfrep{@Rw{elseif} exp @Rw{then} block}

@bnfoft{@Rw{else} block} @Rw{end}}

}

Lua also has a @Rw{for} statement, in two flavors @see{for}.

The @x{condition expression} of a control structure can return any value.

Both

@false and @nil test false.

All values different from @nil and @false test true.

In particular, the number 0 and the empty string also test true.

In the @Rw{repeat}@En@Rw{until} loop, the inner block does not end at the @Rw{until} keyword, but only after the condition.

So, the condition can refer to local variables declared inside the loop block.

The @Rw{goto} statement transfers the program control to a label.

For syntactical reasons,

labels in Lua are considered statements too:

@index{goto statement}

@index{label}

@Produc{

@producname{stat}@producbody{@Rw{goto} Name}

@producname{stat}@producbody{label}

@producname{label}@producbody{@bnfter{::} Name @bnfter{::}}

}

A label is visible in the entire block where it is defined, except inside nested functions.

A goto can jump to any visible label as long as it does not enter into the scope of a local variable.

A label should not be declared

where a label with the same name is visible,



even if this other label has been declared in an enclosing block.

The `@Rw{break}` statement terminates the execution of a `@Rw{while}`, `@Rw{repeat}`, or `@Rw{for}` loop, skipping to the next statement after the loop:

```
@index{break statement}
@Produc{
@producname{stat}@producbody{@Rw{break}}
}
```

A `@Rw{break}` ends the innermost enclosing loop.

The `@Rw{return}` statement is used to return values from a function or a chunk (which is handled as an anonymous function).

```
@index{return statement}
```

Functions can return more than one value, so the syntax for the `@Rw{return}` statement is

```
@Produc{
@producname{stat}@producbody{@Rw{return} @bnfopt{explist} @bnfopt{@bnfter{;}}}
}
```

The `@Rw{return}` statement can only be written as the last statement of a block.

If it is necessary to `@Rw{return}` in the middle of a block, then an explicit inner block can be used, as in the idiom `@T{do return end}`, because now `@Rw{return}` is the last statement in its (inner) block.

```
}
```

```
@sect3{for| @title{For Statement}
```

```
@index{for statement}
```

The `@Rw{for}` statement has two forms:

one

numerical and one generic.

```
@sect4{@title{The numerical @Rw{for} loop}
```

The numerical `@Rw{for}` loop repeats a block of code while a control variable goes through an arithmetic progression.

It has the following syntax:

```
@Produc{
@producname{stat}@producbody{@Rw{for} @bnfNter{Name} @bnfter{=}
exp @bnfter{,} exp @bnfopt{@bnfter{,} exp} @Rw{do} block @Rw{end}}
}
```

The given identifier (`@bnfNter{Name}`) defines the control variable,

which is a new variable local to the loop body (`@emph{block}`).

The loop starts by evaluating once the three control expressions.

Their values are called respectively

the `@emph{initial value}`, the `@emph{limit}`, and the `@emph{step}`.

If the step is absent, it defaults `@N{to 1}`.

If both the initial value and the step are integers,

the loop is done with integers;

note that the limit may not be an integer.

Otherwise, the three values are converted to

floats and the loop is done with floats.

Beware of floating-point accuracy in this case.

After that initialization,

the

loop body is repeated with the value of the control variable

going through an arithmetic progression,

starting at the initial value,

with a common difference given by the step.

A negative step makes a decreasing sequence;

a step equal to zero raises an error.

The loop continues while the value is less than

or equal to the limit

(greater than or equal to for a negative step).

If the initial value is already greater than the limit

(or less than, if the step is negative),

the body is not executed.

For integer loops,

the control variable never wraps around;

instead, the loop ends in case of an overflow.

You should not change the value of the control variable

during the loop.

If you need its value after the loop,

assign it to another variable before exiting the loop.

}

`@sect4{@title{The generic @Rw{for} loop}`

The generic `@Rw{for}` statement works over functions,

called `@def{iterators}`.

On each iteration, the iterator function is called to produce a new value,

stopping when this new

value is `@nil`.

The generic `@Rw{for}` loop has the following syntax:

```
@Produc{
  @producname{stat}@produciblebody{@Rw{for} namelist @Rw{in} explist
    @Rw{do} block @Rw{end}}
  @producname{namelist}@produciblebody{@bnfNter{Name} @bnfrep{@bnfter{,} @bnfNter{Name}}}
}
```

A `@Rw{for}` statement like

```
@verbatim{
  for @rep{var_1}, @Cdots, @rep{var_n} in @rep{explist} do @rep{body} end
}
```

works as follows.

The names `@rep{var_i}` declare loop variables local to the loop body.

The first of these variables is the `@emph{control variable}`.

The loop starts by evaluating `@rep{explist}`

to produce four values:

an `@emph{iterator function}`,

a `@emph{state}`,

an initial value for the control variable,

and a `@emph{closing value}`.

Then, at each iteration,

Lua calls the iterator function with two arguments:

the state and the control variable.

The results from this call are then assigned to the loop variables,

following the rules of multiple assignments `@see{assignment}`.

If the control variable becomes `@nil`,

the

loop terminates.

Otherwise, the body is executed and the loop goes

to the next iteration.

The closing value behaves like a

to-be-closed variable `@see{to-be-closed}`,

which can be used to release resources when the loop ends.

Otherwise, it does not interfere with the loop.

You should not change the value of the control variable

during the loop.

```
}
```

```
}
```

`@sect3{funcstat| @title{Function Calls as Statements}}`

To allow possible side-effects,

function calls can be executed as statements:

```
@Produc{
@producname{stat}@producbody{functioncall}
}
```

In this case, all returned values are thrown away.

Function calls are explained in @See{functioncall}.

```
}
```

```
@sect3{localvar| @title{Local Declarations}
```

@x{Local variables} can be declared anywhere inside a block.

The declaration can include an initialization:

```
@Produc{
@producname{stat}@producbody{@Rw{local} attnamelist @bnfopt{@bnfter{=} explist}}
@producname{attnamelist}@producbody{
@bnfNter{Name} attrib @bnfrep{@bnfter{,} @bnfNter{Name} attrib}}
}
```

If

present, an initial assignment has the same semantics  
of a multiple assignment @see{assignment}.

Otherwise, all variables are initialized with @nil.

Each variable name may be postfixed by an attribute  
(a name between angle brackets):

```
@Produc{
@producname{attrib}@producbody{@bnfopt{@bnfter{<} @bnfNter{Name} @bnfter{>}}}
}
```

There are two possible attributes:

@id{const}, which declares a @x{constant variable},  
that is, a variable that cannot be assigned to  
after its initialization;

and @id{close}, which declares a to-be-closed variable @see{to-be-closed}.

A list of variables can contain at most one to-be-closed variable.

A chunk is also a block @see{chunks},

and so local variables can be declared in a chunk outside any explicit block.

The visibility rules for local variables are explained in @See{visibility}.

```
}
```

```
@sect3{to-be-closed| @title{To-be-closed Variables}
```

A to-be-closed variable behaves like a constant local variable,  
except that its value is @emph{closed} whenever the variable  
goes

out of scope, including normal block termination,  
exiting its block by @Rw{break}/@Rw{goto}/@Rw{return},

or exiting by an error.

Here, to `@emph{close}` a value means to call its `@idx{__close}` metamethod. When calling the metamethod, the value itself is passed as the first argument and the error object that caused the exit (if any) is passed as a second argument; if there was no error, the second argument is `@nil`.

The value assigned to a to-be-closed variable must have a `@idx{__close}` metamethod or be a false value. (`@nil` and `@false` are ignored as to-be-closed values.)

If several to-be-closed variables go out of scope at the same event, they are closed in the reverse order that they were declared.

If there is any error while running a closing method, that error is handled like an error in the regular code where the variable was defined. After an error, the other pending closing methods will still be called.

If a coroutine yields and is never resumed again, some variables may never go out of scope, and therefore they will never be closed. (These variables are the ones created inside the coroutine and in scope at the point where the coroutine yielded.) Similarly, if a coroutine ends with an error, it does not unwind its stack, so it does not close any variable. In both cases, you can either use finalizers or call `@Lid{coroutine.close}` to close the variables. However, if the coroutine was created through `@Lid{coroutine.wrap}`, then its corresponding function will close the coroutine in case of errors.

}

}

`@sect2{expressions| @title{Expressions}`

`@simplesect{`

The basic expressions in Lua are the following:

```
@Produc{
  @producname{exp}@producbody{prefixexp}
  @producname{exp}@producbody{@Rw{nil} @Or @Rw{false} @Or @Rw{true}}
  @producname{exp}@producbody{@bnfNter{Numeral}}
  @producname{exp}@producbody{@bnfNter{LiteralString}}
  @producname{exp}@producbody{functiondef}
  @producname{exp}@producbody{tableconstructor}
  @producname{exp}@producbody{@bnfter{...}}
  @producname{exp}@producbody{exp
    binop exp}
  @producname{exp}@producbody{unop exp}
  @producname{prefixexp}@producbody{var @Or functioncall @Or
    @bnfter{() exp @bnfter{}}}
}
```

Numerals and literal strings are explained in @See{lexical};

variables are explained in @See{variables};

function definitions are explained in @See{func-def};

function calls are explained in @See{functioncall};

table constructors are explained in @See{tableconstructor}.

Vararg expressions,

denoted by three dots (@Char{...}), can only be used when

directly inside a variadic function;

they are explained in @See{func-def}.

Binary operators comprise arithmetic operators @see{arith},

bitwise operators @see{bitwise},

relational operators @see{rel-ops}, logical operators @see{logic},

and the concatenation operator @see{concat}.

Unary operators comprise the unary minus @see{arith},

the unary bitwise NOT @see{bitwise},

the unary logical @Rw{not} @see{logic},

and the unary @def{length operator} @see{len-op}.

}

@sect3{arith|

@title{Arithmetic Operators}

Lua supports the following @x{arithmetic operators}:

@description{

@item{@T{+}|addition}

@item{@T{-}|subtraction}

@item{@T{\*}|multiplication}

```

@item{@T{/}|float division}
@item{@T{//}|floor division}
@item{@T{%}|modulo}
@item{@T{^}|exponentiation}
@item{@T{-}|unary minus}
}

```

With the exception of exponentiation and float division, the arithmetic operators work as follows:

If both operands are integers, the operation is performed over integers and the result is an integer.

Otherwise, if both operands are numbers, then they are converted to floats, the operation is performed following the machine's rules for floating-point arithmetic (usually the `@x{IEEE 754}` standard), and the result is a float.

(The string library coerces strings to numbers in arithmetic operations; see `@See{coercion}` for details.)

Exponentiation and float division (`@T{/}`) always convert their operands to floats and the result is always a float.

Exponentiation uses the `@ANSI{pow}`, so that it works for non-integer exponents too.

Floor division (`@T{//}`) is a division that rounds the quotient towards minus infinity, resulting in the floor of the division of its operands.

Modulo is defined as the remainder of a division that rounds the quotient towards minus infinity (floor division).

In case of overflows in integer arithmetic, all operations `@emphx{wrap around}`.

```

}
```

```

@sect3{bitwise| @title{Bitwise Operators}
Lua supports the following @x{bitwise operators}:
@description{
@item{@T{&}|bitwise AND}
@item{@T{@VerBar}|bitwise OR}
@item{@T{~}|bitwise exclusive OR}
@item{@T{>>}|right shift}
@item{@T{<<}|left shift}
@item{@T{~}|unary bitwise NOT}
}

```

All bitwise operations convert its operands to integers  
@see{coercion},  
operate on all bits of those integers,  
and result in an integer.

Both right and left shifts fill the vacant bits with zeros.  
Negative displacements shift to the other direction;  
displacements with absolute values equal to or higher than  
the  
number of bits in an integer  
result in zero (as all bits are shifted out).

}

@sect3{coercion| @title{Coercions and Conversions}  
Lua provides some automatic conversions between some  
types and representations at run time.  
Bitwise operators always convert float operands to integers.  
Exponentiation and float division  
always convert integer operands to floats.  
All other arithmetic operations applied to mixed numbers  
(integers and floats) convert the integer operand to a float.  
The C API also converts both integers to floats and  
floats to integers, as needed.  
Moreover, string concatenation accepts numbers as arguments,  
besides strings.

In a conversion from integer to float,  
if the integer value has an exact representation as a float,  
that is the result.  
Otherwise,  
the conversion gets the nearest higher or  
the nearest lower representable value.  
This kind of conversion never fails.

The conversion from float to integer  
checks whether the float has an exact representation as an integer  
(that  
is, the float has an integral value and  
it is in the range of integer representation).  
If it does, that representation is the result.  
Otherwise, the conversion fails.

Several places in Lua coerce strings to numbers when necessary.  
In particular,  
the string library sets metamethods that try to coerce  
strings to numbers in all arithmetic operations.



If the conversion fails,  
the library calls the metamethod of the other operand  
(if present) or it raises an error.  
Note that bitwise operators do not do this coercion.

It is always a good practice not to rely on the  
implicit coercions from strings to numbers,  
as they are not always applied;  
in particular, `@T{"1"==1}` is false and `@T{"1"<1}` raises an error  
`@see{rel-ops}`.  
These coercions exist mainly for compatibility and may be removed  
in future versions of the language.

A string is converted to an integer or a float  
following its syntax and the rules of the Lua lexer.  
The string may have also leading and trailing whitespaces and a sign.  
All  
conversions from strings to numbers  
accept both a dot and the current locale mark  
as the radix character.  
(The Lua lexer, however, accepts only a dot.)  
If the string is not a valid numeral,  
the conversion fails.  
If necessary, the result of this first step is then converted  
to a specific number subtype following the previous rules  
for conversions between floats and integers.

The conversion from numbers to strings uses a  
non-specified human-readable format.  
To convert numbers to strings in any specific way,  
use the function `@Lid{string.format}`.

}

`@sect3{rel-ops| @title{Relational Operators}`  
Lua supports the following `@x{relational operators}`:  
`@description{`  
`@item{@T{==}|equality}`  
`@item{@T{~=}|inequality}`  
`@item{@T{<}|less than}`  
`@item{@T{>}|greater than}`  
`@item{@T{<=}|less or equal}`  
`@item{@T{>=}|greater or equal}`  
`}`

These operators always result in `@false` or `@true`.

Equality (`@T{==}`) first compares the type of its operands.  
If the types are different, then the result is `@false`.

Otherwise,  
the values of the operands are compared.  
Strings are equal if they have the same byte content.  
Numbers are equal if they denote the same mathematical value.

Tables, userdata, and threads  
are compared by reference:  
two objects are considered equal only if they are the same object.  
Every time you create a new object  
(a table, a userdata, or a thread),  
this new object is different from any previously existing object.  
A function is always equal to itself.  
Functions with any detectable difference  
(different behavior, different definition) are always different.  
Functions created at different times but with no detectable differences  
may be classified as equal or not  
(depending on internal caching details).

You can change the way that Lua compares tables and userdata  
by using the `@idx{__eq}` metamethod `@see{metatable}`.

Equality comparisons do not convert strings to numbers  
or vice versa.  
Thus, `@T{"0"==0}` evaluates to `@false`,  
and `@T{t[0]}` and `@T{t["0"]}` denote different  
entries in a table.

The  
operator `@T{~=}` is exactly the negation of equality (`@T{==}`).

The order operators work as follows.  
If both arguments are numbers,  
then they are compared according to their mathematical values,  
regardless of their subtypes.  
Otherwise, if both arguments are strings,  
then their values are compared according to the current locale.  
Otherwise, Lua tries to call the `@idx{__lt}` or the `@idx{__le}`  
metamethod `@see{metatable}`.  
A comparison `@T{a > b}` is translated to `@T{b < a}`  
and `@T{a >= b}` is translated to `@T{b <= a}`.

Following the `@x{IEEE 754}` standard,  
the special value `@x{NaN}` is considered neither less than,  
nor equal to, nor greater than any value, including itself.

}

`@sect3{logic| @title{Logical Operators}}`

The `@x{logical operators}` in Lua are `@Rw{and}`, `@Rw{or}`, and `@Rw{not}`.  
Like the control structures `@see{control}`, all logical operators consider both `@false` and `@nil` as false and anything else as true.

The negation operator `@Rw{not}` always returns `@false` or `@true`.

The conjunction

operator `@Rw{and}` returns its first argument

if this value is `@false` or `@nil`;

otherwise, `@Rw{and}` returns its second argument.

The disjunction operator `@Rw{or}` returns its first argument

if this value is different from `@nil` and `@false`;

otherwise, `@Rw{or}` returns its second argument.

Both `@Rw{and}` and `@Rw{or}` use `@x{short-circuit evaluation}`;

that is,

the second operand is evaluated only if necessary.

Here are some examples:

```
@verbatim{
```

```
10 or 20      --> 10
```

```
10 or error() --> 10
```

```
nil or "a"    --> "a"
```

```
nil and 10    --> nil
```

```
false and error() --> false
```

```
false and nil  --> false
```

```
false or nil   --> nil
```

```
10 and 20      --> 20
```

```
}
```

```
}
```

```
@sect3{concat| @title{Concatenation}}
```

The string `@x{concatenation}` operator in Lua is denoted by two dots (`@Char{..}`).

If both operands are strings or numbers,

then the numbers are converted to strings

in a non-specified format `@see{coercion}`.

Otherwise, the `@idx{__concat}` metamethod is called `@see{metatable}`.

```
}
```

```
@sect3{len-op|
```

```
@title{The Length Operator}
```

The length operator is denoted by the unary prefix operator `@T{#}`.

The length of a string is its number of bytes.

(That is the usual meaning of string length when each

character is one byte.)

The length operator applied on a table  
returns a `@x{border}` in that table.

A `@def{border}` in a table `@id{t}` is any non-negative integer  
that satisfies the following condition:

```
@verbatim{
(border == 0 or t[border] ~= nil) and
(t[border + 1] == nil or border == math.maxinteger)
}
```

In words,

a border is any positive integer index present in the table  
that is followed by an absent index,

plus two limit cases:

zero, when index 1 is absent;

and the maximum value for an integer, when that index is present.

Note that keys that are not positive integers  
do not interfere with borders.

A table with exactly one border is called a `@def{sequence}`.

For instance, the table `@T{{10, 20, 30, 40, 50}}` is a sequence,  
as it has only one border (5).

The table `@T{{10, 20, 30, nil, 50}}` has  
two borders (3 and 5),

and therefore it is not a sequence.

(The `@nil` at index 4 is called a `@emphx{hole}`.)

The table `@T{{nil, 20, 30, nil, nil, 60, nil}}`  
has three borders (0, 3, and 6),

so it is not a sequence, too.

The table `@T{{}}` is a sequence with border 0.

When `@id{t}` is a sequence,

`@T{#t}` returns its only border,

which corresponds to the intuitive notion of the length of the sequence.

When `@id{t}` is not a sequence,

`@T{#t}` can return any of its borders.

(The exact one depends on details of  
the internal representation of the table,

which in turn can depend on how the table was populated and  
the memory addresses of its non-numeric keys.)

The computation of the length of a table

has a guaranteed worst time of `@M{O(log n)}`,

where `@M{n}` is the largest integer key in the table.

A program can modify the behavior of the length operator for

any value but strings through the `@idx{__len}` metamethod `@see{metatable}`.

}

@sect3{prec| @title{Precedence}

@x{Operator precedence} in Lua follows

the table below,

from lower to higher priority:

@verbatim{

or

and

< > <= >= ~= ==

|

~

&

<< >>

..

+ -

\* / // %

unary operators (not # - ~)

^

}

As usual,

you can use parentheses to change the precedences of an expression.

The concatenation (@Char{..}) and exponentiation (@Char{^})

operators are right associative.

All other binary operators are left associative.

}

@sect3{tableconstructor| @title{Table Constructors}

Table @x{constructors} are expressions that create tables.

Every time a constructor is evaluated, a new table is created.

A constructor can be used to create an empty table

or to create a table and initialize some of its fields.

The general syntax for constructors is

@Produc{

@producname{tableconstructor}@produciblebody{@bnfter{@Open} @bnfopt{fieldlist} @bnfter{@Close}}

@producname{fieldlist}@produciblebody{field @bnfrep{fieldsep field} @bnfopt{fieldsep}}

@producname{field}@produciblebody{@bnfter{[] exp @bnfter{[]} @bnfter{=} exp @Or

@bnfNter{Name} @bnfter{=} exp @Or exp}

@producname{fieldsep}@produciblebody{@bnfter{,} @Or @bnfter{;}}

}

Each field of the form @T{[exp1] = exp2} adds to the new table an entry with key @id{exp1} and value @id{exp2}.

A field of the form @T{name = exp} is equivalent to

@T{["name"] = exp}.

Fields of the form @id{exp} are equivalent to

@T{[i] = exp}, where @id{i} are consecutive integers starting with 1;

fields in the other formats do not affect this counting.

For example,

```
@verbatim{
a = { [f(1)] = g; "x", "y"; x = 1, f(x), [30] = 23; 45 }
}
```

is equivalent to

```
@verbatim{
do
  local t = {}
  t[f(1)] = g
  t[1] = "x"      -- 1st exp
  t[2] = "y"      -- 2nd exp
  t.x = 1         -- t["x"] = 1
  t[3] = f(x)     -- 3rd exp
  t[30] = 23
  t[4] = 45       -- 4th exp
  a = t
end
}
```

The order of the assignments in a constructor is undefined.

(This order would be relevant only when there are repeated keys.)

If the last field in the list has the form @id{exp}

and the expression

is a multires expression,

then all values returned by this expression enter the list consecutively

@see{multires}.

The field list can have an optional trailing separator,

as a convenience for machine-generated code.

```
}
```

@sect3{functioncall| @title{Function Calls}

A @x{function call} in Lua has the following syntax:

```
@Produc{
@producname{functioncall}@producbody{prefixexp args}
}
```

In a function call,

first @bnfNter{prefixexp} and @bnfNter{args} are evaluated.

If the value of @bnfNter{prefixexp} has type @emph{function},

then this function is called

with the given arguments.

Otherwise, if present,

the @bnfNter{prefixexp} @idx{\_\_call} metamethod is called:

its first argument is the value of `@bnfNter{prefixexp}`,  
followed by the original call arguments  
`@see{metatable}`.

The form

```
@Produc{  
  @producname{functioncall}@producbody{prefixexp @bnfter{:} @bnfNter{Name} args}  
}
```

can be used to emulate methods.

A call `@T{v:name(@rep{args})}`

is syntactic sugar for `@T{v.name(v,@rep{args})}`,

except that `@id{v}`

is evaluated only once.

Arguments have the following syntax:

```
@Produc{  
  @producname{args}@producbody{@bnfter{() @bnfopt{explist} @bnfter{}}}  
  @producname{args}@producbody{tableconstructor}  
  @producname{args}@producbody{@bnfNter{LiteralString}}  
}
```

All argument expressions are evaluated before the call.

A call of the form `@T{f{@rep{fields}}}` is

syntactic sugar for `@T{f({@rep{fields}})}`;

that is, the argument list is a single new table.

A call of the form `@T{f'@rep{string}'}`

(or `@T{f"@rep{string}"}` or `@T{f[[@rep{string}]}`)

is syntactic sugar for `@T{f('@rep{string}')`;

that is, the argument list is a single literal string.

A call of the form `@T{return @rep{functioncall}}` not in the  
scope of a to-be-closed variable is called a `@def{tail call}`.

Lua implements `@def{proper tail calls}`

(or `@def{proper tail recursion}`):

In a tail call,

the called function reuses the stack entry of the calling function.

Therefore, there is no limit on the number of nested tail calls that  
a program can execute.

However,

a tail call erases any debug information about the  
calling function.

Note that a tail call only happens with a particular syntax,

where the `@Rw{return}` has one single function call as argument,

and it is outside the scope of any to-be-closed variable.

This syntax makes the calling function return exactly

the returns of the called function,

without any intervening action.

So, none of the following examples are tail calls:

```
@verbatim{
```

```

return (f(x))    -- results adjusted to 1
return 2 * f(x)  -- result multiplied by 2
return x, f(x)   -- additional results
f(x); return     -- results discarded
return x or f(x) -- results adjusted to 1
}

}

```

@sect3{func-def| @title{Function Definitions}

The syntax for function definition is

```

@Produc{
@producname{functiondef}@producbody{@Rw{function} funcbody}
@producname{funcbody}@producbody{@bnfter{() @bnfopt{parlist} @bnfter{}} block @Rw{end}}
}

```

The following syntactic sugar simplifies function definitions:

```

@Produc{
@producname{stat}@producbody{@Rw{function}
funcname funcbody}
@producname{stat}@producbody{@Rw{local} @Rw{function} @bnfNter{Name} funcbody}
@producname{funcname}@producbody{@bnfNter{Name} @bnfrep{@bnfter{.} @bnfNter{Name}}
@bnfopt{@bnfter{:} @bnfNter{Name}}}
}

```

The statement

```

@verbatim{
function f () @rep{body} end
}

```

translates to

```

@verbatim{
f = function () @rep{body} end
}

```

The statement

```

@verbatim{
function t.a.b.c.f () @rep{body} end
}

```

translates to

```

@verbatim{
t.a.b.c.f = function () @rep{body} end
}

```

The statement

```

@verbatim{
local function f () @rep{body} end
}

```

translates to

```

@verbatim{
local f; f = function () @rep{body} end
}

```



```

}
not to
@verbatim{
local f = function () @rep{body} end
}

```

(This only makes a difference when the body of the function contains references to @id{f}.)

A function definition is an executable expression, whose value has type @emph{function}.

When Lua precompiles a chunk, all its function bodies are precompiled too, but they are not created yet.

Then, whenever Lua executes the function definition, the function is @emph{instantiated} (or @emph{closed}). This function instance, or @emph{closure}, is the final value of the expression.

Parameters act as local variables that are initialized with the argument values:

```

@Produc{
@producname{parlist}@producbody{namelist @bnfopt{@bnfter{,} @bnfter{...}} @Or
@bnfter{...}}
}

```

When a Lua function is called, it adjusts its list of @x{arguments} to the length of its list of parameters @see{multires}, unless the function is a @def{variadic function}, which is indicated by three dots (@Char{...}) at the end of its parameter list.

A variadic function does not adjust its argument list; instead, it collects all extra arguments and supplies them to the function through a @def{vararg expression}, which is also written as three dots.

The value of this expression is a list of all actual extra arguments, similar to a function with multiple results @see{multires}.

As an example, consider the following definitions:

```

@verbatim{
function
f(a, b) end
function g(a, b, ...) end
function r() return 1,2,3 end
}

```

Then, we have the following mapping from arguments to parameters and to the vararg expression:

@verbatim{  
CALL            PARAMETERS

```
f(3)            a=3, b=nil  
f(3, 4)        a=3, b=4  
f(3, 4, 5)     a=3, b=4  
f(r(), 10)     a=1, b=10  
f(r())        a=1, b=2  
  
g(3)           a=3, b=nil, ... --> (nothing)  
g(3, 4)        a=3, b=4, ... --> (nothing)  
g(3, 4, 5, 8)  a=3, b=4, ... --> 5 8  
g(5, r())      a=5, b=1, ... --> 2 3  
}
```

Results are returned using the @Rw{return} statement @see{control}.  
If control reaches the end of a function  
without encountering a @Rw{return} statement,  
then the function returns with no results.

@index{multiple return}  
There is a system-dependent limit on the number of values  
that a function may return.  
This limit is guaranteed to be greater than 1000.

The @emphx{colon} syntax  
is used to emulate @def{methods},  
adding an implicit extra parameter @idx{self} to  
the function.

Thus, the statement

```
@verbatim{  
function t.a.b.c:f (@rep{params}) @rep{body} end  
}
```

is syntactic sugar for

```
@verbatim{  
t.a.b.c.f = function (self, @rep{params}) @rep{body} end  
}  
  
}
```

@sect3{multires| @title{Lists of expressions, multiple results,  
and adjustment}}

Both function calls and vararg expressions can result in multiple values.  
These expressions are called @def{multires expressions}.

When a multires expression is used as the last element  
of a list of expressions,

all results from the expression are added to the list of values produced by the list of expressions.  
Note that a single expression in a place that expects a list of expressions is the last expression in that (singleton) list.

These are the places where Lua expects a list of expressions:

@description{

@item{A @rw{return} statement,  
for instance @T{return e1, e2, e3} @see{control}.}

@item{A table constructor,  
for instance @T{{e1, e2, e3}} @see{tableconstructor}.}

@item{The arguments of a function call,  
for  
instance @T{foo(e1, e2, e3)} @see{functioncall}.}

@item{A multiple assignment,  
for instance @T{a, b, c = e1, e2, e3} @see{assignment}.}

@item{A local declaration,  
for instance @T{local a, b, c = e1, e2, e3} @see{localvar}.}

@item{The initial values in a generic @rw{for} loop,  
for instance @T{for k in e1, e2, e3 do ... end} @see{for}.}

}

In the last four cases,  
the list of values from the list of expressions  
must be @emph{adjusted} to a specific length:  
the number of parameters in a call to a non-variadic function  
@see{func-def},  
the number of variables in a multiple assignment or  
a local declaration,  
and exactly four values for a generic @rw{for} loop.  
The @def{adjustment} follows these rules:  
If there are more values than needed,  
the extra values are thrown away;  
if there are fewer values than needed,  
the list is extended with @nil's.  
When the list of expressions ends with a multi-res expression,  
all results from that expression enter the list of values  
before the adjustment.

When

a multiresult expression is used  
 in a list of expressions without being the last element,  
 or in a place where the syntax expects a single expression,  
 Lua adjusts the result list of that expression to one element.  
 As a particular case,  
 the syntax expects a single expression inside a parenthesized expression;  
 therefore, adding parentheses around a multiresult expression  
 forces it to produce exactly one result.

We seldom need to use a vararg expression in a place  
 where the syntax expects a single expression.  
 (Usually it is simpler to add a regular parameter before  
 the variadic part and use that parameter.)  
 When there is such a need,  
 we recommend assigning the vararg expression  
 to a single variable and using that variable  
 in its place.

Here are some examples of uses of multiresult expressions.

In all cases, when the construction needs

@Q{the n-th result} and there is no such result,  
 it uses a @nil.

```
@verbatim{
print(x, f())    -- prints x and all results from f().
print(x, (f())) -- prints
x and the first result from f().
print(f(), x)    -- prints the first result from f() and x.
print(1 + f())   -- prints 1 added to the first result from f().
local x = ...    -- x gets the first vararg argument.
x,y = ...        -- x gets the first vararg argument,
                  -- y gets the second vararg argument.
x,y,z = w, f()   -- x gets w, y gets the first result from f(),
                  -- z gets the second result from f().
x,y,z = f()      -- x gets the first result from f(),
                  -- y gets the second result from f(),
                  -- z gets the third result from f().
x,y,z = f(), g() -- x gets the first result from f(),
                  -- y gets the first result from g(),
                  -- z gets the second result from g().
x,y,z = (f())    -- x gets the first result from f(), y and z get nil.
return f()       -- returns all results from f().
return x, ...    -- returns x and all received vararg arguments.
return x,y,f()
    -- returns x, y, and all results from f().
{f()}           -- creates a list with all results from f().
{...}           -- creates a list with all vararg arguments.
{f(), 5}        -- creates a list with the first result from f() and 5.
}
```

}

}

@sect2{visibility| @title{Visibility Rules}

@index{visibility}

Lua is a lexically scoped language.

The scope of a local variable begins at the first statement after its declaration and lasts until the last non-void statement of the innermost block that includes the declaration.

(@emph{Void statements} are labels and empty statements.)

Consider the following example:

@verbatim{

```
x = 10          -- global variable
do              -- new block
  local x = x    -- new 'x', with value 10
  print(x)       --> 10
  x = x+1
do              -- another block
  local x = x+1  -- another 'x'
  print(x)       --> 12
end
print(x)        --> 11
end
print(x)        --> 10 (the global one)
}
```

Notice

that, in a declaration like @T{local x = x}, the new @id{x} being declared is not in scope yet, and so the second @id{x} refers to the outside variable.

Because of the @x{lexical scoping} rules, local variables can be freely accessed by functions defined inside their scope.

A local variable used by an inner function is called an @def{upvalue} (or @emphx{external local variable}, or simply @emphx{external variable}) inside the inner function.

Notice that each execution of a @Rw{local} statement defines new local variables.

Consider the following example:

@verbatim{

```
a = {}
local x = 20
for i = 1, 10 do
```

```

local y = 0
a[i] = function () y = y + 1; return x + y end
end
}

```

The loop creates ten closures

(that is, ten instances of the anonymous function).

Each of these closures uses a different `@id{y}` variable,  
while all of them share the same `@id{x}`.

```

}

```

```

}

```

```

@C{-----}

```

```

@sect1{API| @title{The Application Program Interface}

```

```

@simplesect{

```

```

@index{C
API}

```

This section describes the `@N{C API}` for Lua, that is,  
the set of `@N{C functions}` available to the host program to communicate  
with Lua.

All API functions and related types and constants  
are declared in the header file `@defid{lua.h}`.

Even when we use the term `@Q{function}`,  
any facility in the API may be provided as a macro instead.  
Except where stated otherwise,  
all such macros use each of their arguments exactly once  
(except for the first argument, which is always a Lua state),  
and so do not generate any hidden side-effects.

As in most `@N{C libraries}`,  
the Lua API functions do not check their arguments  
for validity or consistency.  
However, you can change this behavior by compiling Lua  
with the macro `@defid{LUA_USE_APICHECK}` defined.

The Lua library is fully reentrant:  
it has no global variables.  
It keeps all information it needs in a dynamic structure,  
called the `@def{Lua state}`.

Each Lua state has one or more threads,  
which correspond to independent,

cooperative lines of execution.

The type `@Lid{lua_State}` (despite its name) refers to a thread. (Indirectly, through the thread, it also refers to the Lua state associated to the thread.)

A pointer to a thread must be passed as the first argument to every function in the library, except to `@Lid{lua_newstate}`, which creates a Lua state from scratch and returns a pointer to the `@emph{main thread}` in the new state.

}

`@sect2{@title{The Stack}`

`@simplesect{`

Lua uses a `@emph{virtual stack}` to pass values to and from C. Each element in this stack represents a Lua value (`@nil`, number, string, etc.). Functions in the API can access this stack through the Lua state parameter that they receive.

Whenever Lua calls C, the called function gets a new stack, which is independent of previous stacks and of stacks of `@N{C functions}` that are still active. This stack initially contains any arguments to the `@N{C function}` and it is where the `@N{C function}` can store temporary Lua values and must push its results to be returned to the caller `@seeC{lua_CFunction}`.

For convenience, most query operations in the API do not follow a strict stack discipline. Instead, they can refer to any element in the stack by using an `@emph{index}:@index{index (API stack)}`. A positive index represents an absolute stack position, starting `@N{at 1}` as the bottom of the stack; a negative index represents an offset relative to the top of the stack. More specifically, if the stack has `@rep{n}` elements, then `@N{index 1}` represents the first element (that is, the element that was pushed onto the stack first) and `@N{index @rep{n}}` represents the last element; `@N{index @num{-1}}` also represents the last element (that is, the element at `@N{the top}`) and index `@M{-n}` represents the first element.

}

@sect3{stacksize| @title{Stack Size}

When you interact with the Lua API,  
you are responsible for ensuring consistency.

In particular,

@emph{you are responsible for controlling stack overflow}.

When you call any

API function,

you must ensure the stack has enough room to accommodate the results.

There is one exception to the above rule:

When you call a Lua function

without a fixed number of results @seeF{lua\_call},

Lua ensures that the stack has enough space for all results.

However, it does not ensure any extra space.

So, before pushing anything on the stack after such a call

you should use @Lid{lua\_checkstack}.

Whenever Lua calls C,

it ensures that the stack has space for

at least @defid{LUA\_MINSTACK} extra elements;

that is, you can safely push up to @id{LUA\_MINSTACK} values into it.

@id{LUA\_MINSTACK} is defined as 20,

so that usually you do not have to worry about stack space

unless your code has loops pushing elements onto the stack.

Whenever necessary,

you can use the function @Lid{lua\_checkstack}

to ensure that the stack has enough space for pushing new elements.

}

@sect3{@title{Valid and Acceptable Indices}

Any function in the API that receives stack indices

works only with @emphx{valid

indices} or @emphx{acceptable indices}.

A @def{valid index} is an index that refers to a  
position that stores a modifiable Lua value.

It comprises stack indices @N{between 1} and the stack top

(@T{1 @leq abs(index) @leq top})

@index{stack index}

plus @def{pseudo-indices},

which represent some positions that are accessible to @N{C code}

but that are not in the stack.

Pseudo-indices are used to access the registry @see{registry}



and the upvalues of a `@N{C function}` `@see{c-closure}`.

Functions that do not need a specific mutable position, but only a value (e.g., query functions), can be called with acceptable indices.

An `@def{acceptable index}` can be any valid index, but it also can be any positive index after the stack top within the space allocated for the stack, that is, indices up to the stack size.

(Note that 0 is never an acceptable index.)

Indices to upvalues `@see{c-closure}` greater than the real number of upvalues in the current `@N{C function}` are also acceptable (but invalid).

Except

when noted otherwise, functions in the API work with acceptable indices.

Acceptable indices serve to avoid extra tests against the stack top when querying the stack.

For instance, a `@N{C function}` can query its third argument without the need to check whether there is a third argument, that is, without the need to check whether 3 is a valid index.

For functions that can be called with acceptable indices, any non-valid index is treated as if it contains a value of a virtual type `@defid{LUA_TNONE}`, which behaves like a nil value.

}

`@sect3{constchar|@title{Pointers to strings}`

Several functions in the API return pointers (`@T{const char*}`) to Lua strings in the stack.

(See `@Lid{lua_pushfstring}`, `@Lid{lua_pushlstring}`, `@Lid{lua_pushstring}`, and `@Lid{lua_tolstring}`.

See also `@Lid{luaL_checklstring}`, `@Lid{luaL_checkstring}`, and `@Lid{luaL_tolstring}` in the auxiliary library.)

In general,

Lua's garbage collection can free or move internal memory and then invalidate pointers to internal strings.

To allow a safe use of these pointers, the API guarantees that any pointer to a string in a stack index is valid while the string value at that index is not removed from the stack. (It can be moved to another index, though.)

When the index is a pseudo-index (referring to an upvalue), the pointer is valid while the corresponding call is active and

the corresponding upvalue is not modified.

Some functions in the debug interface also return pointers to strings, namely `@Lid{lua_getlocal}`, `@Lid{lua_getupvalue}`, `@Lid{lua_setlocal}`, and `@Lid{lua_setupvalue}`. For these functions, the pointer is guaranteed to be valid while the caller function is active and the given closure (if one was given) is in the stack.

Except for these guarantees, the garbage collector is free to invalidate any pointer to internal strings.

}

}

@sect2{c-closure| @title{C Closures}

When a `@N{C function}` is created, it is possible to associate some values with it, thus creating a `@def{@N{C closure}}` `@seeC{lua_pushcclosure}`; these values are called `@def{upvalues}` and are accessible to the function whenever it is called.

Whenever a `@N{C function}` is called, its upvalues are located at specific pseudo-indices. These pseudo-indices are produced by the macro `@Lid{lua_upvalueindex}`. The first upvalue associated with a function is at index `@T{lua_upvalueindex(1)}`, and so on. Any access to `@T{lua_upvalueindex(@rep{n})}`, where `@rep{n}` is greater than the number of upvalues of the current function (but not greater than 256, which is one plus the maximum number of upvalues in a closure), produces an acceptable but invalid index.

A `@N{C closure}` can also change the values of its corresponding upvalues.

}

@sect2{registry| @title{Registry}

Lua provides a `@def{registry}`,  
a predefined table that can be used by any `@N{C code}` to  
store whatever Lua values it needs to store.  
The registry table is always accessible at pseudo-index  
`@defid{LUA_REGISTRYINDEX}`.  
Any `@N{C library}` can store data into  
this table,  
but it must take care to choose keys  
that are different from those used  
by other libraries, to avoid collisions.  
Typically, you should use as key a string containing your library name,  
or a light userdata with the address of a `@N{C object}` in your code,  
or any Lua object created by your code.  
As with variable names,  
string keys starting with an underscore followed by  
uppercase letters are reserved for Lua.

The integer keys in the registry are used  
by the reference mechanism `@seeC{luaL_ref}`  
and by some predefined values.  
Therefore, integer keys in the registry  
must not be used for other purposes.

When you create a new Lua state,  
its registry comes with some predefined values.  
These predefined values are indexed with integer keys  
defined as constants in `@id{lua.h}`.

The following constants are defined:

```
@description{
@item{@defid{LUA_RIDX_MAINTHREAD}| At this index the registry has
the main thread of the state.
(The main thread is the one created together with the state.)
}
```

```
@item{@defid{LUA_RIDX_GLOBALS}|
At this index the registry has
the @x{global environment}.
}
}
```

`@sect2{C-error|@title{Error Handling in C}`

```
@simplesect{
```

Internally, Lua uses the C `@id{longjmp}` facility to handle errors.  
(Lua will use exceptions if you compile it as C++;

search for @id{LUA\_THROW} in the source code for details.)

When Lua faces any error,

such as a @x{memory allocation error} or a type error,

it @emph{raises} an error;

that is, it does a long jump.

A @emphx{protected environment} uses @id{setjmp}

to set a recovery point;

any error jumps to the most recent active recovery point.

Inside a @N{C function} you can raise an error explicitly

by calling @Lid{lua\_error}.

Most functions in the API can raise an error,

for instance due to a @x{memory allocation error}.

The documentation for each function indicates whether

it can raise errors.

If an error happens outside any protected environment,

Lua calls a @def{panic function} (see @Lid{lua\_atpanic})

and then calls @T{abort},

thus

exiting the host application.

Your panic function can avoid this exit by

never returning

(e.g., doing a long jump to your own recovery point outside Lua).

The panic function,

as its name implies,

is a mechanism of last resort.

Programs should avoid it.

As a general rule,

when a @N{C function} is called by Lua with a Lua state,

it can do whatever it wants on that Lua state,

as it should be already protected.

However,

when C code operates on other Lua states

(e.g., a Lua-state argument to the function,

a Lua state stored in the registry, or

the result of @Lid{lua\_newthread}),

it should use them only in API calls that cannot raise errors.

The panic function runs as if it were a @x{message handler} @see{error};

in particular, the error object is on the top of the stack.

However, there is no guarantee about stack space.

To push anything on the stack,

the panic function must first check the available space @see{stacksize}.

}

@sect3{statuscodes|@title{Status Codes}

Several functions

that report errors in the API use the following

status codes to indicate different kinds of errors or other conditions:

@description{

@item{@defid{LUA\_OK} (0)| no errors.}

@item{@defid{LUA\_ERRRUN}| a runtime error.}

@item{@defid{LUA\_ERRMEM}|

@x{memory allocation error}.

For such errors, Lua does not call the @x{message handler}.

}

@item{@defid{LUA\_ERRERR}| error while running the @x{message handler}.

@item{@defid{LUA\_ERRSYNTAX}| syntax error during precompilation.}

@item{@defid{LUA\_YIELD}| the thread (coroutine) yields.}

@item{@defid{LUA\_ERRFILE}| a file-related error;

e.g., it cannot open or read the file.}

}

These constants are defined in the header file @id{lua.h}.

}

}

@sect2{continuations|@title{Handling Yields in C}

Internally, Lua uses the C @id{longjmp} facility to yield a coroutine.

Therefore, if a @N{C function} @id{foo} calls an API function

and this API function yields

(directly or indirectly by calling another function that yields),

Lua cannot return to

@id{foo} any more,

because the @id{longjmp} removes its frame from the @N{C stack}.

To avoid this kind of problem,

Lua raises an error whenever it tries to yield across an API call,

except for three functions:

@Lid{lua\_yieldk}, @Lid{lua\_callk}, and @Lid{lua\_pcallk}.

All those functions receive a `@def{continuation function}`  
(as a parameter named `@id{k}`) to continue execution after a yield.

We need to set some terminology to explain continuations.

We have a `@N{C function}` called from Lua which we will call  
the `@emph{original function}`.

This original function then calls one of those three functions in the C API,  
which we will call the `@emph{callee function}`,  
that then yields the current thread.

This can happen when the callee function is `@Lid{lua_yieldk}`,  
or when the callee function is either `@Lid{lua_callk}` or `@Lid{lua_pcallk}`  
and the function called by them yields.

Suppose the running thread yields while executing the callee function.

After the thread resumes,  
it eventually will finish  
running the callee function.

However,

the callee function cannot return to the original function,  
because its frame in the `@N{C stack}` was destroyed by the yield.

Instead, Lua calls a `@def{continuation function}`,  
which was given as an argument to the callee function.

As the name implies,  
the continuation function should continue the task  
of the original function.

As an illustration, consider the following function:

```
@verbatim{
int original_function (lua_State *L) {
    ... /* code 1 */
    status = lua_pcall(L, n, m, h); /* calls Lua */
    ... /* code 2 */
}
}
```

Now we want to allow  
the Lua code being run by `@Lid{lua_pcall}` to yield.

First, we can rewrite our function like here:

```
@verbatim{
int k (lua_State *L, int status, lua_KContext ctx) {
    ... /* code 2 */
}
}
```

```
int original_function (lua_State *L) {
    ... /* code 1 */
    return k(L, lua_pcall(L, n, m, h), ctx);
}
}
```

In the above code,

the new function `@id{k}` is a  
`@emph{continuation function}` (with type `@Lid{lua_KFunction}`),  
 which  
 should do all the work that the original function  
 was doing after calling `@Lid{lua_pcall}`.  
 Now, we must inform Lua that it must call `@id{k}` if the Lua code  
 being executed by `@Lid{lua_pcall}` gets interrupted in some way  
 (errors or yielding),  
 so we rewrite the code as here,  
 replacing `@Lid{lua_pcall}` by `@Lid{lua_pcallk}`:

```
@verbatim{
int original_function (lua_State *L) {
...   /* code 1 */
return k(L, lua_pcallk(L, n, m, h, ctx2, k), ctx1);
}
}
```

Note the external, explicit call to the continuation:  
 Lua will call the continuation only if needed, that is,  
 in case of errors or resuming after a yield.  
 If the called function returns normally without ever yielding,  
`@Lid{lua_pcallk}` (and `@Lid{lua_callk}`) will also return normally.  
 (Of course, instead of calling the continuation in that case,  
 you can do the equivalent work directly inside the original function.)

Besides the Lua state,  
 the continuation function has two other parameters:  
 the final status of the call and the context value  
 (`@id{ctx}`) that  
 was passed originally to `@Lid{lua_pcallk}`.  
 Lua does not use this context value;  
 it only passes this value from the original function to the  
 continuation function.  
 For `@Lid{lua_pcallk}`,  
 the status is the same value that would be returned by `@Lid{lua_pcallk}`,  
 except that it is `@Lid{LUA_YIELD}` when being executed after a yield  
 (instead of `@Lid{LUA_OK}`).  
 For `@Lid{lua_yieldk}` and `@Lid{lua_callk}`,  
 the status is always `@Lid{LUA_YIELD}` when Lua calls the continuation.  
 (For these two functions,  
 Lua will not call the continuation in case of errors,  
 because they do not handle errors.)  
 Similarly, when using `@Lid{lua_callk}`,  
 you should call the continuation function  
 with `@Lid{LUA_OK}` as the status.  
 (For `@Lid{lua_yieldk}`, there is not much point in calling  
 directly the continuation function,  
 because `@Lid{lua_yieldk}` usually does not return.)

Lua treats the continuation function as if it were the original function.  
 The continuation function receives the same Lua stack  
 from the original  
 function,  
 in the same state it would be if the callee function had returned.  
 (For instance,  
 after a `@Lid{lua_callk}` the function and its arguments are  
 removed from the stack and replaced by the results from the call.)  
 It also has the same upvalues.  
 Whatever it returns is handled by Lua as if it were the return  
 of the original function.

}

@sect2{@title{Functions and Types}}

Here we list all functions and types from the `@N{C API}` in  
 alphabetical order.

Each function has an indicator like this:

`@apii{o,p,x}`

The first field, `@T{o}`,

is how many elements the function pops from the stack.

The second field, `@T{p}`,

is how many elements the function pushes onto the stack.

(Any function always pushes its results after popping its arguments.)

A field in the form `@T{x|y}` means the function can push (or pop)

`@T{x}` or `@T{y}` elements,

depending on the situation;

an interrogation mark `@Char{?}` means that

we cannot know how many elements the function pops/pushes  
 by looking only at its arguments.

(For

instance, they may depend on what is in the stack.)

The third field, `@T{x}`,

tells whether the function may raise errors:

`@Char{-}` means the function never raises any error;

`@Char{m}` means the function may raise only out-of-memory errors;

`@Char{v}` means the function may raise the errors explained in the text;

`@Char{e}` means the function can run arbitrary Lua code,

either directly or through metamethods,

and therefore may raise any errors.

`@APIEntry{int lua_absindex (lua_State *L, int idx);|`

`@apii{0,0,-}`

Converts the `@x{acceptable index}` `@id{idx}`



into an equivalent `@x{absolute index}`  
(that is, one that does not depend on the stack size).

}

```
@APIEntry{
typedef void * (*lua_Alloc) (void *ud,
                             void *ptr,
                             size_t osize,
                             size_t nsize);|
```

The type of the `@x{memory-allocation function}` used by Lua states.

The allocator function must provide a  
functionality similar to `@id{realloc}`,  
but not exactly the  
same.

Its arguments are

`@id{ud}`, an opaque pointer passed to `@Lid{lua_newstate}`;  
`@id{ptr}`, a pointer to the block being allocated/reallocated/freed;  
`@id{osize}`, the original size of the block or some code about what  
is being allocated;  
and `@id{nsize}`, the new size of the block.

When `@id{ptr}` is not `@id{NULL}`,  
`@id{osize}` is the size of the block pointed by `@id{ptr}`,  
that is, the size given when it was allocated or reallocated.

When `@id{ptr}` is `@id{NULL}`,  
`@id{osize}` encodes the kind of object that Lua is allocating.  
`@id{osize}` is any of  
`@Lid{LUA_TSTRING}`, `@Lid{LUA_TTABLE}`, `@Lid{LUA_TFUNCTION}`,  
`@Lid{LUA_TUSERDATA}`, or `@Lid{LUA_TTHREAD}` when (and only when)  
Lua is creating a new object of that type.  
When `@id{osize}` is some other value,  
Lua is allocating memory for something else.

Lua assumes the following behavior from the allocator function:

When `@id{nsize}` is zero,  
the allocator must behave like `@id{free}`  
and then return `@id{NULL}`.

When `@id{nsize}` is not zero,  
the allocator must behave  
like `@id{realloc}`.  
In particular, the allocator returns `@id{NULL}`  
if and only if it cannot fulfill the request.

Here is a simple implementation for the @x{allocator function}.

It is used in the auxiliary library by @Lid{luaL\_newstate}.

```
@verbatim{
static void *l_alloc (void *ud, void *ptr, size_t osize,
                      size_t nsize) {
    (void)ud; (void)osize; /* not used */
    if (nsize == 0) {
        free(ptr);
        return NULL;
    }
    else
        return realloc(ptr, nsize);
}
}
```

Note that @N{ISO C} ensures

that @T{free(NULL)} has no effect and that

@T{realloc(NULL,size)} is equivalent to @T{malloc(size)}.

```
}
```

```
@APIEntry{void lua_arith (lua_State *L, int op);|
```

```
@apii{2|1,1,e}
```

Performs an arithmetic or bitwise operation over the two values

(or one, in the case of negations)

at the top of the stack,

with the value on the top being the second operand,

pops these values, and pushes the result of the operation.

The function follows the semantics of the corresponding Lua

operator

(that is, it may call metamethods).

The value of @id{op} must be one of the following constants:

```
@description{
```

```
@item{@defid{LUA_OPADD}| performs addition (@T{+})}
```

```
@item{@defid{LUA_OPSUB}| performs subtraction (@T{-})}
```

```
@item{@defid{LUA_OPMUL}| performs multiplication (@T{*})}
```

```
@item{@defid{LUA_OPDIV}| performs float division (@T{/})}
```

```
@item{@defid{LUA_OPIDIV}| performs floor division (@T{//})}
```

```
@item{@defid{LUA_OPMOD}| performs modulo (@T{%})}
```

```
@item{@defid{LUA_OPPOW}| performs exponentiation (@T{^})}
```

```
@item{@defid{LUA_OPUNM}| performs mathematical negation (unary @T{-})}
```

```
@item{@defid{LUA_OPBNOT}| performs bitwise NOT (@T{~})}
```

```
@item{@defid{LUA_OPBAND}| performs bitwise AND (@T{&})}
```

```
@item{@defid{LUA_OPBOR}| performs bitwise OR (@T{|})}
```

```
@item{@defid{LUA_OPBXOR}| performs bitwise exclusive OR (@T{~})}
```

```

@item{@defid{LUA_OPSHL}| performs left shift (@T{<<})}
@item{@defid{LUA_OPSHR}| performs right shift (@T{>>})}

}

}

```

```

@APIEntry{lua_CFunction lua_atpanic (lua_State *L, lua_CFunction
panicf);|
@apii{0,0,-}

```

Sets a new panic function and returns the old one @see{C-error}.

```

}

```

```

@APIEntry{void lua_call (lua_State *L, int nargs, int nresults);|
@apii{nargs+1,nresults,e}

```

Calls a function.

Like regular Lua calls,

@id{lua\_call} respects the @idx{\_\_call} metamethod.

So, here the word @Q{function}

means any callable value.

To do a call you must use the following protocol:

first, the function to be called is pushed onto the stack;

then, the arguments to the call are pushed

in direct order;

that is, the first argument is pushed first.

Finally you call @Lid{lua\_call};

@id{nargs} is the number of arguments that you pushed onto the stack.

When the function returns,

all arguments and the function value are popped

and the call results are pushed onto the stack.

The number of results is adjusted to @id{nresults},

unless @id{nresults} is @defid{LUA\_MULTRET}.

In this case, all results from the function are pushed;

Lua takes care that the returned values fit into the stack space,

but

it does not ensure any extra space in the stack.

The function results are pushed onto the stack in direct order

(the first result is pushed first),

so that after the call the last result is on the top of the stack.

Any error while calling and running the function is propagated upwards  
(with a @id{longjmp}).

The following example shows how the host program can do the

equivalent to this Lua code:

```
@verbatim{
a = f("how", t.x, 14)
}
```

Here it is @N{in C}:

```
@verbatim{
lua_getglobal(L, "f");           /* function to be called */
lua_pushliteral(L, "how");       /* 1st argument */
lua_getglobal(L, "t");           /* table to be indexed */
lua_getfield(L, -1, "x");        /* push result of t.x (2nd arg) */
lua_remove(L, -2);              /* remove 't' from the stack */
lua_pushinteger(L, 14);          /* 3rd argument */
lua_call(L, 3, 1);              /* call 'f' with 3 arguments and 1 result */
lua_setglobal(L, "a");           /* set global
'a' */
}
```

Note that the code above is @emph{balanced}:

at its end, the stack is back to its original configuration.

This is considered good programming practice.

```
}
```

```
@APIEntry{
void lua_callk (lua_State *L,
               int nargs,
               int nresults,
               lua_KContext ctx,
               lua_KFunction k);|
@apii{nargs + 1,nresults,e}
```

This function behaves exactly like @Lid{lua\_call},  
but allows the called function to yield @see{continuations}.

```
}
```

```
@APIEntry{typedef int (*lua_CFunction) (lua_State *L);|
```

Type for @N{C functions}.

In order to communicate properly with Lua,

a @N{C function} must use the following protocol,

which defines the way parameters and results are passed:

a @N{C function} receives its arguments from Lua in its stack  
in direct order (the first argument is pushed first).

So, when the function starts,

@T{lua\_gettop(L)} returns the number of arguments received by the function.

The first argument (if any) is at index 1

and its last argument

is at index `@T{lua_gettop(L)}`.

To return values to Lua, a `@N{C function}` just pushes them onto the stack, in direct order (the first result is pushed first), and returns in C the number of results.

Any other value in the stack below the results will be properly discarded by Lua.

Like a Lua function, a `@N{C function}` called by Lua can also return many results.

As an example, the following function receives a variable number of numeric arguments and returns their average and their sum:

```
@verbatim{
static int foo (lua_State *L) {
    int n = lua_gettop(L); /* number of arguments */
    lua_Number sum = 0.0;
    int i;
    for (i = 1; i <= n; i++) {
        if (!lua_isnumber(L, i)) {
            lua_pushliteral(L, "incorrect argument");
            lua_error(L);
        }
        sum += lua_tonumber(L, i);
    }
    lua_pushnumber(L, sum/n); /* first result */
    lua_pushnumber(L, sum); /* second result */
    return 2; /* number of results */
}
}
```

```
@APIEntry{int lua_checkstack (lua_State
*L, int n);|
@api{0,0,-}
```

Ensures that the stack has space for at least `@id{n}` extra elements, that is, that you can safely push up to `@id{n}` values into it.

It returns false if it cannot fulfill the request, either because it would cause the stack to be greater than a fixed maximum size (typically at least several thousand elements) or because it cannot allocate memory for the extra space. This function never shrinks the stack; if the stack already has space for the extra elements, it is left unchanged.

```
}
```

```
@APIEntry{void lua_close (lua_State *L);|  
@apii{0,0,-}}
```

Close all active to-be-closed variables in the main thread,  
release all objects in the given Lua state  
(calling the corresponding garbage-collection metamethods, if any),  
and frees all dynamic memory used by this state.

On several platforms, you may not need to call this function,  
because all resources are naturally released when the host program ends.  
On the other hand, long-running programs that create multiple states,  
such  
as daemons or web servers,  
will probably need to close states as soon as they are not needed.

```
}
```

```
@APIEntry{void lua_closeslot (lua_State *L, int index);|  
@apii{0,0,e}}
```

Close the to-be-closed slot at the given index and set its value to `@nil`.  
The index must be the last index previously marked to be closed  
`@see{lua_toclose}` that is still active (that is, not closed yet).

A `@idx{__close}` metamethod cannot yield  
when called through this function.

(This function was introduced in `@N{release 5.4.3}`.)

```
}
```

```
@APIEntry{int lua_closethread (lua_State *L, lua_State *from);|  
@apii{0,?, -}}
```

Resets a thread, cleaning its call stack and closing all pending  
to-be-closed variables.

Returns a status code:

`@Lid{LUA_OK}` for no errors in the thread  
(either the original error that stopped the thread or  
errors in closing methods),  
or an error status otherwise.

In case of error,

leaves the error object on the top of the stack.

The parameter `@id{from}` represents the coroutine that is resetting `@id{L}`.

If  
there is no such coroutine,  
this parameter can be @id{NULL}.

(This function was introduced in @N{release 5.4.6}.)

}

```
@APIEntry{int lua_compare (lua_State *L, int index1, int index2, int op);|
@apii{0,0,e}
```

Compares two Lua values.  
Returns 1 if the value at index @id{index1} satisfies @id{op}  
when compared with the value at index @id{index2},  
following the semantics of the corresponding Lua operator  
(that is, it may call metamethods).  
Otherwise @N{returns 0}.  
Also @N{returns 0} if any of the indices is not valid.

The value of @id{op} must be one of the following constants:

@description{

@item{@defid{LUA\_OPEQ}| compares for equality (@T{==})}  
@item{@defid{LUA\_OPLT}| compares for less than (@T{<})}  
@item{@defid{LUA\_OPLE}| compares for less or equal (@T{<=})}

}

}

```
@APIEntry{void lua_concat (lua_State *L, int n);|
@apii{n,1,e}
```

Concatenates the @id{n} values at the top of the stack,  
pops them, and leaves the result on the top.  
If @N{@T{n} is 1}, the result is the single value on the  
stack  
(that is, the function does nothing);  
if @id{n} is 0, the result is the empty string.  
Concatenation is performed following the usual semantics of Lua  
@see{concat}.

}

```
@APIEntry{void lua_copy (lua_State *L, int fromidx, int toidx);|
@apii{0,0,-}
```

Copies the element at index @id{fromidx}

into the valid index @id{toidx},  
replacing the value at that position.  
Values at other positions are not affected.

}

```
@APIEntry{void lua_createtable (lua_State *L, int narr, int nrec);|
@apii{0,1,m}
```

Creates a new empty table and pushes it onto the stack.  
Parameter @id{narr} is a hint for how many elements the table  
will have as a sequence;  
parameter @id{nrec} is a hint for how many other elements  
the table will have.  
Lua may use these hints to preallocate memory for the new table.  
This preallocation may help performance when you know in advance  
how many elements the table will have.  
Otherwise you can use the function @Lid{lua\_newtable}.

}

```
@APIEntry{int lua_dump (lua_State *L,

    lua_Writer writer,
        void *data,
        int strip);|
@apii{0,0,-}
```

Dumps a function as a binary chunk.  
Receives a Lua function on the top of the stack  
and produces a binary chunk that,  
if loaded again,  
results in a function equivalent to the one dumped.  
As it produces parts of the chunk,  
@Lid{lua\_dump} calls function @id{writer} @seeC{lua\_Writer}  
with the given @id{data}  
to write them.

If @id{strip} is true,  
the binary representation may not include all debug information  
about the function,  
to save space.

The value returned is the error code returned by the last  
call to the writer;  
@N{0 means} no errors.

This function does not pop the Lua function from the stack.



```
}
```

```
@APIEntry{int lua_error (lua_State *L);|  
@apii{1,0,v}
```

Raises a Lua error,  
using the value on the top of the stack as the error object.  
This function does a long jump,  
and therefore never returns  
@seeC{luaL\_error}.

```
}
```

```
@APIEntry{int lua_gc (lua_State *L, int what, ...);|  
@apii{0,0,-}
```

Controls  
the garbage collector.

This function performs several tasks,  
according to the value of the parameter @id{what}.  
For options that need extra arguments,  
they are listed after the option.  
@description{

```
@item{@id{LUA_GCCOLLECT}}|  
Performs a full garbage-collection cycle.  
}
```

```
@item{@id{LUA_GCSTOP}}|  
Stops the garbage collector.  
}
```

```
@item{@id{LUA_GCRESTART}}|  
Restarts the garbage collector.  
}
```

```
@item{@id{LUA_GCCOUNT}}|  
Returns the current amount of memory (in Kbytes) in use by Lua.  
}
```

```
@item{@id{LUA_GCCOUNTB}}|  
Returns the remainder of dividing the current amount of bytes of  
memory in use by Lua by 1024.  
}
```

```
@item{@id{LUA_GCSTEP} @T{(int stepsize)}}|
```

Performs an incremental step of garbage collection,  
corresponding to the allocation of @id{stepsize} Kbytes.

}

@item{@id{LUA\_GCISRUNNING}|

Returns a boolean that tells whether the collector is running  
(i.e., not stopped).

}

@item{@id{LUA\_GCINC} (int pause, int stepmul, stepsize)|

Changes the collector to incremental mode  
with the

given parameters @see{incmode}.

Returns the previous mode (@id{LUA\_GCGEN} or @id{LUA\_GCINC}).

}

@item{@id{LUA\_GCGEN} (int minormul, int majormul)|

Changes the collector to generational mode

with the given parameters @see{genmode}.

Returns the previous mode (@id{LUA\_GCGEN} or @id{LUA\_GCINC}).

}

}

For more details about these options,  
see @Lid{collectgarbage}.

This function should not be called by a finalizer.

}

@APIEntry{lua\_Alloc lua\_getallocf (lua\_State \*L, void \*\*ud);|

@apii{0,0,-}

Returns the @x{memory-allocation function} of a given state.

If @id{ud} is not @id{NULL}, Lua stores in @T{\*ud} the  
opaque pointer given when the memory-allocator function was set.

}

@APIEntry{int lua\_getfield (lua\_State \*L, int index, const char \*k);|

@apii{0,1,e}

Pushes onto the stack the value @T{t[k]},

where @id{t} is the value at the given index.

As in Lua, this function may trigger a metamethod  
for the @Q{index} event @see{metatable}.

Returns the type of the pushed value.

```
}
```

```
@APIEntry{void  
  *lua_getextraspaces (lua_State *L);|  
  @apii{0,0,-}
```

Returns a pointer to a raw memory area associated with the given Lua state.

The application can use this area for any purpose;  
Lua does not use it for anything.

Each new thread has this area initialized with a copy of the area of the @x{main thread}.

By default, this area has the size of a pointer to void, but you can recompile Lua with a different size for this area. (See @id{LUA\_EXTRASPACE} in @id{luaconf.h}.)

```
}
```

```
@APIEntry{int lua_getglobal (lua_State *L, const char *name);|  
  @apii{0,1,e}
```

Pushes onto the stack the value of the global @id{name}.  
Returns the type of that value.

```
}
```

```
@APIEntry{int lua_geti (lua_State *L, int index, lua_Integer i);|  
  @apii{0,1,e}
```

Pushes onto the stack the value @T{t[i]},  
where @id{t} is the value at the given index.  
As in Lua, this function may trigger a metamethod  
for the @Q{index} event @see{metatable}.

Returns the type of the pushed value.

```
}
```

```
@APIEntry{int lua_getmetatable (lua_State *L, int index);|  
  @apii{0,0|1,-}
```

If  
the value at the given index has a metatable,  
the function pushes that metatable onto the stack and @N{returns 1}.  
Otherwise,

the function @N{returns 0} and pushes nothing on the stack.

}

```
@APIEntry{int lua_gettable (lua_State *L, int index);|
@apii{1,1,e}
```

Pushes onto the stack the value @T{t[k]},  
where @id{t} is the value at the given index  
and @id{k} is the value on the top of the stack.

This function pops the key from the stack,  
pushing the resulting value in its place.  
As in Lua, this function may trigger a metamethod  
for the @Q{index} event @see{metatable}.

Returns the type of the pushed value.

}

```
@APIEntry{int lua_gettop (lua_State *L);|
@apii{0,0,-}
```

Returns the index of the top element in the stack.  
Because indices start @N{at 1},  
this result is equal to the number of elements in the stack;  
in particular, @N{0 means} an empty stack.

}

```
@APIEntry{int lua_getiuservalue (lua_State *L, int index, int n);|
@apii{0,1,-}
```

Pushes onto the stack the @id{n}-th  
user value associated with the  
full userdata at the given index and  
returns the type of the pushed value.

If the userdata does not have that value,  
pushes @nil and returns @Lid{LUA\_TNONE}.

}

```
@APIEntry{void lua_insert (lua_State *L, int index);|
@apii{1,1,-}
```

Moves the top element into the given valid index,  
shifting up the elements above this index to open space.

This function cannot be called with a pseudo-index,  
because a pseudo-index is not an actual stack position.

}

@APIEntry{typedef @ldots lua\_Integer;|

The type of integers in Lua.

By default this type is @id{long long},  
(usually a 64-bit two-complement integer),  
but that can be changed to @id{long} or @id{int}  
(usually a 32-bit two-complement integer).  
(See @id{LUA\_INT\_TYPE} in @id{luaconf.h}.)

Lua also defines the constants

@defid{LUA\_MININTEGER} and @defid{LUA\_MAXINTEGER},  
with the minimum and the maximum values that fit in this type.

}

@APIEntry{int lua\_isboolean (lua\_State \*L, int index);|  
@apii{0,0,-}}

Returns 1

if the value at the given index is a boolean,  
and @N{0 otherwise}.

}

@APIEntry{int lua\_iscfunction (lua\_State \*L, int index);|  
@apii{0,0,-}}

Returns 1 if the value at the given index is a @N{C function},  
and @N{0 otherwise}.

}

@APIEntry{int lua\_isfunction (lua\_State \*L, int index);|  
@apii{0,0,-}}

Returns 1 if the value at the given index is a function  
(either C or Lua), and @N{0 otherwise}.

}

@APIEntry{int lua\_isinteger (lua\_State \*L, int index);|  
@apii{0,0,-}}

Returns 1 if the value at the given index is an integer  
(that is, the value is a number and is represented as an integer),  
and @N{0 otherwise}.

}

```
@APIEntry{int lua_islightuserdata (lua_State *L, int index);|
@apii{0,0,-}
```

Returns 1 if the value at the given index is a light userdata,  
and @N{0 otherwise}.

}

```
@APIEntry{int lua_isnil (lua_State *L, int index);|
@apii{0,0,-}
```

Returns 1 if the value at the given index is @nil,  
and @N{0 otherwise}.

}

```
@APIEntry{int lua_isnone (lua_State *L, int index);|
@apii{0,0,-}
```

Returns  
1 if the given index is not valid,  
and @N{0 otherwise}.

}

```
@APIEntry{int lua_isnoneornil (lua_State *L, int index);|
@apii{0,0,-}
```

Returns 1 if the given index is not valid  
or if the value at this index is @nil,  
and @N{0 otherwise}.

}

```
@APIEntry{int lua_isnumber (lua_State *L, int index);|
@apii{0,0,-}
```

Returns 1 if the value at the given index is a number  
or a string convertible to a number,  
and @N{0 otherwise}.

```
}
```

```
@APIEntry{int lua_isstring (lua_State *L, int index);|  
@apii{0,0,-}}
```

Returns 1 if the value at the given index is a string  
or a number (which is always convertible to a string),  
and @N{0 otherwise}.

```
}
```

```
@APIEntry{int lua_istable (lua_State *L, int index);|  
@apii{0,0,-}}
```

Returns 1 if the value at the given index is a table,  
and @N{0 otherwise}.

```
}
```

```
@APIEntry{int lua_isthread (lua_State *L, int index);|  
@apii{0,0,-}}
```

Returns 1 if the value at the given index is a thread,  
and @N{0 otherwise}.

```
}
```

```
@APIEntry{int lua_isuserdata (lua_State *L, int index);|  
@apii{0,0,-}}
```

Returns  
1 if the value at the given index is a userdata  
(either full or light), and @N{0 otherwise}.

```
}
```

```
@APIEntry{int lua_isyieldable (lua_State *L);|  
@apii{0,0,-}}
```

Returns 1 if the given coroutine can yield,  
and @N{0 otherwise}.

```
}
```

```
@APIEntry{typedef @ldots lua_KContext;|
```

The type for continuation-function contexts.  
It must be a numeric type.

This type is defined as `@id{intptr_t}`  
when `@id{intptr_t}` is available,  
so that it can store pointers too.  
Otherwise, it is defined as `@id{ptrdiff_t}`.

}

@APIEntry{  
typedef int (\*lua\_KFunction) (lua\_State \*L, int status, lua\_KContext ctx);|

Type for continuation functions @see{continuations}.

}

@APIEntry{void lua\_len (lua\_State \*L, int index);|  
@apii{0,1,e}

Returns the length of the value at the given index.  
It is equivalent to the `@Char{#}` operator in Lua @see{len-op} and  
may trigger a metamethod for the `@Q{length}` event @see{metatable}.  
The result is pushed on the stack.

}

@APIEntry{  
int lua\_load (lua\_State \*L,  
              lua\_Reader reader,  
              void \*data,  
              const char \*chunkname,  
              const char \*mode);|  
@apii{0,1,-}

Loads a Lua chunk without running it.  
If there are no errors,  
`@id{lua_load}` pushes the compiled chunk as a Lua  
function on top of the stack.  
Otherwise, it pushes an error message.

The `@id{lua_load}` function uses a user-supplied `@id{reader}` function  
to read the chunk @seeC{lua\_Reader}.  
The `@id{data}` argument is an opaque value passed to the reader function.

The `@id{chunkname}` argument gives a name to the chunk,  
which is used for error messages and in debug information @see{debugI}.

`@id{lua_load}` automatically detects whether the chunk is text or binary  
and loads it accordingly (see program @idx{luac}).  
The string `@id{mode}` works as in function @Lid{load},



with the addition that  
a @id{NULL} value is equivalent to the string @St{bt}.

@id{lua\_load} uses the stack internally,  
so the reader function must always leave the stack  
unmodified when returning.

@id{lua\_load} can return  
@Lid{LUA\_OK},  
@Lid{LUA\_ERRSYNTAX}, or @Lid{LUA\_ERRMEM}.  
The function may also return other values corresponding to  
errors raised by the read function @see{statuscodes}.

If the resulting function has upvalues,  
its first upvalue is set to the value of the @x{global environment}  
stored at index @id{LUA\_RIDX\_GLOBALS} in the registry @see{registry}.  
When loading main chunks,  
this upvalue will be the @id{\_ENV} variable @see{globalenv}.  
Other upvalues are initialized with @nil.

}

@APIEntry{lua\_State \*lua\_newstate (lua\_Alloc f, void \*ud);|  
@apii{0,0,-}}

Creates a new independent state and returns its main thread.  
Returns @id{NULL} if it cannot create the state  
(due to lack of memory).  
The argument @id{f} is the @x{allocator function};  
Lua will do all memory allocation for this state  
through this function @seeF{lua\_Alloc}.  
The second argument, @id{ud}, is an opaque pointer that Lua  
passes to the allocator in every call.

}

@APIEntry{void lua\_newtable (lua\_State \*L);|  
@apii{0,1,m}}

Creates  
a new empty table and pushes it onto the stack.  
It is equivalent to @T{lua\_createtable(L, 0, 0)}.

}

@APIEntry{lua\_State \*lua\_newthread (lua\_State \*L);|  
@apii{0,1,m}}

Creates a new thread, pushes it on the stack,  
and returns a pointer to a @Lid{lua\_State} that represents this new thread.  
The new thread returned by this function shares with the original thread  
its global environment,  
but has an independent execution stack.

Threads are subject to garbage collection,  
like any Lua object.

}

```
@APIEntry{void *lua_newuserdatauv (lua_State *L, size_t size, int nuvalue);|
@apii{0,1,m}
```

This function creates and pushes on the stack a new full userdata,  
with @id{nuvalue} associated Lua values, called @id{user values},  
plus an associated block of raw memory with @id{size} bytes.  
(The user values can be set and read with the functions  
@Lid{lua\_setiuservalue} and @Lid{lua\_getiuservalue}.)

The function returns the address of the block of memory.  
Lua ensures that this address is valid as long as  
the  
corresponding userdata is alive @see{GC}.  
Moreover, if the userdata is marked for finalization @see{finalizers},  
its address is valid at least until the call to its finalizer.

}

```
@APIEntry{int lua_next (lua_State *L, int index);|
@apii{1,2|0,v}
```

Pops a key from the stack,  
and pushes a key@En{ }value pair from the table at the given index,  
the @Q{next} pair after the given key.  
If there are no more elements in the table,  
then @Lid{lua\_next} @N{returns 0} and pushes nothing.

A typical table traversal looks like this:

```
@verbatim{
/* table is in the stack at index 't' */
lua_pushnil(L); /* first key */
while (lua_next(L, t) != 0) {
/* uses 'key' (at index -2) and 'value' (at index -1) */
printf("%s - %s\n",
    lua_typename(L, lua_type(L, -2)),
    lua_typename(L, lua_type(L, -1)));
/* removes 'value'; keeps 'key' for next iteration */
```

```

lua_pop(L, 1);
}
}

```

While traversing a table,  
avoid calling `@Lid{lua_tolstring}` directly on a key,  
unless you know that the key is  
actually a string.  
Recall that `@Lid{lua_tolstring}` may change  
the value at the given index;  
this confuses the next call to `@Lid{lua_next}`.

This function may raise an error if the given key  
is neither `@nil` nor present in the table.  
See function `@Lid{next}` for the caveats of modifying  
the table during its traversal.

```

}

```

```

@APIEntry{typedef @ldots lua_Number;}

```

The type of floats in Lua.

By default this type is double,  
but that can be changed to a single float or a long double.  
(See `@id{LUA_FLOAT_TYPE}` in `@id{luaconf.h}`.)

```

}

```

```

@APIEntry{int lua_numbertointeger (lua_Number n, lua_Integer *p);}

```

Tries to convert a Lua float to a Lua integer;  
the float `@id{n}` must have an integral value.  
If that value is within the range of Lua integers,  
it is converted to an integer and assigned to `@T{*p}`.  
The macro results in a boolean indicating whether the  
conversion was successful.  
(Note that this range test can be tricky to do  
correctly without this macro, due to rounding.)

This macro may evaluate its  
arguments more than once.

```

}

```

```

@APIEntry{int lua_pcall (lua_State *L, int nargs, int nresults, int msgch);|
@apii{nargs + 1,nresults|1,-}

```

Calls a function (or a callable object) in protected mode.

Both `@id{nargs}` and `@id{nresults}` have the same meaning as in `@Lid{lua_call}`.

If there are no errors during the call,

`@Lid{lua_pcall}` behaves exactly like `@Lid{lua_call}`.

However, if there is any error,

`@Lid{lua_pcall}` catches it,

pushes a single value on the stack (the error object),

and returns an error code.

Like `@Lid{lua_call}`,

`@Lid{lua_pcall}` always removes the function

and its arguments from the stack.

If `@id{msggh}` is 0,

then the error object returned on the stack

is exactly the original error object.

Otherwise, `@id{msggh}` is the stack index of a

`@emph{message handler}`.

(This index cannot be a pseudo-index.)

In case of runtime errors,

this handler will be called with the error object

and its return value will be the object

returned on the stack by `@Lid{lua_pcall}`.

Typically, the message

handler is used to add more debug

information to the error object, such as a stack traceback.

Such information cannot be gathered after the return of `@Lid{lua_pcall}`,

since by then the stack has unwound.

The `@Lid{lua_pcall}` function returns one of the following status codes:

`@Lid{LUA_OK}`, `@Lid{LUA_ERRRUN}`, `@Lid{LUA_ERRMEM}`, or `@Lid{LUA_ERRERR}`.

}

`@APIEntry{`

`int lua_pcallk (lua_State *L,`

`int nargs,`

`int nresults,`

`int msggh,`

`lua_KContext ctx,`

`lua_KFunction k);`

`@apii{nargs + 1,nresults|1,-}`

This function behaves exactly like `@Lid{lua_pcall}`,

except that it allows the called function to yield `@see{continuations}`.

}

```
@APIEntry{void lua_pop (lua_State *L, int n);|
@apii{n,0,e}
```

Pops @id{n} elements from the stack.

It is implemented as a macro over @Lid{lua\_settop}.

}

```
@APIEntry{void lua_pushboolean (lua_State *L, int b);|
@apii{0,1,-}
```

Pushes a boolean value with value @id{b} onto the stack.

}

```
@APIEntry{void
lua_pushcclosure (lua_State *L, lua_CFunction fn, int n);|
@apii{n,1,m}
```

Pushes a new @N{C closure} onto the stack.

This function receives a pointer to a @N{C function}

and pushes onto the stack a Lua value of type @id{function} that,

when called, invokes the corresponding @N{C function}.

The parameter @id{n} tells how many upvalues this function will have

@see{c-closure}.

Any function to be callable by Lua must

follow the correct protocol to receive its parameters

and return its results @seeC{lua\_CFunction}.

When a @N{C function} is created,

it is possible to associate some values with it,

the so called upvalues;

these upvalues are then accessible to the function whenever it is called.

This association is called a @x{@N{C closure}} @see{c-closure}.

To create a @N{C closure},

first the initial values for its upvalues must be pushed onto the stack.

(When there are multiple upvalues, the first value is pushed first.)

Then @Lid{lua\_pushcclosure}

is called to create and push the @N{C

function} onto the stack,

with the argument @id{n} telling how many values will be

associated with the function.

@Lid{lua\_pushcclosure} also pops these values from the stack.

The maximum value for @id{n} is 255.

When @id{n} is zero,  
this function creates a @def{light @N{C function}},  
which is just a pointer to the @N{C function}.  
In that case, it never raises a memory error.

}

```
@APIEntry{void lua_pushcfunction (lua_State *L, lua_CFunction f);|
@apii{0,1,-}}
```

Pushes a @N{C function} onto the stack.  
This function is equivalent to @Lid{lua\_pushcclosure} with no upvalues.

}

```
@APIEntry{const char *lua_pushfstring (lua_State *L, const char *fmt, ...);|
@apii{0,1,v}}
```

Pushes onto the stack a formatted string  
and returns a pointer to this string @see{constchar}.  
It is similar to the @ANSI{sprintf},  
but has two important differences.

First,  
you do not have to allocate space for the result;  
the result is a Lua string and Lua takes care of memory allocation  
(and deallocation, through garbage  
collection).

Second,  
the conversion specifiers are quite restricted.  
There are no flags, widths, or precisions.  
The conversion specifiers can only be  
@Char{%%} (inserts the character @Char{%}),  
@Char{%s} (inserts a zero-terminated string, with no size restrictions),  
@Char{%f} (inserts a @Lid{lua\_Number}),  
@Char{%I} (inserts a @Lid{lua\_Integer}),  
@Char{%p} (inserts a pointer),  
@Char{%d} (inserts an @T{int}),  
@Char{%c} (inserts an @T{int} as a one-byte character), and  
@Char{%U} (inserts a @T{long int} as a @x{UTF-8} byte sequence).

This function may raise errors due to memory overflow  
or an invalid conversion specifier.

}

```
@APIEntry{void lua_pushglobaltable (lua_State *L);|
@apii{0,1,-}}
```

Pushes the @x{global environment} onto the stack.

}

```
@APIEntry{void lua_pushinteger (lua_State *L, lua_Integer n);|
@apii{0,1,-}}
```

Pushes an integer with value @id{n} onto the stack.

}

```
@APIEntry{void lua_pushlightuserdata (lua_State *L, void *p);|
@apii{0,1,-}}
```

Pushes a light userdata onto the stack.

Userdata

represent @N{C values} in Lua.

A @def{light userdata} represents a pointer, a @T{void\*}.

It is a value (like a number):

you do not create it, it has no individual metatable,

and it is not collected (as it was never created).

A light userdata is equal to @Q{any}

light userdata with the same @N{C address}.

}

```
@APIEntry{const char *lua_pushliteral (lua_State *L, const char *s);|
@apii{0,1,m}}
```

This macro is equivalent to @Lid{lua\_pushstring},  
but should be used only when @id{s} is a literal string.  
(Lua may optimize this case.)

}

```
@APIEntry{const char *lua_pushlstring (lua_State *L, const char *s, size_t len);|
@apii{0,1,m}}
```

Pushes the string pointed to by @id{s} with size @id{len}  
onto the stack.

Lua will make or reuse an internal copy of the given string,  
so the memory at @id{s} can be freed or reused immediately after  
the function returns.

The string can contain any binary data,  
including @x{embedded zeros}.

Returns a pointer to the internal copy of the string @see{constchar}.

}

```
@APIEntry{void  
lua_pushnil (lua_State *L);|  
@apii{0,1,-}
```

Pushes a nil value onto the stack.

}

```
@APIEntry{void lua_pushnumber (lua_State *L, lua_Number n);|  
@apii{0,1,-}
```

Pushes a float with value @id{n} onto the stack.

}

```
@APIEntry{const char *lua_pushstring (lua_State *L, const char *s);|  
@apii{0,1,m}
```

Pushes the zero-terminated string pointed to by @id{s}  
onto the stack.

Lua will make or reuse an internal copy of the given string,  
so the memory at @id{s} can be freed or reused immediately after  
the function returns.

Returns a pointer to the internal copy of the string @see{constchar}.

If @id{s} is @id{NULL}, pushes @nil and returns @id{NULL}.

}

```
@APIEntry{int lua_pushthread (lua_State *L);|  
@apii{0,1,-}
```

Pushes the thread represented by @id{L} onto the stack.  
Returns 1 if this thread is the @x{main thread} of its state.

}

```
@APIEntry{void lua_pushvalue (lua_State *L, int index);|  
@apii{0,1,-}
```

Pushes a copy of the element at the given index  
onto the stack.



```
}
```

```
@APIEntry{  
const  
char *lua_pushvfstring (lua_State *L,  
                        const char *fmt,  
                        va_list argp);|  
@apii{0,1,v}
```

Equivalent to @Lid{lua\_pushfstring}, except that it receives a @id{va\_list} instead of a variable number of arguments.

```
}
```

```
@APIEntry{int lua_rawequal (lua_State *L, int index1, int index2);|  
@apii{0,0,-}
```

Returns 1 if the two values in indices @id{index1} and @id{index2} are primitively equal (that is, equal without calling the @idx{\_\_eq} metamethod). Otherwise @N{returns 0}. Also @N{returns 0} if any of the indices are not valid.

```
}
```

```
@APIEntry{int lua_rawget (lua_State *L, int index);|  
@apii{1,1,-}
```

Similar to @Lid{lua\_gettable}, but does a raw access (i.e., without metamethods). The value at @id{index} must be a table.

```
}
```

```
@APIEntry{int lua_rawgeti (lua_State *L, int index, lua_Integer n);|  
@apii{0,1,-}
```

Pushes onto the stack the value @T{t[n]}, where @id{t} is the table at the given index. The access is raw, that is, it does not use the @idx{\_\_index} metavalue.

Returns the type of the pushed value.

```
}
```

```
@APIEntry{int lua_rawgetp (lua_State *L, int index, const void *p);|
```

@apii{0,1,-}

Pushes onto the stack the value @T{t[k]},  
where @id{t} is the table at the given index and  
@id{k} is the pointer @id{p} represented as a light userdata.  
The access is raw;  
that is, it does not use the @idx{\_\_index} metavalue.

Returns the type of the pushed value.

}

@APIEntry{lua\_Unsigned lua\_rawlen (lua\_State \*L, int index);|  
@apii{0,0,-}

Returns the raw @Q{length} of the value at the given index:  
for strings, this is the string length;  
for tables, this is the result of the length operator (@Char{#})  
with no metamethods;  
for userdata, this is the size of the block of memory allocated  
for the userdata.  
For other values, this call @N{returns 0}.

}

@APIEntry{void lua\_rawset (lua\_State \*L, int index);|  
@apii{2,0,m}

Similar to @Lid{lua\_settable}, but does a raw assignment  
(i.e., without metamethods).  
The value at @id{index} must  
be a table.

}

@APIEntry{void lua\_rawseti (lua\_State \*L, int index, lua\_Integer i);|  
@apii{1,0,m}

Does the equivalent of @T{t[i] = v},  
where @id{t} is the table at the given index  
and @id{v} is the value on the top of the stack.

This function pops the value from the stack.  
The assignment is raw,  
that is, it does not use the @idx{\_\_newindex} metavalue.

}

```
@APIEntry{void lua_rawsetp (lua_State *L, int index, const void *p);|
@apii{1,0,m}
```

Does the equivalent of `@T{t[p] = v}`,  
 where `@id{t}` is the table at the given index,  
`@id{p}` is encoded as a light userdata,  
 and `@id{v}` is the value on the top of the stack.

This function pops the value from the stack.  
 The assignment is raw,  
 that is, it does not use the `@idx{__newindex}` metavalue.

```
}
```

```
@APIEntry{
typedef const char * (*lua_Reader) (lua_State *L,
                                   void *data,
                                   size_t *size);|
```

The reader function used by `@Lid{lua_load}`.  
 Every time `@Lid{lua_load}` needs another piece of  
 the chunk,  
 it calls the reader,  
 passing along its `@id{data}` parameter.  
 The reader must return a pointer to a block of memory  
 with a new piece of the chunk  
 and set `@id{size}` to the block size.  
 The block must exist until the reader function is called again.  
 To signal the end of the chunk,  
 the reader must return `@id{NULL}` or set `@id{size}` to zero.  
 The reader function may return pieces of any size greater than zero.

```
}
```

```
@APIEntry{void lua_register (lua_State *L, const char *name, lua_CFunction f);|
@apii{0,0,e}
```

Sets the `@N{C function}` `@id{f}` as the new value of global `@id{name}`.  
 It is defined as a macro:

```
@verbatim{
#define lua_register(L,n,f) \
    (lua_pushcfunction(L, f), lua_setglobal(L, n))
}

}
```

```
@APIEntry{void lua_remove (lua_State *L, int index);|
@apii{1,0,-}
```

Removes the element at the given valid index,  
shifting down the elements above this index to fill the gap.  
This function cannot be called with a pseudo-index,  
because a pseudo-index is not an actual stack position.

}

```
@APIEntry{void  
lua_replace (lua_State *L, int index);|  
@apii{1,0,-}
```

Moves the top element into the given valid index  
without shifting any element  
(therefore replacing the value at that given index),  
and then pops the top element.

}

```
@APIEntry{int lua_resetthread (lua_State *L);|  
@apii{0,?, -}
```

This function is deprecated;  
it is equivalent to @Lid{lua\_closethread} with  
@id{from} being @id{NULL}.

}

```
@APIEntry{int lua_resume (lua_State *L, lua_State *from, int nargs,  
int *nresults);|  
@apii{?,?, -}
```

Starts and resumes a coroutine in the given thread @id{L}.

To start a coroutine,  
you push the main function plus any arguments  
onto the empty stack of the thread.  
then you call @Lid{lua\_resume},  
with @id{nargs} being the number of arguments.  
This call returns when the coroutine suspends or finishes its execution.  
When it returns,  
@id{\*nresults} is updated and  
the top of the stack contains  
the @id{\*nresults} values passed to @Lid{lua\_yield}  
or returned by the body function.  
@Lid{lua\_resume}  
returns  
@Lid{LUA\_YIELD} if the coroutine yields,

@Lid{LUA\_OK} if the coroutine finishes its execution without errors,  
or an error code in case of errors @see{statuscodes}.  
In case of errors,  
the error object is on the top of the stack.

To resume a coroutine,  
you remove the @id{\*nresults} yielded values from its stack,  
push the values to be passed as results from @id{yield},  
and then call @Lid{lua\_resume}.

The parameter @id{from} represents the coroutine that is resuming @id{L}.  
If there is no such coroutine,  
this parameter can be @id{NULL}.

}

@APIEntry{void lua\_rotate (lua\_State \*L, int idx, int n);|  
@apii{0,0,-}}

Rotates the stack elements between the valid index @id{idx}  
and the top of the stack.  
The elements are rotated @id{n} positions in the direction of the top,  
for a positive @id{n},  
or @T{-n} positions in the direction of the bottom,  
for a negative @id{n}.  
The absolute value of @id{n} must not be greater than the size  
of the slice being rotated.  
This function  
cannot be called with a pseudo-index,  
because a pseudo-index is not an actual stack position.

}

@APIEntry{void lua\_setallocf (lua\_State \*L, lua\_Alloc f, void \*ud);|  
@apii{0,0,-}}

Changes the @x{allocator function} of a given state to @id{f}  
with user data @id{ud}.

}

@APIEntry{void lua\_setfield (lua\_State \*L, int index, const char \*k);|  
@apii{1,0,e}}

Does the equivalent to @T{t[k] = v},  
where @id{t} is the value at the given index  
and @id{v} is the value on the top of the stack.

This function pops the value from the stack.  
As in Lua, this function may trigger a metamethod  
for the @Q{newindex} event @see{metatable}.

```
}
```

```
@APIEntry{void lua_setglobal (lua_State *L, const char *name);|  
@apii{1,0,e}}
```

Pops a value from the stack and  
sets it as the new value of global @id{name}.

```
}
```

```
@APIEntry{void lua_seti (lua_State *L, int index, lua_Integer n);|  
@apii{1,0,e}}
```

Does the equivalent to @T{t[n] = v},  
where @id{t} is the value at the given index  
and @id{v} is the value on the top of  
the stack.

This function pops the value from the stack.  
As in Lua, this function may trigger a metamethod  
for the @Q{newindex} event @see{metatable}.

```
}
```

```
@APIEntry{int lua_setiuservalue (lua_State *L, int index, int n);|  
@apii{1,0,-}}
```

Pops a value from the stack and sets it as  
the new @id{n}-th user value associated to the  
full userdata at the given index.  
Returns 0 if the userdata does not have that value.

```
}
```

```
@APIEntry{int lua_setmetatable (lua_State *L, int index);|  
@apii{1,0,-}}
```

Pops a table or @nil from the stack and  
sets that value as the new metatable for the value at the given index.  
(@nil means no metatable.)

(For historical reasons, this function returns an @id{int},  
which now is always 1.)

```
}
```

```
@APIEntry{void lua_settable (lua_State *L, int index);|  
@apii{2,0,e}
```

Does the equivalent to `@T{t[k] = v}`,  
where `@id{t}` is the value at the given index,  
`@id{v}` is the value on the top of the stack,  
and `@id{k}` is the value just below the top.

This function pops both the key and the value  
from the stack.  
As in Lua, this function may trigger a metamethod  
for the `@Q{newindex}` event `@see{metatable}`.

```
}
```

```
@APIEntry{void lua_settop (lua_State *L, int index);|  
@apii{?,?,e}
```

Accepts any index, `@N{or 0}`,  
and sets the stack top to this index.  
If the new top is greater than the old one,  
then the new elements are filled with `@nil`.  
If `@id{index} @N{is 0}`, then all stack elements are removed.

This function can run arbitrary code when removing an index  
marked as to-be-closed from the stack.

```
}
```

```
@APIEntry{void lua_setwarnf (lua_State *L, lua_WarnFunction f, void *ud);|  
@apii{0,0,-}
```

Sets the `@x{warning function}` to be used by Lua to emit warnings  
`@see{lua_WarnFunction}`.  
The `@id{ud}` parameter sets the value `@id{ud}` passed to  
the warning function.

```
}
```

```
@APIEntry{typedef struct lua_State lua_State;|
```

An opaque structure that points to a thread and indirectly  
(through the thread) to the whole state of a Lua interpreter.  
The Lua library is fully reentrant:  
it has no global variables.

All

information about a state is accessible through this structure.

A pointer to this structure must be passed as the first argument to every function in the library, except to `@Lid{lua_newstate}`, which creates a Lua state from scratch.

}

```
@APIEntry{int lua_status (lua_State *L);|
@apii{0,0,-}}
```

Returns the status of the thread `@id{L}`.

The status can be `@Lid{LUA_OK}` for a normal thread, an error code if the thread finished the execution of a `@Lid{lua_resume}` with an error, or `@Lid{LUA_YIELD}` if the thread is suspended.

You can call functions only in threads with status `@Lid{LUA_OK}`. You can resume threads with status `@Lid{LUA_OK}` (to start a new coroutine) or `@Lid{LUA_YIELD}` (to resume a coroutine).

}

```
@APIEntry{size_t lua_stringtonumber (lua_State *L, const char *s);|
@apii{0,1,-}}
```

Converts the zero-terminated string `@id{s}` to a number, pushes that number into the stack, and returns the total size of the string, that is, its length plus one.

The conversion can result in an integer or a float,

according to the lexical conventions of Lua `@see{lexical}`.

The string may have leading and trailing whitespaces and a sign.

If the string is not a valid numeral,

returns 0 and pushes nothing.

(Note that the result can be used as a boolean, true if the conversion succeeds.)

}

```
@APIEntry{int lua_toboolean (lua_State *L, int index);|
@apii{0,0,-}}
```

Converts the Lua value at the given index to a `@N{C boolean}`



value (@N{0 or 1}).

Like all tests in Lua,

@Lid{lua\_toboolean} returns true for any Lua value different from @false and @nil; otherwise it returns false.

(If you want to accept only actual boolean values, use @Lid{lua\_isboolean} to test the value's type.)

}

```
@APIEntry{lua_CFunction lua_tocfunction (lua_State *L, int index);|
@apii{0,0,-}
```

Converts a value at the given index to a @N{C function}. That value must be a @N{C function}; otherwise, returns @id{NULL}.

}

```
@APIEntry{void lua_toclose (lua_State *L, int index);|
@apii{0,0,v}
```

Marks the given index in the stack as a to-be-closed

slot @see{to-be-closed}.

Like a to-be-closed variable in Lua, the value at that slot in the stack will be closed when it goes out of scope.

Here, in the context of a C function, to go out of scope means that the running function returns to Lua, or there is an error,

or the slot is removed from the stack through

@Lid{lua\_settop} or @Lid{lua\_pop},

or there is a call to @Lid{lua\_closeslot}.

A slot marked as to-be-closed should not be removed from the stack by any other function in the API except @Lid{lua\_settop} or @Lid{lua\_pop}, unless previously deactivated by @Lid{lua\_closeslot}.

This function raises an error if the value at the given slot neither has a @idx{\_\_close} metamethod nor is a false value.

This function should not be called for an index that is equal to or below an active to-be-closed slot.

Note that, both in case of errors and of a regular return, by the time the @idx{\_\_close} metamethod runs, the @N{C stack} was already unwound, so that any automatic @N{C variable}

declared in the calling function  
(e.g., a buffer) will be out of scope.

}

```
@APIEntry{lua_Integer lua_tointeger (lua_State *L, int index);|
@apii{0,0,-}
```

Equivalent to @Lid{lua\_tointegerx} with @id{isnum} equal to @id{NULL}.

}

```
@APIEntry{lua_Integer lua_tointegerx (lua_State *L, int index, int *isnum);|
@apii{0,0,-}
```

Converts the Lua value at the given index  
to the signed integral type @Lid{lua\_Integer}.

The Lua value must be an integer,  
or a number or string convertible to an integer @see{coercion};  
otherwise, @id{lua\_tointegerx} @N{returns 0}.

If @id{isnum} is not @id{NULL},  
its referent is assigned a boolean value that  
indicates whether the operation succeeded.

}

```
@APIEntry{const char *lua_tolstring (lua_State *L, int index, size_t *len);|
@apii{0,0,m}
```

Converts the Lua value at the given index to a @N{C string}.

If @id{len} is not @id{NULL},  
it sets @T{\*len} with the string length.

The Lua value must be a string or a number;  
otherwise, the function returns @id{NULL}.

If  
the value is a number,  
then @id{lua\_tolstring} also  
@emph{changes the actual value in the stack to a string}.

(This change confuses @Lid{lua\_next}  
when @id{lua\_tolstring} is applied to keys during a table traversal.)

@id{lua\_tolstring} returns a pointer  
to a string inside the Lua state @see{constchar}.

This string always has a zero (@Char{\0})  
after its last character (as @N{in C}),  
but can contain other zeros in its body.

This function can raise memory errors only  
when converting a number to a string  
(as then it may create a new string).

}

```
@APIEntry{lua_Number lua_tonumber (lua_State *L, int index);|  
@apii{0,0,-}}
```

Equivalent to @Lid{lua\_tonumberx} with @id{isnum} equal to @id{NULL}.

}

```
@APIEntry{lua_Number lua_tonumberx (lua_State *L, int index, int *isnum);|  
@apii{0,0,-}}
```

Converts the Lua value at the given index  
to the @N{C type} @Lid{lua\_Number} @seeC{lua\_Number}.  
The Lua value must be a number or a string convertible to a number  
@see{coercion};  
otherwise, @Lid{lua\_tonumberx}  
@N{returns 0}.

If @id{isnum} is not @id{NULL},  
its referent is assigned a boolean value that  
indicates whether the operation succeeded.

}

```
@APIEntry{const void *lua_topointer (lua_State *L, int index);|  
@apii{0,0,-}}
```

Converts the value at the given index to a generic  
@N{C pointer} (@T{void\*}).  
The value can be a userdata, a table, a thread, a string, or a function;  
otherwise, @id{lua\_topointer} returns @id{NULL}.  
Different objects will give different pointers.  
There is no way to convert the pointer back to its original value.

Typically this function is used only for hashing and debug information.

}

```
@APIEntry{const char *lua_tolstring (lua_State *L, int index);|  
@apii{0,0,m}}
```

Equivalent to @Lid{lua\_tolstring} with @id{len} equal to @id{NULL}.

```
}
```

```
@APIEntry{lua_State *lua_tothread (lua_State *L, int index);|  
@apii{0,0,-}}
```

Converts the value at the given index to a Lua thread  
(represented as @T{lua\_State\*}).  
This value must be a thread;  
otherwise, the function returns @id{NULL}.

```
}
```

```
@APIEntry{void  
*lua_touserdata (lua_State *L, int index);|  
@apii{0,0,-}}
```

If the value at the given index is a full userdata,  
returns its memory-block address.  
If the value is a light userdata,  
returns its value (a pointer).  
Otherwise, returns @id{NULL}.

```
}
```

```
@APIEntry{int lua_type (lua_State *L, int index);|  
@apii{0,0,-}}
```

Returns the type of the value in the given valid index,  
or @id{LUA\_TNONE} for a non-valid but acceptable index.  
The types returned by @Lid{lua\_type} are coded by the following constants  
defined in @id{lua.h}:

```
@defid{LUA_TNIL},  
@defid{LUA_TNUMBER},  
@defid{LUA_TBOOLEAN},  
@defid{LUA_TSTRING},  
@defid{LUA_TTABLE},  
@defid{LUA_TFUNCTION},  
@defid{LUA_TUSERDATA},  
@defid{LUA_TTHREAD},  
and  
@defid{LUA_TLIGHTUSERDATA}.
```

```
}
```

```
@APIEntry{const char *lua_typename (lua_State *L, int tp);|  
@apii{0,0,-}}
```

Returns the name of the type encoded by the value @id{tp},

which must be one the values returned by @Lid{lua\_type}.

```
}
```

```
@APIEntry{typedef @ldots lua_Unsigned;|
```

The unsigned version of @Lid{lua\_Integer}.

```
}
```

```
@APIEntry{int  
lua_upvalueindex (int i);|  
@apii{0,0,-}
```

Returns the pseudo-index that represents the @id{i}-th upvalue of the running function @see{c-closure}.

@id{i} must be in the range @M{[1,256]}.

```
}
```

```
@APIEntry{lua_Number lua_version (lua_State *L);|  
@apii{0,0,-}
```

Returns the version number of this core.

```
}
```

```
@APIEntry{  
typedef void (*lua_WarnFunction) (void *ud, const char *msg, int tocont);|
```

The type of @x{warning function}s, called by Lua to emit warnings.

The first parameter is an opaque pointer set by @Lid{lua\_setwarnf}.

The second parameter is the warning message.

The third parameter is a boolean that indicates whether the message is to be continued by the message in the next call.

See @Lid{warn} for more details about warnings.

```
}
```

```
@APIEntry{  
void lua_warning (lua_State *L, const char *msg, int tocont);|  
@apii{0,0,-}
```

Emits a warning with the given message.

A message in a call with @id{tocont} true should be

continued in another call to this function.

See

@Lid{warn} for more details about warnings.

}

```
@APIEntry{
typedef int (*lua_Writer) (lua_State *L,
                           const void* p,
                           size_t sz,
                           void* ud);|
```

The type of the writer function used by @Lid{lua\_dump}.  
Every time @Lid{lua\_dump} produces another piece of chunk,  
it calls the writer,  
passing along the buffer to be written (@id{p}),  
its size (@id{sz}),  
and the @id{ud} parameter supplied to @Lid{lua\_dump}.

The writer returns an error code:

@N{0 means} no errors;

any other value means an error and stops @Lid{lua\_dump} from  
calling the writer again.

}

```
@APIEntry{void lua_xmove (lua_State *from, lua_State *to, int n);|
@apii{?,?,-}
```

Exchange values between different threads of the same state.

This function pops @id{n} values from the stack @id{from},  
and pushes them onto the stack @id{to}.

}

```
@APIEntry{int lua_yield (lua_State *L, int nresults);|
@apii{?,?,v}
```

This function is equivalent to @Lid{lua\_yieldk},  
but it has

no continuation @see{continuations}.

Therefore, when the thread resumes,  
it continues the function that called  
the function calling @id{lua\_yield}.

To avoid surprises,  
this function should be called only in a tail call.

```
}
```

```
@APIEntry{  
int lua_yieldk (lua_State *L,  
               int nresults,  
               lua_KContext ctx,  
               lua_KFunction k);  
@apii{?,?,v}
```

Yields a coroutine (thread).

When a @N{C function} calls @Lid{lua\_yieldk},  
the running coroutine suspends its execution,  
and the call to @Lid{lua\_resume} that started this coroutine returns.  
The parameter @id{nresults} is the number of values from the stack  
that will be passed as results to @Lid{lua\_resume}.

When the coroutine is resumed again,  
Lua calls the given @x{continuation function} @id{k} to continue  
the execution of the @N{C function} that yielded @see{continuations}.  
This continuation function receives the same stack  
from the previous function,  
with the @id{n} results removed and  
replaced by the arguments  
passed to @Lid{lua\_resume}.  
Moreover,  
the continuation function receives the value @id{ctx}  
that was passed to @Lid{lua\_yieldk}.

Usually, this function does not return;  
when the coroutine eventually resumes,  
it continues executing the continuation function.  
However, there is one special case,  
which is when this function is called  
from inside a line or a count hook @see{debugI}.  
In that case, @id{lua\_yieldk} should be called with no continuation  
(probably in the form of @Lid{lua\_yield}) and no results,  
and the hook should return immediately after the call.  
Lua will yield and,  
when the coroutine resumes again,  
it will continue the normal execution  
of the (Lua) function that triggered the hook.

This function can raise an error if it is called from a thread  
with a pending C call with no continuation function  
(what is called a @emphx{C-call boundary}),

or it is called from a thread that is not running inside a resume (typically the main thread).

```
}
```

```
}
```

```
@sect2{debugI| @title{The Debug  
Interface}
```

Lua has no built-in debugging facilities.  
Instead, it offers a special interface  
by means of functions and `@emph{hooks}`.  
This interface allows the construction of different  
kinds of debuggers, profilers, and other tools  
that need `@Q{inside information}` from the interpreter.

```
@APIEntry{  
typedef struct lua_Debug {  
    int event;  
    const char *name;      /* (n) */  
    const char *namewhat;  /* (n) */  
    const char *what;      /* (S) */  
    const char *source;    /* (S) */  
    size_t srclen;         /* (S) */  
    int currentline;       /* (l) */  
    int linedefined;       /* (S) */  
    int lastlinedefined;   /* (S) */  
    unsigned char nups;    /* (u) number of upvalues */  
    unsigned char nparams; /* (u) number of parameters */  
    char isvararg;         /* (u) */  
    char istailcall;       /* (t) */  
    unsigned short ftransfer; /* (r) index of first value transferred */  
    unsigned short ntransfer; /* (r) number of transferred values */  
    /*  
    char short_src[LUA_IDSIZE]; /* (S) */  
    /* private part */  
    @rep{other fields}  
} lua_Debug;  
|
```

A structure used to carry different pieces of  
information about a function or an activation record.

`@Lid{lua_getstack}` fills only the private part  
of this structure, for later use.

To fill the other fields of `@Lid{lua_Debug}` with useful information,  
you must call `@Lid{lua_getinfo}` with an appropriate parameter.



(Specifically, to get a field,  
you must add the letter between parentheses in the field's comment  
to the parameter `@id{what}` of `@Lid{lua_getinfo}`.)

The fields of `@Lid{lua_Debug}` have the following meaning:  
`@description{`

`@item{@id{source}|`  
the source of the chunk that created the function.  
If `@T{source}` starts with a `@Char{@At}`,  
it means that the function was defined in a file where  
the file name follows the `@Char{@At}`.  
If `@T{source}` starts with a `@Char{=}`,  
the remainder of its contents describes the source in a user-dependent manner.  
Otherwise,  
the function was defined in a string  
where  
`@T{source}` is that string.  
`}`

`@item{@id{srclen}|`  
The length of the string `@id{source}`.  
`}`

`@item{@id{short_src}|`  
a `@Q{printable}` version of `@T{source}`, to be used in error messages.  
`}`

`@item{@id{linedefined}|`  
the line number where the definition of the function starts.  
`}`

`@item{@id{lastlinedefined}|`  
the line number where the definition of the function ends.  
`}`

`@item{@id{what}|`  
the string `@T{"Lua"}` if the function is a Lua function,  
`@T{"C"}` if it is a `@N{C}` function,  
`@T{"main"}` if it is the main part of a chunk.  
`}`

`@item{@id{currentline}|`  
the current line where the given function is executing.  
When no line information is available,  
`@T{currentline}` is set to `@num{-1}`.  
`}`

`@item{@id{name}}`  
 a reasonable name for the given function.  
 Because functions in Lua are first-class values,  
 they do not have a fixed name:  
 some functions can be the value of multiple global variables,  
 while others can be stored only in a table field.  
 The `@T{lua_getinfo}` function checks how the function was  
 called  
 to find a suitable name.  
 If it cannot find a name,  
 then `@id{name}` is set to `@id{NULL}`.  
}

`@item{@id{namewhat}}`  
 explains the `@T{name}` field.  
 The value of `@T{namewhat}` can be  
`@T{"global"}`, `@T{"local"}`, `@T{"method"}`,  
`@T{"field"}`, `@T{"upvalue"}`, or `@T{""}` (the empty string),  
 according to how the function was called.  
 (Lua uses the empty string when no other option seems to apply.)  
}

`@item{@id{istailcall}}`  
 true if this function invocation was called by a tail call.  
 In this case, the caller of this level is not in the stack.  
}

`@item{@id{nups}}`  
 the number of upvalues of the function.  
}

`@item{@id{nparams}}`  
 the number of parameters of the function  
 (always `@N{0}` for `@N{C}` functions).  
}

`@item{@id{isvararg}}`  
 true if the function is a variadic function  
 (always true for `@N{C}` functions).  
}

`@item{@id{ftransfer}}`  
 the index in the stack of the first value being `@Q{transferred}`,  
 that is, parameters in a call or return values in a return.  
 (The other values are in consecutive indices.)  
 Using this  
 index, you can access and modify these values  
 through `@Lid{lua_getlocal}` and `@Lid{lua_setlocal}`.

This field is only meaningful during a call hook, denoting the first parameter, or a return hook, denoting the first value being returned. (For call hooks, this value is always 1.)

```
}
```

```
@item{@id{ntransfer}|
```

The number of values being transferred (see previous item). (For calls of Lua functions, this value is always equal to @id{nparams}.)

```
}
```

```
}
```

```
}
```

```
@APIEntry{lua_Hook lua_gethook (lua_State *L);|
```

```
@apii{0,0,-}
```

Returns the current hook function.

```
}
```

```
@APIEntry{int lua_gethookcount (lua_State *L);|
```

```
@apii{0,0,-}
```

Returns the current hook count.

```
}
```

```
@APIEntry{int lua_gethookmask (lua_State *L);|
```

```
@apii{0,0,-}
```

Returns the current hook mask.

```
}
```

```
@APIEntry{int lua_getinfo (lua_State *L, const char *what, lua_Debug *ar);|
```

```
@apii{0|1,0|1|2,m}
```

Gets information about a specific function or function invocation.

To get information about a function invocation, the parameter @id{ar} must be a valid activation record that was filled by a previous call to @Lid{lua\_getstack} or given as argument to a hook @seeC{lua\_Hook}.

To get information about a function, you push it onto the stack and start the `@id{what}` string with the character `@Char{>}`.

(In that case,

`@id{lua_getinfo}` pops the function from the top of the stack.)

For instance, to know in which line a function `@id{f}` was defined, you can write the following code:

```
@verbatim{
lua_Debug ar;
lua_getglobal(L, "f"); /* get global 'f' */
lua_getinfo(L, ">S", &ar);
printf("%d\n", ar.linedefined);
}
```

Each character in the string `@id{what}`

selects some fields of the structure `@id{ar}` to be filled or a value to be pushed on the stack.

(These characters are also documented in the declaration of the structure `@Lid{lua_Debug}`,

between parentheses in the comments following each field.)

`@description{`

`@item{@Char{f}|`

pushes onto the stack the function that is running at the given level;

`}`

`@item{@Char{l}|` fills in the field `@id{currentline}`;

`}`

`@item{@Char{n}|`

fills in the fields `@id{name}` and `@id{namewhat}`;

`}`

`@item{@Char{r}|` fills in the fields `@id{ftransfer}` and `@id{ntransfer}`;

`}`

`@item{@Char{S}|`

fills in the fields `@id{source}`, `@id{short_src}`,

`@id{linedefined}`, `@id{lastlinedefined}`, and `@id{what}`;

`}`

`@item{@Char{t}|` fills in the field `@id{istailcall}`;

`}`

`@item{@Char{u}|` fills in the fields

`@id{nups}`, `@id{nparams}`, and `@id{isvararg}`;

`}`

```
@item{@Char{L}|
pushes onto the stack a table whose indices are
the lines on the function with some associated code,
that is, the lines where you can put a break point.
(Lines with no code include empty lines and comments.)
If this option is given together with option @Char{f},
its table is pushed after the function.
This is the only option that can raise a memory error.
}

}
```

This function returns 0 to signal an invalid option in @id{what};  
even then the valid options are handled correctly.

```
}
```

```
@APIEntry{const char *lua_getlocal (lua_State *L, const lua_Debug *ar, int n);|
@apii{0,0|1,-}
```

**Gets**  
information about a local variable or a temporary value  
of a given activation record or a given function.

In the first case,  
the parameter @id{ar} must be a valid activation record that was  
filled by a previous call to @Lid{lua\_getstack} or  
given as argument to a hook @seeC{lua\_Hook}.  
The index @id{n} selects which local variable to inspect;  
see @Lid{debug.getlocal} for details about variable indices  
and names.

@Lid{lua\_getlocal} pushes the variable's value onto the stack  
and returns its name.

In the second case, @id{ar} must be @id{NULL} and the function  
to be inspected must be on the top of the stack.  
In this case, only parameters of Lua functions are visible  
(as there is no information about what variables are active)  
and no values are pushed onto the stack.

Returns @id{NULL} (and pushes nothing)  
when the index is greater than  
the number of active local variables.

```
}
```

```
@APIEntry{int lua_getstack (lua_State *L, int level, lua_Debug *ar);|
```

@apii{0,0,-}

Gets information about the interpreter runtime stack.

This function fills parts of a @Lid{lua\_Debug} structure with an identification of the @emph{activation record} of the function executing at a given level.

@N{Level 0} is the current running function, whereas level @M{n+1} is the function that has called level @M{n} (except for tail calls, which do not count in the stack). When called with a level greater than the stack depth, @Lid{lua\_getstack} returns 0; otherwise it returns 1.

}

@APIEntry{const char \*lua\_getupvalue (lua\_State \*L, int funcindex, int n);|  
@apii{0,0|1,-}

Gets information about the @id{n}-th upvalue of the closure at index @id{funcindex}.

It pushes the upvalue's value onto the stack and returns its name.

Returns @id{NULL} (and pushes nothing) when the index @id{n} is greater than the number of upvalues.

See @Lid{debug.getupvalue} for more information about upvalues.

}

@APIEntry{typedef void (\*lua\_Hook) (lua\_State \*L, lua\_Debug \*ar);|

Type for debugging hook functions.

Whenever a hook is called, its @id{ar} argument has its field @id{event} set to the specific event that triggered the hook.

Lua identifies these events with the following constants:

@defid{LUA\_HOOKCALL}, @defid{LUA\_HOOKRET}, @defid{LUA\_HOOKTAILCALL}, @defid{LUA\_HOOKLINE}, and @defid{LUA\_HOOKCOUNT}.

Moreover, for line events, the field @id{currentline} is also set.

To get the value of any other field in @id{ar}, the hook must call @Lid{lua\_getinfo}.

For call events, @id{event} can be @id{LUA\_HOOKCALL}, the normal value, or @id{LUA\_HOOKTAILCALL}, for a tail call;

in this case, there will be no corresponding return event.

While Lua is running a hook, it disables other calls to hooks.

Therefore, if a hook calls back Lua to execute a function or a chunk, this execution occurs without any calls to hooks.

Hook functions cannot have continuations, that is, they cannot call `@Lid{lua_yieldk}`, `@Lid{lua_pcallk}`, or `@Lid{lua_callk}` with a non-null `@id{k}`.

Hook functions can yield under the following conditions:

Only

count and line events can yield;

to yield, a hook function must finish its execution

calling `@Lid{lua_yield}` with `@id{nresults}` equal to zero

(that is, with no values).

}

```
@APIEntry{void lua_sethook (lua_State *L, lua_Hook f, int mask, int count);|
@apii{0,0,-}
```

Sets the debugging hook function.

Argument `@id{f}` is the hook function.

`@id{mask}` specifies on which events the hook will be called:

it is formed by a bitwise OR of the constants

`@defid{LUA_MASKCALL}`,

`@defid{LUA_MASKRET}`,

`@defid{LUA_MASKLINE}`,

and `@defid{LUA_MASKCOUNT}`.

The `@id{count}` argument is only meaningful when the mask includes `@id{LUA_MASKCOUNT}`.

For each event, the hook is called as explained below:

`@description{`

`@item{The call hook|}` is called when the interpreter calls a function.

The hook is called just after Lua enters the new function.

}

`@item{The return hook|}` is called when the interpreter returns from a function.

The hook is called just before Lua leaves the function.

}

`@item{The line hook|}` is called

when the interpreter is about to

start the execution of a new line of code,

or when it jumps back in the code (even to the same line).

This event only happens while Lua is executing a Lua function.

}

@item{The count hook| is called after the interpreter executes every  
@T{count} instructions.

This event only happens while Lua is executing a Lua function.

}

}

Hooks are disabled by setting @id{mask} to zero.

}

@APIEntry{const char \*lua\_setlocal (lua\_State \*L, const lua\_Debug \*ar, int n);|  
@apii{0|1,0,-}}

Sets the value of a local variable of a given activation record.

It assigns the value on the top of the stack  
to the variable and returns its name.

It also pops the value from the stack.

Returns @id{NULL} (and pops nothing)

when the index is greater than  
the number of active local variables.

Parameters @id{ar} and @id{n} are as in the function @Lid{lua\_getlocal}.

}

@APIEntry{const char \*lua\_setupvalue (lua\_State \*L, int funcindex, int n);|  
@apii{0|1,0,-}}

Sets the value of a closure's

upvalue.

It assigns the value on the top of the stack  
to the upvalue and returns its name.

It also pops the value from the stack.

Returns @id{NULL} (and pops nothing)

when the index @id{n} is greater than the number of upvalues.

Parameters @id{funcindex} and @id{n} are as in  
the function @Lid{lua\_getupvalue}.

}

@APIEntry{void \*lua\_upvalueid (lua\_State \*L, int funcindex, int n);|



$@apii\{0,0,-\}$ 

Returns a unique identifier for the upvalue numbered `@id{n}` from the closure at index `@id{funcindex}`.

These unique identifiers allow a program to check whether different closures share upvalues.

Lua closures that share an upvalue  
(that is, that access a same external local variable)  
will return identical ids for those upvalue indices.

Parameters `@id{funcindex}` and `@id{n}` are as in the function `@Lid{lua_getupvalue}`, but `@id{n}` cannot be greater than the number of upvalues.

$$\}$$

```
@APIEntry{
void lua_upvaluejoin (lua_State *L, int funcindex1, int n1,
                      int
                      funcindex2, int n2);|
@api{0,0,-}
```

Make the @id{n1}-th upvalue of the Lua closure at index @id{funcindex1} refer to the @id{n2}-th upvalue of the Lua closure at index @id{funcindex2}.

$$\}$$
$$\}$$

}

@C{-----}  
@sect1{auxlib}@title{The Auxiliary Library}

@simplesect{

@index{lauxlib.h}

The `@def{auxiliary library}` provides several convenient functions to interface C with Lua.

While the basic API provides the primitive functions for all interactions between C and Lua, the auxiliary library provides higher-level functions for some common tasks.

All functions and types from the auxiliary library are defined in header file `@id{lauxlib.h}` and

have a prefix `@id{luaL_}`.

All functions in the auxiliary library are built on top of the basic API, and so they provide nothing that cannot be done with that API. Nevertheless, the use of the auxiliary library ensures more consistency to your code.

Several functions in the auxiliary library use internally some extra stack slots.

When a function in the auxiliary library uses less than five slots, it does not check the stack size; it simply assumes that there are enough slots.

Several functions in the auxiliary library are used to check `@N{C function}` arguments. Because the error message is formatted for arguments (e.g., `@St{bad argument #1}`), you should not use these functions for other stack values.

Functions called `@id{luaL_check*}` always raise an error if the check is not satisfied.

}

`@sect2{@title{Functions and Types}`

Here we list all functions and types from the auxiliary library in alphabetical order.

`@APIEntry{void luaL_addchar (luaL_Buffer *B, char c);|@apii{?,?,m}`

Adds the byte `@id{c}` to the buffer `@id{B}`  
`@seeC{luaL_Buffer}`.

}

`@APIEntry{const void luaL_addgsub (luaL_Buffer *B, const char *s, const char *p, const char *r);|@apii{?,?,m}`

Adds a copy of the string `@id{s}` to the buffer `@id{B}` `@seeC{luaL_Buffer}`,

replacing any  
occurrence of the string @id{p}  
with the string @id{r}.

}

@APIEntry{void luaL\_addlstring (luaL\_Buffer \*B, const char \*s, size\_t l);|  
@apii{?,?,m}

Adds the string pointed to by @id{s} with length @id{l} to  
the buffer @id{B}  
@seeC{luaL\_Buffer}.  
The string can contain @x{embedded zeros}.

}

@APIEntry{void luaL\_addsize (luaL\_Buffer \*B, size\_t n);|  
@apii{?,?,-}

Adds to the buffer @id{B}  
a string of length @id{n} previously copied to the  
buffer area @seeC{luaL\_prepbuffer}.

}

@APIEntry{void luaL\_addstring (luaL\_Buffer \*B, const char \*s);|  
@apii{?,?,m}

Adds the zero-terminated string pointed to by @id{s}  
to the buffer @id{B}  
@seeC{luaL\_Buffer}.

}

@APIEntry{void luaL\_addvalue (luaL\_Buffer \*B);|  
@apii{?,?,m}

Adds the value on the top of the stack  
to the buffer @id{B}  
@seeC{luaL\_Buffer}.  
Pops the value.

This is the only function on string buffers that can (and must)  
be called with an extra element on the stack,  
which is the value to be added to the buffer.

}

```
@APIEntry{
void luaL_argcheck
(lua_State *L,
    int cond,
    int arg,
    const char *extramsg);|
@apii{0,0,v}
```

Checks whether @id{cond} is true.

If it is not, raises an error with a standard message @seeF{luaL\_argerror}.

```
}
```

```
@APIEntry{int luaL_argerror (lua_State *L, int arg, const char *extramsg);|
@apii{0,0,v}
```

Raises an error reporting a problem with argument @id{arg}

of the @N{C function} that called it,

using a standard message

that includes @id{extramsg} as a comment:

```
@verbatim{
bad argument #@rep{arg} to '@rep{funcname}' (@rep{extramsg})
}
```

This function never returns.

```
}
```

```
@APIEntry{
void luaL_argexpected (lua_State *L,
    int cond,
    int arg,
    const char *tname);|
@apii{0,0,v}
```

Checks whether @id{cond} is true.

If it is not, raises an error about the type of the argument @id{arg}

with a standard message @seeF{luaL\_typeerror}.

```
}
```

```
@APIEntry{typedef struct luaL_Buffer luaL_Buffer;|
```

Type for

a @def{string buffer}.

A string buffer allows @N{C code} to build Lua strings piecemeal.

Its pattern of use is as follows:

```
@itemize{
```

@item{First declare a variable @id{b} of type @Lid{luaL\_Buffer}.}

@item{Then initialize it with a call @T{luaL\_buffinit(L, &b)}.

@item{  
Then add string pieces to the buffer calling any of  
the @id{luaL\_add\*} functions.  
}

@item{  
Finish by calling @T{luaL\_pushresult(&b)}.  
This call leaves the final string on the top of the stack.  
}

}

If you know beforehand the maximum size of the resulting string,  
you can use the buffer like this:

@itemize{

@item{First declare a variable @id{b} of type @Lid{luaL\_Buffer}.}

@item{Then initialize it and preallocate a space of  
size @id{sz} with a call @T{luaL\_buffinitsize(L, &b, sz)}.

@item{Then produce the string into that space.}

@item{  
Finish by calling @T{luaL\_pushresultsize(&b, sz)},  
where @id{sz} is the total size of the resulting string  
copied into that space (which may be less than or  
equal to the preallocated  
size).  
}

}

During its normal operation,  
a string buffer uses a variable number of stack slots.  
So, while using a buffer, you cannot assume that you know where  
the top of the stack is.  
You can use the stack between successive calls to buffer operations  
as long as that use is balanced;  
that is,  
when you call a buffer operation,  
the stack is at the same level  
it was immediately after the previous buffer operation.

(The only exception to this rule is @Lid{luaL\_addvalue}.)  
After calling @Lid{luaL\_pushresult},  
the stack is back to its level when the buffer was initialized,  
plus the final string on its top.

}

@APIEntry{char \*luaL\_buffaddr (luaL\_Buffer \*B);|  
@apii{0,0,-}}

Returns the address of the current content of buffer @id{B}  
@seeC{luaL\_Buffer}.  
Note that any addition to the buffer may invalidate this address.

}

@APIEntry{void luaL\_buffinit (lua\_State \*L, luaL\_Buffer \*B);|  
@apii{0,?,-}}

Initializes a buffer @id{B}  
@seeC{luaL\_Buffer}.  
This function does not allocate any space;  
the  
buffer must be declared as a variable.

}

@APIEntry{size\_t luaL\_bufflen (luaL\_Buffer \*B);|  
@apii{0,0,-}}

Returns the length of the current content of buffer @id{B}  
@seeC{luaL\_Buffer}.

}

@APIEntry{char \*luaL\_buffinitsize (lua\_State \*L, luaL\_Buffer \*B, size\_t sz);|  
@apii{?,?,m}}

Equivalent to the sequence  
@Lid{luaL\_buffinit}, @Lid{luaL\_prepbuffsize}.

}

@APIEntry{void luaL\_buffsub (luaL\_Buffer \*B, int n);|  
@apii{?,?,-}}

Removes @id{n} bytes from the buffer @id{B}  
@seeC{luaL\_Buffer}.

The buffer must have at least that many bytes.

```
}
```

```
@APIEntry{int luaL_callmeta (lua_State *L, int obj, const char *e);|  
@apii{0,0|1,e}
```

Calls a metamethod.

If the object at index @id{obj} has a metatable and this metatable has a field @id{e}, this function calls this field passing the object as its only argument. In this case this function returns true and pushes onto the stack the value returned by the call. If there is no metatable or no metamethod, this function returns false without pushing any value on the stack.

```
}
```

```
@APIEntry{void luaL_checkany (lua_State *L, int arg);|  
@apii{0,0,v}
```

Checks whether the function has an argument of any type (including @nil) at position @id{arg}.

```
}
```

```
@APIEntry{lua_Integer luaL_checkinteger (lua_State *L, int arg);|  
@apii{0,0,v}
```

Checks whether the function argument @id{arg} is an integer (or can be converted to an integer) and returns this integer.

```
}
```

```
@APIEntry{const char *luaL_checklstring (lua_State *L, int arg, size_t *l);|  
@apii{0,0,v}
```

Checks whether the function argument @id{arg} is a string and returns this string; if @id{l} is not @id{NULL} fills its referent with the string's length.

This function uses @Lid{lua\_tolstring} to get its result, so all conversions and caveats of that function apply here.

```
}
```

```
@APIEntry{lua_Number luaL_checknumber (lua_State *L, int arg);|
@apii{0,0,v}
```

Checks whether the function argument @id{arg} is a number and returns this number converted to a @id{lua\_Number}.

```
}
```

```
@APIEntry{
int luaL_checkoption (lua_State
*L,
    int arg,
    const char *def,
    const char *const lst[]);|
@apii{0,0,v}
```

Checks whether the function argument @id{arg} is a string and searches for this string in the array @id{lst} (which must be NULL-terminated). Returns the index in the array where the string was found. Raises an error if the argument is not a string or if the string cannot be found.

If @id{def} is not @id{NULL}, the function uses @id{def} as a default value when there is no argument @id{arg} or when this argument is @nil.

This is a useful function for mapping strings to @N{C enums}. (The usual convention in Lua libraries is to use strings instead of numbers to select options.)

```
}
```

```
@APIEntry{void luaL_checkstack (lua_State *L, int sz, const char *msg);|
@apii{0,0,v}
```

Grows the stack size to @T{top + sz} elements, raising an error if the stack cannot grow to that size. @id{msg} is an additional text to go into the error message (or @id{NULL} for no additional text).

```
}
```

```
@APIEntry{const char *luaL_checkstring (lua_State *L, int arg);|
@apii{0,0,v}
```



Checks whether the function argument @id{arg} is a string and returns this string.

This function uses @Lid{lua\_tolstring} to get its result, so all conversions and caveats of that function apply here.

```
}
```

```
@APIEntry{void luaL_checktype (lua_State *L, int arg, int t);|
@apii{0,0,v}
```

Checks whether the function argument @id{arg} has type @id{t}. See @Lid{lua\_type} for the encoding of types for @id{t}.

```
}
```

```
@APIEntry{void *luaL_checkudata (lua_State *L, int arg, const char *tname);|
@apii{0,0,v}
```

Checks whether the function argument @id{arg} is a userdata of the type @id{tname} @seeC{luaL\_newmetatable} and returns the userdata's memory-block address @seeC{lua\_touserdata}.

```
}
```

```
@APIEntry{void luaL_checkversion (lua_State *L);|
@apii{0,0,v}
```

Checks whether the code making the call and the Lua library being called are using the same version of Lua and the same numeric types.

```
}
```

```
@APIEntry{int
luaL_dofile (lua_State *L, const char *filename);|
@apii{0,?,m}
```

Loads and runs the given file.

It is defined as the following macro:

```
@verbatim{
(luaL_loadfile(L, filename) || lua_pcall(L, 0, LUA_MULTRET, 0))
}
```

It @N{returns 0} (@Lid{LUA\_OK}) if there are no errors, or 1 in case of errors.

```
}
```

```
@APIEntry{int luaL_dostring (lua_State *L, const char *str);|
@apii{0,?,-}}
```

Loads and runs the given string.

It is defined as the following macro:

```
@verbatim{
(luaL_loadstring(L, str) || luaL_pcall(L, 0, LUA_MULTRET, 0))
}
```

It @N{returns 0} (@Lid{LUA\_OK}) if there are no errors,  
or 1 in case of errors.

```
}
```

```
@APIEntry{int luaL_error (lua_State *L, const char *fmt, ...);|
@apii{0,0,v}}
```

Raises an error.

The error message format is given by @id{fmt}

plus any extra arguments,

following the same rules of @Lid{lua\_pushfstring}.

It also adds at the beginning of the message the file name and  
the line number where the error occurred,  
if this information is available.

This function never returns,

but it is an

idiom to use it in @N{C functions}

as @T{return luaL\_error(@rep{args})}.

```
}
```

```
@APIEntry{int luaL_execresult (lua_State *L, int stat);|
@apii{0,3,m}}
```

This function produces the return values for  
process-related functions in the standard library  
(@Lid{os.execute} and @Lid{io.close}).

```
}
```

```
@APIEntry{
int luaL_fileresult (lua_State *L, int stat, const char *fname);|
@apii{0,1|3,m}}
```

This function produces the return values for  
file-related functions in the standard library  
(@Lid{io.open}, @Lid{os.rename}, @Lid{file:seek}, etc.).

}

```
@APIEntry{int luaL_getmetafield (lua_State *L, int obj, const char *e);|
@apii{0,0|1,m}
```

Pushes onto the stack the field @id{e} from the metatable of the object at index @id{obj} and returns the type of the pushed value. If the object does not have a metatable, or if the metatable does not have this field, pushes nothing and returns @id{LUA\_TNIL}.

}

```
@APIEntry{int luaL_getmetatable (lua_State *L, const char *tname);|
@apii{0,1,m}
```

Pushes onto the stack the metatable associated with the name @id{tname} in the registry @seeC{luaL\_newmetatable}, or @nil if there is no metatable associated with that name. Returns the type of the pushed value.

}

```
@APIEntry{int luaL_getsubtable (lua_State *L, int idx, const char *fname);|
@apii{0,1,e}
```

Ensures that the value @T{t[fname]}, where @id{t} is the value at index @id{idx}, is a table, and pushes that table onto the stack. Returns true if it finds a previous table there and false if it creates a new table.

}

```
@APIEntry{
const char *luaL_gsub (lua_State *L,
    const char *s,
    const char *p,
    const char *r);|
@apii{0,1,m}
```

Creates a copy of string @id{s}, replacing any occurrence of the string @id{p} with the string @id{r}. Pushes the resulting string on the stack and returns it.

```
}
```

```
@APIEntry{lua_Integer luaL_len (lua_State *L, int index);|
@apii{0,0,e}
```

Returns the @Q{length} of the value at the given index  
as a number;

it is equivalent to the

@Char{#} operator in Lua @see{len-op}.

Raises an error if the result of the operation is not an integer.

(This case can only happen through metamethods.)

```
}
```

```
@APIEntry{
int luaL_loadbuffer (lua_State *L,
    const char *buff,
    size_t sz,
    const char *name);|
@apii{0,1,-}
```

Equivalent to @Lid{luaL\_loadbufferx} with @id{mode} equal to @id{NULL}.

```
}
```

```
@APIEntry{
int luaL_loadbufferx (lua_State *L,
    const char *buff,
    size_t sz,
    const char *name,
    const char *mode);|
@apii{0,1,-}
```

Loads a buffer as a Lua chunk.

This function uses @Lid{lua\_load} to load the chunk in the  
buffer pointed to by @id{buff} with size @id{sz}.

This function returns the same results as @Lid{lua\_load}.

@id{name} is the chunk name,

used for debug information and error messages.

The string @id{mode} works as in the function @Lid{lua\_load}.

```
}
```

```
@APIEntry{int luaL_loadfile (lua_State
```

```
*L, const char *filename);|
@apii{0,1,m}
```

Equivalent to @Lid{luaL\_loadfilex} with @id{mode} equal to @id{NULL}.

```
}
```

```
@APIEntry{int luaL_loadfilex (lua_State *L, const char *filename,
                                const char *mode);|
@apii{0,1,m}
```

Loads a file as a Lua chunk.

This function uses @Lid{lua\_load} to load the chunk in the file named @id{filename}.

If @id{filename} is @id{NULL},

then it loads from the standard input.

The first line in the file is ignored if it starts with a @T{#}.

The string @id{mode} works as in the function @Lid{lua\_load}.

This function returns the same results as @Lid{lua\_load} or @Lid{LUA\_ERRFILE} for file-related errors.

As @Lid{lua\_load}, this function only loads the chunk; it does not run it.

```
}
```

```
@APIEntry{int luaL_loadstring (lua_State *L, const char *s);|
@apii{0,1,-}
```

Loads a string as a Lua chunk.

This function uses @Lid{lua\_load} to load the chunk in the zero-terminated string @id{s}.

This function returns the same results as @Lid{lua\_load}.

Also as @Lid{lua\_load}, this function only loads the chunk; it does not run it.

```
}
```

```
@APIEntry{void luaL_newlib (lua_State *L, const luaL_Reg l[]);|
@apii{0,1,m}
```

Creates a new table and registers there

the functions in the list @id{1}.

It is implemented as the following macro:

```
@verbatim{
(luaL_newlibtable(L,l), luaL_setfuncs(L,l,0))
}
```

The array @id{1} must be the actual array,  
not a pointer to it.

```
}
```

```
@APIEntry{void luaL_newlibtable (lua_State *L, const luaL_Reg l[]);|
@apii{0,1,m}
```

Creates a new table with a size optimized  
to store all entries in the array @id{1}  
(but does not actually store them).

It is intended to be used in conjunction with @Lid{luaL\_setfuncs}  
@seeF{luaL\_newlib}.

It is implemented as a macro.

The array @id{1} must be the actual array,  
not a pointer to it.

```
}
```

```
@APIEntry{int luaL_newmetatable (lua_State *L, const char *tname);|
@apii{0,1,m}
```

If the registry already has the key @id{tname},  
returns 0.

Otherwise,

creates a new table to be used as a

metatable for userdata,

adds to this new table the pair @T{\_\_name = tname},

adds to the registry the pair @T{[tname] = new table},

and returns 1.

In both cases,

the function pushes onto the stack the final value associated  
with @id{tname} in the registry.

```
}
```

```
@APIEntry{lua_State *luaL_newstate (void);|
@apii{0,0,-}
```

Creates a new Lua state.

It calls `@Lid{lua_newstate}` with an allocator based on the `@N{ISO C}` allocation functions and then sets a warning function and a panic function `@see{C-error}` that print messages to the standard error output.

Returns the new state,  
or `@id{NULL}` if there is a `@x{memory allocation error}`.

}

```
@APIEntry{void luaL_openlibs (lua_State *L);|
@apii{0,0,e}
```

Opens all standard Lua libraries into the given state.

}

```
@APIEntry{
T luaL_opt (L, func, arg, dflt);|
@apii{0,0,-}
```

This macro is defined as follows:

```
@verbatim{
(lua_isnoneornil(L,(arg)) ? (dflt) : func(L,(arg)))
}
```

In words, if the argument `@id{arg}` is nil or absent,  
the macro results in the default

`@id{dflt}`.

Otherwise, it results in the result of calling `@id{func}`  
with the state `@id{L}` and the argument index `@id{arg}` as  
arguments.

Note that it evaluates the expression `@id{dflt}` only if needed.

}

```
@APIEntry{
lua_Integer luaL_optinteger (lua_State *L,
                           int arg,
                           lua_Integer d);|
@apii{0,0,v}
```

If the function argument `@id{arg}` is an integer  
(or it is convertible to an integer),  
returns this integer.

If this argument is absent or is `@nil`,  
returns `@id{d}`.

Otherwise, raises an error.

```
}
```

```
@APIEntry{  
const char *luaL_optlstring (lua_State *L,  
                             int arg,  
                             const char *d,  
                             size_t *l);|  
@apii{0,0,v}
```

If the function argument @id{arg} is a string,  
returns this string.

If this argument is absent or is @nil,  
returns @id{d}.

Otherwise, raises an error.

If @id{l} is not @id{NULL},  
fills its referent with the result's length.

If the result is @id{NULL}

(only

possible when returning @id{d} and @T{d == NULL}),  
its length is considered zero.

This function uses @Lid{lua\_tolstring} to get its result,  
so all conversions and caveats of that function apply here.

```
}
```

```
@APIEntry{lua_Number luaL_optnumber (lua_State *L, int arg, lua_Number d);|  
@apii{0,0,v}
```

If the function argument @id{arg} is a number,  
returns this number as a @id{lua\_Number}.

If this argument is absent or is @nil,  
returns @id{d}.

Otherwise, raises an error.

```
}
```

```
@APIEntry{  
const char *luaL_optstring (lua_State *L,  
                             int arg,  
                             const char *d);|  
@apii{0,0,v}
```

If the function argument @id{arg} is a string,  
returns this string.

If this argument is absent or is @nil,  
returns @id{d}.



Otherwise, raises an error.

}

@APIEntry{char \*luaL\_prepbuffer (luaL\_Buffer \*B);|  
@apii{?,?,m}}

Equivalent to @Lid{luaL\_prepbuffsize}  
with the predefined size @defid{LUAL\_BUFFERSIZE}.

}

@APIEntry{char \*luaL\_prepbuffsize (luaL\_Buffer \*B, size\_t sz);|  
@apii{?,?,m}}

Returns

an address to a space of size @id{sz}  
where you can copy a string to be added to buffer @id{B}  
@seeC{luaL\_Buffer}.  
After copying the string into this space you must call  
@Lid{luaL\_addsize} with the size of the string to actually add  
it to the buffer.

}

@APIEntry{void luaL\_pushfail (lua\_State \*L);|  
@apii{0,1,-}}

Pushes the @fail value onto the stack @see{libraries}.

}

@APIEntry{void luaL\_pushresult (luaL\_Buffer \*B);|  
@apii{?,1,m}}

Finishes the use of buffer @id{B} leaving the final string on  
the top of the stack.

}

@APIEntry{void luaL\_pushresultsize (luaL\_Buffer \*B, size\_t sz);|  
@apii{?,1,m}}

Equivalent to the sequence @Lid{luaL\_addsize}, @Lid{luaL\_pushresult}.

}

@APIEntry{int luaL\_ref (lua\_State \*L, int t);|

@apii{1,0,m}

Creates and returns a @def{reference},  
in the table at index @id{t},  
for the object on the top of the stack (and pops the object).

A reference is a unique integer key.

As long as you do not manually add integer keys into the table @id{t},

@Lid{luaL\_ref}

ensures the uniqueness of the key it returns.

You can retrieve an object referred by the reference @id{r}

by calling @T{lua\_rawgeti(L, t, r)}.

The function @Lid{luaL\_unref} frees a reference.

If the object on the top of the stack is @nil,

@Lid{luaL\_ref} returns the constant @defid{LUA\_REFNIL}.

The constant @defid{LUA\_NOREF} is guaranteed to be different  
from any reference returned by @Lid{luaL\_ref}.

}

@APIEntry{

typedef struct luaL\_Reg {

const char \*name;

lua\_CFunction func;

} luaL\_Reg;

|

Type for arrays of functions to be registered by

@Lid{luaL\_setfuncs}.

@id{name} is the function name and @id{func} is a pointer to  
the function.

Any array of @Lid{luaL\_Reg} must end with a sentinel entry  
in which both @id{name} and @id{func} are @id{NULL}.

}

@APIEntry{

void luaL\_requiref (lua\_State \*L, const char \*modname,

lua\_CFunction openf, int glb);|

@apii{0,1,e}

If @T{package.loaded[modname]} is not true,

calls the function @id{openf} with the string @id{modname}  
as an argument

and sets the call result to @T{package.loaded[modname]},  
as if that function has been called through @Lid{require}.

If @id{glb} is true,  
also stores the module into the global @id{modname}.

Leaves a copy of the module on the stack.

}

```
@APIEntry{void luaL_setfuncs (lua_State *L, const luaL_Reg *l, int nup);|
@apii{nup,0,m}
```

Registers all functions in the array @id{l}  
@seeC{luaL\_Reg} into the table on the top of the stack  
(below optional upvalues, see next).

When @id{nup} is not zero,  
all functions are created with @id{nup} upvalues,  
initialized with copies of the @id{nup} values  
previously pushed on the stack  
on top of the library table.  
These values are popped from the stack after the registration.

A function with a @id{NULL} value represents a placeholder,  
which is filled with @false.

}

```
@APIEntry{void luaL_setmetatable (lua_State *L, const char *tname);|
@apii{0,0,-}
```

Sets the metatable of the object on the top of the stack  
as the metatable associated  
with name @id{tname}  
in the registry @seeC{luaL\_newmetatable}.

}

```
@APIEntry{
typedef struct luaL_Stream {
    FILE *f;
    lua_CFunction closef;
} luaL_Stream;
|
```

The standard representation for @x{file handles}  
used by the standard I/O library.

A file handle is implemented as a full userdata,  
with a metatable called @id{LUA\_FILEHANDLE}

(where @id{LUA\_FILEHANDLE} is a macro with the actual metatable's name).

The metatable is created by the I/O library

@seeF{luaL\_newmetatable}.

This userdata must start with the structure @id{luaL\_Stream};

it can contain other data after this initial structure.

The field @id{f} points to the corresponding C stream

(or it can be @id{NULL} to indicate an incompletely created handle).

The field @id{closef} points to a Lua function

that will be called to close the stream

when the handle is closed or collected;

this function receives the file handle as its sole argument and

must return either a true value, in case of success,

or a false value plus an error message,

in case of error.

Once Lua calls this field,

it changes the field value to @id{NULL}

to signal that the handle is closed.

}

@APIEntry{void \*luaL\_testudata (lua\_State \*L, int arg, const char \*tname);|

@apii{0,0,m}

This function works like @Lid{luaL\_checkudata},

except that, when the test fails,

it returns @id{NULL} instead of raising an error.

}

@APIEntry{const char \*luaL\_tolstring (lua\_State \*L, int idx, size\_t \*len);|

@apii{0,1,e}

Converts any Lua value at the given index to a @N{C string}

in a reasonable format.

The resulting string is pushed onto the stack and also

returned by the function @see{constchar}.

If @id{len} is not @id{NULL},

the function also sets @T{\*len} with the string length.

If the value has a metatable with a @idx{\_\_tostring} field,

then @id{luaL\_tolstring} calls the corresponding metamethod

with the value as argument,

and uses the result of the call as its result.

}

@APIEntry{

```
void luaL_traceback (lua_State *L, lua_State *L1, const char *msg,
```

```
    int level);|
```

```
@apii{0,1,m}
```

Creates and pushes a traceback of the stack @id{L1}.

If @id{msg} is not @id{NULL}, it is appended

at the beginning of the traceback.

The @id{level} parameter tells at which level

to start the traceback.

```
}
```

```
@APIEntry{int luaL_typeerror (lua_State *L, int arg, const char *tname);|
```

```
@apii{0,0,v}
```

Raises a type error for the argument @id{arg}

of the @N{C function} that called it,

using a standard message;

@id{tname} is a @Q{name} for the expected type.

This function never returns.

```
}
```

```
@APIEntry{const char *luaL_typename (lua_State *L, int index);|
```

```
@apii{0,0,-}
```

Returns the name of the type of the value at the given index.

```
}
```

```
@APIEntry{void luaL_unref (lua_State *L, int t, int ref);|
```

```
@apii{0,0,-}
```

Releases the reference @id{ref} from the table at index @id{t}

@seeC{luaL\_ref}.

The entry is removed from the table,

so that the referred object can be collected.

The reference @id{ref} is also freed to be used again.

If @id{ref} is @Lid{LUA\_NOREF} or @Lid{LUA\_REFNIL},

@Lid{luaL\_unref}

does nothing.

```
}
```

```
@APIEntry{void luaL_where (lua_State *L, int lvl);|
```

```
@apii{0,1,m}
```

Pushes onto the stack a string identifying the current position of the control at level @id{lvl} in the call stack.

Typically this string has the following format:

```
@verbatim{
@rep{chunkname}:@rep{currentline}:
}
@N{Level 0} is the running function,
@N{level 1} is the function that called the running function,
etc.
```

This function is used to build a prefix for error messages.

```
}
```

```
}
```

```
}
```

```
@C{-----}
@sect1{libraries| @title{The Standard Libraries}
```

```
@simplesect{
```

The standard Lua libraries provide useful functions that are implemented @N{in C} through the @N{C API}. Some of these functions provide essential services to the language (e.g., @Lid{type} and @Lid{getmetatable}); others provide access to outside services (e.g., I/O); and others could be implemented in Lua itself, but that for different reasons deserve an implementation in C (e.g., @Lid{table.sort}).

All libraries are implemented through the official @N{C API} and are provided as separate @N{C modules}.

Unless otherwise noted, these library functions do not adjust its number of arguments to its expected parameters.

For instance, a function documented as @T{foo(arg)} should not be called without an argument.

The notation @fail means a false value representing some kind of failure.

(Currently, @fail is equal to @nil, but that may change in future versions.

The recommendation is to always test the success of these functions

with `@T{(not status)}`, instead of `@T{(status == nil)}`.)

Currently, Lua has the following standard libraries:

`@itemize{`

`@item{@link{predefined|basic library};}`

`@item{@link{corolib|coroutine library};}`

`@item{@link{packlib|package library};}`

`@item{@link{strlib|string manipulation};}`

`@item{@link{utf8|basic UTF-8 support};}`

`@item{@link{tablib|table manipulation};}`

`@item{@link{mathlib|mathematical functions}`  
`(sin, log, etc.);}`

`@item{@link{iolib|input and output};}`

`@item{@link{oslib|operating system facilities};}`

`@item{@link{debuglib|debug facilities}.}`

`}`

Except for the basic and the package libraries,  
each library provides all its functions as fields of a global table  
or as methods of its objects.

To have access to these libraries,  
the `@N{C host}` program should call the `@Lid{luaL_openlibs}` function,  
which opens all standard libraries.

Alternatively,

the host program can open them individually by using

`@Lid{luaL_requiref}` to call

`@defid{luaopen_base}` (for the basic library),

`@defid{luaopen_package}` (for the package library),

`@defid{luaopen_coroutine}` (for the coroutine library),

`@defid{luaopen_string}` (for the string library),

`@defid{luaopen_utf8}` (for the UTF-8 library),

`@defid{luaopen_table}` (for the table library),

`@defid{luaopen_math}` (for the mathematical library),

`@defid{luaopen_io}` (for the I/O library),

`@defid{luaopen_os}` (for the operating system library),

and `@defid{luaopen_debug}`

(for the debug library).

These functions are declared in @defid{lualib.h}.

}

@sect2{predefined| @title{Basic Functions}}

The basic library provides core functions to Lua.

If you do not include this library in your application,  
you should check carefully whether you need to provide  
implementations for some of its facilities.

@LibEntry{assert (v [, message])|

Raises an error if

the value of its argument @id{v} is false (i.e., @nil or @false);  
otherwise, returns all its arguments.

In case of error,

@id{message} is the error object;

when absent, it defaults to @St{assertion failed!}

}

@LibEntry{collectgarbage ([opt [, arg]])|

This function is a generic interface to the garbage collector.

It performs different functions according to its first argument, @id{opt}:  
@description{

@item{@St{collect}|

Performs a full garbage-collection cycle.

This is the default option.

}

@item{@St{stop}|

Stops automatic execution of the garbage collector.

The collector will run only when explicitly  
invoked,

until a call to restart it.

}

@item{@St{restart}|

Restarts automatic execution of the garbage collector.

}

@item{@St{count}|



Returns the total memory in use by Lua in Kbytes.  
The value has a fractional part,  
so that it multiplied by 1024  
gives the exact number of bytes in use by Lua.  
}

@item{@St{step}|  
Performs a garbage-collection step.  
The step @Q{size} is controlled by @id{arg}.  
With a zero value,  
the collector will perform one basic (indivisible) step.  
For non-zero values,  
the collector will perform as if that amount of memory  
(in Kbytes) had been allocated by Lua.  
Returns @true if the step finished a collection cycle.  
}

@item{@St{isrunning}|  
Returns a boolean that tells whether the collector is running  
(i.e., not stopped).  
}

@item{@St{incremental}|  
Change the collector mode to incremental.  
This option can be followed by three numbers:  
the garbage-collector pause,  
the step multiplier,  
and the step size @see{incmode}.  
A zero means to not change that value.  
}

@item{@St{generational}|  
Change  
the collector mode to generational.  
This option can be followed by two numbers:  
the garbage-collector minor multiplier  
and the major multiplier @see{genmode}.  
A zero means to not change that value.  
}

}  
See @See{GC} for more details about garbage collection  
and some of these options.

This function should not be called by a finalizer.

}

@LibEntry{dofile ([filename])|

Opens the named file and executes its content as a Lua chunk.

When called without arguments,

@id{dofile} executes the content of the standard input (@id{stdin}).

Returns all values returned by the chunk.

In case of errors, @id{dofile} propagates the error to its caller.

(That is, @id{dofile} does not run in protected mode.)

}

@LibEntry{error (message [, level])|

Raises an error @see{error} with @id{message} as the error object.

This function never returns.

Usually, @id{error} adds some information about the error position at the beginning of the message, if the message is a string.

The @id{level}

argument specifies how to get the error position.

With @N{level 1} (the default), the error position is where the

@id{error} function was called.

@N{Level 2} points the error to where the function

that called @id{error} was called; and so on.

Passing a @N{level 0} avoids the addition of error position information to the message.

}

@LibEntry{\_G|

A global variable (not a function) that

holds the @x{global environment} @see{globalenv}.

Lua itself does not use this variable;

changing its value does not affect any environment,

nor vice versa.

}

@LibEntry{getmetatable (object)|

If @id{object} does not have a metatable, returns @nil.

Otherwise,

if the object's metatable has a @idx{\_\_metatable} field,

returns the associated value.

Otherwise, returns the metatable of the given object.

}

@LibEntry{ipairs (t)|

Returns three values (an iterator function, the table `@id{t}`, and 0)

so that the construction

```
@verbatim{
for i,v in ipairs(t) do @rep{body} end
}
will iterate over the key@En{ }value
pairs
(@T{1,t[1]}), (@T{2,t[2]}), @ldots,
up to the first absent index.

}
```

`@LibEntry{load (chunk [, chunkname [, mode [, env]]])}`

Loads a chunk.

If `@id{chunk}` is a string, the chunk is this string.

If `@id{chunk}` is a function,

`@id{load}` calls it repeatedly to get the chunk pieces.

Each call to `@id{chunk}` must return a string that concatenates with previous results.

A return of an empty string, `@nil`, or no value signals the end of the chunk.

If there are no syntactic errors,

`@id{load}` returns the compiled chunk as a function;

otherwise, it returns `@fail` plus the error message.

When you load a main chunk,

the resulting function will always have exactly one upvalue,

the `@id{_ENV}` variable `@see{globalenv}`.

However,

when you load a binary chunk created from a function `@seeF{string.dump}`,

the resulting function can have an arbitrary number of upvalues,

and there is no guarantee that its first upvalue will be

the `@id{_ENV}` variable.

(A non-main function may not even have an `@id{_ENV}` upvalue.)

Regardless, if the resulting function has any upvalues,

its first upvalue is set to the value of `@id{env}`,

if that parameter is given,

or to the value of the `@x{global environment}`.

Other upvalues are initialized with `@nil`.

All upvalues are fresh, that is,

they are not shared with any other function.

`@id{chunkname}` is used as the name of the chunk for error messages

and debug information `@see{debugI}`.

When absent,

it defaults to `@id{chunk}`, if `@id{chunk}` is a string,

or to `@St{=(load)}` otherwise.

The string `@id{mode}` controls whether the chunk can be text or binary (that is, a precompiled chunk).

It may be the string `@St{b}` (only `@x{binary chunk}s`),

`@St{t}` (only text chunks),

or `@St{bt}` (both binary and text).

The default is `@St{bt}`.

It is safe to load malformed binary chunks;

`@id{load}` signals an appropriate error.

However,

Lua does not check the consistency of the code inside binary chunks; running maliciously crafted bytecode can crash the interpreter.

}

`@LibEntry{loadfile  
([filename [, mode [, env]])}`

Similar to `@Lid{load}`,

but gets the chunk from file `@id{filename}`

or from the standard input,

if no file name is given.

}

`@LibEntry{next (table [, index])}`

Allows a program to traverse all fields of a table.

Its first argument is a table and its second argument is an index in this table.

A call to `@id{next}` returns the next index of the table and its associated value.

When called with `@nil` as its second argument,

`@id{next}` returns an initial index and its associated value.

When called with the last index,

or with `@nil` in an empty table,

`@id{next}` returns `@nil`.

If the second argument is absent, then it is interpreted as `@nil`.

In particular,

you can use `@T{next(t)}` to check whether a table is empty.

The order in which the indices are enumerated is not specified,

@emph{even for numeric indices}.  
(To traverse a table in numerical order,  
use a numerical @Rw{for}.)

You should not assign any value to a non-existent field in a table  
during its traversal.

You

may however modify existing fields.

In particular, you may set existing fields to nil.

}

@LibEntry{pairs (t)|

If @id{t} has a metamethod @idx{\_\_pairs},  
calls it with @id{t} as argument and returns the first three  
results from the call.

Otherwise,

returns three values: the @Lid{next} function, the table @id{t}, and @nil,  
so that the construction

@verbatim{

for k,v in pairs(t) do @rep{body} end

}

will iterate over all key@En{ }value pairs of table @id{t}.

See function @Lid{next} for the caveats of modifying  
the table during its traversal.

}

@LibEntry{pcall (f [, arg1, @Cdots])|

Calls the function @id{f} with

the given arguments in @emphx{protected mode}.

This means that any error @N{inside @T{f}} is not propagated;  
instead, @id{pcall} catches the error  
and returns a status code.

Its first result is the status code (a boolean),

which is @true if the call succeeds without errors.

In such case, @id{pcall} also returns all results from the call,  
after this first result.

In

case of any error, @id{pcall} returns @false plus the error object.

Note that errors caught by @id{pcall} do not call a message handler.

}

@LibEntry{print (@Cdots)|

Receives any number of arguments  
and prints their values to @id{stdout},  
converting each argument to a string  
following the same rules of @Lid{tostring}.

The function @id{print} is not intended for formatted output,  
but only as a quick way to show a value,  
for instance for debugging.  
For complete control over the output,  
use @Lid{string.format} and @Lid{io.write}.

}

@LibEntry{rawequal (v1, v2)|

Checks whether @id{v1} is equal to @id{v2},  
without invoking the @idx{\_\_eq} metamethod.  
Returns a boolean.

}

@LibEntry{rawget (table, index)|

Gets the real value of @T{table[index]},  
without using the @idx{\_\_index} metavalue.  
@id{table} must be a table;  
@id{index} may be any value.

}

@LibEntry{rawlen (v)|

Returns the length of the object @id{v},  
which must be a table or a string,  
without invoking the @idx{\_\_len} metamethod.  
Returns  
an integer.

}

@LibEntry{rawset (table, index, value)|

Sets the real value of @T{table[index]} to @id{value},  
without using the @idx{\_\_newindex} metavalue.  
@id{table} must be a table,  
@id{index} any value different from @nil and @x{NaN},  
and @id{value} any Lua value.

This function returns @id{table}.

}

@LibEntry{select (index, @Cdots)|

If @id{index} is a number,  
returns all arguments after argument number @id{index};  
a negative number indexes from the end (@num{-1} is the last argument).  
Otherwise, @id{index} must be the string @T{"#"},  
and @id{select} returns the total number of extra arguments it received.

}

@LibEntry{setmetatable (table, metatable)|

Sets the metatable for the given table.  
If @id{metatable} is @nil,  
removes the metatable of the given table.  
If the original metatable has a @idx{\_\_metatable} field,  
raises an error.

This function returns @id{table}.

To change the metatable of other types from Lua code,  
you must use the @link{debuglib|debug library}.

}

@LibEntry{tonumber  
(e [, base])|

When called with no @id{base},  
@id{tonumber} tries to convert its argument to a number.  
If the argument is already a number or  
a string convertible to a number,  
then @id{tonumber} returns this number;  
otherwise, it returns @fail.

The conversion of strings can result in integers or floats,  
according to the lexical conventions of Lua @see{lexical}.  
The string may have leading and trailing spaces and a sign.

When called with @id{base},  
then @id{e} must be a string to be interpreted as  
an integer numeral in that base.  
The base may be any integer between 2 and 36, inclusive.  
In bases @N{above 10}, the letter @Char{A} (in either upper or lower case)  
@N{represents 10}, @Char{B} @N{represents 11}, and so forth,  
with @Char{Z} representing 35.  
If the string @id{e} is not a valid numeral in the given base,

the function returns @fail.

}

@LibEntry{tostring (v)|

Receives a value of any type and  
converts it to a string in a human-readable format.

If the metatable  
of @id{v} has a @idx{\_\_tostring} field,  
then @id{tostring} calls the corresponding value  
with @id{v} as argument,  
and uses the result of the call as its result.  
Otherwise, if the metatable of @id{v} has a @idx{\_\_name} field  
with a string value,  
@id{tostring} may use that string in its final result.

For complete control of how numbers are converted,  
use @Lid{string.format}.

}

@LibEntry{type (v)|

Returns the type of its only argument, coded as a string.  
The possible results of this function are  
@St{nil} (a string, not the value @nil),  
@St{number},  
@St{string},  
@St{boolean},  
@St{table},  
@St{function},  
@St{thread},  
and @St{userdata}.

}

@LibEntry{\_VERSION|

A global variable (not a function) that  
holds a string containing the running Lua version.  
The current value of this variable is @St{Lua 5.4}.

}

@LibEntry{warn (msg1, @Cdots)|



Emits a warning with a message composed by the concatenation of all its arguments (which should be strings).

By convention,  
a one-piece message starting  
with `@Char{@At}`  
is intended to be a `@emph{control message}`,  
which is a message to the warning system itself.  
In particular, the standard warning function in Lua  
recognizes the control messages `@St{@At}{off}`,  
to stop the emission of warnings,  
and `@St{@At}{on}`, to (re)start the emission;  
it ignores unknown control messages.

}

`@LibEntry{xpcall (f, msgh [, arg1, @Cdots])|`

This function is similar to `@Lid{pcall}`,  
except that it sets a new `@x{message handler}` `@id{msgh}`.

}

}

`@sect2{corolib| @title{Coroutine Manipulation}`

This library comprises the operations to manipulate coroutines,  
which come inside the table `@defid{coroutine}`.  
See `@See{coroutine}` for a general description of coroutines.

`@LibEntry{coroutine.close (co)|`

Closes coroutine `@id{co}`,  
that is,  
closes all its pending to-be-closed variables  
and puts the coroutine in a dead state.  
The given coroutine must be dead or suspended.  
In case of error  
(either the original error that stopped the coroutine or  
errors in closing  
methods),  
returns `@false` plus the error object;  
otherwise returns `@true`.

}

@LibEntry{coroutine.create (f)|

Creates a new coroutine, with body @id{f}.

@id{f} must be a function.

Returns this new coroutine,  
an object with type @T{"thread"}.

}

@LibEntry{coroutine.isyieldable ([co])|

Returns @true when the coroutine @id{co} can yield.

The default for @id{co} is the running coroutine.

A coroutine is yieldable if it is not the main thread and  
it is not inside a non-yieldable @N{C function}.

}

@LibEntry{coroutine.resume (co [, val1, @Cdots])|

Starts or continues the execution of coroutine @id{co}.

The first time you resume a coroutine,  
it starts running its body.

The values @id{val1}, @ldots are passed  
as the arguments to the body function.

If the coroutine has yielded,

@id{resume} restarts it;

the values @id{val1}, @ldots are passed  
as the results from the yield.

If the coroutine runs without any errors,

@id{resume} returns @true plus any values passed to @id{yield}

(when the coroutine

yields) or any values returned by the body function

(when the coroutine terminates).

If there is any error,

@id{resume} returns @false plus the error message.

}

@LibEntry{coroutine.running ()|

Returns the running coroutine plus a boolean,

@true when the running coroutine is the main one.

}

@LibEntry{coroutine.status (co)|

Returns the status of the coroutine @id{co}, as a string:

@T{"running"},

if the coroutine is running

(that is, it is the one that called @id{status});

@T{"suspended"}, if the coroutine is suspended in a call to @id{yield},

or if it has not started running yet;

@T{"normal"} if the coroutine is active but not running

(that is, it has resumed another coroutine);

and @T{"dead"} if the coroutine has finished its body function,

or if it has stopped with an error.

}

@LibEntry{coroutine.wrap (f)|

Creates a new coroutine, with body @id{f};

@id{f} must be a function.

Returns a function that resumes the coroutine each time it is called.

Any arguments passed to this

function behave as the

extra arguments to @id{resume}.

The function returns the same values returned by @id{resume},

except the first boolean.

In case of error,

the function closes the coroutine and propagates the error.

}

@LibEntry{coroutine.yield (@Cdots)|

Suspends the execution of the calling coroutine.

Any arguments to @id{yield} are passed as extra results to @id{resume}.

}

}

@sect2{packlib| @title{Modules}}

The package library provides basic

facilities for loading modules in Lua.

It exports one function directly in the global environment:

@Lid{require}.

Everything else is exported in the table @defid{package}.

@LibEntry{require (modname)}

Loads the given module.

The function starts by looking into the @Lid{package.loaded} table to determine whether @id{modname} is already loaded.

If it is, then @id{require} returns the value stored at @T{package.loaded[modname]}.

(The absence of a second result in this case signals that this call did not have to load the module.)

Otherwise,

it tries to find a @emph{loader} for the module.

To find a loader,

@id{require} is guided by the table @Lid{package.searchers}.

Each item in this table is a search function, that searches for the module in a particular way.

By changing this table,

we can change how @id{require} looks for a module.

The following explanation is based on the default configuration for @Lid{package.searchers}.

First @id{require} queries @T{package.preload[modname]}.

If it has a value,

this value (which must be a function) is the loader.

Otherwise @id{require} searches for a Lua loader using the path stored in @Lid{package.path}.

If that also fails, it searches for a @N{C loader} using the path stored in @Lid{package.cpath}.

If that also fails,

it tries an @emph{all-in-one} loader @seeF{package.searchers}.

Once a loader is found,

@id{require} calls the loader with two arguments:

@id{modname} and an extra value,

a @emph{loader data},

also returned by the searcher.

The loader data can be any value useful to the module;

for the default searchers,

it indicates where the loader was found.

(For instance, if the loader came from a file, this extra value is the file path.)

If the loader returns any non-nil value,

@id{require} assigns the returned value to @T{package.loaded[modname]}.

If the loader does not return a non-nil value and

has not assigned any value to @T{package.loaded[modname]},

then @id{require} assigns @true to this entry.

In any case, @id{require} returns the

final value of `@T{package.loaded[modname]}`.  
Besides that value, `@id{require}` also returns as a second result  
the loader data returned by the searcher,  
which indicates how `@id{require}` found the module.

If there is any error loading or running the module,  
or if it cannot find any loader for the module,  
then `@id{require}` raises an error.

}

`@LibEntry{package.config|`

A string describing some compile-time configurations for packages.  
This string is a sequence of lines:

`@itemize{`

`@item{The first line is the @x{directory  
separator} string.`

Default is `@Char{\}` for `@x{Windows}` and `@Char{/}` for all other systems.}

`@item{The second line is the character that separates templates in a path.  
Default is @Char{;}.}`

`@item{The third line is the string that marks the  
substitution points in a template.  
Default is @Char{?}.}`

`@item{The fourth line is a string that, in a path in @x{Windows},  
is replaced by the executable's directory.  
Default is @Char{!}.}`

`@item{The fifth line is a mark to ignore all text after it  
when building the @id{luaopen_} function name.  
Default is @Char{-}.}`

}

}

`@LibEntry{package.cpath|`

A string with the path used by `@Lid{require}`  
to search for a `@N{C loader}`.

Lua initializes the `@N{C path}` `@Lid{package.cpath}` in the same way  
it initializes the Lua path `@Lid{package.path}`,  
using the environment variable `@defid{LUA_CPATH_5_4}`,

or the environment variable @defid{LUA\_CPATH},  
or a default path defined in @id{luaconf.h}.

}

@LibEntry{package.loaded|

A table used by @Lid{require} to control  
which  
modules are already loaded.

When you require a module @id{modname} and  
@T{package.loaded[modname]} is not false,  
@Lid{require} simply returns the value stored there.

This variable is only a reference to the real table;  
assignments to this variable do not change the  
table used by @Lid{require}.  
The real table is stored in the C registry @see{registry},  
indexed by the key @defid{LUA\_LOADED\_TABLE}, a string.

}

@LibEntry{package.loadlib (libname, funcname)|

Dynamically links the host program with the @N{C library} @id{libname}.

If @id{funcname} is @St{\*},  
then it only links with the library,  
making the symbols exported by the library  
available to other dynamically linked libraries.  
Otherwise,  
it looks for a function @id{funcname} inside the library  
and returns this function as a @N{C function}.  
So, @id{funcname} must follow the @Lid{lua\_CFunction} prototype  
@seeC{lua\_CFunction}.

This is a low-level function.  
It completely bypasses the package and module system.  
Unlike @Lid{require},  
it  
does not perform any path searching and  
does not automatically adds extensions.  
@id{libname} must be the complete file name of the @N{C library},  
including if necessary a path and an extension.  
@id{funcname} must be the exact name exported by the @N{C library}  
(which may depend on the @N{C compiler} and linker used).

This functionality is not supported by @N{ISO C}.

As such, it is only available on some platforms  
(Windows, Linux, Mac OS X, Solaris, BSD,  
plus other Unix systems that support the `@id{dlfcn}` standard).

This function is inherently insecure,  
as it allows Lua to call any function in any readable dynamic  
library in the system.

(Lua calls any function assuming the function  
has a proper prototype and respects a proper protocol  
`@see{lua_CFunction}`).

Therefore,  
calling an arbitrary function in an arbitrary dynamic library  
more often than not results in an access violation.)

}

`@LibEntry{package.path|`

A string with the path used by `@Lid{require}`  
to search for a Lua  
loader.

At start-up, Lua initializes this variable with  
the value of the environment variable `@defid{LUA_PATH_5_4}` or  
the environment variable `@defid{LUA_PATH}` or  
with a default path defined in `@id{luaconf.h}`,  
if those environment variables are not defined.  
A `@St{;;}` in the value of the environment variable  
is replaced by the default path.

}

`@LibEntry{package.preload|`

A table to store loaders for specific modules  
`@seeF{require}`.

This variable is only a reference to the real table;  
assignments to this variable do not change the  
table used by `@Lid{require}`.

The real table is stored in the C registry `@see{registry}`,  
indexed by the key `@defid{LUA_PRELOAD_TABLE}`, a string.

}

`@LibEntry{package.searchers|`

A table used by `@Lid{require}` to control how to find modules.

Each entry in this table is a `@def{searcher function}`.  
When looking for a module,  
`@Lid{require}` calls each of these searchers in ascending order,  
with the module name (the argument given to `@Lid{require}`) as its  
sole argument.

If  
the searcher finds the module,  
it returns another function, the module `@def{loader}`,  
plus an extra value, a `@emph{loader data}`,  
that will be passed to that loader and  
returned as a second result by `@Lid{require}`.  
If it cannot find the module,  
it returns a string explaining why  
(or `@nil` if it has nothing to say).

Lua initializes this table with four searcher functions.

The first searcher simply looks for a loader in the  
`@Lid{package.preload}` table.

The second searcher looks for a loader as a Lua library,  
using the path stored at `@Lid{package.path}`.  
The search is done as described in function `@Lid{package.searchpath}`.

The third searcher looks for a loader as a `@N{C library}`,  
using the path given by the variable `@Lid{package.cpath}`.  
Again,  
the search is done as described in function `@Lid{package.searchpath}`.

For instance,  
if the `@N{C path}` is the string  
`@verbatim{  
"./?.so;./?.dll;/usr/local/?/init.so"  
}`  
the searcher for module `@id{foo}`  
will try to open the files `@T{./foo.so}`,  
`@T{./foo.dll}`,  
and `@T{/usr/local/foo/init.so}`, in that order.

Once it finds a `@N{C library}`,  
this searcher first uses a dynamic link facility to link the  
application with the library.  
Then it tries to find a `@N{C function}` inside the library to  
be used as the loader.

The name of this `@N{C function}` is the string `@St{luaopen_}`  
concatenated with a copy of the module name where each dot  
is replaced by an underscore.

Moreover, if the module name has a hyphen,  
its suffix after (and including) the first hyphen is removed.



For instance, if the module name is `@id{a.b.c-v2.1}`,  
the function name will be `@id{luaopen_a_b_c}`.

The fourth searcher tries an `@def{all-in-one loader}`.  
It searches the `@N{C path}` for a library for  
the root name of the given module.

For instance, when requiring `@id{a.b.c}`,  
it will search for a `@N{C library}` for `@id{a}`.

If found, it looks into it for an open function for  
the submodule;

in our example, that would be `@id{luaopen_a_b_c}`.

With this facility, a package can pack  
several `@N{C submodules}`

into one single library,  
with each submodule keeping its original open function.

All searchers except the first one (preload) return as the extra value  
the file path where the module was found,  
as returned by `@Lid{package.searchpath}`.

The first searcher always returns the string `@St{:preload:}`.

Searchers should raise no errors and have no side effects in Lua.  
(They may have side effects in C,  
for instance by linking the application with a library.)

}

`@LibEntry{package.searchpath (name, path [, sep [, rep]])|`

Searches for the given `@id{name}` in the given `@id{path}`.

A path is a string containing a sequence of  
`@emph{templates}` separated by semicolons.

For each template,  
the function replaces each interrogation mark (if any)  
in the template with a copy of `@id{name}`  
wherein all occurrences of `@id{sep}`  
(a dot, by default)  
were replaced by `@id{rep}`  
(the system's directory separator, by default),  
and then tries to open the resulting file name.

For instance, if  
the path is the string  
`@verbatim{  
"./?.lua;./?.lc;/usr/local/?/init.lua"  
}`  
the search for the name `@id{foo.a}`

will try to open the files  
@T{./foo/a.lua}, @T{./foo/a.lc}, and  
@T{/usr/local/foo/a/init.lua}, in that order.

Returns the resulting name of the first file that it can  
open in read mode (after closing the file),  
or @fail plus an error message if none succeeds.  
(This error message lists all file names it tried to open.)

}

}

@sect2{strlib| @title{String Manipulation}

@simplesect{

This library provides generic functions for string manipulation,  
such as finding and extracting substrings, and pattern matching.  
When indexing a string in Lua, the first character is at @N{position 1}  
(not @N{at 0}, as in C).  
Indices are allowed to be negative and are interpreted as indexing backwards,  
from the end of the string.  
Thus, the last character is at position @num{-1}, and so on.

The string library provides all its functions inside the table  
@defid{string}.  
It also sets a @x{metatable for  
strings}  
where the @idx{\_\_index} field points to the @id{string} table.  
Therefore, you can use the string functions in object-oriented style.  
For instance, @T{string.byte(s,i)}  
can be written as @T{s:byte(i)}.

The string library assumes one-byte character encodings.

@LibEntry{string.byte (s [, i [, j]])|  
Returns the internal numeric codes of the characters @T{s[i]},  
@T{s[i+1]}, @ldots, @T{s[j]}.  
The default value for @id{i} @N{is 1};  
the default value for @id{j} @N{is @id{i}}.  
These indices are corrected  
following the same rules of function @Lid{string.sub}.

Numeric codes are not necessarily portable across platforms.

}

@LibEntry{string.char (@Cdots)|

Receives zero or more integers.

Returns a string with length equal to the number of arguments,  
in which each character has the internal numeric code equal  
to its corresponding argument.

Numeric codes are not necessarily portable across platforms.

}

@LibEntry{string.dump (function [, strip])|

Returns a string containing a binary  
representation

(a *@emph{binary chunk}*)

of the given function,

so that a later @Lid{load} on this string returns

a copy of the function (but with new upvalues).

If @id{strip} is a true value,

the binary representation may not include all debug information  
about the function,

to save space.

Functions with upvalues have only their number of upvalues saved.

When (re)loaded,

those upvalues receive fresh instances.

(See the @Lid{load} function for details about

how these upvalues are initialized.

You can use the debug library to serialize

and reload the upvalues of a function

in a way adequate to your needs.)

}

@LibEntry{string.find (s, pattern [, init [, plain]])|

Looks for the first match of

@id{pattern} @see{pm} in the string @id{s}.

If it finds a match, then @id{find} returns the indices @N{of @T{s}}

where this occurrence starts and ends;

otherwise, it returns @fail.

A third, optional numeric argument @id{init} specifies

where to start the search;

its default value @N{is 1} and can

be negative.

A @true as a fourth, optional argument @id{plain}

turns off the pattern matching facilities,

so the function does a plain `@Q{find substring}` operation,  
with no characters in `@id{pattern}` being considered magic.

If the pattern has captures,  
then in a successful match  
the captured values are also returned,  
after the two indices.

}

`@LibEntry{string.format (formatstring, @Cdots)}`

Returns a formatted version of its variable number of arguments  
following the description given in its first argument,  
which must be a string.

The format string follows the same rules as the `@ANSI{sprintf}`.

The only differences are that the conversion specifiers and modifiers  
`@id{F}`, `@id{n}`, `@T{*}`, `@id{h}`, `@id{L}`, and `@id{l}` are not supported  
and that there is an extra specifier, `@id{q}`.

Both width and precision, when present,  
are limited to two digits.

The specifier `@id{q}` formats booleans, nil, numbers, and strings  
in a way that the result is a valid constant in Lua source code.

Booleans and nil

are written in the obvious way

(`@id{true}`, `@id{false}`, `@id{nil}`).

Floats are written in hexadecimal,  
to preserve full precision.

A string is written between double quotes,  
using escape sequences when necessary to ensure that  
it can safely be read back by the Lua interpreter.

For instance, the call

```
@verbatim{
string.format("%q", 'a string with "quotes" and \n new line')
}
```

may produce the string:

```
@verbatim{
"a string with \"quotes\" and \
new line"
}
```

This specifier does not support modifiers (flags, width, precision).

The conversion specifiers

`@id{A}`, `@id{a}`, `@id{E}`, `@id{e}`, `@id{f}`,  
`@id{G}`, and `@id{g}` all expect a number as argument.

The specifiers `@id{c}`, `@id{d}`,

`@id{i}`, `@id{o}`, `@id{u}`, `@id{X}`, and `@id{x}`

expect an integer.

When Lua is compiled with a C89 compiler,  
the specifiers `@id{A}` and `@id{a}` (hexadecimal floats)  
do not support modifiers.

The specifier `@id{s}` expects a string;

if its argument is not a string,

it is converted to one following the same rules of `@Lid{tostring}`.

If

the specifier has any modifier,

the corresponding string argument should not contain `@x{embedded zeros}`.

The specifier `@id{p}` formats the pointer

returned by `@Lid{lua_topointer}`.

That gives a unique string identifier for tables, userdata,  
threads, strings, and functions.

For other values (numbers, nil, booleans),  
this specifier results in a string representing  
the pointer `@id{NULL}`.

}

`@LibEntry{string.gmatch (s, pattern [, init])}`

Returns an iterator function that,

each time it is called,

returns the next captures from `@id{pattern}` `@see{pm}`  
over the string `@id{s}`.

If `@id{pattern}` specifies no captures,

then the whole match is produced in each call.

A third, optional numeric argument `@id{init}` specifies  
where to start the search;

its default value `@N{is 1}` and can be negative.

As an example, the following loop

will iterate over all the words from string `@id{s}`,

printing one per line:

```
@verbatim{
s = "hello world from Lua"
for w in string.gmatch(s, "%a+") do
  print(w)
end
}
```

The next

example collects all pairs `@T{key=value}` from the  
given string into a table:

```
@verbatim{
t = {}
s = "from=world, to=Lua"
```

```

for k, v in string.gmatch(s, "(%w+)=(%w+)") do
    t[k] = v
end
}

```

For this function, a caret `@Char{^}` at the start of a pattern does not work as an anchor, as this would prevent the iteration.

```

}

```

`@LibEntry{string.gsub (s, pattern, repl [, n])}`

Returns a copy of `@id{s}`

in which all (or the first `@id{n}`, if given)

occurrences of the `@id{pattern}` `@see{pm}` have been

replaced by a replacement string specified by `@id{repl}`,

which can be a string, a table, or a function.

`@id{gsub}` also returns, as its second value,

the total number of matches that occurred.

The name `@id{gsub}` comes from `@emph{Global SUBstitution}`.

If `@id{repl}` is a string, then its value is used for replacement.

The `@N{character @T{%%}}` works as an escape character:

any sequence in `@id{repl}` of the form `@T{%%@rep{d}}`,

with `@rep{d}` between 1 and 9,

stands for the value of the `@rep{d}`-th captured substring;

the

sequence `@T{%0}` stands for the whole match;

the sequence `@T{%%}` stands for a `@N{single @T{%%}}`.

If `@id{repl}` is a table, then the table is queried for every match, using the first capture as the key.

If `@id{repl}` is a function, then this function is called every time a match occurs, with all captured substrings passed as arguments, in order.

In any case,

if the pattern specifies no captures,

then it behaves as if the whole pattern was inside a capture.

If the value returned by the table query or by the function call is a string or a number,

then it is used as the replacement string;

otherwise, if it is `@Rw{false}` or `@nil`,

then there is no replacement

(that is, the original match is kept in the string).

Here are some examples:

```

@verbatim{
x = string.gsub("hello world", "(%w+)", "%1 %1")
--> x="hello hello world world"

x = string.gsub("hello world", "%w+", "%0 %0", 1)
--> x="hello hello world"

x = string.gsub("hello world from Lua", "(%w+)%s*(%w+)", "%2 %1")
--> x="world hello Lua
from"

x = string.gsub("home = $HOME, user = $USER", "%$(%w+)", os.getenv)
--> x="home = /home/roberto, user = roberto"

x = string.gsub("4+5 = $return 4+5$", "%$(.)%$", function (s)
    return load(s)()
end)
--> x="4+5 = 9"

local t = {name="lua", version="5.4"}
x = string.gsub("$name-$version.tar.gz", "%$(%w+)", t)
--> x="lua-5.4.tar.gz"
}
}

```

@LibEntry{string.len (s)|

Receives a string and returns its length.  
The empty string @T{""} has length 0.  
Embedded zeros are counted,  
so @T{"a\000bc\000"} has length 5.

}

@LibEntry{string.lower (s)|

Receives a string and returns a copy of this string with all  
uppercase letters changed to lowercase.  
All other characters are left unchanged.  
The definition of what an uppercase letter is depends on the current locale.

}

@LibEntry{string.match (s, pattern [, init])|

Looks for the first @emph{match} of  
the @id{pattern} @see{pm} in the string @id{s}.

If it finds one, then `@id{match}` returns the captures from the pattern; otherwise it returns `@fail`.  
 If `@id{pattern}` specifies no captures, then the whole match is returned.  
 A third, optional numeric argument `@id{init}` specifies where to start the search; its default value `@N{is 1}` and can be negative.

}

`@LibEntry{string.pack (fmt, v1, v2, @Cdots)|`

Returns a binary string containing the values `@id{v1}`, `@id{v2}`, etc. serialized in binary form (packed) according to the format string `@id{fmt}` `@see{pack}`.

}

`@LibEntry{string.packsize (fmt)|`

Returns the length of a string resulting from `@Lid{string.pack}` with the given format.  
 The format string cannot have the variable-length options `@Char{s}` or `@Char{z}` `@see{pack}`.

}

`@LibEntry{string.rep (s, n [, sep])|`

Returns a string that is the concatenation of `@id{n}` copies of the string `@id{s}` separated by the string `@id{sep}`.  
 The default value for `@id{sep}` is the empty string (that is, no separator).  
 Returns the empty string if `@id{n}` is not positive.

(Note that it is very easy to exhaust the memory of your machine with a single call to this function.)

}

`@LibEntry{string.reverse (s)|`

Returns a string that is the string `@id{s}` reversed.

}



@LibEntry{string.sub (s, i [, j])|

Returns the substring of @id{s} that starts at @id{i} and continues until @id{j};  
@id{i} and @id{j} can be negative.  
If @id{j} is absent, then it is assumed to be equal to @num{-1} (which is the same as the string length).  
In particular,  
the call @T{string.sub(s,1,j)} returns a prefix of @id{s} with length @id{j},  
and @T{string.sub(s, -i)} (for a positive @id{i}) returns a suffix of @id{s} with length @id{i}.

If, after the translation of negative indices,  
@id{i} is less than 1,  
it is corrected to 1.  
If @id{j} is greater than the string length,  
it is corrected to that length.  
If, after these corrections,  
@id{i} is greater than @id{j},  
the function returns the empty string.

}

@LibEntry{string.unpack (fmt, s [, pos])|

Returns the values packed in string @id{s} @seeF{string.pack} according to the format string @id{fmt} @see{pack}.  
An  
optional @id{pos} marks where  
to start reading in @id{s} (default is 1).  
After the read values,  
this function also returns the index of the first unread byte in @id{s}.

}

@LibEntry{string.upper (s)|

Receives a string and returns a copy of this string with all lowercase letters changed to uppercase.  
All other characters are left unchanged.  
The definition of what a lowercase letter is depends on the current locale.

}

}

@sect3{pm| @title{Patterns}

@simplesect{

Patterns in Lua are described by regular strings,  
which are interpreted as patterns by the pattern-matching functions

@Lid{string.find},

@Lid{string.gmatch},

@Lid{string.gsub},

and @Lid{string.match}.

This section describes the syntax and the meaning  
(that is, what they match) of these strings.

}

@sect4{@title{Character Class:}}

A @def{character class} is used to represent a set of characters.

The following combinations are allowed in describing a character class:

@description{

@item{@rep{x}|

(where @rep{x} is not one

of the @emphx{magic characters}

@T{^\$()%.[]\*+-.?})

represents the character @emph{x} itself.

}

@item{@T{.}| (a dot) represents all characters.}

@item{@T{%a}| represents all letters.}

@item{@T{%c}| represents all control characters.}

@item{@T{%d}| represents all digits.}

@item{@T{%g}| represents all printable characters except space.}

@item{@T{%l}| represents all lowercase letters.}

@item{@T{%p}| represents all punctuation characters.}

@item{@T{%s}| represents all space characters.}

@item{@T{%u}| represents all uppercase letters.}

@item{@T{%w}| represents all alphanumeric characters.}

@item{@T{%x}| represents all hexadecimal digits.}

@item{@T{%@rep{x}}| (where @rep{x} is any non-alphanumeric character)  
represents the character @rep{x}.

This is the standard way to escape the magic characters.

Any non-alphanumeric character

(including all punctuation characters, even the non-magical)

can be preceded by a @Char{%} to represent itself in a pattern.

}

@item{@T{[@rep{set}]|

represents

the class which is the union of all

characters in @rep{set}.

A range of characters can be specified by

separating the end characters of the range,

in ascending order, with a @Char{-}.

All classes @T{%}@emph{x} described above can also be used as  
components in @rep{set}.

All other characters in @rep{set} represent themselves.

For example, @T{[%w\_]} (or @T{[\_%w]})

represents all alphanumeric characters plus the underscore,

@T{[0-7]} represents the octal digits,

and @T{[0-7%l%-]} represents the octal digits plus  
the lowercase letters plus the @Char{-} character.

You can put a closing square bracket in a set

by positioning it as the first character in the set.

You can put a hyphen in a set

by positioning it as the first or the last character in the set.

(You can also use an escape for both cases.)

The interaction between ranges and classes is not defined.

Therefore, patterns like @T{[%a-z]} or @T{[a-%%]}

have no meaning.

}

@item{@T{^[@rep{set}]|

represents the complement of @rep{set},

where

@rep{set} is interpreted as above.

}

}

For all classes represented by single letters (@T{%a}, @T{%c}, etc.),

the corresponding uppercase letter represents the complement of the class.

For instance, @T{%S} represents all non-space characters.

The definitions of letter, space, and other character groups depend on the current locale.

In particular, the class `@T{[a-z]}` may not be equivalent to `@T{%l}`.

}

@sect4{@title{Pattern Item:}

A `@def{pattern item}` can be

`@itemize{`

`@item{`

a single character class,

which matches any single character in the class;

}

`@item{`

a single character class followed by `@Char{*}`,

which matches sequences of zero or more characters in the class.

These repetition items will always match the longest possible sequence;

}

`@item{`

a single character class followed by `@Char{+}`,

which matches sequences of one or more characters in the class.

These repetition items will always match the longest possible sequence;

}

`@item{`

a single character class followed

by `@Char{-}`,

which also matches sequences of zero or more characters in the class.

Unlike `@Char{*}`,

these repetition items will always match the shortest possible sequence;

}

`@item{`

a single character class followed by `@Char{?}`,

which matches zero or one occurrence of a character in the class.

It always matches one occurrence if possible;

}

`@item{`

`@T{%@rep{n}}`, for `@rep{n}` between 1 and 9;

such item matches a substring equal to the `@rep{n}`-th captured string (see below);

}

```
@item{
@T{%b@rep{xy}}, where @rep{x} and @rep{y} are two distinct characters;
such item matches strings that start @N{with @rep{x}}, end @N{with @rep{y}},
and where the @rep{x} and @rep{y} are @emph{balanced}.
This means that, if one reads the string from left to right,
counting @M{+1} for an @rep{x} and @M{-1} for a @rep{y},
the ending @rep{y} is the first @rep{y} where the count reaches 0.
For instance, the item @T{%b()} matches expressions with
balanced parentheses.
}
```

```
@item{
@T{%f[@rep{set}]}, a @def{frontier
pattern};
such item matches an empty string at any position such that
the next character belongs to @rep{set}
and the previous character does not belong to @rep{set}.
The set @rep{set} is interpreted as previously described.
The beginning and the end of the subject are handled as if
they were the character @Char{\0}.
}

}

}
```

```
@sect4{@title{Pattern:}
A @def{pattern} is a sequence of pattern items.
A caret @Char{^} at the beginning of a pattern anchors the match at the
beginning of the subject string.
A @Char{$} at the end of a pattern anchors the match at the
end of the subject string.
At other positions,
@Char{^} and @Char{$} have no special meaning and represent themselves.
}
```

```
@sect4{@title{Captures:}
A pattern can contain sub-patterns enclosed in parentheses;
they describe @def{captures}.
When a match succeeds, the substrings of the subject string
that match captures are stored (@emph{captured}) for future use.
Captures are numbered according to their left parentheses.
For instance,
in the pattern @T{"a*(.)%w(%s*)"},
the part of the string matching @T{"a*(.)%w(%s*)"} is
stored as the first capture, and therefore has @N{number 1};
the character matching @St{.} is captured with @N{number 2},
```

and the part matching `@St{%s*}` has `@N{number 3}`.

As a special case, the capture `@T{()}` captures the current string position (a number).

For instance, if we apply the pattern `@T{"()aa()}"` on the string `@T{"flaaap"}`, there will be two captures: `@N{3 and 5}`.

}

`@sect4{@title{Multiple matches:}`

The function `@Lid{string.gsub}` and the iterator `@Lid{string.gmatch}` match multiple occurrences of the given pattern in the subject.

For these functions,

a new match is considered valid only

if it ends at least one byte after the end of the previous match.

In other words, the pattern machine never accepts the empty string as a match immediately after another match.

As an example,

consider the results of the following code:

`@verbatim{`

`> string.gsub("abc", "()a*()", print);`

`--> 1 2`

`--> 3`

`3`

`--> 4 4`

`}`

The second and third results come from Lua matching an empty string after `@Char{b}` and another one after `@Char{c}`.

Lua does not match an empty string after `@Char{a}`, because it would end at the same position of the previous match.

}

}

`@sect3{pack| @title{Format Strings for Pack and Unpack}`

The first argument to `@Lid{string.pack}`,

`@Lid{string.packsize}`, and `@Lid{string.unpack}`

is a format string,

which describes the layout of the structure being created or read.

A format string is a sequence of conversion options.

The conversion options are as follows:

`@description{`

`@item{@T{<}|sets little endian}`

`@item{@T{>}|sets big endian}`

`@item{@T{=}|sets native endian}`

`@item{@T{![@rep{n}]}|sets maximum alignment to @id{n}`  
`(default is native alignment)}`  
`@item{@T{b}|a signed byte (@id{char})}`  
`@item{@T{B}|an unsigned byte (@id{char})}`  
`@item{@T{h}|a signed @id{short} (native size)}`  
`@item{@T{H}|an unsigned @id{short} (native size)}`  
`@item{@T{l}|a signed @id{long} (native size)}`  
`@item{@T{L}|an`  
`unsigned @id{long} (native size)}`  
`@item{@T{j}|a @id{lua_Integer}}`  
`@item{@T{J}|a @id{lua_Unsigned}}`  
`@item{@T{T}|a @id{size_t} (native size)}`  
`@item{@T{i[@rep{n}]}|a signed @id{int} with @id{n} bytes`  
`(default is native size)}`  
`@item{@T{I[@rep{n}]}|an unsigned @id{int} with @id{n} bytes`  
`(default is native size)}`  
`@item{@T{f}|a @id{float} (native size)}`  
`@item{@T{d}|a @id{double} (native size)}`  
`@item{@T{n}|a @id{lua_Number}}`  
`@item{@T{c@rep{n}}|a fixed-sized string with @id{n} bytes}`  
`@item{@T{z}|a zero-terminated string}`  
`@item{@T{s[@emph{n}]}|a string preceded by its length`  
`coded as an unsigned integer with @id{n} bytes`  
`(default is a @id{size_t})}`  
`@item{@T{x}|one byte of padding}`  
`@item{@T{X@rep{op}}|an empty item that aligns`  
`according to option @id{op}`  
`(which is otherwise ignored)}`  
`@item{@Char{ }|(space) ignored}`  
`}`

(A `@St{![@rep{n}]}` means an optional integral numeral.)

Except for padding, spaces, and configurations

(options `@St{XX <=>!}`),

each option corresponds to an argument in `@Lid{string.pack}`

or

a result in `@Lid{string.unpack}`.

For options `@St{![@rep{n}]}`, `@St{s@rep{n}]}`, `@St{i@rep{n}]}`, and `@St{I@rep{n}]}`,

`@id{n}` can be any integer between 1 and 16.

All integral options check overflows;

`@Lid{string.pack}` checks whether the given value fits in the given size;

`@Lid{string.unpack}` checks whether the read value fits in a Lua integer.

For the unsigned options,

Lua integers are treated as unsigned values too.

Any format string starts as if prefixed by `@St{!1=}`,

that is,

with maximum alignment of 1 (no alignment)

and native endianness.

Native endianness assumes that the whole system is either big or little endian.

The packing functions will not emulate correctly the behavior of mixed-endian formats.

Alignment works as follows:

For each option,

the format gets extra padding until the data starts at an offset that is a multiple of the minimum between the option size and the maximum alignment; this minimum must be a power of 2.

Options `@St{c}` and `@St{z}` are not aligned; option

`@St{s}` follows the alignment of its starting integer.

All padding is filled with zeros by `@Lid{string.pack}` and ignored by `@Lid{string.unpack}`.

}

}

`@sect2{utf8| @title{UTF-8 Support}`

This library provides basic support for `@x{UTF-8}` encoding.

It provides all its functions inside the table `@defid{utf8}`.

This library does not provide any support for `@x{Unicode}` other than the handling of the encoding.

Any operation that needs the meaning of a character, such as character classification, is outside its scope.

Unless stated otherwise,

all functions that expect a byte position as a parameter assume that the given position is either the start of a byte sequence or one plus the length of the subject string.

As in the string library,

negative indices count from the end of the string.

Functions that create byte sequences

accept all values up to `@T{0x7FFFFFFF}`,

as defined in the original UTF-8 specification;

that implies byte sequences of up to six bytes.

Functions that interpret



byte sequences only accept valid sequences (well formed and not overlong).  
By default, they only accept byte sequences that result in valid Unicode code points, rejecting values greater than @T{10FFFF} and surrogates.  
A boolean argument @id{lax}, when available, lifts these checks, so that all values up to @T{0x7FFFFFFF} are accepted.  
(Not well formed and overlong sequences are still rejected.)

```
@LibEntry{utf8.char (@Cdots)|
```

Receives zero or more integers, converts each one to its corresponding UTF-8 byte sequence and returns a string with the concatenation of all these sequences.

```
}
```

```
@LibEntry{utf8.charpattern|
```

The pattern (a string, not a function) @St{[\0-\x7F\xC2-\xFD][\x80-\xBF]\*} @see{pm}, which matches exactly one UTF-8 byte sequence, assuming that the subject is a valid UTF-8 string.

```
}
```

```
@LibEntry{utf8.codes (s [, lax])|
```

Returns values so that the construction  
@verbatim{  
for p, c in utf8.codes(s) do @rep{body} end  
}  
will iterate over all UTF-8 characters in string @id{s},  
with  
@id{p} being the position (in bytes) and @id{c} the code point  
of each character.  
It raises an error if it meets any invalid byte sequence.

```
}
```

```
@LibEntry{utf8.codepoint (s [, i [, j [, lax]]])|
```

Returns the code points (as integers) from all characters in @id{s} that start between byte position @id{i} and @id{j} (both included).  
The default for @id{i} is 1 and for @id{j} is @id{i}.  
It raises an error if it meets any invalid byte sequence.

}

@LibEntry{utf8.len (s [, i [, j [, lax]])]|

Returns the number of UTF-8 characters in string @id{s} that start between positions @id{i} and @id{j} (both inclusive). The default for @id{i} is @num{1} and for @id{j} is @num{-1}. If it finds any invalid byte sequence, returns @fail plus the position of the first invalid byte.

}

@LibEntry{utf8.offset (s, n [, i)]|

Returns the position (in bytes) where the encoding of the @id{n}-th character of @id{s} (counting from position @id{i}) starts. A negative @id{n} gets characters before position @id{i}. The default for @id{i} is 1 when @id{n} is non-negative and @T{#s + 1} otherwise, so that @T{utf8.offset(s, -n)} gets the offset of the @id{n}-th character from the end of the string. If the specified character is neither in the subject nor right after its end, the function returns @fail.

As a special case, when @id{n} is 0 the function returns the start of the encoding of the character that contains the @id{i}-th byte of @id{s}.

This function assumes that @id{s} is a valid UTF-8 string.

}

}

@sect2{tablib| @title{Table Manipulation}}

This library provides generic functions for table manipulation. It provides all its functions inside the table @defid{table}.

Remember that, whenever an operation needs the length of a table, all caveats about the length operator apply @see{len-op}. All functions ignore non-numeric keys in the tables given as arguments.

@LibEntry{table.concat (list [, sep [, i [, j]])]}

Given a list where all elements are strings or numbers,  
returns the string

@T{list[i]..sep..list[i+1] @Cdots sep..list[j]}.

The default value for @id{sep} is the empty string,

the default for @id{i} is 1,

and the default for @id{j} is @T{#list}.

If @id{i} is greater than @id{j}, returns the empty string.

}

@LibEntry{table.insert (list, [pos,] value)}

Inserts element @id{value} at position @id{pos} in @id{list},  
shifting up the elements

@T{list[pos], list[pos+1], @Cdots, list[#list]}.

The default value for @id{pos} is @T{#list+1},

so that a call @T{table.insert(t,x)} inserts @id{x} at the end  
of the list @id{t}.

}

@LibEntry{table.move (a1, f, e, t [,a2])}

Moves elements from the table @id{a1} to the table @id{a2},  
performing the equivalent to the following  
multiple assignment:

@T{a2[t],@Cdots = a1[f],@Cdots,a1[e]}.

The default for @id{a2} is @id{a1}.

The destination range can overlap with the source range.

The number of elements to be moved must fit in a Lua integer.

Returns the destination table @id{a2}.

}

@LibEntry{table.pack (@Cdots)}

Returns

a new table with all arguments stored into keys 1, 2, etc.

and with a field @T{n} with the total number of arguments.

Note that the resulting table may not be a sequence,

if some arguments are @nil.

}

@LibEntry{table.remove (list [, pos])|

Removes from @id{list} the element at position @id{pos},  
returning the value of the removed element.

When @id{pos} is an integer between 1 and @T{#list},  
it shifts down the elements

@T{list[pos+1], list[pos+2], @Cdots, list[#list]}

and erases element @T{list[#list]};

The index @id{pos} can also be 0 when @T{#list} is 0,  
or @T{#list + 1}.

The default value for @id{pos} is @T{#list},  
so that a call @T{table.remove(l)} removes the last element  
of the list @id{l}.

}

@LibEntry{table.sort (list [, comp])|

Sorts the list elements in a given order, @emph{in-place},  
from @T{list[1]} to @T{list[#list]}.

If @id{comp} is given,

then it must be a function that receives two list elements  
and returns true when the first element must come  
before the second in

the final order,

so that, after the sort,

@T{i <= j} implies @T{not comp(list[j],list[i])}.

If @id{comp} is not given,

then the standard Lua operator @T{<} is used instead.

The @id{comp} function must define a consistent order;  
more formally, the function must define a strict weak order.  
(A weak order is similar to a total order,  
but it can equate different elements for comparison purposes.)

The sort algorithm is not stable:

Different elements considered equal by the given order  
may have their relative positions changed by the sort.

}

@LibEntry{table.unpack (list [, i [, j]])|

Returns the elements from the given list.

This function is equivalent to

@verbatim{

return list[i], list[i+1], @Cdots, list[j]

}

By default, `@id{i}` `@N{is 1}` and `@id{j}` is `@T{#list}`.

}

}

`@sect2{mathlib| @title{Mathematical Functions}}`

This library provides basic mathematical functions.

It provides all its functions and constants inside the table `@defid{math}`.

Functions with the annotation `@St{integer/float}`

give

integer results for integer arguments

and float results for non-integer arguments.

The rounding functions

`@Lid{math.ceil}`, `@Lid{math.floor}`, and `@Lid{math.modf}`

return an integer when the result fits in the range of an integer,

or a float otherwise.

`@LibEntry{math.abs (x)|`

Returns the maximum value between `@id{x}` and `@id{-x}`. (integer/float)

}

`@LibEntry{math.acos (x)|`

Returns the arc cosine of `@id{x}` (in radians).

}

`@LibEntry{math.asin (x)|`

Returns the arc sine of `@id{x}` (in radians).

}

`@LibEntry{math.atan (y [, x])|`

`@index{atan}` `@index{atan2}`

Returns the arc tangent of `@T{y/x}` (in radians),

using the signs of both arguments to find the

quadrant of the result.

It also handles correctly the case of `@id{x}` being zero.

The default value for `@id{x}` is 1,

so that the call `@T{math.atan(y)}`

returns the arc tangent of @id{y}.

}

@LibEntry{math.ceil (x)|

Returns the smallest integral value greater than or equal to @id{x}.

}

@LibEntry{math.cos (x)|

Returns the cosine of  
@id{x} (assumed to be in radians).

}

@LibEntry{math.deg (x)|

Converts the angle @id{x} from radians to degrees.

}

@LibEntry{math.exp (x)|

Returns the value @M{e@sp{x}}  
(where @id{e} is the base of natural logarithms).

}

@LibEntry{math.floor (x)|

Returns the largest integral value less than or equal to @id{x}.

}

@LibEntry{math.fmod (x, y)|

Returns the remainder of the division of @id{x} by @id{y}  
that rounds the quotient towards zero. (integer/float)

}

@LibEntry{math.huge|

The float value @idx{HUGE\_VAL},  
a value greater than any other numeric value.

}

@LibEntry{math.log (x [, base])|

Returns the logarithm of @id{x} in the given base.  
The default for @id{base} is @M{e}  
(so that the function returns the natural logarithm of @id{x}).

}

@LibEntry{math.max (x, @Cdots)|

Returns the argument with the maximum value,  
according to the Lua operator @T{<}.

}

@LibEntry{math.maxinteger|

An integer with the maximum value for an integer.

}

@LibEntry{math.min (x, @Cdots)|

Returns  
the argument with the minimum value,  
according to the Lua operator @T{<}.

}

@LibEntry{math.mininteger|

An integer with the minimum value for an integer.

}

@LibEntry{math.modf (x)|

Returns the integral part of @id{x} and the fractional part of @id{x}.  
Its second result is always a float.

}

@LibEntry{math.pi|

The value of @M{@pi}.

}

@LibEntry{math.rad (x)|

Converts the angle @id{x} from degrees to radians.

}

@LibEntry{math.random ([m [, n]])|

When called without arguments,  
returns a pseudo-random float with uniform distribution  
in the range @C{() @M{[0,1)}. @C{}}

When called with two integers @id{m} and @id{n},  
@id{math.random} returns a pseudo-random integer  
with uniform distribution in the range @M{[m, n]}.

The call @T{math.random(n)}, for a positive @id{n},  
is equivalent to @T{math.random(1,n)}.

The call @T{math.random(0)} produces an integer with  
all bits (pseudo)random.

This function uses the @idx{xoshiro256\*\*} algorithm to produce  
pseudo-random 64-bit integers,  
which

are the results of calls with @N{argument 0}.

Other results (ranges and floats)  
are unbiased extracted from these integers.

Lua initializes its pseudo-random generator with the equivalent of  
a call to @Lid{math.randomseed} with no arguments,  
so that @id{math.random} should generate  
different sequences of results each time the program runs.

}

@LibEntry{math.randomseed ([x [, y]])|

When called with at least one argument,  
the integer parameters @id{x} and @id{y} are  
joined into a 128-bit @emph{x}{seed} that  
is used to reinitialize the pseudo-random generator;  
equal seeds produce equal sequences of numbers.  
The default for @id{y} is zero.

When called with no arguments,  
Lua generates a seed with  
a weak attempt for randomness.

This function returns the two seed components  
that were effectively used,



so that setting them again repeats the sequence.

To ensure a required level of randomness to the initial state  
(or contrarily, to have a deterministic sequence,  
for instance when debugging  
a program),  
you should call `@LibEntry{math.randomseed}` with explicit arguments.

}

`@LibEntry{math.sin (x)|`

Returns the sine of `@id{x}` (assumed to be in radians).

}

`@LibEntry{math.sqrt (x)|`

Returns the square root of `@id{x}`.  
(You can also use the expression `@T{x^0.5}` to compute this value.)

}

`@LibEntry{math.tan (x)|`

Returns the tangent of `@id{x}` (assumed to be in radians).

}

`@LibEntry{math.tointeger (x)|`

If the value `@id{x}` is convertible to an integer,  
returns that integer.  
Otherwise, returns `@fail`.

}

`@LibEntry{math.type (x)|`

Returns `@St{integer}` if `@id{x}` is an integer,  
`@St{float}` if it is a float,  
or `@fail` if `@id{x}` is not a number.

}

`@LibEntry{math.ult (m, n)|`

Returns a boolean,

@true if and only if integer @id{m} is below integer @id{n} when they are compared as @x{unsigned integers}.

}

}

@sect2{iolib| @title{Input and Output Facilities}

The I/O library provides two different styles for file manipulation.

The first one uses implicit file handles;

that is, there

are operations to set a default input file and a

default output file,

and all input/output operations are done over these default files.

The second style uses explicit file handles.

When using implicit file handles,

all operations are supplied by table @defid{io}.

When using explicit file handles,

the operation @Lid{io.open} returns a file handle

and then all operations are supplied as methods of the file handle.

The metatable for file handles provides metamethods

for @idx{\_\_gc} and @idx{\_\_close} that try

to close the file when called.

The table @id{io} also provides

three predefined file handles with their usual meanings from C:

@defid{io.stdin}, @defid{io.stdout}, and @defid{io.stderr}.

The I/O library never closes these files.

Unless otherwise stated,

all I/O functions return @fail on failure,

plus an error message as a second result and

a system-dependent error code as a third result,

and some non-false value on success.

On non-POSIX systems,

the computation of the error message

and error code

in case of errors

may be not @x{thread safe},

because they rely on the global C variable @id{errno}.

@LibEntry{io.close ([file])|

Equivalent to @T{file:close()}.

Without a @id{file}, closes the default output file.

```
}
```

```
@LibEntry{io.flush ()|
```

Equivalent to `@T{io.output():flush()}.flush()`.

```
}
```

```
@LibEntry{io.input ([file])|
```

When called with a file name, it opens the named file (in text mode), and sets its handle as the default input file.

When called with a file handle,

it simply sets this file handle as the default input file.

When called without arguments,

it returns the current default input file.

In case of errors this function raises the error,  
instead of returning an error code.

```
}
```

```
@LibEntry{io.lines ([filename, @Cdots])|
```

Opens the given file name in read mode  
and returns an iterator function that  
works like `@T{file:lines(@Cdots)}` over the opened file.

When the iterator function fails to read any value,  
it automatically closes the file.

Besides the iterator function,

```
@id{io.lines}
```

returns three other values:

two `@nil` values as placeholders,

plus the created file handle.

Therefore, when used in a generic `@Rw{for}` loop,  
the file is closed also if the loop is interrupted by an  
error or a `@Rw{break}`.

The call `@T{io.lines()}` (with no file name) is equivalent  
to `@T{io.input():lines("I")}`;  
that is, it iterates over the lines of the default input file.  
In this case, the iterator does not close the file when the loop ends.

In case of errors opening the file,  
this function raises the error,  
instead of returning an error code.

```
}
```

```
@LibEntry{io.open (filename [, mode])|
```

This function opens a file,  
in the mode specified in the string @id{mode}.  
In case of success,  
it returns a new file handle.

The @id{mode} string can be any of the following:

```
@description{  
@item{@St{r}| read mode (the default);}  
@item{@St{w}| write mode;}  
@item{@St{a}| append mode;}  
@item{@St{r+}| update mode, all previous data is preserved;}  
@item{@St{w+}| update mode, all previous data is  
erased;}  
@item{@St{a+}| append update mode, previous data is preserved,  
writing is only allowed at the end of file.}  
}
```

The @id{mode} string can also have a @Char{b} at the end,  
which is needed in some systems to open the file in binary mode.

```
}
```

```
@LibEntry{io.output ([file])|
```

Similar to @Lid{io.input}, but operates over the default output file.

```
}
```

```
@LibEntry{io.popen (prog [, mode])|
```

This function is system dependent and is not available  
on all platforms.

Starts the program @id{prog} in a separated process and returns  
a file handle that you can use to read data from this program  
(if @id{mode} is @T{"r"}, the default)  
or to write data to this program  
(if @id{mode} is @T{"w"}).

```
}
```

```
@LibEntry{io.read (@Cdots)|
```

Equivalent to @T{io.input().read(@Cdots)}.

}

@LibEntry{io.tmpfile ()|

In case of success,  
returns a handle for a temporary file.  
This file is opened in update mode  
and it is automatically removed when the program ends.

}

@LibEntry{io.type (obj)|

Checks whether @id{obj}  
is a valid file handle.  
Returns the string @T{"file"} if @id{obj} is an open file handle,  
@T{"closed file"} if @id{obj} is a closed file handle,  
or @fail if @id{obj} is not a file handle.

}

@LibEntry{io.write (@Cdots)|

Equivalent to @T{io.output():write(@Cdots)}.

}

@LibEntry{file:close ()|

Closes @id{file}.  
Note that files are automatically closed when  
their handles are garbage collected,  
but that takes an unpredictable amount of time to happen.

When closing a file handle created with @Lid{io.popen},  
@Lid{file:close} returns the same values  
returned by @Lid{os.execute}.

}

@LibEntry{file:flush ()|

Saves any written data to @id{file}.

}

@LibEntry{file:lines (@Cdots)|

Returns an iterator function that,  
each time it is called,  
reads the file according to the given formats.  
When no format is given,  
uses `@St{1}` as a default.  
As an example, the construction

```
@verbatim{
for c in file:lines(1) do @rep{body} end
}
```

will iterate over all characters of the file,  
starting at the current  
position.  
Unlike `@Lid{io.lines}`, this function does not close the file  
when the loop ends.

```
}
```

```
@LibEntry{file:read (@Cdots)|
```

Reads the file `@id{file}`,  
according to the given formats, which specify what to read.  
For each format,  
the function returns a string or a number with the characters read,  
or `@fail` if it cannot read data with the specified format.  
(In this latter case,  
the function does not read subsequent formats.)  
When called without arguments,  
it uses a default format that reads the next line  
(see below).

The available formats are

```
@description{
```

```
@item{@St{n}|
```

reads a numeral and returns it as a float or an integer,  
following the lexical conventions of Lua.  
(The numeral may have leading whitespaces and a sign.)  
This format always reads the longest input sequence that  
is a valid prefix for a numeral;  
if that prefix does not form a valid numeral  
(e.g., an empty string, `@St{0x}`, or `@St{3.4e-}`)  
or it is too long (more than 200 characters),  
it is discarded and the format returns `@fail`.

```
}
```

```
@item{@St{a}|
```

reads

the whole file, starting at the current position.  
On end of file, it returns the empty string;  
this format never fails.  
}

@item{@St{1}|  
reads the next line skipping the end of line,  
returning @fail on end of file.  
This is the default format.  
}

@item{@St{L}|  
reads the next line keeping the end-of-line character (if present),  
returning @fail on end of file.  
}

@item{@emph{number}|  
reads a string with up to this number of bytes,  
returning @fail on end of file.  
If @id{number} is zero,  
it reads nothing and returns an empty string,  
or @fail on end of file.  
}

}  
The formats @St{1} and @St{L} should be used only for text files.  
}

@LibEntry{file:seek ([whence [, offset]])}

Sets and gets the file position,  
measured from the beginning of the file,  
to the position given by @id{offset} plus a base  
specified by the string @id{whence}, as follows:  
@description{  
@item{@St{set}| base is position 0 (beginning of the file);}  
@item{@St{cur}| base is current position;}  
@item{@St{end}|  
base is end of file;}  
}

In case of success, @id{seek} returns the final file position,  
measured in bytes from the beginning of the file.  
If @id{seek} fails, it returns @fail,  
plus a string describing the error.

The default value for @id{whence} is @T{"cur"},  
and for @id{offset} is 0.

Therefore, the call `@T{file:seek()}` returns the current file position, without changing it;  
the call `@T{file:seek("set")}` sets the position to the beginning of the file (and returns 0);  
and the call `@T{file:seek("end")}` sets the position to the end of the file, and returns its size.

}

`@LibEntry{file:setvbuf (mode [, size])|`

Sets the buffering mode for a file.

There are three available modes:

`@description{`  
`@item{@St{no}| no buffering.}`  
`@item{@St{full}| full buffering.}`  
`@item{@St{line}| line buffering.}`  
`}`

For the last two cases,

`@id{size}` is a hint for the size of the buffer, in bytes.

The default is an appropriate size.

The specific behavior of each mode is non portable;  
check the underlying

`@ANSI{setvbuf}` in your platform for  
more details.

}

`@LibEntry{file:write (@Cdots)|`

Writes the value of each of its arguments to `@id{file}`.

The arguments must be strings or numbers.

In case of success, this function returns `@id{file}`.

}

}

`@sect2{oslib| @title{Operating System Facilities}`

This library is implemented through table `@defid{os}`.

`@LibEntry{os.clock ()|`



Returns an approximation of the amount in seconds of CPU time used by the program,  
as returned by the underlying `@ANSI{clock}`.

}

`@LibEntry{os.date ([format [, time]])}`

Returns a string or a table containing date and time,  
formatted according to the given string `@id{format}`.

If the `@id{time}` argument is present,  
this is the time to be formatted  
(see the `@Lid{os.time}` function for a description of this value).  
Otherwise, `@id{date}` formats the current time.

If `@id{format}` starts with `@Char{!}`,  
then the date is formatted in Coordinated Universal Time.  
After this optional character,  
if `@id{format}` is the string `@St{*t}`,  
then

`@id{date}` returns a table with the following fields:  
`@id{year}`, `@id{month}` (1@En{ }12), `@id{day}` (1@En{ }31),  
`@id{hour}` (0@En{ }23), `@id{min}` (0@En{ }59),  
`@id{sec}` (0@En{ }61, due to leap seconds),  
`@id{wday}` (weekday, 1@En{ }7, Sunday @N{is 1}),  
`@id{yday}` (day of the year, 1@En{ }366),  
and `@id{isdst}` (daylight saving flag, a boolean).  
This last field may be absent  
if the information is not available.

If `@id{format}` is not `@St{*t}`,  
then `@id{date}` returns the date as a string,  
formatted according to the same rules as the `@ANSI{strftime}`.

If `@id{format}` is absent, it defaults to `@St{%c}`,  
which gives a human-readable date and time representation  
using the current locale.

On non-POSIX systems,  
this function may be not `@x{thread safe}`  
because of its reliance on `@CId{gmtime}` and `@CId{localtime}`.

}

`@LibEntry{os.difftime (t2, t1)}`

Returns the difference, in seconds,

from time @id{t1} to time @id{t2}  
 (where the times are values returned by @Lid{os.time}).  
 In @x{POSIX}, @x{Windows}, and  
 some other systems,  
 this value is exactly @id{t2}@M{-}@id{t1}.

}

@LibEntry{os.execute ([command])|

This function is equivalent to the @ANSI{system}.  
 It passes @id{command} to be executed by an operating system shell.  
 Its first result is @true  
 if the command terminated successfully,  
 or @fail otherwise.  
 After this first result  
 the function returns a string plus a number,  
 as follows:  
 @description{

@item{@St{exit}|  
 the command terminated normally;  
 the following number is the exit status of the command.  
 }

@item{@St{signal}|  
 the command was terminated by a signal;  
 the following number is the signal that terminated the command.  
 }

}

When called without a @id{command},  
 @id{os.execute} returns a boolean that is true if a shell is available.

}

@LibEntry{os.exit ([code [, close]])|

Calls the @ANSI{exit} to terminate the host program.  
 If @id{code} is @true,  
 the returned status is @idx{EXIT\_SUCCESS};  
 if @id{code} is @false,  
 the returned status is @idx{EXIT\_FAILURE};  
 if @id{code} is a number,  
 the  
 returned status is this number.  
 The default value for @id{code} is @true.

If the optional second argument `@id{close}` is true,  
the function closes the Lua state before exiting `@seeF{lua_close}`.

}

`@LibEntry{os.getenv (varname)|`

Returns the value of the process environment variable `@id{varname}`  
or `@fail` if the variable is not defined.

}

`@LibEntry{os.remove (filename)|`

Deletes the file (or empty directory, on `@x{POSIX}` systems)  
with the given name.

If this function fails, it returns `@fail`  
plus a string describing the error and the error code.  
Otherwise, it returns true.

}

`@LibEntry{os.rename (oldname, newname)|`

Renames the file or directory named `@id{oldname}` to `@id{newname}`.  
If this function fails, it returns `@fail`,  
plus a string describing the error and the error code.  
Otherwise, it returns true.

}

`@LibEntry{os.setlocale (locale [, category])|`

Sets the current locale of the program.  
`@id{locale}` is a system-dependent string specifying a locale;  
`@id{category}` is an optional  
string describing which category to change:  
`@T{"all"}`, `@T{"collate"}`, `@T{"ctype"}`,  
`@T{"monetary"}`, `@T{"numeric"}`, or `@T{"time"}`;  
the default category is `@T{"all"}`.  
The function returns the name of the new locale,  
or `@fail` if the request cannot be honored.

If `@id{locale}` is the empty string,  
the current locale is set to an implementation-defined native locale.  
If `@id{locale}` is the string `@St{C}`,  
the current locale is set to the standard C locale.

When called with `@nil` as the first argument,  
this function only returns the name of the current locale  
for the given category.

This function may be not `@x{thread safe}`  
because of its reliance on `@Cid{setlocale}`.

}

`@LibEntry{os.time ([table])}`

Returns the current time when called without arguments,  
or a time representing the local date and time specified by the given table.  
This table must have fields `@id{year}`, `@id{month}`, and `@id{day}`,  
and may have fields  
`@id{hour}` (default is 12),  
`@id{min}` (default is 0),  
`@id{sec}` (default is 0),  
and  
`@id{isdst}` (default is `@nil`).  
Other fields are ignored.  
For a description of these fields, see the `@Lid{os.date}` function.

When the function is called,  
the values in these fields do not need to be inside their valid ranges.  
For instance, if `@id{sec}` is -10,  
it means 10 seconds before the time specified by the other fields;  
if `@id{hour}` is 1000,  
it means 1000 hours after the time specified by the other fields.

The returned value is a number, whose meaning depends on your system.  
In `@x{POSIX}`, `@x{Windows}`, and some other systems,  
this number counts the number  
of seconds since some given start time (the `@Q{epoch}`).  
In other systems, the meaning is not specified,  
and the number returned by `@id{time}` can be used only as an argument to  
`@Lid{os.date}` and `@Lid{os.difftime}`.

When called with a table,  
`@id{os.time}` also normalizes all the fields  
documented in the `@Lid{os.date}` function,  
so that they represent the same time as before the call  
but with values inside their valid ranges.

}

`@LibEntry{os.tmpname}`

()

Returns a string with a file name that can be used for a temporary file.

The file must be explicitly opened before its use and explicitly removed when no longer needed.

In @x{POSIX} systems, this function also creates a file with that name, to avoid security risks. (Someone else might create the file with wrong permissions in the time between getting the name and creating the file.) You still have to open the file to use it and to remove it (even if you do not use it).

When possible, you may prefer to use @Lid{io.tmpfile}, which automatically removes the file when the program ends.

}

}

@sect2{debuglib| @title{The Debug Library}}

This library provides the functionality of the @link{debugI|debug interface} to Lua programs. You should exert care when using this library. Several of its functions violate basic assumptions about Lua code (e.g., that variables local to a function cannot be accessed from outside; that userdata metatables cannot be changed by Lua code; that Lua programs do not crash) and therefore can compromise otherwise secure code. Moreover, some functions in this library may be slow.

All functions in this library are provided inside the @defid{debug} table. All functions that operate over a thread have an optional first argument which is the thread to operate over. The default is always the current thread.

@LibEntry{debug.debug ()}

Enters an interactive mode with the user,  
running each string that the user enters.  
Using simple commands and other debug facilities,  
the user can inspect global and local variables,  
change their values, evaluate expressions, and so on.  
A line containing only the word `@id{cont}` finishes this function,  
so that the caller continues its execution.

Note that commands for `@id{debug.debug}` are not lexically nested  
within any function and so have no direct access to local variables.

}

`@LibEntry{debug.gethook ([thread])|`

Returns the current hook settings of the thread, as three values:  
the current  
hook function, the current hook mask,  
and the current hook count,  
as set by the `@Lid{debug.sethook}` function.

Returns `@fail` if there is no active hook.

}

`@LibEntry{debug.getinfo ([thread,] f [, what])|`

Returns a table with information about a function.  
You can give the function directly  
or you can give a number as the value of `@id{f}`,  
which means the function running at level `@id{f}` of the call stack  
of the given thread:  
`@N{level 0}` is the current function (`@id{getinfo}` itself);  
`@N{level 1}` is the function that called `@id{getinfo}`  
(except for tail calls, which do not count in the stack);  
and so on.  
If `@id{f}` is a number greater than the number of active functions,  
then `@id{getinfo}` returns `@fail`.

The returned table can contain all the fields returned by `@Lid{lua_getinfo}`,  
with the string `@id{what}` describing which fields to fill in.  
The default for `@id{what}` is to get all information available,  
except the table of valid lines.  
The option `@Char{f}`  
adds a field named `@id{func}` with  
the function itself.  
The option `@Char{L}` adds a field named `@id{activelines}`  
with the table of valid lines,

provided the function is a Lua function.  
If the function has no debug information,  
the table is empty.

For instance, the expression `@T{debug.getinfo(1,"n").name}` returns  
a name for the current function,  
if a reasonable name can be found,  
and the expression `@T{debug.getinfo(print)}`  
returns a table with all available information  
about the `@Lid{print}` function.

}

`@LibEntry{debug.getlocal ([thread,] f, local)|`

This function returns the name and the value of the local variable  
with index `@id{local}` of the function at level `@id{f}` of the stack.  
This function accesses not only explicit local variables,  
but also parameters and temporary values.

The first parameter or local variable has `@N{index 1}`, and so on,  
following the order that they are declared in the code,  
counting only the variables that are active  
in the current scope of the function.  
Compile-time constants may not appear  
in this listing,  
if they were optimized away by the compiler.  
Negative indices refer to vararg arguments;  
`@num{-1}` is the first vararg argument.  
The function returns `@fail`  
if there is no variable with the given index,  
and raises an error when called with a level out of range.  
(You can call `@Lid{debug.getinfo}` to check whether the level is valid.)

Variable names starting with `@Char{() (open parenthesis) @C{}}`  
represent variables with no known names  
(internal variables such as loop control variables,  
and variables from chunks saved without debug information).

The parameter `@id{f}` may also be a function.  
In that case, `@id{getlocal}` returns only the name of function parameters.

}

`@LibEntry{debug.getmetatable (value)|`

Returns the metatable of the given `@id{value}`  
or `@nil` if it does not have a metatable.

}

@LibEntry{debug.getregistry ()|

Returns the registry table @see{registry}.

}

@LibEntry{debug.getupvalue (f, up)|

This function returns the name and the value of the upvalue with

index @id{up} of the function @id{f}.

The function returns @fail

if there is no upvalue with the given index.

(For Lua functions,

upvalues are the external local variables that the function uses, and that are consequently included in its closure.)

For @N{C functions}, this function uses the empty string @T{""} as a name for all upvalues.

Variable name @Char{?} (interrogation mark)

represents variables with no known names

(variables from chunks saved without debug information).

}

@LibEntry{debug.getuservalue (u, n)|

Returns the @id{n}-th user value associated

to the userdata @id{u} plus a boolean,

@false if the userdata does not have that value.

}

@LibEntry{debug.sethook ([thread,] hook, mask [, count])|

Sets the given function as the debug hook.

The string @id{mask} and the number @id{count} describe when the hook will be called.

The string mask may have any combination of the following characters, with the given meaning:

@description{

@item{@Char{c}| the hook is called every



```

time Lua calls a function;}
@item{@Char{r}| the hook is called every time Lua returns from a function;}
@item{@Char{1}| the hook is called every time Lua enters a new line of code.}
}

```

Moreover,

with a @id{count} different from zero,  
the hook is called also after every @id{count} instructions.

When called without arguments,

@Lid{debug.sethook} turns off the hook.

When the hook is called, its first parameter is a string  
describing the event that has triggered its call:

```

@T{"call"}, @T{"tail call"}, @T{"return"},
@T{"line"}, and @T{"count"}.

```

For line events,

the hook also gets the new line number as its second parameter.

Inside a hook,

you can call @id{getinfo} with @N{level 2} to get more information about  
the running function.

(@N{Level 0} is the @id{getinfo} function,  
and @N{level 1} is the hook function.)

```

}

```

```

@LibEntry{debug.setlocal ([thread,] level, local, value)|

```

This function assigns the value @id{value} to the local variable  
with index @id{local} of the function at level @id{level}  
of the stack.

The function returns @fail if there is no local  
variable with the given index,

and raises an error when called with a @id{level} out of range.

(You can call @id{getinfo} to check whether the level is valid.)

Otherwise, it returns the name of the local variable.

See @Lid{debug.getlocal} for more information about  
variable indices and names.

```

}

```

```

@LibEntry{debug.setmetatable (value, table)|

```

Sets the metatable for the given @id{value} to the given @id{table}  
(which can be @nil).

Returns @id{value}.

```

}

```

@LibEntry{debug.setupvalue (f, up, value)|

This function assigns the value @id{value} to the upvalue with index @id{up} of the function @id{f}.

The function returns @fail if there is no upvalue with the given index.

Otherwise, it returns the name of the upvalue.

See @Lid{debug.getupvalue} for more information about upvalues.

}

@LibEntry{debug.setuservalue (udata, value, n)|

Sets the given @id{value} as the @id{n}-th user value associated to the given @id{udata}.

@id{udata} must be a full userdata.

Returns @id{udata}, or @fail if the userdata does not have that value.

}

@LibEntry{debug.traceback ([thread,] [message [, level]])|

If @id{message} is present but is neither a string nor @nil, this function returns @id{message} without further processing.

Otherwise,

it returns a string with a traceback of the call stack.

The optional @id{message} string is appended at the beginning of the traceback.

An optional @id{level} number tells at which level to start the traceback

(default is 1, the function calling @id{traceback}).

}

@LibEntry{debug.upvalueid (f, n)|

Returns a unique identifier (as a light userdata) for the upvalue numbered @id{n} from the given function.

These unique identifiers allow a program to check whether different closures share upvalues.

Lua closures that share an upvalue

(that is, that access a same external local variable)  
will return identical ids for those upvalue indices.

}

@LibEntry{debug.upvaluejoin (f1, n1, f2, n2)|

Make

the @id{n1}-th upvalue of the Lua closure @id{f1}  
refer to the @id{n2}-th upvalue of the Lua closure @id{f2}.

}

}

}

@C{-----}

@sect1{lua-sa| @title{Lua Standalone}}

Although Lua has been designed as an extension language,  
to be embedded in a host @N{C program},  
it is also frequently used as a standalone language.

An interpreter for Lua as a standalone language,  
called simply @id{lua},  
is provided with the standard distribution.

The @x{standalone interpreter} includes  
all standard libraries.

Its usage is:

@verbatim{

lua [options] [script [args]]

}

The options are:

@description{

@item{@T{-e @rep{stat}}| execute string @rep{stat};}

@item{@T{-i}| enter interactive mode after running @rep{script};}

@item{@T{-l @rep{mod}}| @Q{require} @rep{mod} and assign the  
result to global @rep{mod};}

@item{@T{-l @rep{g=mod}}| @Q{require} @rep{mod} and assign the  
result to global @rep{g};}

@item{@T{-v}| print version information;}

@item{@T{-E}|

ignore environment variables;}

@item{@T{-W}| turn warnings on;}

@item{@T{--}| stop handling options;}

@item{@T{-}| execute @id{stdin} as a file and stop handling options.}

}

(The form `@T{-l @rep{g=mod}}` was introduced in `@N{release 5.4.4}.`)

After handling its options, `@id{lua}` runs the given `@emph{script}`.

When called without arguments,

`@id{lua}` behaves as `@T{lua -v -i}`

when the standard input (`@id{stdin}`) is a terminal,

and as `@T{lua -}` otherwise.

When called without the option `@T{-E}`,

the interpreter checks for an environment variable `@defid{LUA_INIT_5_4}`

(or `@defid{LUA_INIT}` if the versioned name is not defined)

before running any argument.

If the variable content has the format `@T{@At@rep{filename}}`,

then `@id{lua}` executes the file.

Otherwise, `@id{lua}` executes the string itself.

When called with the option `@T{-E}`,

Lua does not consult any environment variables.

In particular,

the values of `@Lid{package.path}` and `@Lid{package.cpath}`

are set with the default

paths defined in `@id{luaconf.h}`.

To signal to the libraries that this option is on,

the stand-alone interpreter sets the field

`@idx{"LUA_NOENV"}` in the registry to a true value.

Other libraries may consult this field for the same purpose.

The options `@T{-e}`, `@T{-l}`, and `@T{-W}` are handled in the order they appear.

For instance, an invocation like

```
@verbatim{
```

```
$ lua -e 'a=1' -llib1 script.lua
```

```
}
```

will first set `@id{a}` to 1, then require the library `@id{lib1}`,

and finally run the file `@id{script.lua}` with no arguments.

(Here `@T{$}` is the shell prompt. Your prompt may be different.)

Before running any code,

`@id{lua}` collects all command-line arguments

in a global table called `@id{arg}`.

The script name goes to index 0,

the first argument after the script name goes to index 1,

and so on.

Any arguments before the script name

(that is, the interpreter name plus its options)

go to negative indices.

For instance, in the call

```
@verbatim{
```

```
$ lua -la b.lua t1 t2
```

```
}
```

the table is like this:

```
@verbatim{
```

```
arg
```

```
= { [-2] = "lua", [-1] = "-la",
```

```
    [0] = "b.lua",
```

```
    [1] = "t1", [2] = "t2" }
```

```
}
```

If there is no script in the call,

the interpreter name goes to index 0,

followed by the other arguments.

For instance, the call

```
@verbatim{
```

```
$ lua -e "print(arg[1])"
```

```
}
```

will print @St{-e}.

If there is a script,

the script is called with arguments

```
@T{arg[1]}, @Cdots, @T{arg[#arg]}.
```

Like all chunks in Lua,

the script is compiled as a variadic function.

In interactive mode,

Lua repeatedly prompts and waits for a line.

After reading a line,

Lua first try to interpret the line as an expression.

If it succeeds, it prints its value.

Otherwise, it interprets the line as a statement.

If you write an incomplete statement,

the interpreter waits for its completion

by issuing a different prompt.

If the global variable @defid{\_PROMPT} contains a string,

then its value is used as the prompt.

Similarly, if the global variable @defid{\_PROMPT2} contains a string,

its value is used as the secondary prompt

(issued

during incomplete statements).

In case of unprotected errors in the script,

the interpreter reports the error to the standard error stream.

If the error object is not a string but

has a metamethod @idx{\_\_tostring},

the interpreter calls this metamethod to produce the final message.

Otherwise, the interpreter converts the error object to a string

and adds a stack traceback to it.

When warnings are on,

they are simply printed in the standard error output.

When finishing normally,  
the interpreter closes its main Lua state  
@seeF{lua\_close}.  
The script can avoid this step by  
calling @Lid{os.exit} to terminate.

To allow the use of Lua as a  
script interpreter in Unix systems,  
Lua skips the first line of a file chunk if it starts with @T{#}.  
Therefore, Lua scripts can be made into executable programs  
by using @T{chmod +x} and @N{the @T{#!}} form,  
as in

```
@verbatim{  
#!/usr/local/bin/lua  
}
```

Of course,  
the location of the Lua interpreter may be different in your machine.  
If @id{lua} is in your

```
@id{PATH},  
then  
@verbatim{  
#!/usr/bin/env lua  
}
```

is a more portable solution.

```
}
```

@sect1{incompat| @title{Incompatibilities with the Previous Version}}

@simplesect{

Here we list the incompatibilities that you may find when moving a program  
from @N{Lua 5.3} to @N{Lua 5.4}.

You can avoid some incompatibilities by compiling Lua with  
appropriate options (see file @id{luaconf.h}).

However,  
all these compatibility options will be removed in the future.  
More often than not,  
compatibility issues arise when these compatibility options  
are removed.

So, whenever you have the chance,  
you should try to test your code with a version of Lua compiled  
with all compatibility options turned off.

That will ease transitions to newer versions of Lua.

Lua versions can always change the C API in ways that do not imply source-code changes in a program, such as the numeric values for constants or the implementation of functions as macros. Therefore, you should never assume that binaries are compatible between different Lua versions. Always recompile clients of the Lua API when using a new version.

Similarly, Lua versions can always change the internal representation of precompiled chunks; precompiled chunks are not compatible between different Lua versions.

The standard paths in the official distribution may change between versions.

}

@sect2{@title{Incompatibilities in the Language}  
@itemize{

@item{  
The coercion of strings to numbers in arithmetic and bitwise operations has been removed from the core language. The string library does a similar job for arithmetic (but not for bitwise) operations using the string metamethods. However, unlike in previous versions, the new implementation preserves the implicit type of the numeral in the string. For instance, the result of @T{"1" + "2"} now is an integer, not a float.  
}

@item{  
Literal decimal integer constants that overflow are read as floats, instead of wrapping around. You can use hexadecimal notation for such constants if you want the old behavior (reading them as integers with wrap around).  
}

@item{

The use of the `@idx{__lt}` metamethod to emulate `@idx{__le}` has been removed.  
When needed, this metamethod must be explicitly defined.  
}

@item{  
The semantics of the numerical `@Rw{for}` loop over integers changed in some details.  
In particular, the control variable never wraps around.  
}

@item{  
A label for a `@Rw{goto}` cannot be declared where a label with the same name is visible, even if this other label is declared in an enclosing block.  
}

@item{  
When finalizing an object,  
Lua does not ignore `@idx{__gc}` metamethods that are not functions.  
Any value will be called, if present.  
(Non-callable values will generate a warning, like any other error when calling a finalizer.)  
}  
  
}  
  
}

@sect2{@title{Incompatibilities in the Libraries}  
@itemize{

@item{  
The function `@Lid{print}` does not call `@Lid{tostring}` to format its arguments;  
instead, it has this functionality hardwired.  
You should use `@idx{__tostring}` to modify how values are printed.  
}

@item{  
The pseudo-random number generator used by the function `@Lid{math.random}` now starts with a somewhat random seed.  
Moreover, it uses a different algorithm.  
}

@item{  
By default, the decoding functions in the `@Lid{utf8}` library



do not accept surrogates as valid code points.  
An extra parameter in these functions makes them more permissive.  
}

@item{  
The options @St{setpause} and @St{setstepmul}  
of the function @Lid{collectgarbage} are deprecated.  
You should use the new option @St{incremental} to set them.  
}

@item{  
The function @Lid{io.lines} now returns four values,  
instead of just one.  
That can be a problem when it is used as the sole  
argument to another function that has optional parameters,  
such as in @T{load(io.lines(filename, "L"))}.  
To fix that issue,  
you can wrap the call into parentheses,  
to adjust its number of results to one.  
}

}

}

@sect2{@title{Incompatibilities in the API}

@itemize{

@item{  
Full userdata now has an arbitrary number of associated  
user values.  
Therefore, the functions @id{lua\_newuserdata},  
@id{lua\_setuservalue}, and @id{lua\_getuservalue} were  
replaced by @Lid{lua\_newuserdatauv},  
@Lid{lua\_setiuservalue}, and @Lid{lua\_getiuservalue},  
which have an extra argument.

For compatibility, the old names still work as macros assuming  
one single user value.

Note, however, that userdata with zero user values  
are more efficient memory-wise.  
}

@item{  
The function @Lid{lua\_resume} has an extra parameter.  
This out parameter returns the number of values on  
the top of the stack that were yielded or returned by the coroutine.

(In previous versions,  
those values were the entire stack.)  
}

@item{  
The function @Lid{lua\_version} returns the version number,  
instead of an address of the version number.  
The Lua core should work correctly with libraries using their  
own static copies of the same core,  
so there is no need to check whether they are using the same  
address space.  
}

@item{  
The constant @id{LUA\_ERRGCMM} was removed.  
Errors in  
finalizers are never propagated;  
instead, they generate a warning.  
}

@item{  
The options @idx{LUA\_GCSETPAUSE} and @idx{LUA\_GCSETSTEPMUL}  
of the function @Lid{lua\_gc} are deprecated.  
You should use the new option @id{LUA\_GCINC} to set them.  
}  
  
}  
  
}  
  
}

@C{[=====]}

@sect1{BNF| @title{The Complete Syntax of Lua}

Here is the complete syntax of Lua in extended BNF.  
As usual in extended BNF,  
@bnfNter{ {A} } means 0 or more @bnfNter{A}s,  
and @bnfNter{[A]} means an optional @bnfNter{A}.  
(For operator precedences, see @See{prec};  
for a description of the terminals  
@bnfNter{Name}, @bnfNter{Numeral},  
and @bnfNter{LiteralString}, see @See{lexical}.)  
@index{grammar}

@Produc{

```

@producname{chunk}@producbody{block}

@producname{block}@producbody{@bnfrep{stat} @bnfopt{retstat}}

@producname{stat}@producbody{
  @bnfter{;}
  @OrNL varlist @bnfter{=} explist
  @OrNL functioncall
  @OrNL label
  @OrNL @Rw{break}
  @OrNL @Rw{goto} Name
  @OrNL @Rw{do} block
  @Rw{end}
  @OrNL @Rw{while} exp @Rw{do} block @Rw{end}
  @OrNL @Rw{repeat} block @Rw{until} exp
  @OrNL @Rw{if} exp @Rw{then} block
  @bnfrep{@Rw{elseif} exp @Rw{then} block}
  @bnfopt{@Rw{else} block} @Rw{end}
  @OrNL @Rw{for} @bnfNter{Name} @bnfter{=} exp @bnfter{,} exp @bnfopt{@bnfter{,} exp}
  @Rw{do} block @Rw{end}
  @OrNL @Rw{for} namelist @Rw{in} explist @Rw{do} block @Rw{end}
  @OrNL @Rw{function} funcname funcbody
  @OrNL @Rw{local} @Rw{function} @bnfNter{Name} funcbody
  @OrNL @Rw{local} attnamelist @bnfopt{@bnfter{=} explist}
}

@producname{attnamelist}@producbody{
  @bnfNter{Name} attrib @bnfrep{@bnfter{,} @bnfNter{Name} attrib}}

@producname{attrib}@producbody{@bnfopt{@bnfter{<} @bnfNter{Name} @bnfter{>}}}}

@producname{retstat}@producbody{@Rw{return}
  @bnfopt{explist} @bnfopt{@bnfter{;}}}}

@producname{label}@producbody{@bnfter{::} Name @bnfter{::}}

@producname{funcname}@producbody{@bnfNter{Name} @bnfrep{@bnfter{.} @bnfNter{Name}}

  @bnfopt{@bnfter{:} @bnfNter{Name}}}}

@producname{varlist}@producbody{var @bnfrep{@bnfter{,} var}}

@producname{var}@producbody{
  @bnfNter{Name}
  @Or prefixexp @bnfter{[] exp @bnfter{[]}}
  @Or prefixexp @bnfter{.} @bnfNter{Name}
}

```

@producname{namelist}@producbody{@bnfNter{Name} @bnfrep{@bnfter{,} @bnfNter{Name}}}

@producname{explist}@producbody{exp @bnfrep{@bnfter{,} exp}}

@producname{exp}@producbody{  
@Rw{nil}  
@Or @Rw{false}  
@Or @Rw{true}  
@Or @bnfNter{Numeral}  
@Or @bnfNter{LiteralString}  
@Or @bnfter{...}  
@Or functiondef  
@OrNL prefixexp  
@Or tableconstructor  
@Or exp binop exp  
@Or unop exp  
}

@producname{prefixexp}@producbody{var @Or functioncall @Or @bnfter{() exp @bnfter{}}}

@producname{functioncall}@producbody{  
prefixexp args  
@Or prefixexp @bnfter{:} @bnfNter{Name} args  
}

@producname{args}@producbody{  
@bnfter{() @bnfopt{explist} @bnfter{}}  
@Or tableconstructor  
@Or @bnfNter{LiteralString}  
}

@producname{functiondef}@producbody{@Rw{function} funcbody}

@producname{funcbody}@producbody{@bnfter{(  
@bnfopt{parlist} @bnfter{)} block @Rw{end}}

@producname{parlist}@producbody{namelist @bnfopt{@bnfter{,} @bnfter{...}}  
@Or @bnfter{...}}

@producname{tableconstructor}@producbody{@bnfter{@Open} @bnfopt{fieldlist} @bnfter{@Close}}

@producname{fieldlist}@producbody{field @bnfrep{fieldsep field} @bnfopt{fieldsep}}

@producname{field}@producbody{@bnfter{[] exp @bnfter{[]} @bnfter{=} exp @Or @bnfNter{Name}  
@bnfter{=} exp @Or exp}

```

@producname{fieldsep}@producbody{@bnfter{,} @Or @bnfter{;}}

@producname{binop}@producbody{
@bnfter{+} @Or @bnfter{-} @Or @bnfter{*} @Or @bnfter{/} @Or @bnfter{//}
@Or @bnfter{^} @Or @bnfter{%}
@OrNL
@bnfter{&} @Or @bnfter{~} @Or @bnfter{|} @Or @bnfter{>>} @Or @bnfter{<<}
@Or @bnfter{..}
@OrNL
@bnfter{<} @Or @bnfter{<=} @Or @bnfter{>} @Or @bnfter{>=}
@Or @bnfter{==} @Or @bnfter{~=}
@OrNL
@Rw{and} @Or @Rw{or}}

@producname{unop}@producbody{@bnfter{-} @Or @Rw{not} @Or @bnfter{#} @Or
@bnfter{~}}

}

}

@C{ }=====}

}
@C{ }-----}

```

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in path(s):

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--[[
```

```
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]]
```

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header = string.gsub(header, "All rights reserved",

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```
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```

# 1.154 libxml2 2.13.4-r6

## 1.154.1 Available under license :

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Because  
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That's all there is to it!

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## 1.157 bzip2 1.0.8-r6

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Julian Seward, jseward@acm.org  
bzip2/libbzip2 version 1.0.8 of 13 July 2019

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```
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## 1.159 libnetfilter-cthelper 1.0.1-r2

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Format: <http://dep.debian.net/deps/dep5>

Upstream-Name: libnetfilter-cthelper

Source: [http://www.netfilter.org/projects/libnetfilter\\_cthelper/index.html](http://www.netfilter.org/projects/libnetfilter_cthelper/index.html)

Files: \*

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pkgdesc="Meta package for minimal alpine base"

url="https://alpinelinux.org"

arch="noarch"

license="MIT"

depends=""



# 1.169 libnfnetlink 1.0.2-r3

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## 1.172 kerberos 1.21.3-r0

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cmd/krb5/kproplog/kproplog.c  
cmd/krb5/slave/kpropd\_rpc.c  
lib/gss\_mechs/mech\_krb5/et/kdb5\_err.c  
lib/gss\_mechs/mech\_spnego/mech/gssapiP\_spnego.h  
lib/gss\_mechs/mech\_spnego/mech/spnego\_mech.c  
lib/krb5/kadm5/kadm\_host\_srv\_names.c  
lib/krb5/kdb/kdb\_convert.c  
lib/krb5/kdb/kdb\_hdr.h  
lib/krb5/kdb/kdb\_log.c  
lib/krb5/kdb/kdb\_log.h  
lib/libgss/g\_accept\_sec\_context.c  
lib/libgss/g\_acquire\_cred.c  
lib/libgss/g\_canon\_name.c  
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lib/libgss/g\_dup\_name.c  
lib/libgss/g\_exp\_sec\_context.c  
lib/libgss/g\_export\_name.c  
lib/libgss/g\_glue.c  
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lib/libgss/g\_init\_sec\_context.c  
lib/libgss/g\_initialize.c  
lib/libgss/g\_inquire\_context.c  
lib/libgss/g\_inquire\_cred.c  
lib/libgss/g\_inquire\_names.c  
lib/libgss/g\_process\_context.c  
lib/libgss/g\_rel\_buffer.c  
lib/libgss/g\_rel\_cred.c  
lib/libgss/g\_rel\_name.c  
lib/libgss/g\_rel\_oid\_set.c  
lib/libgss/g\_seal.c  
lib/libgss/g\_sign.c  
lib/libgss/g\_store\_cred.c  
lib/libgss/g\_unseal.c  
lib/libgss/g\_userok.c  
lib/libgss/g\_utils.c  
lib/libgss/g\_verify.c  
lib/libgss/gssd\_pname\_to\_uid.c  
uts/common/gssapi/include/gssapi\_err\_generic.h  
uts/common/gssapi/include/mechglueP.h

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The implementations of GSSAPI mechglue in GSSAPI-SPNEGO in  
"src/lib/gssapi", including the following files:

lib/gssapi/generic/gssapi\_err\_generic.et  
lib/gssapi/mechglue/g\_accept\_sec\_context.c  
lib/gssapi/mechglue/g\_acquire\_cred.c  
lib/gssapi/mechglue/g\_canon\_name.c  
lib/gssapi/mechglue/g\_compare\_name.c  
lib/gssapi/mechglue/g\_context\_time.c  
lib/gssapi/mechglue/g\_delete\_sec\_context.c  
lib/gssapi/mechglue/g\_dsp\_name.c  
lib/gssapi/mechglue/g\_dsp\_status.c  
lib/gssapi/mechglue/g\_dup\_name.c  
lib/gssapi/mechglue/g\_exp\_sec\_context.c  
lib/gssapi/mechglue/g\_export\_name.c  
lib/gssapi/mechglue/g\_glue.c  
lib/gssapi/mechglue/g\_imp\_name.c  
lib/gssapi/mechglue/g\_imp\_sec\_context.c  
lib/gssapi/mechglue/g\_init\_sec\_context.c  
lib/gssapi/mechglue/g\_initialize.c  
lib/gssapi/mechglue/g\_inquire\_context.c  
lib/gssapi/mechglue/g\_inquire\_cred.c  
lib/gssapi/mechglue/g\_inquire\_names.c  
lib/gssapi/mechglue/g\_process\_context.c  
lib/gssapi/mechglue/g\_rel\_buffer.c  
lib/gssapi/mechglue/g\_rel\_cred.c  
lib/gssapi/mechglue/g\_rel\_name.c  
lib/gssapi/mechglue/g\_rel\_oid\_set.c  
lib/gssapi/mechglue/g\_seal.c  
lib/gssapi/mechglue/g\_sign.c  
lib/gssapi/mechglue/g\_store\_cred.c  
lib/gssapi/mechglue/g\_unseal.c  
lib/gssapi/mechglue/g\_userok.c  
lib/gssapi/mechglue/g\_utils.c  
lib/gssapi/mechglue/g\_verify.c  
lib/gssapi/mechglue/gssd\_pname\_to\_uid.c  
lib/gssapi/mechglue/mglueP.h  
lib/gssapi/mechglue/oid\_ops.c  
lib/gssapi/spnego/gssapiP\_spnego.h  
lib/gssapi/spnego/spnego\_mech.c

and the initial implementation of incremental propagation, including the following new or changed files:

```
include/iproper_hdr.h
kadmin/server/iproperd_svc.c
lib/kdb/iproper.x
lib/kdb/kdb_convert.c
lib/kdb/kdb_log.c
lib/kdb/kdb_log.h
lib/krb5/error_tables/kdb5_err.et
kprop/kpropd_rpc.c
kprop/kproplog.c
```

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\*

\* stdio.c

\* by Mark Gates <[mgates@nlanr.net](mailto:mgates@nlanr.net)>

\* and Ajay Tirumalla <[tirumala@ncsa.uiuc.edu](mailto:tirumala@ncsa.uiuc.edu)>

\* -----

\* input and output numbers, converting with kilo, mega, giga

\* ----- \*/

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```
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@c Local Variables:

@c ispell-local-pdict: "ispell-dict"

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# 1.180 musl-fts 1.2.7-r6

## 1.180.1 Available under license :

No license file was found, but licenses were detected in source scan.

/alpine-standard-3-19-0-x86-64-iso-zip/alpine-standard-3.19.0-x86\_64.iso: binary file matches

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\* /bin/grep

# 1.181 e2fsprogs 1.47.1-r1

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Index: tdbsa/tdb.c

=====

--- tdbsa.orig/tdb.c

+++ tdbsa/tdb.c

@@ -4,11 +4,11 @@ Rev: 23371

Last Changed Date: 2007-06-06 20:14:06 -0400 (Wed, 06 Jun 2007)

\*/

/\*

- Unix SMB/CIFS implementation.
- + trivial database library - standalone version

- trivial database library - private includes

-

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part of  
its purpose remains meaningful.

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That's all there is to it!

#

# This is a Makefile stub which handles the creation of BSD shared  
# libraries.

#

# In order to use this stub, the following makefile variables must be defined.



```

#
# BSDLIB_VERSION = 1.0
# BSDLIB_IMAGE = libce
# BSDLIB_MYDIR = et
# BSDLIB_INSTALL_DIR = $(SHLIBDIR)
#

all:: image

real-subdirs:: Makefile
@echo " MKDIR pic"
@mkdir -p pic

BSD_LIB = $(BSDLIB_IMAGE).so.$(BSDLIB_VERSION)
BSDLIB_PIC_FLAG = -fpic

image: $(BSD_LIB)

$(BSD_LIB): $(OBS)
(cd pic; ld -Bshareable -o $(BSD_LIB) $(LDFLAGS_SHLIB) $(OBS))
$(MV) pic/$(BSD_LIB) .
$(RM) -f ../$(BSD_LIB)
(cd ..; $(LN) $(LINK_BUILD_FLAGS) \
`echo $(my_dir) | sed -e 's;lib/;;'/'$(BSD_LIB) $(BSD_LIB)`)

install-shlibs install:: $(BSD_LIB)
@echo " INSTALL_PROGRAM $(BSDLIB_INSTALL_DIR)/$(BSD_LIB)"
@$(INSTALL_PROGRAM) $(BSD_LIB) \
$(DESTDIR)$$(BSDLIB_INSTALL_DIR)/$(BSD_LIB)
@-$(LDCONFIG)

install-strip: install

install-shlibs-strip:: install-shlibs

uninstall-shlibs uninstall::
$(RM) -f $(DESTDIR)$$(BSDLIB_INSTALL_DIR)/$(BSD_LIB)

clean::
$(RM)
-rf pic
$(RM) -f $(BSD_LIB)
$(RM) -f ../$(BSD_LIB)

```

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Upstream-Name: e2fsprogs

Upstream-Contact: Theodore Ts'o <tytso@mit.edu>

Source: <http://sourceforge.net/projects/e2fsprogs>

Comment:

This is the Debian GNU/Linux prepackaged version of the EXT2 file system utilities (e2fsck, mke2fs, etc.). The EXT2 utilities were written by Theodore Ts'o <tytso@mit.edu> and Remy Card <card@masi.ibp.fr>.

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2001 Alcove <<http://www.alcove.com/>>

1997 Klee Dienes

1995-1996 Michael Nonweiler <mrn20@cam.ac.uk>

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lib/ss/\*

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2003 Theodore Ts'o

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Comment: Taken from lib/com\_err/error.c from Kerberos4kth distribution.

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lib/e2p/\*

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misc/e2fuzz.c

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2002 Theodore Ts'o.

2002 Andreas Dilger

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Reuse Bob Pearson's slice-by-8 implementation  
for e2fsprogs.

.

July 20, 2011 Bob Pearson <rpearson at systemfabricworks.com>

...

Oct 15, 2000 Matt Domsch <Matt\_Domsch@dell.com>

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Files: CleanSpec.mk

contrib/android/ext2simg.c

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Files: e2fsck/\*

debugfs/do\_journal.c

debugfs/journal.\*  
debugfs/logdump.c  
debugfs/xattrs.c  
lib/support/plausible.c  
misc/fuse2fs.c  
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misc/blkid.c

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Files: misc/blkid.8.in

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misc/badblocks.c

misc/chattr.c

misc/dumpe2fs.c

misc/lsattr.c

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misc/tune2fs.c

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Additionally the following files are automatically generated by tools provided by the same projects:

- - `\_\_init\_\_.py`
- `fastjsonschema\_validations.py`

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`fastjsonschema`  
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# 1.185 curl 8.12.1-r1

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as a successor of a language called ABC. Guido remains Python's principal author, although it includes many contributions from others.

In 1995, Guido continued his work on Python at the Corporation for National Research Initiatives (CNRI, see <https://www.cnri.reston.va.us>) in Reston, Virginia where he released several versions of the software.

In May 2000, Guido and the Python core development team moved to BeOpen.com to form the BeOpen PythonLabs team. In October of the same year, the PythonLabs team moved to Digital Creations, which became Zope Corporation. In 2001, the Python Software Foundation (PSF, see <https://www.python.org/psf/>) was formed, a non-profit organization created specifically to own Python-related Intellectual Property. Zope Corporation was a sponsoring member of the PSF.

All

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|----------------|--------------|-----------|------------|---------------------|
| 0.9.0 thru 1.2 |              | 1991-1995 | CWI        | yes                 |
| 1.3 thru 1.5.2 | 1.2          | 1995-1999 | CNRI       | yes                 |
| 1.6            | 1.5.2        | 2000      | CNRI       | no                  |
| 2.0            | 1.6          | 2000      | BeOpen.com | no                  |
| 1.6.1          | 1.6          | 2001      | CNRI       | yes (2)             |
| 2.1            | 2.0+1.6.1    | 2001      | PSF        | no                  |
| 2.0.1          | 2.0+1.6.1    | 2001      | PSF        | yes                 |
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| 2.1.2          | 2.1.1        | 2002      | PSF        | yes                 |
| 2.1.3          | 2.1.2        | 2002      | PSF        | yes                 |
| 2.2 and above  | 2.1.1        | 2001-now  |            |                     |
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In 1995, Guido continued his work on Python at the Corporation for National Research Initiatives (CNRI, see <http://www.cnri.reston.va.us>) in Reston, Virginia where he released several versions of the software.

In May 2000, Guido and the Python core development team moved to BeOpen.com to form the BeOpen PythonLabs team. In October of the same year, the PythonLabs team moved to Digital Creations (now Zope Corporation, see <http://www.zope.com>). In 2001, the Python Software Foundation (PSF, see <http://www.python.org/psf/>) was formed, a non-profit organization created specifically to own Python-related Intellectual Property. Zope Corporation is a sponsoring member of the PSF.

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#### A. HISTORY OF THE SOFTWARE

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Python was created in the early 1990s by Guido van Rossum at Stichting Mathematisch Centrum (CWI, see <http://www.cwi.nl>) in the Netherlands as a successor of a language called ABC. Guido remains Python's principal author, although it includes many contributions from others.

In 1995, Guido continued his work on Python at the Corporation for National Research Initiatives (CNRI, see <http://www.cnri.reston.va.us>) in Reston, Virginia where he released several versions of the software.

In May 2000, Guido and the Python core development team moved to BeOpen.com to form the BeOpen PythonLabs team. In October of the same year, the PythonLabs team moved to Digital Creations (now Zope Corporation, see <http://www.zope.com>). In 2001, the Python Software Foundation (PSF, see <http://www.python.org/psf/>) was formed, a non-profit organization created specifically to own Python-related Intellectual Property. Zope Corporation is a sponsoring member of the PSF.

All Python releases are Open Source (see <http://www.opensource.org> for the Open Source Definition). Historically, most, but not all, Python releases have also been GPL-compatible; the table below summarizes the various releases.

| Release        | Derived from | Year      | Owner      | GPL-compatible? (1) |
|----------------|--------------|-----------|------------|---------------------|
| 0.9.0 thru 1.2 |              | 1991-1995 | CWI        | yes                 |
| 1.3 thru 1.5.2 | 1.2          | 1995-1999 | CNRI       | yes                 |
| 1.6            | 1.5.2        | 2000      | CNRI       | no                  |
| 2.0            | 1.6          | 2000      | BeOpen.com | no                  |
| 1.6.1          | 1.6          | 2001      | CNRI       | yes (2)             |
| 2.1            | 2.0+1.6.1    | 2001      | PSF        | no                  |
| 2.0.1          | 2.0+1.6.1    | 2001      | PSF        | yes                 |
| 2.1.1          | 2.1+2.0.1    | 2001      | PSF        | yes                 |
| 2.2            | 2.1.1        | 2001      | PSF        | yes                 |
| 2.1.2          | 2.1.1        | 2002      | PSF        | yes                 |
| 2.1.3          |              |           |            |                     |

|       |       |           |     |     |
|-------|-------|-----------|-----|-----|
| 2.1.2 | 2002  | PSF       | yes |     |
| 2.2.1 | 2.2   | 2002      | PSF | yes |
| 2.2.2 | 2.2.1 | 2002      | PSF | yes |
| 2.2.3 | 2.2.2 | 2003      | PSF | yes |
| 2.3   | 2.2.2 | 2002-2003 | PSF | yes |
| 2.3.1 | 2.3   | 2002-2003 | PSF | yes |
| 2.3.2 | 2.3.1 | 2002-2003 | PSF | yes |
| 2.3.3 | 2.3.2 | 2002-2003 | PSF | yes |
| 2.3.4 | 2.3.3 | 2004      | PSF | yes |
| 2.3.5 | 2.3.4 | 2005      | PSF | yes |
| 2.4   | 2.3   | 2004      | PSF | yes |
| 2.4.1 | 2.4   | 2005      | PSF | yes |
| 2.4.2 | 2.4.1 | 2005      | PSF | yes |
| 2.4.3 | 2.4.2 | 2006      | PSF | yes |
| 2.4.4 | 2.4.3 | 2006      | PSF | yes |
| 2.5   | 2.4   | 2006      | PSF | yes |
| 2.5.1 | 2.5   | 2007      | PSF | yes |
| 2.5.2 | 2.5.1 | 2008      | PSF | yes |
| 2.5.3 | 2.5.2 | 2008      | PSF | yes |
| 2.6   | 2.5   | 2008      | PSF | yes |
| 2.6.1 | 2.6   | 2008      | PSF | yes |
| 2.6.2 | 2.6.1 | 2009      | PSF | yes |
| 2.6.3 | 2.6.2 | 2009      | PSF | yes |
| 2.6.4 | 2.6.3 | 2009      | PSF | yes |
| 2.6.5 | 2.6.4 | 2010      | PSF | yes |
| 3.0   | 2.6   | 2008      | PSF | yes |
| 3.0.1 | 3.0   | 2009      | PSF | yes |
| 3.1   | 3.0.1 | 2009      | PSF | yes |
| 3.1.1 | 3.1   | 2009      | PSF | yes |
| 3.1.2 | 3.1   | 2010      | PSF | yes |
| 3.2   | 3.1   | 2010      | PSF | yes |

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# 1.190 ncurses 6.5\_p20241006-r3

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-- vile: txtmode file-encoding=utf-8

Upstream source <https://invisible-island.net/ncurses/ncurses.html>

This package is used for testing builds of ncurses.

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This license, the Lesser General Public License, applies to some specially designated software packages--typically libraries--of the Free Software Foundation and other authors who decide to use it. You can use it too, but we suggest you first think carefully about whether this license or the ordinary General Public License is the better strategy to use in any particular case, based on the explanations below.

When we speak of free software, we are referring to freedom of use,

not price. Our General Public Licenses are designed to make sure that you have the freedom to distribute copies of free software (and charge for this service if you wish); that you receive source code or can get it if you want it; that you can change the software and use pieces of it in new free programs; and that you are informed that you can do these things.

To protect your rights, we need to make restrictions that forbid distributors to deny you these rights or to ask you to surrender these rights. These restrictions translate to certain responsibilities for you if you distribute copies of the library or if you modify it.

For example, if you distribute copies of the library, whether gratis or for a fee, you must give the recipients all the rights that we gave you. You must make sure that they, too, receive or can get the source code. If you link other code with the library, you must provide complete object files to the recipients, so that they can relink them with the library after making changes to the library and recompiling it. And you must show them these terms so they know their rights.

We protect your rights with a two-step method: (1) we copyright the library, and (2) we offer you this license, which gives you legal permission to copy, distribute and/or modify the library.

To protect each distributor, we want to make it very clear that there is no warranty for the free library. Also, if the library is modified by someone else and passed on, the recipients should know that what they have is not the original version, so that the original author's reputation will not be affected by problems that might be introduced by others.

Finally, software patents pose a constant threat to the existence of any free program. We wish to make sure that a company cannot effectively restrict the users of a free program by obtaining a restrictive license from a patent holder. Therefore, we insist that any patent license obtained for a version of the library must be consistent with the full freedom of use specified in this license.

Most GNU software, including some libraries, is covered by the ordinary GNU General Public License. This license, the GNU Lesser General Public License, applies to certain designated libraries, and is quite different from the ordinary General Public License. We use this license for certain libraries in order to permit linking those libraries into non-free programs.

When a program is linked with a library, whether statically or using

a shared library, the combination of the two is legally speaking a combined work, a derivative of the original library. The ordinary General Public License therefore permits such linking only if the entire combination fits its criteria of freedom. The Lesser General Public License permits more lax criteria for linking other code with the library.

We call this license the "Lesser" General Public License because it does Less to protect the user's freedom than the ordinary General Public License. It also provides other free software developers Less of an advantage over competing non-free programs. These disadvantages are the reason we use the ordinary General Public License for many libraries. However, the Lesser license provides advantages in certain special circumstances.

For example, on rare occasions, there may be a special need to encourage the widest possible use of a certain library, so that it becomes a de-facto standard. To achieve this, non-free programs must be allowed to use the library. A more frequent case is that a free library does the same job as widely used non-free libraries. In this case, there is little to gain by limiting the free library to free software only, so we use the Lesser General Public License.

In other cases, permission to use a particular library in non-free programs enables a greater number of people to use a large body of free software. For example, permission to use the GNU C Library in non-free programs enables many more people to use the whole GNU operating system, as well as its variant, the GNU/Linux operating system.

Although the Lesser General Public License is Less protective of the users' freedom, it does ensure that the user of a program that is linked with the Library has the freedom and the wherewithal to run that program using a modified version of the Library.

The precise terms and conditions for copying, distribution and modification follow. Pay close attention to the difference between a "work based on the library" and a "work that uses the library". The former contains code derived from the library, whereas the latter must be combined with the library in order to run.

## GNU LESSER GENERAL PUBLIC LICENSE

### TERMS AND CONDITIONS FOR COPYING, DISTRIBUTION AND MODIFICATION

0. This License Agreement applies to any software library or other program which contains a notice placed by the copyright holder or

other authorized party saying it may be distributed under the terms of this Lesser General Public License (also called "this License"). Each licensee is addressed as "you".

A "library" means a collection of software functions and/or data prepared so as to be conveniently linked with application programs (which use some of those functions and data) to form executables.

The "Library", below, refers to any such software library or work which has been distributed under these terms. A "work based on the Library" means either the Library or any derivative work under copyright law: that is to say, a work containing the Library or a portion of it, either verbatim or with modifications and/or translated straightforwardly into another language. (Hereinafter, translation is included without limitation in the term "modification".)

"Source code" for a work means the preferred form of the work for making modifications to it. For a library, complete source code means all the source code for all modules it contains, plus any associated interface definition files, plus the scripts used to control compilation and installation of the library.

Activities other than copying, distribution and modification are not covered by this License; they are outside its scope. The act of running a program using the Library is not restricted, and output from such a program is covered only if its contents constitute a work based on the Library (independent of the use of the Library in a tool for writing it). Whether that is true depends on what the Library does and what the program that uses the Library does.

1. You may copy and distribute verbatim copies of the Library's complete source code as you receive it, in any medium, provided that you conspicuously and appropriately publish on each copy an appropriate copyright notice and disclaimer of warranty; keep intact all the notices that refer to this License and to the absence of any warranty; and distribute a copy of this License along with the Library.

You may charge a fee for the physical act of transferring a copy, and you may at your option offer warranty protection in exchange for a fee.

2. You may modify your copy or copies of the Library or any portion of it, thus forming a work based on the Library, and copy and distribute such modifications or work under the terms of Section 1 above, provided that you also meet all of these conditions:

a) The modified work must itself be a software library.

b) You must cause the files modified to carry prominent notices stating that you changed the files and the date of any change.

c) You must cause the whole of the work to be licensed at no charge to all third parties under the terms of this License.

d) If a facility in the modified Library refers to a function or a table of data to be supplied by an application program that uses the facility, other than as an argument passed when the facility is invoked, then you must make a good faith effort to ensure that, in the event an application does not supply such function or table, the facility still operates, and performs whatever part of its purpose remains meaningful.

(For example, a function in a library to compute square roots has a purpose that is entirely well-defined independent of the application. Therefore, Subsection 2d requires that any application-supplied function or table used by this function must be optional: if the application does not supply it, the square root function must still compute square roots.)

These requirements apply to the modified work as a whole. If identifiable sections of that work are not derived from the Library, and can be reasonably considered independent and separate works in themselves,

then this License, and its terms, do not apply to those sections when you distribute them as separate works. But when you distribute the same sections as part of a whole which is a work based on the Library, the distribution of the whole must be on the terms of this License, whose permissions for other licensees extend to the entire whole, and thus to each and every part regardless of who wrote it.

Thus, it is not the intent of this section to claim rights or contest your rights to work written entirely by you; rather, the intent is to exercise the right to control the distribution of derivative or collective works based on the Library.

In addition, mere aggregation of another work not based on the Library with the Library (or with a work based on the Library) on a volume of a storage or distribution medium does not bring the other work under the scope of this License.

3. You may opt to apply the terms of the ordinary GNU General Public

License instead of this License to a given copy of the Library. To do this, you must alter all the notices that refer to this License, so that they refer to the ordinary GNU General Public License, version 2, instead of to this License. (If a newer version than version 2 of the ordinary GNU General Public License has appeared, then you can specify that version instead if you wish.) Do not make any other change in these notices.

Once this change is made in a given copy, it is irreversible for that copy, so the ordinary GNU General Public License applies to all subsequent copies and derivative works made from that copy.

This option is useful when you wish to copy part of the code of the Library into a program that is not a library.

4. You may copy and distribute the Library (or a portion or derivative of it, under Section 2) in object code or executable form under the terms of Sections 1 and 2 above provided that you accompany it with the complete corresponding machine-readable source code, which must be distributed under the terms of Sections 1 and 2 above on a medium customarily used for software interchange.

If distribution of object code is made by offering access to copy from a designated place, then offering equivalent access to copy the source code from the same place satisfies the requirement to distribute the source code, even though third parties are not compelled to copy the source along with the object code.

5. A program that contains no derivative of any portion of the Library, but is designed to work with the Library by being compiled or linked with it, is called a "work that uses the Library". Such a work, in isolation, is not a derivative work of the Library, and therefore falls outside the scope of this License.

However, linking a "work that uses the Library" with the Library creates an executable that is a derivative of the Library (because it contains portions of the Library), rather than a "work that uses the library". The executable is therefore covered by this License.

Section 6 states terms for distribution of such executables.

When a "work that uses the Library" uses material from a header file that is part of the Library, the object code for the work may be a derivative work of the Library even though the source code is not. Whether this is true is especially significant if the work can be linked without the Library, or if the work is itself a library. The



threshold for this to be true is not precisely defined by law.

If such an object file uses only numerical parameters, data structure layouts and accessors, and small macros and small inline functions (ten lines or less in length), then the use of the object file is unrestricted, regardless of whether it is legally a derivative work. (Executables containing this object code plus portions of the Library will still fall under Section 6.)

Otherwise, if the work is a derivative of the Library, you may distribute the object code for the work under the terms of Section 6.

Any executables

containing that work also fall under Section 6,  
whether or not they are linked directly with the Library itself.

6. As an exception to the Sections above, you may also combine or link a "work that uses the Library" with the Library to produce a work containing portions of the Library, and distribute that work under terms of your choice, provided that the terms permit modification of the work for the customer's own use and reverse engineering for debugging such modifications.

You must give prominent notice with each copy of the work that the Library is used in it and that the Library and its use are covered by this License. You must supply a copy of this License. If the work during execution displays copyright notices, you must include the copyright notice for the Library among them, as well as a reference directing the user to the copy of this License. Also, you must do one of these things:

a) Accompany the work with the complete corresponding machine-readable source code for the Library including whatever changes were used in the work (which must be distributed under Sections 1 and 2 above); and, if the work is an executable linked with the Library, with the complete machine-readable "work that uses the Library", as object code and/or source code, so that the user can modify the Library and then relink to produce a modified executable containing the modified Library. (It is understood that the user who changes the contents of definitions files in the Library will not necessarily be able to recompile the application to use the modified definitions.)

b) Use a suitable shared library mechanism for linking with the Library. A suitable mechanism is one that (1) uses at run time a copy of the library already present on the user's computer system, rather than copying library functions into the executable, and (2) will operate properly with a modified version of the library, if

the user  
installs one, as long as the modified version is  
interface-compatible with the version that the work was made with.

c) Accompany the work with a written offer, valid for at least three years, to give the same user the materials specified in Subsection 6a, above, for a charge no more than the cost of performing this distribution.

d) If distribution of the work is made by offering access to copy from a designated place, offer equivalent access to copy the above specified materials from the same place.

e) Verify that the user has already received a copy of these materials or that you have already sent this user a copy.

For an executable, the required form of the "work that uses the Library" must include any data and utility programs needed for reproducing the executable from it. However, as a special exception, the materials to be distributed need not include anything that is normally distributed (in either source or binary form) with the major components (compiler, kernel, and so on) of the operating system on which the executable runs, unless that component itself accompanies the executable.

It may happen that this requirement contradicts the license restrictions of other proprietary libraries that do not normally accompany the operating system. Such a contradiction means you cannot use both them and the Library together in an executable that you distribute.

7. You may place library facilities that are a work based on the Library side-by-side in a single library together with other library facilities not covered by this License, and distribute such a combined library, provided that the separate distribution of the work based on the Library and of the other library facilities is otherwise permitted, and provided that you do these two things:

a) Accompany the combined library with a copy of the same work based on the Library, uncombined with any other library facilities. This must be distributed under the terms of the Sections above.

b) Give prominent notice with the combined library of the fact that part of it is a work based on the Library, and explaining where to find the accompanying uncombined form of the same work.

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integrity of the free software distribution system which is implemented by public license practices. Many people have made generous contributions to the wide range of software distributed through that system in reliance on consistent application of that system; it is up to the author/donor to decide if he or she is willing to distribute software through any other system and a licensee cannot impose that choice.

This section is intended to make thoroughly clear what is believed to be a consequence of the rest of this License.

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#### END OF TERMS AND CONDITIONS

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To apply these terms, attach the following notices to the library. It is safest to attach them to the start of each source file to most effectively convey the exclusion of warranty; and each file should have at least the "copyright" line and a pointer to where the full notice is found.

<one line to give the library's name and a brief idea of what it does.>  
Copyright (C) <year> <name of author>

This library is free software; you can redistribute it and/or modify it under the terms of the GNU Lesser General Public License as published by the Free Software Foundation; either version 2.1 of the License, or (at your option) any later version.

This library is distributed in the hope that it will be useful, but WITHOUT ANY WARRANTY; without even the implied warranty of MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the GNU Lesser General Public License for more details.

You should have received a copy of the GNU Lesser General Public License along with this library; if not, write to the Free Software Foundation, Inc., 59 Temple Place, Suite 330, Boston, MA 02111-1307 USA

Also add information on how to contact you by electronic and paper mail.

You should also  
get your employer (if you work as a programmer) or your school, if any, to sign a "copyright disclaimer" for the library, if necessary. Here is a sample; alter the names:

Yoyodyne, Inc., hereby disclaims all copyright interest in the library `Frob' (a library for tweaking knobs) written by James Random Hacker.

<signature of Ty Coon>, 1 April 1990  
Ty Coon, President of Vice

That's all there is to it!  
\*uganda.txt\* For Vim version 9.1. Last change: 2024 Aug 14

VIM REFERENCE MANUAL by Bram Moolenaar

\*uganda\* \*Uganda\* \*copying\* \*copyright\* \*license\*  
SUMMARY  
\*iccf\* \*ICCF\*

Vim is Charityware. You can use and copy it as much as you like, but you are encouraged to make a donation for needy children in Uganda. Please see |kcc| below or visit the ICCF web site, available at these URLs:

<https://iccf-holland.org/>  
<https://www.vim.org/iccf/>  
<https://www.iccf.nl/>

You can also sponsor the development of Vim, see |sponsor|. The money goes to Uganda anyway.

The Open Publication License applies to the Vim documentation, see |manual-copyright|.

=== begin of license ===

VIM LICENSE

I) There are no restrictions on distributing unmodified copies of Vim except that they must include this license text. You can also distribute

unmodified parts of Vim, likewise unrestricted except that they must include this license text. You are also allowed to include executables that you made from the unmodified Vim sources, plus your own usage examples and Vim scripts.

II) It is allowed to distribute a modified (or extended) version of Vim, including executables and/or source code, when the following four conditions are met:

- 1) This license text must be included unmodified.
- 2) The modified Vim must be distributed in one of the following five ways:

- a) If you make changes to Vim yourself, you must clearly describe in the distribution how to contact you. When the maintainer asks you (in any way) for a copy of the modified Vim you distributed, you must make your changes, including source code, available to the maintainer without fee. The maintainer reserves the right to include your changes in the official version of Vim. What the maintainer will do with your changes and under what license they will be distributed is negotiable. If there has been no negotiation then this license, or a later version,

also applies to your changes.

The current maintainers are listed here: <https://github.com/orgs/vim/people>.

If this changes it will be announced in appropriate places (most likely [vim.sf.net](http://vim.sf.net), [www.vim.org](http://www.vim.org) and/or [comp.editors](http://comp.editors)). When it is completely impossible to contact the maintainer, the obligation to send him your changes ceases. Once the maintainer has confirmed that he has received your changes they will not have to be sent again.

- b) If you have received a modified Vim that was distributed as mentioned under a) you are allowed to further distribute it unmodified, as mentioned at I). If you make additional changes the text under a) applies to those changes.

- c) Provide all the changes, including source code, with every copy of the modified Vim you distribute. This may be done in the form of a context diff. You can choose what license to use for new code you add. The changes and their license must not restrict others from making

their own changes to the official version of Vim.

- d) When you have a modified Vim which includes changes as mentioned under c), you can distribute it without the source code for the changes if the following three conditions are met:

- The license that applies to the changes permits you to distribute the changes to the Vim maintainer without fee or restriction, and permits the Vim maintainer to include the changes in the official version of Vim without fee or restriction.
- You keep the changes for at least three years after last distributing the corresponding modified Vim. When the maintainer or someone who you distributed the modified Vim to asks you (in any way) for the changes within this period, you must make them available to him.

- You clearly describe in the distribution how to contact you. This contact information must remain valid for at least three years after last distributing the corresponding modified

Vim, or as long  
as possible.

- e) When the GNU General Public License (GPL) applies to the changes, you can distribute the modified Vim under the GNU GPL version 2 or any later version.

3) A message must be added, at least in the output of the ":version" command and in the intro screen, such that the user of the modified Vim is able to see that it was modified. When distributing as mentioned under 2)e) adding the message is only required for as far as this does not conflict with the license used for the changes.

4) The contact information as required under 2)a) and 2)d) must not be removed or changed, except that the person himself can make corrections.

III) If you distribute a modified version of Vim, you are encouraged to use the Vim license for your changes and make them available to the maintainer, including the source code. The preferred way to do this is by e-mail or by uploading the files to a server and e-mailing the URL.

If the number of changes is small (e.g., a modified Makefile) e-mailing a context diff will do. The e-mail address to be used is  
<maintainer@vim.org>

IV) It is not allowed to remove this license from the distribution of the Vim sources, parts of it or from a modified version. You may use this license for previous Vim releases instead of the license that they came with, at your option.

=== end of license ===

Note:

- If you are happy with Vim, please express that by reading the rest of this file and consider helping needy children in Uganda.
- If you want to support further Vim development consider becoming a [sponsor]. The money goes to Uganda anyway.
- According to Richard Stallman the Vim license is GNU GPL compatible. A few minor changes have been made since he checked it, but that should not make a difference.
- If you link Vim with a library that goes under the GNU GPL, this limits further distribution



to the GNU GPL. Also when you didn't actually change anything in Vim.

- Once a change is included that goes under the GNU GPL, this forces all further changes to also be made under the GNU GPL or a compatible license.
- If you distribute a modified version of Vim, you can include your name and contact information with the "--with-modified-by" configure argument or the MODIFIED\_BY define.

=====

Kibaale Children's Centre \*kcc\* \*Kibaale\* \*charity\*

Kibaale Children's Centre (KCC) is located in Kibaale, a small town in the south of Uganda, near Tanzania, in East Africa. The area is known as Rakai District. The population is mostly farmers. Although people are poor, there usually is enough food. But this district is suffering from AIDS more than any other part of the world. Some say that it started there. Estimations are that in the past 10 to 30% of the Ugandans are infected with HIV. Because parents die, there are many orphans. In this district about 60,000 children have lost one or both parents, out of a population of 350,000. Although AIDS is now mostly under control, the problems are still continuing.

The children need a lot of help. The KCC is working hard to provide the needy with food, medical care and education. Food and medical care to keep them healthy now, and education so that they can take care of themselves in the future. KCC works on a Christian base, but help is given to children of any religion.

The key to solving the problems in this area is education. This has been neglected in the past years with president Idi Amin and the following civil wars. Now that the government is stable again, the children and parents have to learn how to take care of themselves and how to avoid infections. There is also help for people who are ill and hungry, but the primary goal is to prevent people from getting ill and to teach them how to grow healthy food.

Most of the orphans are living in an extended family. An uncle or older sister is taking care of them. Because these families are big and the income (if any) is low, a child is lucky if it gets healthy food. Clothes, medical care and schooling is beyond its reach. To help these needy children, a sponsorship program was put into place. A child can be financially adopted. For a few dollars a month KCC sees to it that the child gets indispensable items, is healthy, goes to school and KCC takes care of anything else that needs to be done for the child and the family that supports it.

Besides helping the child directly, the environment where the child grows up

needs to be improved. KCC helps schools to improve their teaching methods. There is a demonstration school at the centre and teacher trainings are given. Health workers are being trained, hygiene education is carried out and households are stimulated to build a proper latrine. I helped setting up a production site for cement slabs. These are used to build a good latrine. They are sold below cost price.

There is a clinic at the project, which provides children and their family medical help. Since 2020 a maternity ward was added and 24/7 service is available. When needed, transport to a hospital is offered. Immunization programs are carried out and help is provided when an epidemic is breaking out (measles and cholera have been a problem).

\*donate\*

Summer 1994 to summer 1995 I spent a whole year at the centre, working as a volunteer. I have helped to expand the centre and worked in the area of water and sanitation. I learned that the help that the KCC provides really helps. When I came back to Holland, I wanted to continue supporting KCC. To do this I'm raising funds and organizing the sponsorship program. Please consider one of these possibilities:

1. Sponsor a child in primary school: 17 euro a month (or more).
2. Sponsor a child in secondary school: 25 euro a month (or more).
3. Sponsor the clinic:  
Any amount a month or quarter
4. A one-time donation

Compared with other organizations that do child sponsorship the amounts are very low. This is because the money goes directly to the centre. Less than 5% is used for administration. This is possible because this is a small organization that works with volunteers. If you would like to sponsor a child, you should have the intention to do this for at least one year.

How do you know that the money will be spent right? First of all you have my personal guarantee as the author of Vim. I trust the people that are working at the centre, I know them personally. Furthermore, the centre has been co-sponsored and inspected by World Vision, Save the Children Fund and is now under the supervision of Pacific Academy Outreach Society. The centre is visited about once a year to check the progress (at our own cost). I have visited the centre myself many times, starting in 1993. The visit reports are on the ICCF web site.

If you have  
any further questions, send e-mail: <Bram@vim.org>.

The address of the centre is:  
Kibaale Children's Centre  
p.o. box 1658

Masaka, Uganda, East Africa

Sending money:    \*iccf-donations\*

Check the ICCF web site for the latest information! See |iccf| for the URL.

USA: The methods mentioned below can be used.

If you must send a check send it to our Canadian partner:

<https://www.kuwasha.net/>

Canada: Contact Kuwasha in Surrey, Canada. They take care of the Canadian sponsors for the children in Kibaale. Kuwasha forwards 100% of the money to the project in Uganda. You can send them a one time donation directly.

Look on their site for information about sponsorship:

<https://www.kuwasha.net/>

If you make a donation to Kuwasha you will receive a tax receipt which can be submitted with your tax return.

Holland: Transfer to the account of "Stichting ICCF Holland" in Amersfoort. This will allow for tax deduction if you live in Holland. ING bank, IBAN: NL95 INGB 0004 5487 74

Germany: It is possible to make donations that allow for a tax return.

Check the ICCF web site for the latest information:

<https://iccf-holland.org/germany.html>

Europe: Use a bank transfer if possible. See "Others" below for the swift code and IBAN number.

Any other method should work. Ask for information about sponsorship.

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ING bank: IBAN: NL95 INGB 0004 5487 74

Swift code: INGBNL2A

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vim:tw=78:ts=8:noet:ft=help:norl:

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## 1.194 platformdirs 4.2.2

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The threshold for this to be true is not precisely defined by law.

If such an object file uses only numerical parameters, data structure layouts and accessors, and small macros and small inline functions (ten lines or less in length), then the use of the object file is unrestricted, regardless of whether it is legally a derivative work. (Executables containing this object code plus portions of the Library will still fall under Section 6.)

Otherwise, if the work is a derivative of the Library, you may distribute the object code for the work under the terms of Section 6. Any executables containing that work also fall under Section 6, whether or not they are linked directly with the Library itself.

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For an executable, the required form of the "work that uses the Library" must include any data and utility programs needed for reproducing the executable from it. However, as a special exception, the materials to be distributed need not include anything that is normally distributed (in either source or binary form) with the major components (compiler, kernel, and so on) of the operating system on which the executable runs, unless that component itself accompanies the executable.

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# 1.197 libnl3 3.11.0-r0

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## 1.201 strace 6.12-r0

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Source: <http://www.openbsd.org/cgi-bin/cvsweb/src/usr.bin/nc/>

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## 1.204 lua5.4 5.4.7-r0

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```
@Ci{$Id: manual.of $}  
@C{[(-----}  
@manual{
```

```
@sect1{@title{Introduction}
```

Lua is a powerful, efficient, lightweight, embeddable scripting language.  
It supports procedural programming,  
object-oriented programming, functional programming,  
data-driven programming, and data description.

Lua combines simple procedural syntax with powerful data description  
constructs based on associative arrays and extensible semantics.

Lua is dynamically typed,  
runs by interpreting bytecode with a register-based  
virtual machine,  
and has automatic memory management with  
a generational garbage collection,  
making it ideal for configuration, scripting,  
and rapid prototyping.

Lua is implemented as a library, written in @emphx{clean C},  
the common subset of @N{standard C} and C++.

The Lua distribution includes a host program called @id{lua},  
which uses the Lua library to offer  
a complete,  
standalone Lua interpreter,  
for interactive or batch use.

Lua is intended to be used both as a powerful, lightweight,  
embeddable scripting language for any program that needs one,  
and as a powerful but lightweight and efficient stand-alone language.

As an extension language, Lua has no notion of a @Q{main} program:  
it works @emph{embedded} in a host client,  
called the @emph{embedding program} or simply the @emphx{host}.  
(Frequently, this host is the stand-alone @id{lua} program.)

The host program can invoke functions to execute a piece of Lua code,  
can write and read Lua variables,  
and can register @N{C functions} to be called by Lua code.

Through the use of @N{C functions}, Lua can be augmented to cope with  
a wide range of different domains,  
thus creating customized programming languages sharing a syntactical framework.

Lua is free software,  
and is provided as usual with no guarantees,

as stated in its license.

The implementation described in this manual is available  
at  
Lua's official web site, @id{www.lua.org}.

Like any other reference manual,  
this document is dry in places.  
For a discussion of the decisions behind the design of Lua,  
see the technical papers available at Lua's web site.  
For a detailed introduction to programming in Lua,  
see Roberto's book, @emphx{Programming in Lua}.

}

@C{-----}  
@sect1{basic| @title{Basic Concepts}

@simplesect{

This section describes the basic concepts of the language.

}

@sect2{TypesSec| @title{Values and Types}

Lua is a dynamically typed language.  
This means that  
variables do not have types; only values do.  
There are no type definitions in the language.  
All values carry their own type.

All values in Lua are first-class values.  
This means that all values can be stored in variables,  
passed as arguments to other functions, and returned as results.

There are eight @x{basic types} in Lua:  
@def{nil}, @def{boolean}, @def{number},  
@def{string},  
@def{function}, @def{userdata},  
@def{thread}, and @def{table}.  
The type @emph{nil} has one single value, @nil,  
whose main property is to be different from any other value;  
it often represents the absence of a useful value.  
The type @emph{boolean} has two values, @false and @true.  
Both @nil and @false make a condition false;  
they are collectively called @def{false values}.  
Any other value makes a condition true.

Despite its name,  
@false is frequently used as an alternative to @nil,  
with the key difference that @false behaves  
like a regular value in a table,  
while a @nil in a table represents an absent key.

The type @emph{number} represents both  
integer numbers and real (floating-point) numbers,  
using two @x{subtypes}: @def{integer} and @def{float}.  
Standard Lua uses 64-bit integers and double-precision (64-bit) floats,  
but you can also compile Lua so that it  
uses 32-bit integers and/or single-precision (32-bit) floats.  
The option with 32 bits for both integers and floats  
is particularly  
attractive  
for small machines and embedded systems.  
(See macro @id{LUA\_32BITS} in file @id{luaconf.h}.)

Unless stated otherwise,  
any overflow when manipulating integer values @def{wrap around},  
according to the usual rules of two-complement arithmetic.  
(In other words,  
the actual result is the unique representable integer  
that is equal modulo @M{2@sp{n}} to the mathematical result,  
where @M{n} is the number of bits of the integer type.)

Lua has explicit rules about when each subtype is used,  
but it also converts between them automatically as needed @see{coercion}.  
Therefore,  
the programmer may choose to mostly ignore the difference  
between integers and floats  
or to assume complete control over the representation of each number.

The type @emph{string} represents immutable sequences of bytes.  
@index{eight-bit clean}  
Lua is 8-bit clean:  
strings can contain any 8-bit value,  
including @x{embedded zeros} (@Char{0}).  
Lua is also encoding-agnostic;  
it makes no assumptions about the contents  
of a string.  
The length of any string in Lua must fit in a Lua integer.

Lua can call (and manipulate) functions written in Lua and  
functions written in C @see{functioncall}.  
Both are represented by the type @emph{function}.

The type @emph{userdata} is provided to allow arbitrary @N{C data} to



be stored in Lua variables.

A userdata value represents a block of raw memory.

There are two kinds of userdata:

@emphx{full userdata},

which is an object with a block of memory managed by Lua,

and @emphx{light userdata},

which is simply a @N{C pointer} value.

Userdata has no predefined operations in Lua,

except assignment and identity test.

By using @emph{metatables},

the programmer can define operations for full userdata values

@see{metatable}.

Userdata values cannot be created or modified in Lua,

only through the @N{C API}.

This guarantees the integrity of data owned by

the host program and @N{C libraries}.

The type @def{thread} represents independent threads of execution  
and it is used to

implement coroutines @see{coroutine}.

Lua threads are not related to operating-system threads.

Lua supports coroutines on all systems,

even those that do not support threads natively.

The type @emph{table} implements @x{associative arrays},  
that is, @x{arrays} that can have as indices not only numbers,  
but any Lua value except @nil and @x{NaN}.

(@emphx{Not a Number} is a special floating-point value

used by the @x{IEEE 754} standard to represent

undefined numerical results, such as @T{0/0}.)

Tables can be @emph{heterogeneous};

that is, they can contain values of all types (except @nil).

Any key associated to the value @nil is not considered part of the table.

Conversely, any key that is not part of a table has

an associated value @nil.

Tables are the sole data-structuring mechanism in Lua;

they can be used to represent ordinary arrays, lists,

symbol tables, sets, records, graphs, trees, etc.

To represent @x{records}, Lua uses the field name as an index.

The language supports this representation

by

providing @id{a.name} as syntactic sugar for @T{a["name"]}.

There are several convenient ways to create tables in Lua

@see{tableconstructor}.

Like indices,

the values of table fields can be of any type.

In particular,  
because functions are first-class values,  
table fields can contain functions.  
Thus tables can also carry `@emph{methods}` `@see{func-def}`.

The indexing of tables follows  
the definition of raw equality in the language.  
The expressions `@T{a[i]}` and `@T{a[j]}`  
denote the same table element  
if and only if `@id{i}` and `@id{j}` are raw equal  
(that is, equal without metamethods).  
In particular, floats with integral values  
are equal to their respective integers  
(e.g., `@T{1.0 == 1}`).  
To avoid ambiguities,  
any float used as a key that is equal to an integer  
is converted to that integer.  
For instance, if you write `@T{a[2.0] = true}`,  
the actual key inserted into the table will be the integer `@T{2}`.

Tables, functions, threads, and (full) userdata values are `@emph{objects}`:  
variables  
do not actually `@emph{contain}` these values,  
only `@emph{references}` to them.  
Assignment, parameter passing, and function returns  
always manipulate references to such values;  
these operations do not imply any kind of copy.

The library function `@Lid{type}` returns a string describing the type  
of a given value `@seeF{type}`.

}

`@sect2{globalenv| @title{Environments and the Global Environment}`

As we will discuss further in `@refsec{variables}` and `@refsec{assignment}`,  
any reference to a free name  
(that is, a name not bound to any declaration) `@id{var}`  
is syntactically translated to `@T{_ENV.var}`.  
Moreover, every chunk is compiled in the scope of  
an external local variable named `@id{_ENV}` `@see{chunks}`,  
so `@id{_ENV}` itself is never a free name in a chunk.

Despite the existence of this external `@id{_ENV}` variable and  
the translation of free names,  
`@id{_ENV}` is a completely regular name.  
In particular,

you can define new variables and parameters with that name.

Each reference to a free

name uses the `@id{_ENV}` that is

visible at that point in the program,

following the usual visibility rules of Lua `@see{visibility}`.

Any table used as the value of `@id{_ENV}` is called an `@def{environment}`.

Lua keeps a distinguished environment called the `@def{global environment}`.

This value is kept at a special index in the C registry `@see{registry}`.

In Lua, the global variable `@Lid{_G}` is initialized with this same value.

(`@Lid{_G}` is never used internally,

so changing its value will affect only your own code.)

When Lua loads a chunk,

the default value for its `@id{_ENV}` variable

is the global environment `@seeF{load}`.

Therefore, by default,

free names in Lua code refer to entries in the global environment

and, therefore, they are also called `@def{global variables}`.

Moreover, all standard libraries are loaded in the global environment

and some functions there operate on that environment.

You can use `@Lid{load}` (or `@Lid{loadfile}`)

to load a chunk with a different environment.

(In C,

you have to load the chunk and then change the value

of its first upvalue; see `@See{lua_setupvalue}`.)

}

`@sect2{error| @title{Error Handling}`

Several operations in Lua can `@emph{raise}` an error.

An error interrupts the normal flow of the program,

which can continue by `@emph{catching}` the error.

Lua code can explicitly raise an error by calling the

`@Lid{error}` function.

(This function never returns.)

To catch errors in Lua,

you can do a `@def{protected call}`,

using `@Lid{pcall}` (or `@Lid{xpcall}`).

The function `@Lid{pcall}` calls a given function in `@def{protected mode}`.

Any error while running the function stops its execution,

and control returns immediately to `@id{pcall}`,

which returns a status code.

Because Lua is an embedded extension language,  
Lua code starts running by a call  
from `@N{C code}` in the host program.  
(When you use Lua standalone,  
the `@id{lua}` application is the host program.)  
Usually, this call is protected;  
so, when an otherwise unprotected error occurs during  
the compilation  
or execution of a Lua chunk,  
control returns to the host,  
which can take appropriate measures,  
such as printing an error message.

Whenever there is an error,  
an `@def{error object}`  
is propagated with information about the error.  
Lua itself only generates errors whose error object is a string,  
but programs can generate errors with  
any value as the error object.  
It is up to the Lua program or its host to handle such error objects.  
For historical reasons,  
an error object is often called an `@def{error message}`,  
even though it does not have to be a string.

When you use `@Lid{xpcall}` (or `@Lid{lua_pcall}`, in C)  
you can give a `@def{message handler}`  
to be called in case of errors.  
This function is called with the original error object  
and returns a new error object.  
It is called before the error unwinds the stack,  
so that it can gather more information about the error,  
for instance by inspecting the stack and creating a stack traceback.  
This message handler is still protected by the  
protected call;  
so, an error inside the message handler  
will call the message handler again.  
If this loop goes on for too long,  
Lua breaks it and returns an appropriate message.  
The message handler is called only for regular runtime errors.  
It is not called for memory-allocation errors  
nor for errors while running finalizers or other message handlers.

Lua also offers a system of `@emph{warnings}` `@seeF{warn}`.  
Unlike errors, warnings do not interfere  
in any way with program execution.  
They typically only generate a message to the user,  
although this behavior can be adapted from C `@seeC{lua_setwarnf}`.

}

@sect2{metatable| @title{Metatables and Metamethods}

Every value in Lua can have a @emph{metatable}.

This @def{metatable} is an ordinary Lua table that defines the behavior of the original value under certain events.

You can change several aspects of the behavior of a value by setting specific fields in its metatable.

For instance, when a non-numeric value is the operand of an addition, Lua

checks for a function in the field @idx{\_\_add} of the value's metatable.

If it finds one,

Lua calls this function to perform the addition.

The key for each event in a metatable is a string with the event name prefixed by two underscores; the corresponding value is called a @def{metavalue}.

For most events, the metavalue must be a function, which is then called a @def{metamethod}.

In the previous example, the key is the string @St{\_\_add} and the metamethod is the function that performs the addition.

Unless stated otherwise,

a metamethod can in fact be any @x{callable value},

which is either a function or a value with a @idx{\_\_call} metamethod.

You can query the metatable of any value

using the @Lid{getmetatable} function.

Lua queries metamethods in metatables using a raw access @seeF{rawget}.

You can replace the metatable of tables

using the @Lid{setmetatable} function.

You cannot change the metatable of other types from Lua code, except by using the @link{debuglib|debug library}.

## Tables

and full userdata have individual metatables,

although multiple tables and userdata can share their metatables.

Values of all other types share one single metatable per type;

that is, there is one single metatable for all numbers,

one for all strings, etc.

By default, a value has no metatable,

but the string library sets a metatable for the string type @see{strlib}.

A detailed list of operations controlled by metatables is given next.

Each event is identified by its corresponding key.

By convention, all metatable keys used by Lua are composed by two underscores followed by lowercase Latin letters.

@description{

@item{@idx{\_\_add}|

the addition (@T{+}) operation.

If any operand for an addition is not a number,

Lua will try to call a metamethod.

It starts by checking the first operand (even if it is a number);

if that operand does not define a metamethod for @idx{\_\_add},

then Lua will check the second operand.

If Lua can find a metamethod,

it calls the metamethod with the two

operands as arguments,

and the result of the call

(adjusted to one value)

is the result of the operation.

Otherwise, if no metamethod is found,

Lua raises an error.

}

@item{@idx{\_\_sub}|

the subtraction (@T{-}) operation.

Behavior similar to the addition operation.

}

@item{@idx{\_\_mul}|

the multiplication (@T{\*}) operation.

Behavior similar to the addition operation.

}

@item{@idx{\_\_div}|

the division (@T{/}) operation.

Behavior similar to the addition operation.

}

@item{@idx{\_\_mod}|

the modulo (@T{%}) operation.

Behavior similar to the addition operation.

}

@item{@idx{\_\_pow}|

the exponentiation (@T{^}) operation.

Behavior similar to the addition operation.

}

@item{@idx{\_\_unm}|

the negation (unary `@T{-}`) operation.  
Behavior similar to the addition operation.  
}

`@item{@idx{__idiv}|`  
the floor division (`@T{//}`) operation.  
Behavior similar to the addition operation.  
}

`@item{@idx{__band}|`  
the bitwise AND (`@T{&}`) operation.  
Behavior similar to the addition operation,  
except that Lua will  
try a metamethod  
if any operand is neither an integer  
nor a float coercible to an integer `@see{coercion}`.  
}

`@item{@idx{__bor}|`  
the bitwise OR (`@T{|}`) operation.  
Behavior similar to the bitwise AND operation.  
}

`@item{@idx{__bxor}|`  
the bitwise exclusive OR (binary `@T{~}`) operation.  
Behavior similar to the bitwise AND operation.  
}

`@item{@idx{__bnot}|`  
the bitwise NOT (unary `@T{~}`) operation.  
Behavior similar to the bitwise AND operation.  
}

`@item{@idx{__shl}|`  
the bitwise left shift (`@T{<<}`) operation.  
Behavior similar to the bitwise AND operation.  
}

`@item{@idx{__shr}|`  
the bitwise right shift (`@T{>>}`) operation.  
Behavior similar to the bitwise AND operation.  
}

`@item{@idx{__concat}|`  
the concatenation (`@T{..}`) operation.  
Behavior similar to the addition operation,  
except that Lua will try a metamethod  
if any operand is neither a string nor a number

(which is always coercible to a string).

}

@item{@idx{\_\_len}|

the length (@T{#}) operation.

If the object is not a string,

Lua will try its

metamethod.

If there is a metamethod,

Lua calls it with the object as argument,

and the result of the call

(always adjusted to one value)

is the result of the operation.

If there is no metamethod but the object is a table,

then Lua uses the table length operation @see{len-op}.

Otherwise, Lua raises an error.

}

@item{@idx{\_\_eq}|

the equal (@T{==}) operation.

Behavior similar to the addition operation,

except that Lua will try a metamethod only when the values

being compared are either both tables or both full userdata

and they are not primitively equal.

The result of the call is always converted to a boolean.

}

@item{@idx{\_\_lt}|

the less than (@T{<}) operation.

Behavior similar to the addition operation,

except that Lua will try a metamethod only when the values

being compared are neither both numbers nor both strings.

Moreover, the result of the call is always converted to a boolean.

}

@item{@idx{\_\_le}|

the less equal (@T{<=}) operation.

Behavior similar to the less than operation.

}

@item{@idx{\_\_index}|

The

indexing access operation @T{table[key]}.

This event happens when @id{table} is not a table or

when @id{key} is not present in @id{table}.

The metavalue is looked up in the metatable of @id{table}.

The metavalue for this event can be either a function, a table,



or any value with an `@idx{__index}` metavalue.  
 If it is a function,  
 it is called with `@id{table}` and `@id{key}` as arguments,  
 and the result of the call  
 (adjusted to one value)  
 is the result of the operation.  
 Otherwise,  
 the final result is the result of indexing this metavalue with `@id{key}`.  
 This indexing is regular, not raw,  
 and therefore can trigger another `@idx{__index}` metavalue.  
 }

`@item{@idx{__newindex}|`  
 The indexing assignment `@T{table[key] = value}`.  
 Like the index event,  
 this event happens when `@id{table}` is not a table or  
 when `@id{key}` is not present in `@id{table}`.  
 The metavalue is looked up in the metatable of `@id{table}`.

Like with indexing,  
 the metavalue for this event can be either a function,  
 a table,  
 or any value with an `@idx{__newindex}` metavalue.  
 If it is a function,  
 it is called with `@id{table}`, `@id{key}`, and `@id{value}` as arguments.  
 Otherwise,  
 Lua repeats the indexing assignment over this metavalue  
 with the same key and value.  
 This assignment is regular, not raw,  
 and therefore can trigger another `@idx{__newindex}` metavalue.

Whenever a `@idx{__newindex}` metavalue is invoked,  
 Lua does not perform the primitive assignment.  
 If needed,  
 the metamethod itself can call `@Lid{rawset}`  
 to do the assignment.  
 }

`@item{@idx{__call}|`  
 The call operation `@T{func(args)}`.  
 This event happens when Lua tries to call a non-function value  
 (that is, `@id{func}` is not a function).  
 The metamethod is looked up in `@id{func}`.  
 If present,  
 the metamethod is called with `@id{func}` as its first argument,  
 followed by the arguments of the original call (`@id{args}`).  
 All results of the call  
 are the results of the operation.

This is the only metamethod that allows multiple results.

}

}

In addition to

the previous list,

the interpreter also respects the following keys in metatables:

@idx{\_\_gc} @see{finalizers},

@idx{\_\_close} @see{to-be-closed},

@idx{\_\_mode} @see{weak-table},

and @idx{\_\_name}.

(The entry @idx{\_\_name},

when it contains a string,

may be used by @Lid{tostring} and in error messages.)

For the unary operators (negation, length, and bitwise NOT),

the metamethod is computed and called with a dummy second operand,

equal to the first one.

This extra operand is only to simplify Lua's internals

(by making these operators behave like a binary operation)

and may be removed in future versions.

For most uses this extra operand is irrelevant.

Because metatables are regular tables,

they can contain arbitrary fields,

not only the event names defined above.

Some functions in the standard library

(e.g., @Lid{tostring})

use other fields in metatables for their own purposes.

It is a good practice to add all needed metamethods to a table

before setting it as a metatable of some object.

In

particular, the @idx{\_\_gc} metamethod works only when this order

is followed @see{finalizers}.

It is also a good practice to set the metatable of an object

right after its creation.

}

@sect2{GC| @title{Garbage Collection}}

@simplesect{

Lua performs automatic memory management.

This means that

you do not have to worry about allocating memory for new objects

or freeing it when the objects are no longer needed.

Lua manages memory automatically by running

a `@def{garbage collector}` to collect all `@emph{dead}` objects.

All memory used by Lua is subject to automatic management:

strings, tables, userdata, functions, threads, internal structures, etc.

An object is considered `@def{dead}`

as soon as the collector can be sure the object

will not be accessed again in the normal execution of the program.

(`@Q{Normal execution}` here excludes finalizers,

which can resurrect dead objects `@see{finalizers}`,

and excludes also operations using the debug library.)

Note that the time when the collector can

be sure that an object

is dead may not coincide with the programmer's expectations.

The only guarantees are that Lua will not collect an object

that may still be accessed in the normal execution of the program,

and it will eventually collect an object

that is inaccessible from Lua.

(Here,

`@emph{inaccessible from Lua}` means that neither a variable nor another live object refer to the object.)

Because Lua has no knowledge about `@N{C code}`,

it never collects objects accessible through the registry `@see{registry}`,

which includes the global environment `@see{globalenv}`.

The garbage collector (GC) in Lua can work in two modes:

incremental and generational.

The default GC mode with the default parameters

are adequate for most uses.

However, programs that waste a large proportion of their time

allocating and freeing memory can benefit from other settings.

Keep in mind that the GC behavior is non-portable

both across platforms and across different Lua releases;

therefore, optimal settings

are also non-portable.

You can change the GC mode and parameters by calling

`@Lid{lua_gc}` `@N{in C}`

or `@Lid{collectgarbage}` in Lua.

You can also use these functions to control

the collector directly (e.g., to stop and restart it).

}

`@sect3{incmode| @title{Incremental Garbage Collection}`

In incremental mode,  
each GC cycle performs a mark-and-sweep collection in small steps  
interleaved with the program's execution.

In this mode,  
the collector uses three numbers to control its garbage-collection cycles:  
the `@def{garbage-collector pause}`,  
the `@def{garbage-collector step multiplier}`,  
and the `@def{garbage-collector step size}`.

The garbage-collector pause  
controls how long the collector waits before starting a new cycle.  
The collector starts a new cycle when the use of memory  
hits `@M{n%}` of the use after the previous collection.  
Larger values make the collector less aggressive.  
Values equal to or less than 100 mean the collector will not wait to  
start a new cycle.  
A value of 200 means that  
the collector waits for the total memory in use  
to double before starting a new cycle.  
The default value is 200; the maximum value is 1000.

The garbage-collector step multiplier  
controls the speed of the collector relative to  
memory allocation,  
that is,  
how many elements it marks or sweeps for each  
kilobyte of memory allocated.  
Larger values make the collector more aggressive but also increase  
the size of each incremental step.  
You should not use values less than 100,  
because they make the collector too slow and  
can result in the collector never finishing a cycle.  
The default value is 100; the maximum value is 1000.

The garbage-collector step size controls the  
size of each incremental step,  
specifically how many bytes the interpreter allocates  
before performing a step.  
This parameter is logarithmic:  
A value of `@M{n}` means the interpreter will allocate `@M{2@sp{n}}`  
bytes between steps and perform equivalent work during the step.  
A large value (e.g., 60) makes the collector a stop-the-world  
(non-incremental)  
collector.  
The default value is 13,  
which means steps of approximately `@N{8 Kbytes}`.

}

@sect3{genmode| @title{Generational Garbage Collection}}

In generational mode,  
the collector does frequent @emph{minor} collections,  
which traverses only objects recently created.  
If after a minor collection the use of memory is still above a limit,  
the collector does a stop-the-world @emph{major} collection,  
which traverses all objects.  
The generational mode uses two parameters:  
the @def{minor multiplier} and the @def{the major multiplier}.

The minor multiplier controls the frequency of minor collections.  
For a minor multiplier @M{x},  
a new minor collection will be done when memory  
grows @M{x%} larger than the memory in use after the previous major  
collection.  
For instance, for a multiplier of 20,  
the collector will do a minor collection when the use of memory  
gets 20% larger than the use after the previous major collection.  
The default value is 20; the maximum value is 200.

The  
major multiplier controls the frequency of major collections.  
For a major multiplier @M{x},  
a new major collection will be done when memory  
grows @M{x%} larger than the memory in use after the previous major  
collection.  
For instance, for a multiplier of 100,  
the collector will do a major collection when the use of memory  
gets larger than twice the use after the previous collection.  
The default value is 100; the maximum value is 1000.

}

@sect3{finalizers| @title{Garbage-Collection Metamethods}}

You can set garbage-collector metamethods for tables  
and, using the @N{C API},  
for full userdata @see{metatable}.  
These metamethods, called @def{finalizers},  
are called when the garbage collector detects that the  
corresponding table or userdata is dead.  
Finalizers allow you to coordinate Lua's garbage collection  
with external resource management such as closing files,  
network or database connections,  
or freeing your own memory.

For an object (table or userdata) to be finalized when collected,  
you

must `@emph{mark}` it for finalization.

`@index{mark}` (for finalization)

You mark an object for finalization when you set its metatable  
and the metatable has a `@idx{__gc}` metamethod.

Note that if you set a metatable without a `@idx{__gc}` field  
and later create that field in the metatable,  
the object will not be marked for finalization.

When a marked object becomes dead,  
it is not collected immediately by the garbage collector.

Instead, Lua puts it in a list.

After the collection,

Lua goes through that list.

For each object in the list,

it checks the object's `@idx{__gc}` metamethod:

If it is present,

Lua calls it with the object as its single argument.

At the end of each garbage-collection cycle,  
the finalizers are called in  
the reverse order that the objects were marked for finalization,  
among those collected in that cycle;  
that is, the first finalizer to be called is the one associated  
with the object marked last in the program.  
The execution of each finalizer may occur at any  
point during  
the execution of the regular code.

Because the object being collected must still be used by the finalizer,  
that object (and other objects accessible only through it)  
must be `@emph{resurrected}` by `Lua.@index{resurrection}`

Usually, this resurrection is transient,

and the object memory is freed in the next garbage-collection cycle.

However, if the finalizer stores the object in some global place  
(e.g., a global variable),

then the resurrection is permanent.

Moreover, if the finalizer marks a finalizing object for finalization again,  
its finalizer will be called again in the next cycle where the  
object is dead.

In any case,

the object memory is freed only in a GC cycle where  
the object is dead and not marked for finalization.

When you close a state `@seeF{lua_close}`,

Lua calls the finalizers of all objects marked for finalization,

following the reverse order that they were marked.  
If any finalizer marks objects for collection during that phase,  
these marks have no effect.

#### Finalizers

cannot yield nor run the garbage collector.  
Because they can run in unpredictable times,  
it is good practice to restrict each finalizer  
to the minimum necessary to properly release  
its associated resource.

Any error while running a finalizer generates a warning;  
the error is not propagated.

}

@sect3{weak-table| @title{Weak Tables}

A @def{weak table} is a table whose elements are  
@def{weak references}.  
A weak reference is ignored by the garbage collector.  
In other words,  
if the only references to an object are weak references,  
then the garbage collector will collect that object.

A weak table can have weak keys, weak values, or both.  
A table with weak values allows the collection of its values,  
but prevents the collection of its keys.  
A table with both weak keys and weak values allows the collection of  
both keys and values.  
In any case, if either the key or the value is collected,  
the whole pair is removed from the table.  
The weakness of a table is controlled by the  
@idx{\_\_mode}  
field of its metatable.  
This metavalue, if present, must be one of the following strings:  
@St{k}, for a table with weak keys;  
@St{v}, for a table with weak values;  
or @St{kv}, for a table with both weak keys and values.

A table with weak keys and strong values  
is also called an @def{ephemeron table}.  
In an ephemeron table,  
a value is considered reachable only if its key is reachable.  
In particular,  
if the only reference to a key comes through its value,  
the pair is removed.

Any change in the weakness of a table may take effect only at the next collect cycle.

In particular, if you change the weakness to a stronger mode, Lua may still collect some items from that table before the change takes effect.

Only objects that have an explicit construction are removed from weak tables.

Values, such as numbers and `@x{light @N{C functions}}`, are not subject to garbage collection, and therefore are not removed from weak tables (unless their associated values are collected).

Although strings are subject to garbage collection, they do not have an explicit construction and their equality is by value; they behave more like values than like objects. Therefore, they are not removed from weak tables.

Resurrected objects (that is, objects being finalized and objects accessible only through objects being finalized) have a special behavior in weak tables.

They are removed from weak values before running their finalizers, but are removed from weak keys only in the next collection after running their finalizers, when such objects are actually freed. This behavior allows the finalizer to access properties associated with the object through weak tables.

If a weak table is among the resurrected objects in a collection cycle, it may not be properly cleared until the next cycle.

}

}

@sect2{coroutine| @title{Coroutines}

Lua supports coroutines, also called `@emphx{collaborative multithreading}`. A coroutine in Lua represents an independent thread of execution. Unlike threads in multithread systems, however, a coroutine only suspends its execution by explicitly calling a yield function.

You create a coroutine by calling `@Lid{coroutine.create}`. Its sole argument is a function



that is the main function of the coroutine.

The `@id{create}` function only creates a new coroutine and returns a handle to it (an object of type `@emph{thread}`); it does not start the coroutine.

You execute a coroutine by calling `@Lid{coroutine.resume}`.

When you first call `@Lid{coroutine.resume}`, passing as its first argument a thread returned by `@Lid{coroutine.create}`, the coroutine starts its execution by calling its main function.

Extra arguments passed to `@Lid{coroutine.resume}` are passed as arguments to that function.

After the coroutine starts running, it runs until it terminates or `@emph{yields}`.

A coroutine can terminate its execution in two ways: normally, when its main function returns (explicitly or implicitly, after the last instruction); and abnormally, if there is an unprotected error.

In case of normal termination, `@Lid{coroutine.resume}` returns `@true`, plus any values returned by the coroutine main function. In case of errors, `@Lid{coroutine.resume}` returns `@false` plus the error object. In this case, the coroutine does not unwind its stack, so that it is possible to inspect it after the error with the debug API.

A coroutine yields by calling `@Lid{coroutine.yield}`.

When a coroutine yields, the corresponding `@Lid{coroutine.resume}` returns immediately, even if the yield happens inside nested function calls (that is, not in the main function, but in a function directly or indirectly called by the main function). In the case of a yield, `@Lid{coroutine.resume}` also returns `@true`, plus any values passed to `@Lid{coroutine.yield}`. The next time you resume the same coroutine, it continues its execution from the point where it yielded, with the call to `@Lid{coroutine.yield}` returning any extra arguments passed to `@Lid{coroutine.resume}`.

Like `@Lid{coroutine.create}`, the `@Lid{coroutine.wrap}` function also creates a coroutine, but instead of returning the coroutine itself, it returns a function that, when called, resumes the coroutine.

Any arguments passed to this function go as extra arguments to `@Lid{coroutine.resume}`.  
`@Lid{coroutine.wrap}` returns all the values returned by `@Lid{coroutine.resume}`, except the first one (the boolean error code).  
Unlike `@Lid{coroutine.resume}`, the function created by `@Lid{coroutine.wrap}` propagates any error to the caller.  
In this case, the function also closes the coroutine `@seeF{coroutine.close}`.

As an example of how coroutines work, consider the following code:

```
@verbatim{
function foo (a)
  print("foo", a)
  return coroutine.yield(2*a)
end

co = coroutine.create(function (a,b)
  print("co-body", a, b)
  local r = foo(a+1)
  print("co-body", r)
  local r, s = coroutine.yield(a+b, a-b)
  print("co-body", r, s)
  return b, "end"
end)

print("main", coroutine.resume(co, 1, 10))
print("main", coroutine.resume(co,
  "r"))
print("main", coroutine.resume(co, "x", "y"))
print("main", coroutine.resume(co, "x", "y"))
}
```

When you run it, it produces the following output:

```
@verbatim{
co-body 1    10
foo    2
main   true  4
co-body r
main   true  11  -9
co-body x    y
main   true  10   end
main   false cannot resume dead coroutine
}
```

You can also create and manipulate coroutines through the C API:  
see functions `@Lid{lua_newthread}`, `@Lid{lua_resume}`,  
and `@Lid{lua_yield}`.

}

}

@C{-----}

@sect1{language| @title{The Language}}

@simplesect{

This section describes the lexis, the syntax, and the semantics of Lua.

In other words,

this section describes

which tokens are valid,

how they can be combined,

and what their combinations mean.

Language constructs will be explained using the usual extended BNF notation,

in which

@N{@bnfrep{@rep{a}} means 0} or more @rep{a}'s, and

@N{@bnfopt{@rep{a}} means} an

optional @rep{a}.

Non-terminals are shown like @bnfNter{non-terminal},

keywords are shown like @rw{kword},

and other terminal symbols are shown like @bnfter{=}.

The complete syntax of Lua can be found in @refsec{BNF}

at the end of this manual.

}

@sect2{lexical| @title{Lexical Conventions}}

Lua is a @x{free-form} language.

It ignores spaces and comments between lexical elements (@x{tokens}),

except as delimiters between two tokens.

In source code,

Lua recognizes as spaces the standard ASCII whitespace

characters space, form feed, newline,

carriage return, horizontal tab, and vertical tab.

@def{Names}

(also called @def{identifiers})

in Lua can be any string of Latin letters,

Arabic-Indic digits, and underscores,

not beginning with a digit and

not being a reserved word.

Identifiers are used to name variables, table fields, and labels.

The following @def{keywords} are reserved and cannot be used as names:

```
@index{reserved words}
@verbatim{
and    break    do      else    elseif
      end
false  for      function goto  if     in
local  nil     not     or     repeat return
then   true    until   while
}
```

Lua is a case-sensitive language:

@id{and} is a reserved word, but @id{And} and @id{AND} are two different, valid names.

As a convention, programs should avoid creating names that start with an underscore followed by one or more uppercase letters (such as @Lid{\_VERSION}).

The following strings denote other @x{tokens}:

```
@verbatim{
+   -   *   /   %   ^   #
&   ~   |   <<  >>  //
==  ~=  <=  >=  <   >   =
(   )   {   }   [   ]   ::
;   :   ,   .   ..  ...
}
```

A @def{short literal string}

can be delimited by matching single or double quotes, and can contain the following C-like escape sequences:

```
@Char{\a} (bell),
@Char{\b} (backspace),
@Char{\f} (form feed),
@Char{\n} (newline),
@Char{\r} (carriage return),
@Char{\t} (horizontal tab),
@Char{\v} (vertical tab),
@Char{\\} (backslash),
@Char{\"}
(quotation mark [double quote]),
and @Char{'\'} (apostrophe [single quote]).
```

A backslash followed by a line break results in a newline in the string.

The escape sequence @Char{\z} skips the following span of whitespace characters, including line breaks;

it is particularly useful to break and indent a long literal string into multiple lines without adding the newlines and spaces into the string contents.

A short literal string cannot contain unescaped line breaks nor escapes not forming a valid escape sequence.

We can specify any byte in a short literal string, including `@x{embedded zeros}`, by its numeric value.

This can be done

with the escape sequence `@T{\x@rep{XX}}`,

where `@rep{XX}` is a sequence of exactly two hexadecimal digits,

or with the escape sequence `@T{\@rep{ddd}}`,

where `@rep{ddd}` is a sequence of up to three decimal digits.

(Note that if a decimal escape sequence is to be followed by a digit, it must be expressed using exactly three digits.)

The `@x{UTF-8}` encoding

of a `@x{Unicode}` character

can be inserted in a literal string with

the escape sequence `@T{\u{@rep{XXX}}}`

(with mandatory enclosing braces),

where `@rep{XXX}` is a sequence of one or more hexadecimal digits representing the character code point.

This code point can be any value less than `@M{2@sp{31}}`.

(Lua uses the original UTF-8 specification here,

which is not restricted to valid Unicode code points.)

Literal strings can also be defined using a long format

enclosed by `@def{long brackets}`.

We define an `@def{opening long bracket of level @rep{n}}` as an opening square bracket followed by `@rep{n}` equal signs followed by another opening square bracket.

So, an opening long bracket of `@N{level 0}` is written as `@T{[[, @C{]]}`

an opening long bracket of `@N{level 1}` is written as `@T{[=[, @C{]]}`

and so on.

A `@emph{closing long bracket}` is defined similarly;

for instance,

a closing long bracket of `@N{level 4}` is written as `@C{[[ @T{]===}]}`.

A `@def{long literal}` starts with an opening long bracket of any level and

ends at the first closing long bracket of the same level.

It can contain any text except a closing bracket of the same level.

Literals in this bracketed form can run for several lines,

do not interpret any escape sequences,

and ignore long brackets of any other level.

Any kind of end-of-line sequence

(carriage return, newline, carriage return followed by newline,

or newline followed by carriage return)  
is converted to a simple newline.  
When the opening long bracket is immediately followed by a newline,  
the newline is not included in the string.

As an example, in a system using ASCII  
(in which `@Char{a}` is coded `@N{as 97}`,  
newline is coded `@N{as 10}`, and `@Char{1}` is coded `@N{as 49}`),  
the five literal strings below denote the same string:

```
@verbatim{
a = 'alo\n123'
a = "alo\n123"
a = "\97lo\10\04923"
a = [[alo
123]]
a = [=[
alo
123]=]
}
```

Any byte in a literal string not  
explicitly affected by the previous rules represents itself.  
However, Lua opens files for  
parsing in text mode,  
and the system's file functions may have problems with  
some control characters.  
So, it is safer to represent  
binary data as a quoted literal with  
explicit escape sequences for the non-text characters.

A `@def{numeric constant}` (or `@def{numeral}`)  
can be written with an optional fractional part  
and an optional decimal exponent,  
marked by a letter `@Char{e}` or `@Char{E}`.  
Lua also accepts `@x{hexadecimal constants}`,  
which start with `@T{0x}` or `@T{0X}`.  
Hexadecimal constants also accept an optional fractional part  
plus an optional binary exponent,  
marked by a letter `@Char{p}` or `@Char{P}` and written in decimal.  
(For instance, `@T{0x1.fp10}` denotes 1984,  
which is `@M{0x1f / 16}` multiplied by `@M{2@sp{10}}`.)

A numeric constant with a radix point or an exponent  
denotes a float;  
otherwise,  
if its value fits in an integer or it is a hexadecimal constant,  
it denotes an integer;  
otherwise (that is, a decimal integer numeral that overflows),

it denotes a float.

Hexadecimal numerals

with neither a radix point nor an exponent

always denote an integer value;

if the value overflows, it `@emph{wraps around}`

to fit into a valid integer.

Examples of valid integer constants are

`@verbatim{`

`3 345 0xff 0xBEBADA`

`}`

Examples of valid float constants are

`@verbatim{`

`3.0 3.1416 314.16e-2 0.31416E1 34e1`

`0x0.1E 0xA23p-4 0X1.921FB54442D18P+1`

`}`

A `@def{comment}` starts with a double hyphen (`@T{--}`)

anywhere outside a string.

If the text immediately after `@T{--}` is not an opening long bracket,

the comment is a `@def{short comment}`,

which runs until the end of the line.

Otherwise, it is a `@def{long comment}`,

which runs until the corresponding closing long bracket.

`}`

`@sect2{variables| @title{Variables}}`

Variables are places that store values.

There are three kinds of variables in Lua:

global variables, local variables, and table fields.

A single name can denote a global variable or a local variable

(or a function's formal parameter,

which is a particular kind of

local variable):

`@Produc{`

`@producname{var}@producbody{@bnfNter{Name}}`

`}`

`@bnfNter{Name}` denotes identifiers `@see{lexical}`.

Any variable name is assumed to be global unless explicitly declared

as a local `@see{localvar}`.

`@x{Local variables}` are `@emph{lexically scoped}`:

local variables can be freely accessed by functions

defined inside their scope `@see{visibility}`.

Before the first assignment to a variable, its value is `@nil`.

Square brackets are used to index a table:

```
@Produc{
@producname{var}@producbody{prefixexp @bnfter{[] exp @bnfter{[]}}
}
```

The meaning of accesses to table fields can be changed via metatables

`@see{metatable}`.

The syntax `@id{var.Name}` is just syntactic sugar for

`@T{var["Name"]}`:

```
@Produc{
@producname{var}@producbody{prefixexp @bnfter{.} @bnfNter{Name}}
}
```

An access to a global variable `@id{x}`

is equivalent to `@id{_ENV.x}`.

Due to the way that chunks are compiled,

the variable `@id{_ENV}` itself is never global `@see{globalenv}`.

```
}
```

```
@sect2{stats| @title{Statements}}
```

```
@simplesect{
```

Lua

supports an almost conventional set of `@x{statements}`,

similar to those in other conventional languages.

This set includes

blocks, assignments, control structures, function calls,

and variable declarations.

```
}
```

```
@sect3{@title{Blocks}}
```

A `@x{block}` is a list of statements,

which are executed sequentially:

```
@Produc{
@producname{block}@producbody{@bnfrep{stat}}
}
```

Lua has `@def{empty statements}`

that allow you to separate statements with semicolons,

start a block with a semicolon

or write two semicolons in sequence:

```
@Produc{
@producname{stat}@producbody{@bnfter{;}}
```



```
}
```

Both function calls and assignments  
can start with an open parenthesis.  
This possibility leads to an ambiguity in Lua's grammar.  
Consider the following fragment:

```
@verbatim{  
a = b + c  
(print or io.write)('done')  
}
```

The grammar could see this fragment in two ways:

```
@verbatim{  
a = b + c(print or io.write)('done')
```

```
  
a = b + c; (print or io.write)('done')  
}
```

The current parser always sees such constructions  
in the first way,  
interpreting  
the open parenthesis  
as the start of the arguments to a call.  
To avoid this ambiguity,  
it is a good practice to always precede with a semicolon  
statements that start with a parenthesis:

```
@verbatim{  
;(print or io.write)('done')  
}
```

A block can be explicitly delimited to produce a single statement:

```
@Produc{  
@producname{stat}@producbody{@Rw{do} block @Rw{end}}  
}
```

Explicit blocks are useful  
to control the scope of variable declarations.  
Explicit blocks are also sometimes used to  
add a `@Rw{return}` statement in the middle  
of another block `@see{control}`.

```
}
```

```
@sect3{chunks| @title{Chunks}
```

The unit of compilation of Lua is called a `@def{chunk}`.  
Syntactically,  
a chunk is simply a block:

```
@Produc{  
@producname{chunk}@producbody{block}  
}
```

Lua handles a chunk as the body of an anonymous function with a variable number of arguments  
`@see{func-def}`.

As such, chunks can define local variables, receive arguments, and return values.

Moreover, such anonymous function is compiled as in the scope of

an external local variable called `@id{_ENV}` `@see{globalenv}`.

The resulting function always has `@id{_ENV}` as its only external variable, even if it does not use that variable.

A chunk can be stored in a file or in a string inside the host program.

To execute a chunk,

Lua first `@emph{loads}` it,

precompiling the chunk's code into instructions for a virtual machine,

and then Lua executes the compiled code

with an interpreter for the virtual machine.

Chunks can also be precompiled into binary form;

see the program `@idx{luac}` and the function `@Lid{string.dump}` for details.

Programs in source and compiled forms are interchangeable;

Lua automatically detects the file type and acts accordingly `@seeF{load}`.

}

`@sect3{assignment| @title{Assignment}}`

Lua allows `@x{multiple assignments}`.

Therefore, the syntax for assignment

defines a list of variables on the left side

and a list of expressions on the right side.

The elements in both lists are separated by commas:

`@Produc{`

`@producname{stat}@producbody{varlist`

`@bnfter{=} explist`

`@producname{varlist}@producbody{var @bnfrep{@bnfter{,} var}}`

`@producname{explist}@producbody{exp @bnfrep{@bnfter{,} exp}}`

`}`

Expressions are discussed in `@See{expressions}`.

Before the assignment,

the list of values is `@emph{adjusted}` to the length of

the list of variables `@see{multires}`.

If a variable is both assigned and read

inside a multiple assignment,

Lua ensures that all reads get the value of the variable

before the assignment.

Thus the code

```
@verbatim{
```

```
i = 3
```

```
i, a[i] = i+1, 20
```

```
}
```

sets `@T{a[3]}` to 20, without affecting `@T{a[4]}`

because the `@id{i}` in `@T{a[i]}` is evaluated (to 3)

before it is `@N{assigned 4}`.

Similarly, the line

```
@verbatim{
```

```
x, y = y, x
```

```
}
```

exchanges the values of `@id{x}` and `@id{y}`,

and

```
@verbatim{
```

```
x, y, z = y, z, x
```

```
}
```

cyclically permutes the values of `@id{x}`, `@id{y}`, and `@id{z}`.

Note that this guarantee covers only accesses

syntactically inside the assignment statement.

If a function or a metamethod called during the assignment

changes

the value of a variable,

Lua gives no guarantees about the order of that access.

An assignment to a global name `@T{x = val}`

is equivalent to the assignment

```
@T{_ENV.x = val} @see{globalenv}.
```

The meaning of assignments to table fields and

global variables (which are actually table fields, too)

can be changed via metatables `@see{metatable}`.

```
}
```

```
@sect3{control} @title{Control Structures}
```

The control structures

`@Rw{if}`, `@Rw{while}`, and `@Rw{repeat}` have the usual meaning and familiar syntax:

```
@index{while-do statement}
```

```
@index{repeat-until statement}
```

```
@index{if-then-else statement}
```

```
@Produc{
```

```
@producname{stat}@produciblebody{@Rw{while} exp @Rw{do} block @Rw{end}}
```

```
@producname{stat}@produciblebody{@Rw{repeat} block @Rw{until} exp}
```

```
@producname{stat}@produciblebody{@Rw{if} exp @Rw{then} block
```

```

@bnfrep{@Rw{elseif} exp @Rw{then} block}
@bnfopt{@Rw{else} block} @Rw{end}}
}

```

Lua also has a `@Rw{for}` statement, in two flavors `@see{for}`.

The `@x{condition expression}` of a control structure can return any value.

Both

`@false` and `@nil` test false.

All values different from `@nil` and `@false` test true.

In particular, the number 0 and the empty string also test true.

In the `@Rw{repeat}@En@Rw{until}` loop, the inner block does not end at the `@Rw{until}` keyword, but only after the condition.

So, the condition can refer to local variables declared inside the loop block.

The `@Rw{goto}` statement transfers the program control to a label.

For syntactical reasons,

labels in Lua are considered statements too:

```
@index{goto statement}
```

```
@index{label}
```

```
@Produc{
```

```
@producname{stat}@producbody{@Rw{goto} Name}
```

```
@producname{stat}@producbody{label}
```

```
@producname{label}@producbody{@bnfter{::} Name @bnfter{::}}
```

```
}
```

A label is visible in the entire block where it is defined, except inside nested functions.

A goto can jump to any visible label as long as it does not enter into the scope of a local variable.

A label should not be declared

where a label with the same name is visible,

even if this other label has been declared in an enclosing block.

The `@Rw{break}` statement terminates the execution of a `@Rw{while}`, `@Rw{repeat}`, or `@Rw{for}` loop, skipping to the next statement after the loop:

```
@index{break statement}
```

```
@Produc{
```

```
@producname{stat}@producbody{@Rw{break}}
```

```
}
```

A `@Rw{break}` ends the innermost enclosing loop.

The `@Rw{return}` statement is used to return values

from a function or a chunk

(which is handled as an anonymous function).

```
@index{return statement}
```

Functions can return more than one value,

so the syntax for the `@Rw{return}` statement is

```
@Produc{
@producname{stat}@producbody{@Rw{return} @bnfopt{explist} @bnfopt{@bnfter{;}}}
}
```

The `@Rw{return}` statement can only be written

as the last statement of a block.

If it is necessary to `@Rw{return}` in the middle of a block,

then an explicit inner block can be used,

as in the idiom `@T{do return end}`,

because now `@Rw{return}` is the last statement in its (inner) block.

```
}
```

```
@sect3{for| @title{For Statement}
```

```
@index{for statement}
```

The `@Rw{for}` statement has two forms:

one

numerical and one generic.

```
@sect4{@title{The numerical @Rw{for} loop}
```

The numerical `@Rw{for}` loop repeats a block of code while a

control variable goes through an arithmetic progression.

It has the following syntax:

```
@Produc{
@producname{stat}@producbody{@Rw{for} @bnfNter{Name} @bnfter{=}
exp @bnfter{,} exp @bnfopt{@bnfter{,} exp} @Rw{do} block @Rw{end}}
}
```

The given identifier (`@bnfNter{Name}`) defines the control variable,

which is a new variable local to the loop body (`@emph{block}`).

The loop starts by evaluating once the three control expressions.

Their values are called respectively

the `@emph{initial value}`, the `@emph{limit}`, and the `@emph{step}`.

If the step is absent, it defaults `@N{to 1}`.

If both the initial value and the step are integers,

the loop is done with integers;

note that the limit may not be an integer.

Otherwise, the three values are converted to

floats and the loop is done with floats.

Beware of floating-point accuracy in this case.

After that initialization,  
the  
loop body is repeated with the value of the control variable  
going through an arithmetic progression,  
starting at the initial value,  
with a common difference given by the step.  
A negative step makes a decreasing sequence;  
a step equal to zero raises an error.  
The loop continues while the value is less than  
or equal to the limit  
(greater than or equal to for a negative step).  
If the initial value is already greater than the limit  
(or less than, if the step is negative),  
the body is not executed.

For integer loops,  
the control variable never wraps around;  
instead, the loop ends in case of an overflow.

You should not change the value of the control variable  
during the loop.  
If you need its value after the loop,  
assign it to another variable before exiting the loop.

}

@sect4{@title{The generic @Rw{for} loop}}

The generic @Rw{for} statement works over functions,  
called @def{iterators}.  
On each iteration, the iterator function is called to produce a new value,  
stopping when this new  
value is @nil.

The generic @Rw{for} loop has the following syntax:

```
@Produc{
@producname{stat}@producbody{@Rw{for} namelist @Rw{in} explist
    @Rw{do} block @Rw{end}}
@producname{namelist}@producbody{@bnfNter{Name} @bnfrep{@bnfter{,} @bnfNter{Name}}}
}
```

A @Rw{for} statement like

```
@verbatim{
for @rep{var_1}, @Cdots, @rep{var_n} in @rep{explist} do @rep{body} end
}
```

works as follows.

The names @rep{var\_i} declare loop variables local to the loop body.

The first of these variables is the `@emph{control variable}`.

The loop starts by evaluating `@rep{explist}`  
to produce four values:  
an `@emph{iterator function}`,  
a `@emph{state}`,  
an initial value for the control variable,  
and a `@emph{closing value}`.

Then, at each iteration,  
Lua calls the iterator function with two arguments:  
the state and the control variable.  
The results from this call are then assigned to the loop variables,  
following the rules of multiple assignments `@see{assignment}`.  
If the control variable becomes `@nil`,  
the  
loop terminates.  
Otherwise, the body is executed and the loop goes  
to the next iteration.

The closing value behaves like a  
to-be-closed variable `@see{to-be-closed}`,  
which can be used to release resources when the loop ends.  
Otherwise, it does not interfere with the loop.

You should not change the value of the control variable  
during the loop.

}

}

`@sect3{funcstat| @title{Function Calls as Statements}`

To allow possible side-effects,  
function calls can be executed as statements:

```
@Produc{
@producname{stat}@producbody{functioncall}
}
```

In this case, all returned values are thrown away.  
Function calls are explained in `@See{functioncall}`.

}

`@sect3{localvar| @title{Local Declarations}`

`@x{Local variables}` can be declared anywhere inside a block.

The declaration can include an initialization:

```
@Produc{
@producname{stat}@producbody{@Rw{local} attnamelist @bnfopt{@bnfter{=} explist}}
```

```
@producname{attnamelist}@producbody{
  @bnfNter{Name} attrib @bnfrep{@bnfter{,} @bnfNter{Name} attrib}}
}
```

If

present, an initial assignment has the same semantics  
of a multiple assignment @see{assignment}.

Otherwise, all variables are initialized with @nil.

Each variable name may be postfixed by an attribute  
(a name between angle brackets):

```
@Produc{
  @producname{attrib}@producbody{@bnfopt{@bnfter{<} @bnfNter{Name} @bnfter{>}}}
}
```

There are two possible attributes:

@id{const}, which declares a @x{constant variable},

that is, a variable that cannot be assigned to  
after its initialization;

and @id{close}, which declares a to-be-closed variable @see{to-be-closed}.

A list of variables can contain at most one to-be-closed variable.

A chunk is also a block @see{chunks},

and so local variables can be declared in a chunk outside any explicit block.

The visibility rules for local variables are explained in @See{visibility}.

```
}
```

```
@sect3{to-be-closed| @title{To-be-closed Variables}}
```

A to-be-closed variable behaves like a constant local variable,  
except that its value is @emph{closed} whenever the variable  
goes

out of scope, including normal block termination,  
exiting its block by @Rw{break}/@Rw{goto}/@Rw{return},  
or exiting by an error.

Here, to @emph{close} a value means

to call its @idx{\_\_close} metamethod.

When calling the metamethod,

the value itself is passed as the first argument

and the error object that caused the exit (if any)

is passed as a second argument;

if there was no error, the second argument is @nil.

The value assigned to a to-be-closed variable

must have a @idx{\_\_close} metamethod

or be a false value.

(@nil and @false are ignored as to-be-closed values.)



If several to-be-closed variables go out of scope at the same event, they are closed in the reverse order that they were declared.

If there is any error while running a closing method, that error is handled like an error in the regular code where the variable was defined.

After an error, the other pending closing methods will still be called.

If a coroutine yields and is never resumed again, some variables may never go out of scope, and therefore they will never be closed. (These variables are the ones created inside the coroutine and in scope at the point where the coroutine yielded.)

Similarly, if a coroutine ends with an error, it does not unwind its stack, so it does not close any variable.

In both cases, you can either use finalizers or call `@Lid{coroutine.close}` to close the variables. However, if the coroutine was created through `@Lid{coroutine.wrap}`, then its corresponding function will close the coroutine in case of errors.

}

}

@sect2{expressions| @title{Expressions}}

@simplesect{

The basic expressions in Lua are the following:

```
@Produc{
@producname{exp}@producbody{prefixexp}
@producname{exp}@producbody{@Rw{nil} @Or @Rw{false} @Or @Rw{true}}
@producname{exp}@producbody{@bnfNter{Numeral}}
@producname{exp}@producbody{@bnfNter{LiteralString}}
@producname{exp}@producbody{functiondef}
@producname{exp}@producbody{tableconstructor}
@producname{exp}@producbody{@bnfter{...}}
@producname{exp}@producbody{exp
binop exp}
@producname{exp}@producbody{unop exp}
@producname{prefixexp}@producbody{var @Or functioncall @Or
```

```

        @bnfter{() exp @bnfter{}}
    }

```

Numerals and literal strings are explained in @See{lexical};  
 variables are explained in @See{variables};  
 function definitions are explained in @See{func-def};  
 function calls are explained in @See{functioncall};  
 table constructors are explained in @See{tableconstructor}.  
 Vararg expressions,  
 denoted by three dots (@Char{...}), can only be used when  
 directly inside a variadic function;  
 they are explained in @See{func-def}.

Binary operators comprise arithmetic operators @see{arith},  
 bitwise operators @see{bitwise},  
 relational operators @see{rel-ops}, logical operators @see{logic},  
 and the concatenation operator @see{concat}.  
 Unary operators comprise the unary minus @see{arith},  
 the unary bitwise NOT @see{bitwise},  
 the unary logical @Rw{not} @see{logic},  
 and the unary @def{length operator} @see{len-op}.

```

}

```

```

@sect3{arith|
    @title{Arithmetic Operators}
    Lua supports the following @x{arithmetic operators}:
    @description{
        @item{@T{+}|addition}
        @item{@T{-}|subtraction}
        @item{@T{*}|multiplication}
        @item{@T{/}|float division}
        @item{@T{//}|floor division}
        @item{@T{%}|modulo}
        @item{@T{^}|exponentiation}
        @item{@T{-}|unary minus}
    }

```

With the exception of exponentiation and float division,  
 the arithmetic operators work as follows:  
 If both operands are integers,  
 the operation is performed over integers and the result is an integer.  
 Otherwise, if both operands are numbers,  
 then they are converted to floats,  
 the operation is performed following the machine's rules

for floating-point arithmetic  
(usually the `@x{IEEE 754}` standard),  
and the result is a float.  
(The string library coerces strings to numbers in  
arithmetic operations; see `@See{coercion}` for details.)

Exponentiation and float division (`@T{/}`)  
always convert their operands to floats  
and the result is always a float.  
Exponentiation uses the  
`@ANSI{pow}`,  
so that it works for non-integer exponents too.

Floor division (`@T{//}`) is a division  
that rounds the quotient towards minus infinity,  
resulting in the floor of the division of its operands.

Modulo is defined as the remainder of a division  
that rounds the quotient towards minus infinity (floor division).

In case of overflows in integer arithmetic,  
all operations `@emphx{wrap around}`.  
}

`@sect3{bitwise| @title{Bitwise Operators}`  
Lua supports the following `@x{bitwise operators}`:  
`@description{`  
`@item{@T{&}|bitwise AND}`  
`@item{@T{@VerBar}|bitwise OR}`  
`@item{@T{~}|bitwise exclusive OR}`  
`@item{@T{>>}|right shift}`  
`@item{@T{<<}|left shift}`  
`@item{@T{~}|unary bitwise NOT}`  
`}`

All bitwise operations convert its operands to integers  
`@see{coercion}`,  
operate on all bits of those integers,  
and result in an integer.

Both right and left shifts fill the vacant bits with zeros.  
Negative displacements shift to the other direction;  
displacements with absolute values equal to or higher than  
the  
number of bits in an integer  
result in zero (as all bits are shifted out).

}

@sect3{coercion| @title{Coercions and Conversions}

Lua provides some automatic conversions between some types and representations at run time.

Bitwise operators always convert float operands to integers.

Exponentiation and float division

always convert integer operands to floats.

All other arithmetic operations applied to mixed numbers (integers and floats) convert the integer operand to a float.

The C API also converts both integers to floats and floats to integers, as needed.

Moreover, string concatenation accepts numbers as arguments, besides strings.

In a conversion from integer to float, if the integer value has an exact representation as a float, that is the result.

Otherwise,

the conversion gets the nearest higher or the nearest lower representable value.

This kind of conversion never fails.

The conversion from float to integer checks whether the float has an exact representation as an integer (that

is, the float has an integral value and it is in the range of integer representation).

If it does, that representation is the result.

Otherwise, the conversion fails.

Several places in Lua coerce strings to numbers when necessary.

In particular,

the string library sets metamethods that try to coerce strings to numbers in all arithmetic operations.

If the conversion fails,

the library calls the metamethod of the other operand (if present) or it raises an error.

Note that bitwise operators do not do this coercion.

It is always a good practice not to rely on the

implicit coercions from strings to numbers,

as they are not always applied;

in particular, `@T{"1"==1}` is false and `@T{"1"<1}` raises an error

@see{rel-ops}.

These coercions exist mainly for compatibility and may be removed in future versions of the language.

A string is converted to an integer or a float

following its syntax and the rules of the Lua lexer.

The string may have also leading and trailing whitespaces and a sign.

All

conversions from strings to numbers

accept both a dot and the current locale mark

as the radix character.

(The Lua lexer, however, accepts only a dot.)

If the string is not a valid numeral,

the conversion fails.

If necessary, the result of this first step is then converted

to a specific number subtype following the previous rules

for conversions between floats and integers.

The conversion from numbers to strings uses a

non-specified human-readable format.

To convert numbers to strings in any specific way,

use the function `@Lid{string.format}`.

}

@sect3{rel-ops| @title{Relational Operators}

Lua supports the following `@x{relational operators}`:

@description{

@item{@T{==}|equality}

@item{@T{~=}|inequality}

@item{@T{<}|less than}

@item{@T{>}|greater than}

@item{@T{<=}|less or equal}

@item{@T{>=}|greater or equal}

}

These operators always result in `@false` or `@true`.

Equality (`@T{==}`) first compares the type of its operands.

If the types are different, then the result is `@false`.

Otherwise,

the values of the operands are compared.

Strings are equal if they have the same byte content.

Numbers are equal if they denote the same mathematical value.

Tables, userdata, and threads

are compared by reference:

two objects are considered equal only if they are the same object.

Every time you create a new object

(a table, a userdata, or a thread),

this new object is different from any previously existing object.

A function is always equal to itself.

Functions with any detectable difference

(different behavior, different definition) are always different.

Functions created at different times but with no detectable differences may be classified as equal or not (depending on internal caching details).

You can change the way that Lua compares tables and userdata by using the `@idx{__eq}` metamethod `@see{metatable}`.

Equality comparisons do not convert strings to numbers or vice versa.

Thus, `@T{"0"==0}` evaluates to `@false`, and `@T{t[0]}` and `@T{t["0"]}` denote different entries in a table.

The operator `@T{~=}` is exactly the negation of equality (`@T{==}`).

The order operators work as follows.

If both arguments are numbers, then they are compared according to their mathematical values, regardless of their subtypes.

Otherwise, if both arguments are strings, then their values are compared according to the current locale. Otherwise, Lua tries to call the `@idx{__lt}` or the `@idx{__le}` metamethod `@see{metatable}`.

A comparison `@T{a > b}` is translated to `@T{b < a}` and `@T{a >= b}` is translated to `@T{b <= a}`.

Following the `@x{IEEE 754}` standard, the special value `@x{NaN}` is considered neither less than, nor equal to, nor greater than any value, including itself.

}

`@sect3{logic| @title{Logical Operators}`

The `@x{logical operators}` in Lua are

`@Rw{and}`, `@Rw{or}`, and `@Rw{not}`.

Like the control structures `@see{control}`, all logical operators consider both `@false` and `@nil` as false and anything else as true.

The negation operator `@Rw{not}` always returns `@false` or `@true`.

The conjunction

operator `@Rw{and}` returns its first argument

if this value is `@false` or `@nil`;

otherwise, `@Rw{and}` returns its second argument.

The disjunction operator `@Rw{or}` returns its first argument

if this value is different from `@nil` and `@false`;

otherwise, `@Rw{or}` returns its second argument.

Both `@Rw{and}` and `@Rw{or}` use `@x{short-circuit evaluation}`;

that is,

the second operand is evaluated only if necessary.

Here are some examples:

```
@verbatim{
10 or 20      --> 10
10 or error() --> 10
nil or "a"    --> "a"
nil and 10    --> nil
false and error() --> false
false and nil --> false
false or nil  --> nil
10 and 20     --> 20
}
```

```
}
```

```
@sect3{concat| @title{Concatenation}
```

The string `@x{concatenation}` operator in Lua is denoted by two dots (`@Char{..}`).

If both operands are strings or numbers, then the numbers are converted to strings in a non-specified format `@see{coercion}`.

Otherwise, the `@idx{__concat}` metamethod is called `@see{metatable}`.

```
}
```

```
@sect3{len-op|
```

```
@title{The Length Operator}
```

The length operator is denoted by the unary prefix operator `@T{#}`.

The length of a string is its number of bytes.

(That is the usual meaning of string length when each character is one byte.)

The length operator applied on a table returns a `@x{border}` in that table.

A `@def{border}` in a table `@id{t}` is any non-negative integer that satisfies the following condition:

```
@verbatim{
(border == 0 or t[border] ~= nil) and
(t[border + 1] == nil or border == math.maxinteger)
}
```

In words,

a border is any positive integer index present in the table that is followed by an absent index,

plus two limit cases:

zero, when index 1 is absent;  
 and the maximum value for an integer, when that index is present.  
 Note that keys that are not positive integers  
 do not interfere with borders.

A table with exactly one border is called a `@def{sequence}`.  
 For instance, the table `@T{{10, 20, 30, 40, 50}}` is a sequence,  
 as it has only one border (5).  
 The table `@T{{10, 20, 30, nil, 50}}` has  
 two borders (3 and 5),  
 and therefore it is not a sequence.  
 (The `@nil` at index 4 is called a `@emphx{hole}`.)  
 The table `@T{{nil, 20, 30, nil, nil, 60, nil}}`  
 has three borders (0, 3, and 6),  
 so it is not a sequence, too.  
 The table `@T{{}}` is a sequence with border 0.

When `@id{t}` is a sequence,  
`@T{#t}` returns its only border,  
 which corresponds to the intuitive notion of the length of the sequence.  
 When `@id{t}` is not a sequence,  
`@T{#t}` can return any of its borders.  
 (The exact one depends on details of  
 the internal representation of the table,  
 which in turn can depend on how the table was populated and  
 the memory addresses of its non-numeric keys.)

The computation of the length of a table  
 has a guaranteed worst time of `@M{O(log n)}`,  
 where `@M{n}` is the largest integer key in the table.

A program can modify the behavior of the length operator for  
 any value but strings through the `@idx{__len}` metamethod `@see{metatable}`.

}

`@sect3{prec| @title{Precedence}`  
`@x{Operator precedence}` in Lua follows  
 the table below,  
 from lower to higher priority:  
`@verbatim{`  
 or  
 and  
`< > <= >= ~= ==`  
`|`  
`~`  
`&`  
`<< >>`



```

..
+   -
*   /   //   %
unary operators (not #   -   ~)
^
}

```

As usual,

you can use parentheses to change the precedences of an expression.

The concatenation (@Char{..}) and exponentiation (@Char{^}) operators are right associative.

All other binary operators are left associative.

```

}

```

@sect3{tableconstructor| @title{Table Constructors}

Table @x{constructors} are expressions that create tables.

Every time a constructor is evaluated, a new table is created.

A constructor can be used to create an empty table

or to create a table and initialize some of its fields.

The general syntax for constructors is

```

@Produc{
@producname{tableconstructor}@producbody{@bnfter{@Open} @bnfopt{fieldlist} @bnfter{@Close}}
@producname{fieldlist}@producbody{field @bnfrep{fieldsep field} @bnfopt{fieldsep}}
@producname{field}@producbody{@bnfter{[] exp @bnfter{[] @bnfter{=} exp @Or
    @bnfNter{Name} @bnfter{=} exp @Or exp}
@producname{fieldsep}@producbody{@bnfter{,} @Or @bnfter{;}}
}

```

Each field of the form @T{[exp1] = exp2} adds to the new table an entry with key @id{exp1} and value @id{exp2}.

A field of the form @T{name = exp} is equivalent to

@T{["name"] = exp}.

Fields of the form @id{exp} are equivalent to

@T{[i] = exp}, where @id{i} are consecutive integers starting with 1;

fields in the other formats do not affect this counting.

For example,

```

@verbatim{
a = { [f(1)] = g; "x", "y"; x = 1, f(x), [30] = 23; 45 }
}

```

is equivalent to

```

@verbatim{
do
local t = {}
t[f(1)] = g
t[1] = "x"    -- 1st exp
t[2] = "y"    -- 2nd exp
}

```

```

t.x = 1      -- t["x"] = 1
t[3] = f(x)  -- 3rd exp
t[30] = 23
t[4] = 45    -- 4th exp
a = t
end
}

```

The order of the assignments in a constructor is undefined.  
(This order would be relevant only when there are repeated keys.)

If the last field in the list has the form `@id{exp}`  
and the expression  
is a multires expression,  
then all values returned by this expression enter the list consecutively  
`@see{multires}`.

The field list can have an optional trailing separator,  
as a convenience for machine-generated code.

```

}
```

```

@sect3{functioncall| @title{Function Calls}
A @x{function call} in Lua has the following syntax:
@Produc{
@producname{functioncall}@producbody{prefixexp args}
}

```

In a function call,  
first `@bnfNter{prefixexp}` and `@bnfNter{args}` are evaluated.  
If the value of `@bnfNter{prefixexp}` has type `@emph{function}`,  
then this function is called  
with the given arguments.  
Otherwise, if present,  
the `@bnfNter{prefixexp} @idx{__call}` metamethod is called:  
its first argument is the value of `@bnfNter{prefixexp}`,  
followed by the original call arguments  
`@see{metatable}`.

The form  
`@Produc{`  
`@producname{functioncall}@producbody{prefixexp @bnfter{:} @bnfNter{Name} args}`  
`}`  
can be used to emulate methods.  
A call `@T{v:name(@rep{args})}`  
is syntactic sugar for `@T{v.name(v,@rep{args})}`,  
except that `@id{v}`  
is evaluated only once.

Arguments have the following syntax:

```
@Produc{
@producname{args}@producbody{@bnfter{() @bnfopt{explist} @bnfter{}}}
@producname{args}@producbody{tableconstructor}
@producname{args}@producbody{@bnfNter{LiteralString}}
}
```

All argument expressions are evaluated before the call.

A call of the form `@T{f{@rep{fields}}}` is

syntactic sugar for `@T{f({@rep{fields}})}`;

that is, the argument list is a single new table.

A call of the form `@T{f'@rep{string}'}`

(or `@T{f"@rep{string}"}` or `@T{f[[@rep{string}]]}`)

is syntactic sugar for `@T{f('@rep{string}')`;

that is, the argument list is a single literal string.

A call of the form `@T{return @rep{functioncall}}` not in the scope of a to-be-closed variable is called a `@def{tail call}`.

Lua implements `@def{proper tail calls}`

(or `@def{proper tail recursion}`):

In a tail call,

the called function reuses the stack entry of the calling function.

Therefore, there is no limit on the number of nested tail calls that a program can execute.

However,

a tail call erases any debug information about the calling function.

Note that a tail call only happens with a particular syntax, where the `@Rw{return}` has one single function call as argument, and it is outside the scope of any to-be-closed variable.

This syntax makes the calling function return exactly the returns of the called function, without any intervening action.

So, none of the following examples are tail calls:

```
@verbatim{
return (f(x))    -- results adjusted to 1
return 2 * f(x)  -- result multiplied by 2
return x, f(x)   -- additional results
f(x); return     -- results discarded
return x or f(x) -- results adjusted to 1
}

}
```

`@sect3{func-def| @title{Function Definitions}`

The syntax for function definition is

```
@Produc{
@producname{functiondef}@producbody{@Rw{function} funcbody}
```

```
@producname{funcbody}@producbody{@bnfter{() @bnfopt{parlist} @bnfter{}} block @Rw{end}}
}
```

The following syntactic sugar simplifies function definitions:

```
@Produc{
  @producname{stat}@producbody{@Rw{function}
    funcname funcbody}
  @producname{stat}@producbody{@Rw{local} @Rw{function} @bnfNter{Name} funcbody}
  @producname{funcname}@producbody{@bnfNter{Name} @bnfrep{@bnfter{.} @bnfNter{Name}}
  @bnfopt{@bnfter{:} @bnfNter{Name}}}
}
```

The statement

```
@verbatim{
function f () @rep{body} end
}
```

translates to

```
@verbatim{
f = function () @rep{body} end
}
```

The statement

```
@verbatim{
function t.a.b.c.f () @rep{body} end
}
```

translates to

```
@verbatim{
t.a.b.c.f = function () @rep{body} end
}
```

The statement

```
@verbatim{
local function f () @rep{body} end
}
```

translates to

```
@verbatim{
local f; f = function () @rep{body} end
}
```

not to

```
@verbatim{
local f = function () @rep{body} end
}
```

(This only makes a difference when the body of the function contains references to @id{f}.)

A function definition is an executable expression,

whose value has type @emph{function}.

When Lua precompiles a chunk,

all its function bodies are precompiled too,

but they are not created yet.

Then, whenever Lua executes the

function definition,  
the function is `@emph{instantiated}` (or `@emph{closed}`).  
This function instance, or `@emphx{closure}`,  
is the final value of the expression.

Parameters act as local variables that are  
initialized with the argument values:

```
@Produc{
@producname{parlist}@producbody{namelist @bnfopt{@bnfter{,} @bnfter{...}} @Or
@bnfter{...}}
}
```

When a Lua function is called,  
it adjusts its list of `@x{arguments}` to  
the length of its list of parameters `@see{multires}`,  
unless the function is a `@def{variadic function}`,  
which is indicated by three dots (`@Char{...}`)  
at the end of its parameter list.

A variadic function does not adjust its argument list;  
instead, it collects all extra arguments and supplies them  
to the function through a `@def{vararg expression}`,  
which is also written as three dots.

The value of this expression is a list of all actual extra arguments,  
similar to a function with multiple results `@see{multires}`.

As an example, consider the following definitions:

```
@verbatim{
function
f(a, b) end
function g(a, b, ...) end
function r() return 1,2,3 end
}
```

Then, we have the following mapping from arguments to parameters and  
to the vararg expression:

```
@verbatim{
CALL      PARAMETERS
```

```
f(3)      a=3, b=nil
f(3, 4)    a=3, b=4
f(3, 4, 5) a=3, b=4
f(r(), 10) a=1, b=10
f(r())     a=1, b=2
```

```
g(3)      a=3, b=nil, ... --> (nothing)
g(3, 4)    a=3, b=4, ... --> (nothing)
g(3, 4, 5, 8) a=3, b=4, ... --> 5 8
g(5, r())  a=5, b=1, ... --> 2 3
}
```

Results are returned using the `@Rw{return}` statement `@see{control}`.

If control reaches the end of a function  
without encountering a `@Rw{return}` statement,  
then the function returns with no results.

`@index{multiple return}`

There is a system-dependent limit on the number of values  
that a function may return.

This limit is guaranteed to be greater than 1000.

The `@emphx{colon}` syntax  
is used to emulate `@def{methods}`,  
adding an implicit extra parameter `@idx{self}` to  
the function.

Thus, the statement

```
@verbatim{
function t.a.b.c:f (@rep{params}) @rep{body} end
}
```

is syntactic sugar for

```
@verbatim{
t.a.b.c.f = function (self, @rep{params}) @rep{body} end
}
```

```
}
```

`@sect3{multires| @title{Lists of expressions, multiple results,  
and adjustment}`

Both function calls and vararg expressions can result in multiple values.  
These expressions are called `@def{multires expressions}`.

When a multires expression is used as the last element  
of a list of expressions,  
all results from the expression are added to the  
list of values produced by the list of expressions.

Note that a single expression  
in a place that expects a list of expressions  
is the last expression in that (singleton) list.

These are the places where Lua expects a list of expressions:

`@description{`

`@item{A @rw{return} statement,`  
for instance `@T{return e1, e2, e3} @see{control}.`

`@item{A table constructor,`  
for instance `@T{{e1, e2, e3}} @see{tableconstructor}.`

@item{The arguments of a function call,  
for  
instance @T{foo(e1, e2, e3)} @see{functioncall}.}

@item{A multiple assignment,  
for instance @T{a, b, c = e1, e2, e3} @see{assignment}.}

@item{A local declaration,  
for instance @T{local a, b, c = e1, e2, e3} @see{localvar}.}

@item{The initial values in a generic @rw{for} loop,  
for instance @T{for k in e1, e2, e3 do ... end} @see{for}.}

}

In the last four cases,  
the list of values from the list of expressions  
must be @emph{adjusted} to a specific length:  
the number of parameters in a call to a non-variadic function  
@see{func-def},  
the number of variables in a multiple assignment or  
a local declaration,  
and exactly four values for a generic @rw{for} loop.  
The @def{adjustment} follows these rules:  
If there are more values than needed,  
the extra values are thrown away;  
if there are fewer values than needed,  
the list is extended with @nil's.  
When the list of expressions ends with a multiresult expression,  
all results from that expression enter the list of values  
before the adjustment.

When  
a multiresult expression is used  
in a list of expressions without being the last element,  
or in a place where the syntax expects a single expression,  
Lua adjusts the result list of that expression to one element.  
As a particular case,  
the syntax expects a single expression inside a parenthesized expression;  
therefore, adding parentheses around a multiresult expression  
forces it to produce exactly one result.

We seldom need to use a vararg expression in a place  
where the syntax expects a single expression.  
(Usually it is simpler to add a regular parameter before  
the variadic part and use that parameter.)  
When there is such a need,  
we recommend assigning the vararg expression

to a single variable and using that variable in its place.

Here are some examples of uses of mutres expressions.

In all cases, when the construction needs

@Q{the n-th result} and there is no such result,

it uses a @nil.

@verbatim{

print(x, f()) -- prints x and all results from f().

print(x, (f())) -- prints

x and the first result from f().

print(f(), x) -- prints the first result from f() and x.

print(1 + f()) -- prints 1 added to the first result from f().

local x = ... -- x gets the first vararg argument.

x,y = ... -- x gets the first vararg argument,

-- y gets the second vararg argument.

x,y,z = w, f() -- x gets w, y gets the first result from f(),

-- z gets the second result from f().

x,y,z = f() -- x gets the first result from f(),

-- y gets the second result from f(),

-- z gets the third result from f().

x,y,z = f(), g() -- x gets the first result from f(),

-- y gets the first result from g(),

-- z gets the second result from g().

x,y,z = (f()) -- x gets the first result from f(), y and z get nil.

return f() -- returns all results from f().

return x, ... -- returns x and all received vararg arguments.

return x,y,f()

-- returns x, y, and all results from f().

{f()} -- creates a list with all results from f().

{...} -- creates a list with all vararg arguments.

{f(), 5} -- creates a list with the first result from f() and 5.

}

}

}

@sect2{visibility| @title{Visibility Rules}}

@index{visibility}

Lua is a lexically scoped language.

The scope of a local variable begins at the first statement after its declaration and lasts until the last non-void statement of the innermost block that includes the declaration.

(@emph{Void statements} are labels and empty statements.)

Consider the following example:

@verbatim{



```

x = 10          -- global variable
do             -- new block
  local x = x    -- new 'x', with value 10
  print(x)      --> 10
  x = x+1
do             -- another block
  local x = x+1  -- another 'x'
  print(x)      --> 12
end
print(x)       --> 11
end
print(x)       --> 10 (the global one)
}

```

Notice

that, in a declaration like `@T{local x = x}`,  
the new `@id{x}` being declared is not in scope yet,  
and so the second `@id{x}` refers to the outside variable.

Because of the `@x{lexical scoping}` rules,  
local variables can be freely accessed by functions  
defined inside their scope.

A local variable used by an inner function is called an `@def{upvalue}`  
(or `@emphx{external local variable}`, or simply `@emphx{external variable}`)  
inside the inner function.

Notice that each execution of a `@Rw{local}` statement  
defines new local variables.

Consider the following example:

```

@verbatim{
a = {}
local x = 20
for i = 1, 10 do
  local y = 0
  a[i] = function () y = y + 1; return x + y end
end
}

```

The loop creates ten closures  
(that is, ten instances of the anonymous function).  
Each of these closures uses a different `@id{y}` variable,  
while all of them share the same `@id{x}`.

```

}

```

```

}

```

```

@C{-----}

```

@sect1{API| @title{The Application Program Interface}

@simplesect{

@index{C  
API}

This section describes the @N{C API} for Lua, that is, the set of @N{C functions} available to the host program to communicate with Lua.

All API functions and related types and constants are declared in the header file @defid{lua.h}.

Even when we use the term @Q{function}, any facility in the API may be provided as a macro instead. Except where stated otherwise, all such macros use each of their arguments exactly once (except for the first argument, which is always a Lua state), and so do not generate any hidden side-effects.

As in most @N{C libraries}, the Lua API functions do not check their arguments for validity or consistency. However, you can change this behavior by compiling Lua with the macro @defid{LUA\_USE\_APICHECK} defined.

The Lua library is fully reentrant: it has no global variables. It keeps all information it needs in a dynamic structure, called the @def{Lua state}.

Each Lua state has one or more threads, which correspond to independent, cooperative lines of execution. The type @Lid{lua\_State} (despite its name) refers to a thread. (Indirectly, through the thread, it also refers to the Lua state associated to the thread.)

A pointer to a thread must be passed as the first argument to every function in the library, except to @Lid{lua\_newstate}, which creates a Lua state from scratch and returns a pointer to the @emph{main thread} in the new state.

}

@sect2{@title{The Stack}

@simplesect{

Lua uses a `@emph{virtual stack}` to pass values to and from C.  
Each element in this stack represents a Lua value  
(`@nil`, number, string, etc.).  
Functions in the API can access this stack through the  
Lua state parameter that they receive.

Whenever Lua calls C, the called function gets a new stack,  
which is independent of previous stacks and of stacks of  
`@N{C functions}` that are still active.  
This stack initially contains any arguments to the `@N{C function}`  
and it is where the `@N{C function}` can store temporary  
Lua values and must push  
its results  
to be returned to the caller `@seeC{lua_CFunction}`.

For convenience,  
most query operations in the API do not follow a strict stack discipline.  
Instead, they can refer to any element in the stack  
by using an `@emph{index}:@index{index (API stack)}`  
A positive index represents an absolute stack position,  
starting `@N{at 1}` as the bottom of the stack;  
a negative index represents an offset relative to the top of the stack.  
More specifically, if the stack has `@rep{n}` elements,  
then `@N{index 1}` represents the first element  
(that is, the element that was pushed onto the stack first)  
and  
`@N{index @rep{n}}` represents the last element;  
`@N{index @num{-1}}` also represents the last element  
(that is, the element at `@N{the top}`)  
and index `@M{-n}` represents the first element.

}

`@sect3{stacksize| @title{Stack Size}`

When you interact with the Lua API,  
you are responsible for ensuring consistency.  
In particular,  
`@emph{you are responsible for controlling stack overflow}`.  
When you call any  
API function,  
you must ensure the stack has enough room to accommodate the results.

There is one exception to the above rule:  
When you call a Lua function  
without a fixed number of results `@seeF{lua_call}`,  
Lua ensures that the stack has enough space for all results.

However, it does not ensure any extra space.  
So, before pushing anything on the stack after such a call  
you should use `@Lid{lua_checkstack}`.

Whenever Lua calls C,  
it ensures that the stack has space for  
at least `@defid{LUA_MINSTACK}` extra elements;  
that is, you can safely push up to `@id{LUA_MINSTACK}` values into it.  
`@id{LUA_MINSTACK}` is defined as 20,  
so that usually you do not have to worry about stack space  
unless your code has loops pushing elements onto the stack.  
Whenever necessary,  
you can use the function `@Lid{lua_checkstack}`  
to ensure that the stack has enough space for pushing new elements.

}

`@sect3{@title{Valid and Acceptable Indices}}`

Any function in the API that receives stack indices  
works only with `@emphx{valid  
indices}` or `@emphx{acceptable indices}`.

A `@def{valid index}` is an index that refers to a  
position that stores a modifiable Lua value.  
It comprises stack indices `@N{between 1}` and the stack top  
(`@T{1 @leq abs(index) @leq top}`)  
`@index{stack index}`  
plus `@def{pseudo-indices}`,  
which represent some positions that are accessible to `@N{C code}`  
but that are not in the stack.  
Pseudo-indices are used to access the registry `@see{registry}`  
and the upvalues of a `@N{C function}` `@see{c-closure}`.

Functions that do not need a specific mutable position,  
but only a value (e.g., query functions),  
can be called with acceptable indices.  
An `@def{acceptable index}` can be any valid index,  
but it also can be any positive index after the stack top  
within the space allocated for the stack,  
that is, indices up to the stack size.  
(Note that 0 is never an acceptable index.)  
Indices to upvalues `@see{c-closure}` greater than the real number  
of upvalues in the current `@N{C function}` are also acceptable (but invalid).  
Except  
when noted otherwise,  
functions in the API work with acceptable indices.

Acceptable indices serve to avoid extra tests against the stack top when querying the stack. For instance, a `@N{C function}` can query its third argument without the need to check whether there is a third argument, that is, without the need to check whether 3 is a valid index.

For functions that can be called with acceptable indices, any non-valid index is treated as if it contains a value of a virtual type `@defid{LUA_TNONE}`, which behaves like a nil value.

}

`@sect3{constchar|@title{Pointers to strings}`

Several functions in the API return pointers (`@T{const char*}`) to Lua strings in the stack.

(See `@Lid{lua_pushfstring}`, `@Lid{lua_pushlstring}`, `@Lid{lua_pushstring}`, and `@Lid{lua_tolstring}`. See also `@Lid{luaL_checklstring}`, `@Lid{luaL_checkstring}`, and `@Lid{luaL_tolstring}` in the auxiliary library.)

In general,

Lua's garbage collection can free or move internal memory and then invalidate pointers to internal strings.

To allow a safe use of these pointers, the API guarantees that any pointer to a string in a stack index is valid while the string value at that index is not removed from the stack. (It can be moved to another index, though.)

When the index is a pseudo-index (referring to an upvalue), the pointer is valid while the corresponding call is active and the corresponding upvalue is not modified.

Some functions in the debug interface also return pointers to strings, namely `@Lid{lua_getlocal}`, `@Lid{lua_getupvalue}`, `@Lid{lua_setlocal}`, and `@Lid{lua_setupvalue}`. For these functions, the pointer is guaranteed to be valid while the caller function is active and the given closure (if one was given) is in the stack.

Except for these guarantees, the garbage collector is free to invalidate any pointer to internal strings.

}

}

@sect2{c-closure| @title{C Closures}

When a @N{C function} is created,  
it is possible to associate some values with it,  
thus creating a @def{@N{C closure}}  
@seeC{lua\_pushcclosure};  
these  
values are called @def{upvalues} and are  
accessible to the function whenever it is called.

Whenever a @N{C function} is called,  
its upvalues are located at specific pseudo-indices.  
These pseudo-indices are produced by the macro  
@Lid{lua\_upvalueindex}.  
The first upvalue associated with a function is at index  
@T{lua\_upvalueindex(1)}, and so on.  
Any access to @T{lua\_upvalueindex(@rep{n})},  
where @rep{n} is greater than the number of upvalues of the  
current function  
(but not greater than 256,  
which is one plus the maximum number of upvalues in a closure),  
produces an acceptable but invalid index.

A @N{C closure} can also change the values  
of its corresponding upvalues.

}

@sect2{registry| @title{Registry}

Lua provides a @def{registry},  
a predefined table that can be used by any @N{C code} to  
store whatever Lua values it needs to store.  
The registry table is always accessible at pseudo-index  
@defid{LUA\_REGISTRYINDEX}.  
Any @N{C library} can store data into  
this table,  
but it must take care to choose keys  
that are different from those used  
by other libraries, to avoid collisions.  
Typically, you should use as key a string containing your library name,  
or a light userdata with the address of a @N{C object} in your code,  
or any Lua object created by your code.  
As with variable names,  
string keys starting with an underscore followed by  
uppercase letters are reserved for Lua.

The integer keys in the registry are used by the reference mechanism `@seeC{luaL_ref}` and by some predefined values. Therefore, integer keys in the registry must not be used for other purposes.

When you create a new Lua state, its registry comes with some predefined values. These predefined values are indexed with integer keys defined as constants in `@id{lua.h}`.

The following constants are defined:

```
@description{
@item{@defid{LUA_RIDX_MAINTHREAD}| At this index the registry has
the main thread of the state.
(The main thread is the one created together with the state.)
}
```

```
@item{@defid{LUA_RIDX_GLOBALS}|
At this index the registry has
the @x{global environment}.
}
}
}
```

```
@sect2{C-error|@title{Error Handling in C}
```

```
@simplesect{
```

Internally, Lua uses the C `@id{longjmp}` facility to handle errors. (Lua will use exceptions if you compile it as C++; search for `@id{LUA_THROW}` in the source code for details.) When Lua faces any error, such as a `@x{memory allocation error}` or a type error, it `@emph{raises}` an error; that is, it does a long jump. A `@emph{protected environment}` uses `@id{setjmp}` to set a recovery point; any error jumps to the most recent active recovery point.

Inside a `@N{C function}` you can raise an error explicitly by calling `@Lid{lua_error}`.

Most functions in the API can raise an error, for instance due to a `@x{memory allocation error}`. The documentation for each function indicates whether it can raise errors.

If an error happens outside any protected environment,  
Lua calls a `@def{panic function}` (see `@Lid{lua_atpanic}`)  
and then calls `@T{abort}`,  
thus  
exiting the host application.  
Your panic function can avoid this exit by  
never returning  
(e.g., doing a long jump to your own recovery point outside Lua).

The panic function,  
as its name implies,  
is a mechanism of last resort.  
Programs should avoid it.  
As a general rule,  
when a `@N{C function}` is called by Lua with a Lua state,  
it can do whatever it wants on that Lua state,  
as it should be already protected.  
However,  
when C code operates on other Lua states  
(e.g., a Lua-state argument to the function,  
a Lua state stored in the registry, or  
the result of `@Lid{lua_newthread}`),  
it should use them only in API calls that cannot raise errors.

The panic function runs as if it were a `@x{message handler} @see{error}`;  
in particular, the error object is on the top of the stack.  
However, there is no guarantee about stack space.  
To push anything on the stack,  
the panic function must first check the available space `@see{stacksize}`.

}

`@sect3{statuscodes|@title{Status Codes}`

Several functions  
that report errors in the API use the following  
status codes to indicate different kinds of errors or other conditions:  
`@description{`

`@item{@defid{LUA_OK} (0)| no errors.}`

`@item{@defid{LUA_ERRRUN}| a runtime error.}`

`@item{@defid{LUA_ERRMEM}|`

`@x{memory allocation error}.`

For such errors, Lua does not call the `@x{message handler}`.



}

@item{@defid{LUA\_ERRERR}| error while running the @x{message handler}.

@item{@defid{LUA\_ERRSYNTAX}| syntax error during precompilation.}

@item{@defid{LUA\_YIELD}| the thread (coroutine) yields.}

@item{@defid{LUA\_ERRFILE}| a file-related error;  
e.g., it cannot open or read the file.}

}

These constants are defined in the header file @id{lua.h}.

}

}

@sect2{continuations|@title{Handling Yields in C}}

Internally, Lua uses the C @id{longjmp} facility to yield a coroutine. Therefore, if a @N{C function} @id{foo} calls an API function and this API function yields (directly or indirectly by calling another function that yields), Lua cannot return to @id{foo} any more, because the @id{longjmp} removes its frame from the @N{C stack}.

To avoid this kind of problem, Lua raises an error whenever it tries to yield across an API call, except for three functions: @Lid{lua\_yieldk}, @Lid{lua\_callk}, and @Lid{lua\_pcallk}. All those functions receive a @def{continuation function} (as a parameter named @id{k}) to continue execution after a yield.

We need to set some terminology to explain continuations. We have a @N{C function} called from Lua which we will call the @emph{original function}. This original function then calls one of those three functions in the C API, which we will call the @emph{callee function}, that then yields the current thread. This can happen when the callee function is @Lid{lua\_yieldk}, or when the callee function is either @Lid{lua\_callk} or @Lid{lua\_pcallk} and the function called by them yields.

Suppose the running thread yields while executing the callee function. After the thread resumes, it eventually will finish

running the callee function.

However,

the callee function cannot return to the original function,

because its frame in the `@N{C stack}` was destroyed by the yield.

Instead, Lua calls a `@def{continuation function}`,

which was given as an argument to the callee function.

As the name implies,

the continuation function should continue the task

of the original function.

As an illustration, consider the following function:

`@verbatim{`

```
int original_function (lua_State *L) {
```

```
... /* code 1 */
```

```
status = lua_pcall(L, n, m, h); /* calls Lua */
```

```
... /* code 2 */
```

```
}
```

```
}
```

Now we want to allow

the Lua code being run by `@Lid{lua_pcall}` to yield.

First, we can rewrite our function like here:

`@verbatim{`

```
int k (lua_State *L, int status, lua_KContext ctx) {
```

```
... /* code 2 */
```

```
}
```

```
int original_function (lua_State *L) {
```

```
... /* code 1 */
```

```
return k(L, lua_pcall(L, n, m, h), ctx);
```

```
}
```

```
}
```

In the above code,

the new function `@id{k}` is a

`@emph{continuation function}` (with type `@Lid{lua_KFunction}`),

which

should do all the work that the original function

was doing after calling `@Lid{lua_pcall}`.

Now, we must inform Lua that it must call `@id{k}` if the Lua code

being executed by `@Lid{lua_pcall}` gets interrupted in some way

(errors or yielding),

so we rewrite the code as here,

replacing `@Lid{lua_pcall}` by `@Lid{lua_pcallk}`:

`@verbatim{`

```
int original_function (lua_State *L) {
```

```
... /* code 1 */
```

```
return k(L, lua_pcallk(L, n, m, h, ctx2, k), ctx1);
```

```
}
```

```
}
```

Note the external, explicit call to the continuation:  
Lua will call the continuation only if needed, that is,  
in case of errors or resuming after a yield.  
If the called function returns normally without ever yielding,  
@Lid{lua\_pcallk} (and @Lid{lua\_callk}) will also return normally.  
(Of course, instead of calling the continuation in that case,  
you can do the equivalent work directly inside the original function.)

Besides the Lua state,  
the continuation function has two other parameters:  
the final status of the call and the context value  
(@id{ctx}) that  
was passed originally to @Lid{lua\_pcallk}.  
Lua does not use this context value;  
it only passes this value from the original function to the  
continuation function.  
For @Lid{lua\_pcallk},  
the status is the same value that would be returned by @Lid{lua\_pcallk},  
except that it is @Lid{LUA\_YIELD} when being executed after a yield  
(instead of @Lid{LUA\_OK}).  
For @Lid{lua\_yieldk} and @Lid{lua\_callk},  
the status is always @Lid{LUA\_YIELD} when Lua calls the continuation.  
(For these two functions,  
Lua will not call the continuation in case of errors,  
because they do not handle errors.)  
Similarly, when using @Lid{lua\_callk},  
you should call the continuation function  
with @Lid{LUA\_OK} as the status.  
(For @Lid{lua\_yieldk}, there is not much point in calling  
directly the continuation function,  
because @Lid{lua\_yieldk} usually does not return.)

Lua treats the continuation function as if it were the original function.  
The continuation function receives the same Lua stack  
from the original  
function,  
in the same state it would be if the callee function had returned.  
(For instance,  
after a @Lid{lua\_callk} the function and its arguments are  
removed from the stack and replaced by the results from the call.)  
It also has the same upvalues.  
Whatever it returns is handled by Lua as if it were the return  
of the original function.

}

@sect2{@title{Functions and Types}

Here we list all functions and types from the @N{C API} in alphabetical order.

Each function has an indicator like this:

@apii{o,p,x}

The first field, @T{o},

is how many elements the function pops from the stack.

The second field, @T{p},

is how many elements the function pushes onto the stack.

(Any function always pushes its results after popping its arguments.)

A field in the form @T{x|y} means the function can push (or pop)

@T{x} or @T{y} elements,

depending on the situation;

an interrogation mark @Char{?} means that

we cannot know how many elements the function pops/pushes

by looking only at its arguments.

(For

instance, they may depend on what is in the stack.)

The third field, @T{x},

tells whether the function may raise errors:

@Char{-} means the function never raises any error;

@Char{m} means the function may raise only out-of-memory errors;

@Char{v} means the function may raise the errors explained in the text;

@Char{e} means the function can run arbitrary Lua code,

either directly or through metamethods,

and therefore may raise any errors.

@APIEntry{int lua\_absindex (lua\_State \*L, int idx);|

@apii{0,0,-}

Converts the @x{acceptable index} @id{idx}

into an equivalent @x{absolute index}

(that is, one that does not depend on the stack size).

}

@APIEntry{

typedef void \* (\*lua\_Alloc) (void \*ud,

void \*ptr,

size\_t osize,

size\_t nsize);|

The type of the @x{memory-allocation function} used by Lua states.

The allocator function must provide a

functionality similar to @id{realloc},

but not exactly the

same.

Its arguments are

@id{ud}, an opaque pointer passed to @Lid{lua\_newstate};

@id{ptr}, a pointer to the block being allocated/reallocated/freed;

@id{osize}, the original size of the block or some code about what is being allocated;

and @id{nsize}, the new size of the block.

When @id{ptr} is not @id{NULL},

@id{osize} is the size of the block pointed by @id{ptr},

that is, the size given when it was allocated or reallocated.

When @id{ptr} is @id{NULL},

@id{osize} encodes the kind of object that Lua is allocating.

@id{osize} is any of

@Lid{LUA\_TSTRING}, @Lid{LUA\_TTABLE}, @Lid{LUA\_TFUNCTION},

@Lid{LUA\_TUSERDATA}, or @Lid{LUA\_TTHREAD} when (and only when)

Lua is creating a new object of that type.

When @id{osize} is some other value,

Lua is allocating memory for something else.

Lua assumes the following behavior from the allocator function:

When @id{nsize} is zero,

the allocator must behave like @id{free}

and then return @id{NULL}.

When @id{nsize} is not zero,

the allocator must behave

like @id{realloc}.

In particular, the allocator returns @id{NULL}

if and only if it cannot fulfill the request.

Here is a simple implementation for the @x{allocator function}.

It is used in the auxiliary library by @Lid{luaL\_newstate}.

@verbatim{

```
static void *l_alloc (void *ud, void *ptr, size_t osize,
```

```
                    size_t nsize) {
```

```
    (void)ud; (void)osize; /* not used */
```

```
    if (nsize == 0) {
```

```
        free(ptr);
```

```
        return NULL;
```

```
    }
```

```
    else
```

```
        return realloc(ptr, nsize);
```

```
    }
```

```
    }
```

Note that @N{ISO C} ensures

that `@T{free(NULL)}` has no effect and that  
`@T{realloc(NULL,size)}` is equivalent to `@T{malloc(size)}`.

}

`@APIEntry{void lua_arith (lua_State *L, int op);|`  
`@apii{2|1,1,e}`

Performs an arithmetic or bitwise operation over the two values  
(or one, in the case of negations)  
at the top of the stack,  
with the value on the top being the second operand,  
pops these values, and pushes the result of the operation.  
The function follows the semantics of the corresponding Lua  
operator  
(that is, it may call metamethods).

The value of `@id{op}` must be one of the following constants:  
`@description{`

`@item{@defid{LUA_OPADD}| performs addition (@T{+})}`  
`@item{@defid{LUA_OPSUB}| performs subtraction (@T{-})}`  
`@item{@defid{LUA_OPMUL}| performs multiplication (@T{*})}`  
`@item{@defid{LUA_OPDIV}| performs float division (@T{/})}`  
`@item{@defid{LUA_OPIDIV}| performs floor division (@T{//})}`  
`@item{@defid{LUA_OPMOD}| performs modulo (@T{%})}`  
`@item{@defid{LUA_OPPOW}| performs exponentiation (@T{^})}`  
`@item{@defid{LUA_OPUNM}| performs mathematical negation (unary @T{-})}`  
`@item{@defid{LUA_OPBNOT}| performs bitwise NOT (@T{~})}`  
`@item{@defid{LUA_OPBAND}| performs bitwise AND (@T{&})}`  
`@item{@defid{LUA_OPBOR}| performs bitwise OR (@T{|})}`  
`@item{@defid{LUA_OPBXOR}| performs bitwise exclusive OR (@T{~})}`  
`@item{@defid{LUA_OPSHL}| performs left shift (@T{<<})}`  
`@item{@defid{LUA_OPSHR}| performs right shift (@T{>>})}`

}

}

`@APIEntry{lua_CFunction lua_atpanic (lua_State *L, lua_CFunction`  
`panicf);|`  
`@apii{0,0,-}`

Sets a new panic function and returns the old one `@see{C-error}`.

}

`@APIEntry{void lua_call (lua_State *L, int nargs, int nresults);|`

@apii{nargs+1,nresults,e}

Calls a function.

Like regular Lua calls,

@id{lua\_call} respects the @idx{\_\_call} metamethod.

So, here the word @Q{function}

means any callable value.

To do a call you must use the following protocol:

first, the function to be called is pushed onto the stack;

then, the arguments to the call are pushed

in direct order;

that is, the first argument is pushed first.

Finally you call @Lid{lua\_call};

@id{nargs} is the number of arguments that you pushed onto the stack.

When the function returns,

all arguments and the function value are popped

and the call results are pushed onto the stack.

The number of results is adjusted to @id{nresults},

unless @id{nresults} is @defid{LUA\_MULTRET}.

In this case, all results from the function are pushed;

Lua takes care that the returned values fit into the stack space,

but

it does not ensure any extra space in the stack.

The function results are pushed onto the stack in direct order

(the first result is pushed first),

so that after the call the last result is on the top of the stack.

Any error while calling and running the function is propagated upwards

(with a @id{longjmp}).

The following example shows how the host program can do the equivalent to this Lua code:

```
@verbatim{
```

```
a = f("how", t.x, 14)
```

```
}
```

Here it is @N{in C}:

```
@verbatim{
```

```
lua_getglobal(L, "f");          /* function to be called */
```

```
lua_pushliteral(L, "how");       /* 1st argument */
```

```
lua_getglobal(L, "t");          /* table to be indexed */
```

```
lua_getfield(L, -1, "x");        /* push result of t.x (2nd arg) */
```

```
lua_remove(L, -2);              /* remove 't' from the stack */
```

```
lua_pushinteger(L, 14);         /* 3rd argument */
```

```
lua_call(L, 3, 1);              /* call 'f' with 3 arguments and 1 result */
```

```
lua_setglobal(L, "a");          /* set global
```

```
'a' */
```

```
}
```

Note that the code above is `@emph{balanced}`:  
 at its end, the stack is back to its original configuration.  
 This is considered good programming practice.

```
}
```

```
@APIEntry{
void lua_callk (lua_State *L,
               int nargs,
               int nresults,
               lua_KContext ctx,
               lua_KFunction k);|
@apii{nargs + 1,nresults,e}
```

This function behaves exactly like `@Lid{lua_call}`,  
 but allows the called function to yield `@see{continuations}`.

```
}
```

```
@APIEntry{typedef int (*lua_CFunction) (lua_State *L);|
```

Type for `@N{C functions}`.

In order to communicate properly with Lua,  
 a `@N{C function}` must use the following protocol,  
 which defines the way parameters and results are passed:  
 a `@N{C function}` receives its arguments from Lua in its stack  
 in direct order (the first argument is pushed first).  
 So, when the function starts,  
`@T{lua_gettop(L)}` returns the number of arguments received by the function.  
 The first argument (if any) is at index 1  
 and its last argument  
 is at index `@T{lua_gettop(L)}`.  
 To return values to Lua, a `@N{C function}` just pushes them onto the stack,  
 in direct order (the first result is pushed first),  
 and returns in C the number of results.  
 Any other value in the stack below the results will be properly  
 discarded by Lua.  
 Like a Lua function, a `@N{C function}` called by Lua can also return  
 many results.

As an example, the following function receives a variable number  
 of numeric arguments and returns their average and their sum:

```
@verbatim{
static int foo (lua_State *L) {
  int n = lua_gettop(L); /* number of arguments */
  lua_Number sum = 0.0;
  int i;
```



```

for (i = 1; i <= n; i++) {
    if (!lua_isnumber(L, i)) {
        lua_pushliteral(L, "incorrect argument");
        lua_error(L);
    }
    sum += lua_tonumber(L, i);
}
lua_pushnumber(L, sum/n);    /* first result */
lua_pushnumber(L, sum);     /* second result */
return 2;                    /* number of results */
}
}

}

```

```

@APIEntry{int lua_checkstack (lua_State
*L, int n);|
@api{0,0,-}

```

Ensures that the stack has space for at least @id{n} extra elements, that is, that you can safely push up to @id{n} values into it. It returns false if it cannot fulfill the request, either because it would cause the stack to be greater than a fixed maximum size (typically at least several thousand elements) or because it cannot allocate memory for the extra space. This function never shrinks the stack; if the stack already has space for the extra elements, it is left unchanged.

```

}

```

```

@APIEntry{void lua_close (lua_State *L);|
@api{0,0,-}

```

Close all active to-be-closed variables in the main thread, release all objects in the given Lua state (calling the corresponding garbage-collection metamethods, if any), and frees all dynamic memory used by this state.

On several platforms, you may not need to call this function, because all resources are naturally released when the host program ends. On the other hand, long-running programs that create multiple states, such

as daemons or web servers,  
will probably need to close states as soon as they are not needed.

}

```
@APIEntry{void lua_closeslot (lua_State *L, int index);|
@apii{0,0,e}
```

Close the to-be-closed slot at the given index and set its value to @nil.  
The index must be the last index previously marked to be closed  
@see{lua\_toclose} that is still active (that is, not closed yet).

A @idx{\_\_close} metamethod cannot yield  
when called through this function.

(This function was introduced in @N{release 5.4.3}.)

}

```
@APIEntry{int lua_closethread (lua_State *L, lua_State *from);|
@apii{0,?, -}
```

Resets a thread, cleaning its call stack and closing all pending  
to-be-closed variables.

Returns a status code:

@Lid{LUA\_OK} for no errors in the thread  
(either the original error that stopped the thread or  
errors in closing methods),  
or an error status otherwise.

In case of error,  
leaves the error object on the top of the stack.

The parameter @id{from} represents the coroutine that is resetting @id{L}.  
If  
there is no such coroutine,  
this parameter can be @id{NULL}.

(This function was introduced in @N{release 5.4.6}.)

}

```
@APIEntry{int lua_compare (lua_State *L, int index1, int index2, int op);|
@apii{0,0,e}
```

Compares two Lua values.

Returns 1 if the value at index @id{index1} satisfies @id{op}  
when compared with the value at index @id{index2},  
following the semantics of the corresponding Lua operator

(that is, it may call metamethods).

Otherwise @N{returns 0}.

Also @N{returns 0} if any of the indices is not valid.

The value of @id{op} must be one of the following constants:

@description{

@item{@defid{LUA\_OPEQ}| compares for equality (@T{==})}

@item{@defid{LUA\_OPLT}| compares for less than (@T{<})}

@item{@defid{LUA\_OPLE}| compares for less or equal (@T{<=})}

}

}

@APIEntry{void lua\_concat (lua\_State \*L, int n);|

@apii{n,1,e}

Concatenates the @id{n} values at the top of the stack,

pops them, and leaves the result on the top.

If @N{@T{n} is 1}, the result is the single value on the stack

(that is, the function does nothing);

if @id{n} is 0, the result is the empty string.

Concatenation is performed following the usual semantics of Lua

@see{concat}.

}

@APIEntry{void lua\_copy (lua\_State \*L, int fromidx, int toidx);|

@apii{0,0,-}

Copies the element at index @id{fromidx}

into the valid index @id{toidx},

replacing the value at that position.

Values at other positions are not affected.

}

@APIEntry{void lua\_createtable (lua\_State \*L, int narr, int nrec);|

@apii{0,1,m}

Creates a new empty table and pushes it onto the stack.

Parameter @id{narr} is a hint for how many elements the table will have as a sequence;

parameter @id{nrec} is a hint for how many other elements the table will have.

Lua may use these hints to preallocate memory for the new table.

This preallocation may help performance when you know in advance how many elements the table will have.

Otherwise you can use the function @Lid{lua\_newtable}.

}

@APIEntry{int lua\_dump (lua\_State \*L,

lua\_Writer writer,  
void \*data,  
int strip);|

@apii{0,0,-}

Dumps a function as a binary chunk.

Receives a Lua function on the top of the stack

and produces a binary chunk that,

if loaded again,

results in a function equivalent to the one dumped.

As it produces parts of the chunk,

@Lid{lua\_dump} calls function @id{writer} @seeC{lua\_Writer}

with the given @id{data}

to write them.

If @id{strip} is true,

the binary representation may not include all debug information  
about the function,

to save space.

The value returned is the error code returned by the last

call to the writer;

@N{0 means} no errors.

This function does not pop the Lua function from the stack.

}

@APIEntry{int lua\_error (lua\_State \*L);|

@apii{1,0,v}

Raises a Lua error,

using the value on the top of the stack as the error object.

This function does a long jump,

and therefore never returns

@seeC{luaL\_error}.

}

@APIEntry{int lua\_gc (lua\_State \*L, int what, ...);|

@apii{0,0,-}

## Controls

the garbage collector.

This function performs several tasks,  
according to the value of the parameter @id{what}.  
For options that need extra arguments,  
they are listed after the option.  
@description{

@item{@id{LUA\_GCCOLLECT}}|  
Performs a full garbage-collection cycle.  
}

@item{@id{LUA\_GCSTOP}}|  
Stops the garbage collector.  
}

@item{@id{LUA\_GCRESTART}}|  
Restarts the garbage collector.  
}

@item{@id{LUA\_GCCOUNT}}|  
Returns the current amount of memory (in Kbytes) in use by Lua.  
}

@item{@id{LUA\_GCCOUNTB}}|  
Returns the remainder of dividing the current amount of bytes of  
memory in use by Lua by 1024.  
}

@item{@id{LUA\_GCSTEP} @T{(int stepsize)}}|  
Performs an incremental step of garbage collection,  
corresponding to the allocation of @id{stepsize} Kbytes.  
}

@item{@id{LUA\_GCISRUNNING}}|  
Returns a boolean that tells whether the collector is running  
(i.e., not stopped).  
}

@item{@id{LUA\_GCINC} (int pause, int stepmul, stepsize)}|  
Changes the collector to incremental mode  
with the  
given parameters @see{incmode}.  
Returns the previous mode (@id{LUA\_GCGEN} or @id{LUA\_GCINC}).  
}

@item{@id{LUA\_GCGEN} (int minormul, int majormul)|  
 Changes the collector to generational mode  
 with the given parameters @see{genmode}.  
 Returns the previous mode (@id{LUA\_GCGEN} or @id{LUA\_GCINC}).  
 }

}

For more details about these options,  
 see @Lid{collectgarbage}.

This function should not be called by a finalizer.

}

@APIEntry{lua\_Alloc lua\_getallocf (lua\_State \*L, void \*\*ud);|  
 @apii{0,0,-}}

Returns the @x{memory-allocation function} of a given state.  
 If @id{ud} is not @id{NULL}, Lua stores in @T{\*ud} the  
 opaque pointer given when the memory-allocator function was set.

}

@APIEntry{int lua\_getfield (lua\_State \*L, int index, const char \*k);|  
 @apii{0,1,e}}

Pushes onto the stack the value @T{t[k]},  
 where @id{t} is the value at the given index.  
 As in Lua, this function may trigger a metamethod  
 for the @Q{index} event @see{metatable}.

Returns the type of the pushed value.

}

@APIEntry{void  
 \*lua\_getextraspace (lua\_State \*L);|  
 @apii{0,0,-}}

Returns a pointer to a raw memory area associated with the  
 given Lua state.  
 The application can use this area for any purpose;  
 Lua does not use it for anything.

Each new thread has this area initialized with a copy  
 of the area of the @x{main thread}.

By default, this area has the size of a pointer to void,  
but you can recompile Lua with a different size for this area.  
(See @id{LUA\_EXTRASPACE} in @id{luaconf.h}.)

}

```
@APIEntry{int lua_getglobal (lua_State *L, const char *name);|
@apii{0,1,e}
```

Pushes onto the stack the value of the global @id{name}.

Returns the type of that value.

}

```
@APIEntry{int lua_geti (lua_State *L, int index, lua_Integer i);|
@apii{0,1,e}
```

Pushes onto the stack the value @T{t[i]},  
where @id{t} is the value at the given index.  
As in Lua, this function may trigger a metamethod  
for the @Q{index} event @see{metatable}.

Returns the type of the pushed value.

}

```
@APIEntry{int lua_getmetatable (lua_State *L, int index);|
@apii{0,0|1,-}
```

If  
the value at the given index has a metatable,  
the function pushes that metatable onto the stack and @N{returns 1}.

Otherwise,  
the function @N{returns 0} and pushes nothing on the stack.

}

```
@APIEntry{int lua_gettable (lua_State *L, int index);|
@apii{1,1,e}
```

Pushes onto the stack the value @T{t[k]},  
where @id{t} is the value at the given index  
and @id{k} is the value on the top of the stack.

This function pops the key from the stack,  
pushing the resulting value in its place.  
As in Lua, this function may trigger a metamethod  
for the @Q{index} event @see{metatable}.

Returns the type of the pushed value.

}

```
@APIEntry{int lua_gettop (lua_State *L);|
@apii{0,0,-}}
```

Returns the index of the top element in the stack.  
Because indices start @N{at 1},  
this result is equal to the number of elements in the stack;  
in particular, @N{0 means} an empty stack.

}

```
@APIEntry{int lua_getiuservalue (lua_State *L, int index, int n);|
@apii{0,1,-}}
```

Pushes onto the stack the @id{n}-th  
user value associated with the  
full userdata at the given index and  
returns the type of the pushed value.

If the userdata does not have that value,  
pushes @nil and returns @Lid{LUA\_TNONE}.

}

```
@APIEntry{void lua_insert (lua_State *L, int index);|
@apii{1,1,-}}
```

Moves the top element into the given valid index,  
shifting up the elements above this index to open space.  
This function cannot be called with a pseudo-index,  
because a pseudo-index is not an actual stack position.

}

```
@APIEntry{typedef @ldots lua_Integer;|
```

The type of integers in Lua.

By default this type is @id{long long},  
(usually a 64-bit two-complement integer),  
but that can be changed to @id{long} or @id{int}  
(usually a 32-bit two-complement integer).  
(See @id{LUA\_INT\_TYPE} in @id{luaconf.h}.)



Lua also defines the constants

@defid{LUA\_MININTEGER} and @defid{LUA\_MAXINTEGER},  
with the minimum and the maximum values that fit in this type.

}

@APIEntry{int lua\_isboolean (lua\_State \*L, int index);|  
@apii{0,0,-}}

Returns 1

if the value at the given index is a boolean,  
and @N{0 otherwise}.

}

@APIEntry{int lua\_iscfunction (lua\_State \*L, int index);|  
@apii{0,0,-}}

Returns 1 if the value at the given index is a @N{C function},  
and @N{0 otherwise}.

}

@APIEntry{int lua\_isfunction (lua\_State \*L, int index);|  
@apii{0,0,-}}

Returns 1 if the value at the given index is a function  
(either C or Lua), and @N{0 otherwise}.

}

@APIEntry{int lua\_isinteger (lua\_State \*L, int index);|  
@apii{0,0,-}}

Returns 1 if the value at the given index is an integer  
(that is, the value is a number and is represented as an integer),  
and @N{0 otherwise}.

}

@APIEntry{int lua\_islightuserdata (lua\_State \*L, int index);|  
@apii{0,0,-}}

Returns 1 if the value at the given index is a light userdata,  
and @N{0 otherwise}.

}

```
@APIEntry{int lua_isnil (lua_State *L, int index);|
@apii{0,0,-}}
```

Returns 1 if the value at the given index is @nil,  
and @N{0 otherwise}.

```
}
```

```
@APIEntry{int lua_isnone (lua_State *L, int index);|
@apii{0,0,-}}
```

Returns  
1 if the given index is not valid,  
and @N{0 otherwise}.

```
}
```

```
@APIEntry{int lua_isnoneornil (lua_State *L, int index);|
@apii{0,0,-}}
```

Returns 1 if the given index is not valid  
or if the value at this index is @nil,  
and @N{0 otherwise}.

```
}
```

```
@APIEntry{int lua_isnumber (lua_State *L, int index);|
@apii{0,0,-}}
```

Returns 1 if the value at the given index is a number  
or a string convertible to a number,  
and @N{0 otherwise}.

```
}
```

```
@APIEntry{int lua_isstring (lua_State *L, int index);|
@apii{0,0,-}}
```

Returns 1 if the value at the given index is a string  
or a number (which is always convertible to a string),  
and @N{0 otherwise}.

```
}
```

```
@APIEntry{int lua_istable (lua_State *L, int index);|
@apii{0,0,-}}
```

Returns 1 if the value at the given index is a table,

and @N{0 otherwise}.

}

```
@APIEntry{int lua_isthread (lua_State *L, int index);|
@apii{0,0,-}}
```

Returns 1 if the value at the given index is a thread,  
and @N{0 otherwise}.

}

```
@APIEntry{int lua_isuserdata (lua_State *L, int index);|
@apii{0,0,-}}
```

Returns

1 if the value at the given index is a userdata  
(either full or light), and @N{0 otherwise}.

}

```
@APIEntry{int lua_isyieldable (lua_State *L);|
@apii{0,0,-}}
```

Returns 1 if the given coroutine can yield,  
and @N{0 otherwise}.

}

```
@APIEntry{typedef @ldots lua_KContext;|
```

The type for continuation-function contexts.

It must be a numeric type.

This type is defined as @id{intptr\_t}

when @id{intptr\_t} is available,

so that it can store pointers too.

Otherwise, it is defined as @id{ptrdiff\_t}.

}

```
@APIEntry{
typedef int (*lua_KFunction) (lua_State *L, int status, lua_KContext ctx);|
```

Type for continuation functions @see{continuations}.

}

```
@APIEntry{void lua_len (lua_State *L, int index);|
```

@apii{0,1,e}

Returns the length of the value at the given index.

It is equivalent to the @Char{#} operator in Lua @see{len-op} and may trigger a metamethod for the @Q{length} event @see{metatable}. The result is pushed on the stack.

}

```
@APIEntry{
int lua_load (lua_State *L,
              lua_Reader reader,
              void *data,
              const char *chunkname,
              const char *mode);|
@apii{0,1,-}
```

Loads a Lua chunk without running it.

If there are no errors,

@id{lua\_load} pushes the compiled chunk as a Lua function on top of the stack.

Otherwise, it pushes an error message.

The @id{lua\_load} function uses a user-supplied @id{reader} function to read the chunk @seeC{lua\_Reader}.

The @id{data} argument is an opaque value passed to the reader function.

The @id{chunkname} argument gives a name to the chunk, which is used for error messages and in debug information @see{debugI}.

@id{lua\_load} automatically detects whether the chunk is text or binary and loads it accordingly (see program @idx{luac}).

The string @id{mode} works as in function @Lid{load}, with the addition that a @id{NULL} value is equivalent to the string @St{bt}.

@id{lua\_load} uses the stack internally, so the reader function must always leave the stack unmodified when returning.

@id{lua\_load} can return @Lid{LUA\_OK}, @Lid{LUA\_ERRSYNTAX}, or @Lid{LUA\_ERRMEM}. The function may also return other values corresponding to errors raised by the read function @see{statuscodes}.

If the resulting function has upvalues, its first upvalue is set to the value of the @x{global environment}

stored at index @id{LUA\_RIDX\_GLOBALS} in the registry @see{registry}.

When loading main chunks,  
this upvalue will be the @id{\_ENV} variable @see{globalenv}.

Other upvalues are initialized with @nil.

}

```
@APIEntry{lua_State *lua_newstate (lua_Alloc f, void *ud);|
@apii{0,0,-}
```

Creates a new independent state and returns its main thread.

Returns @id{NULL} if it cannot create the state  
(due to lack of memory).

The argument @id{f} is the @x{allocator function};  
Lua will do all memory allocation for this state  
through this function @seeF{lua\_Alloc}.

The second argument, @id{ud}, is an opaque pointer that Lua  
passes to the allocator in every call.

}

```
@APIEntry{void lua_newtable (lua_State *L);|
@apii{0,1,m}
```

Creates  
a new empty table and pushes it onto the stack.

It is equivalent to @T{lua\_createtable(L, 0, 0)}.

}

```
@APIEntry{lua_State *lua_newthread (lua_State *L);|
@apii{0,1,m}
```

Creates a new thread, pushes it on the stack,  
and returns a pointer to a @Lid{lua\_State} that represents this new thread.

The new thread returned by this function shares with the original thread  
its global environment,  
but has an independent execution stack.

Threads are subject to garbage collection,  
like any Lua object.

}

```
@APIEntry{void *lua_newuserdatauv (lua_State *L, size_t size, int nuvalue);|
@apii{0,1,m}
```

This function creates and pushes on the stack a new full userdata,

with `@id{nuvalue}` associated Lua values, called `@id{user values}`, plus an associated block of raw memory with `@id{size}` bytes. (The user values can be set and read with the functions `@Lid{lua_setiuservalue}` and `@Lid{lua_getiuservalue}`.)

The function returns the address of the block of memory. Lua ensures that this address is valid as long as the corresponding userdata is alive `@see{GC}`. Moreover, if the userdata is marked for finalization `@see{finalizers}`, its address is valid at least until the call to its finalizer.

}

```
@APIEntry{int lua_next (lua_State *L, int index);|
@apii{1,2|0,v}
```

Pops a key from the stack, and pushes a key@En{ }value pair from the table at the given index, the @Q{next} pair after the given key. If there are no more elements in the table, then `@Lid{lua_next}` @N{returns 0} and pushes nothing.

A typical table traversal looks like this:

```
@verbatim{
/* table is in the stack at index 't' */
lua_pushnil(L); /* first key */
while (lua_next(L, t) != 0) {
/* uses 'key' (at index -2) and 'value' (at index -1) */
printf("%s - %s\n",
    lua_typename(L, lua_type(L, -2)),
    lua_typename(L, lua_type(L, -1)));
/* removes 'value'; keeps 'key' for next iteration */
lua_pop(L, 1);
}
}
```

While traversing a table, avoid calling `@Lid{lua_tolstring}` directly on a key, unless you know that the key is actually a string. Recall that `@Lid{lua_tolstring}` may change the value at the given index; this confuses the next call to `@Lid{lua_next}`.

This function may raise an error if the given key is neither `@nil` nor present in the table. See function `@Lid{next}` for the caveats of modifying

the table during its traversal.

```
}
```

```
@APIEntry{typedef @ldots lua_Number;|
```

The type of floats in Lua.

By default this type is double,  
but that can be changed to a single float or a long double.  
(See @id{LUA\_FLOAT\_TYPE} in @id{luaconf.h}.)

```
}
```

```
@APIEntry{int lua_numbertointeger (lua_Number n, lua_Integer *p);|
```

Tries to convert a Lua float to a Lua integer;  
the float @id{n} must have an integral value.  
If that value is within the range of Lua integers,  
it is converted to an integer and assigned to @T{\*p}.  
The macro results in a boolean indicating whether the  
conversion was successful.  
(Note that this range test can be tricky to do  
correctly without this macro, due to rounding.)

This macro may evaluate its  
arguments more than once.

```
}
```

```
@APIEntry{int lua_pcall (lua_State *L, int nargs, int nresults, int msggh);|  
@apii{nargs + 1,nresults|1,-}
```

Calls a function (or a callable object) in protected mode.

Both @id{nargs} and @id{nresults} have the same meaning as  
in @Lid{lua\_call}.

If there are no errors during the call,  
@Lid{lua\_pcall} behaves exactly like @Lid{lua\_call}.  
However, if there is any error,  
@Lid{lua\_pcall} catches it,  
pushes a single value on the stack (the error object),  
and returns an error code.

Like @Lid{lua\_call},  
@Lid{lua\_pcall} always removes the function  
and its arguments from the stack.

If @id{msggh} is 0,

then the error object returned on the stack  
 is exactly the original error object.  
 Otherwise, @id{msggh} is the stack index of a  
 @emph{message handler}.  
 (This index cannot be a pseudo-index.)  
 In case of runtime errors,  
 this handler will be called with the error object  
 and its return value will be the object  
 returned on the stack by @Lid{lua\_pcall}.

Typically, the message  
 handler is used to add more debug  
 information to the error object, such as a stack traceback.  
 Such information cannot be gathered after the return of @Lid{lua\_pcall},  
 since by then the stack has unwound.

The @Lid{lua\_pcall} function returns one of the following status codes:  
 @Lid{LUA\_OK}, @Lid{LUA\_ERRRUN}, @Lid{LUA\_ERRMEM}, or @Lid{LUA\_ERRERR}.

}

```
@APIEntry{
int lua_pcallk (lua_State *L,
               int nargs,
               int nresults,
               int msggh,
               lua_KContext ctx,
               lua_KFunction k);|
@apii{nargs + 1,nresults|1,-}
```

This function behaves exactly like @Lid{lua\_pcall},  
 except that it allows the called function to yield @see{continuations}.

}

```
@APIEntry{void lua_pop (lua_State *L, int n);|
@apii{n,0,e}
```

Pops @id{n} elements from the stack.  
 It is implemented as a macro over @Lid{lua\_settop}.

}

```
@APIEntry{void lua_pushboolean (lua_State *L, int b);|
@apii{0,1,-}
```

Pushes a boolean value with value @id{b} onto the stack.



}

```
@APIEntry{void  
lua_pushcclosure (lua_State *L, lua_CFunction fn, int n);|  
@apii{n,1,m}
```

Pushes a new @N{C closure} onto the stack.

This function receives a pointer to a @N{C function}

and pushes onto the stack a Lua value of type @id{function} that,

when called, invokes the corresponding @N{C function}.

The parameter @id{n} tells how many upvalues this function will have

@see{c-closure}.

Any function to be callable by Lua must

follow the correct protocol to receive its parameters

and return its results @seeC{lua\_CFunction}.

When a @N{C function} is created,

it is possible to associate some values with it,

the so called upvalues;

these upvalues are then accessible to the function whenever it is called.

This association is called a @x{@N{C closure}} @see{c-closure}.

To create a @N{C closure},

first the initial values for its upvalues must be pushed onto the stack.

(When there are multiple upvalues, the first value is pushed first.)

Then @Lid{lua\_pushcclosure}

is called to create and push the @N{C

function} onto the stack,

with the argument @id{n} telling how many values will be

associated with the function.

@Lid{lua\_pushcclosure} also pops these values from the stack.

The maximum value for @id{n} is 255.

When @id{n} is zero,

this function creates a @def{light @N{C function}},

which is just a pointer to the @N{C function}.

In that case, it never raises a memory error.

}

```
@APIEntry{void lua_pushcfunction (lua_State *L, lua_CFunction f);|  
@apii{0,1,-}
```

Pushes a @N{C function} onto the stack.

This function is equivalent to @Lid{lua\_pushcclosure} with no upvalues.

}

```
@APIEntry{const char *lua_pushfstring (lua_State *L, const char *fmt, ...);|
@apii{0,1,v}
```

Pushes onto the stack a formatted string  
and returns a pointer to this string @see{constchar}.

It is similar to the @ANSI{sprintf},  
but has two important differences.

First,

you do not have to allocate space for the result;  
the result is a Lua string and Lua takes care of memory allocation  
(and deallocation, through garbage  
collection).

Second,

the conversion specifiers are quite restricted.

There are no flags, widths, or precisions.

The conversion specifiers can only be

@Char{%%} (inserts the character @Char{%}),  
@Char{%s} (inserts a zero-terminated string, with no size restrictions),  
@Char{%f} (inserts a @Lid{lua\_Number}),  
@Char{%I} (inserts a @Lid{lua\_Integer}),  
@Char{%p} (inserts a pointer),  
@Char{%d} (inserts an @T{int}),  
@Char{%c} (inserts an @T{int} as a one-byte character), and  
@Char{%U} (inserts a @T{long int} as a @x{UTF-8} byte sequence).

This function may raise errors due to memory overflow  
or an invalid conversion specifier.

```
}
```

```
@APIEntry{void lua_pushglobaltable (lua_State *L);|
@apii{0,1,-}
```

Pushes the @x{global environment} onto the stack.

```
}
```

```
@APIEntry{void lua_pushinteger (lua_State *L, lua_Integer n);|
@apii{0,1,-}
```

Pushes an integer with value @id{n} onto the stack.

```
}
```

```
@APIEntry{void lua_pushlightuserdata (lua_State *L, void *p);|
@apii{0,1,-}
```

Pushes a light userdata onto the stack.

Userdata

represent @N{C values} in Lua.

A @def{light userdata} represents a pointer, a @T{void\*}.

It is a value (like a number):

you do not create it, it has no individual metatable,

and it is not collected (as it was never created).

A light userdata is equal to @Q{any}

light userdata with the same @N{C address}.

}

@APIEntry{const char \*lua\_pushliteral (lua\_State \*L, const char \*s);|

@apii{0,1,m}

This macro is equivalent to @Lid{lua\_pushstring},

but should be used only when @id{s} is a literal string.

(Lua may optimize this case.)

}

@APIEntry{const char \*lua\_pushlstring (lua\_State \*L, const char \*s, size\_t len);|

@apii{0,1,m}

Pushes the string pointed to by @id{s} with size @id{len}  
onto the stack.

Lua will make or reuse an internal copy of the given string,  
so the memory at @id{s} can be freed or reused immediately after  
the function returns.

The string can contain any binary data,  
including @x{embedded zeros}.

Returns a pointer to the internal copy of the string @see{constchar}.

}

@APIEntry{void

lua\_pushnil (lua\_State \*L);|

@apii{0,1,-}

Pushes a nil value onto the stack.

}

@APIEntry{void lua\_pushnumber (lua\_State \*L, lua\_Number n);|

@apii{0,1,-}

Pushes a float with value @id{n} onto the stack.

}

```
@APIEntry{const char *lua_pushstring (lua_State *L, const char *s);|
@apii{0,1,m}
```

Pushes the zero-terminated string pointed to by @id{s} onto the stack.

Lua will make or reuse an internal copy of the given string, so the memory at @id{s} can be freed or reused immediately after the function returns.

Returns a pointer to the internal copy of the string @see{constchar}.

If @id{s} is @id{NULL}, pushes @nil and returns @id{NULL}.

}

```
@APIEntry{int lua_pushthread (lua_State *L);|
@apii{0,1,-}
```

Pushes the thread represented by @id{L} onto the stack.

Returns 1 if this thread is the @x{main thread} of its state.

}

```
@APIEntry{void lua_pushvalue (lua_State *L, int index);|
@apii{0,1,-}
```

Pushes a copy of the element at the given index onto the stack.

}

```
@APIEntry{
const
char *lua_pushvfstring (lua_State *L,
                        const char *fmt,
                        va_list argp);|
@apii{0,1,v}
```

Equivalent to @Lid{lua\_pushstring}, except that it receives a @id{va\_list} instead of a variable number of arguments.

}

```
@APIEntry{int lua_rawequal (lua_State *L, int index1, int index2);|
```

@apii{0,0,-}

Returns 1 if the two values in indices @id{index1} and @id{index2} are primitively equal (that is, equal without calling the @idx{\_\_eq} metamethod). Otherwise @N{returns 0}. Also @N{returns 0} if any of the indices are not valid.

}

@APIEntry{int lua\_rawget (lua\_State \*L, int index);|  
@apii{1,1,-}}

Similar to @Lid{lua\_gettable}, but does a raw access (i.e., without metamethods). The value at @id{index} must be a table.

}

@APIEntry{int lua\_rawgeti (lua\_State \*L, int index, lua\_Integer n);|  
@apii{0,1,-}}

Pushes onto the stack the value @T{t[n]}, where @id{t} is the table at the given index. The access is raw, that is, it does not use the @idx{\_\_index} metavalue.

Returns the type of the pushed value.

}

@APIEntry{int lua\_rawgetp (lua\_State \*L, int index, const void \*p);|  
@apii{0,1,-}}

Pushes onto the stack the value @T{t[k]}, where @id{t} is the table at the given index and @id{k} is the pointer @id{p} represented as a light userdata. The access is raw; that is, it does not use the @idx{\_\_index} metavalue.

Returns the type of the pushed value.

}

@APIEntry{lua\_Unsigned lua\_rawlen (lua\_State \*L, int index);|  
@apii{0,0,-}}

Returns the raw `@Q{length}` of the value at the given index:  
 for strings, this is the string length;  
 for tables, this is the result of the length operator (`@Char{#}`)  
 with no metamethods;  
 for userdata, this is the size of the block of memory allocated  
 for the userdata.  
 For other values, this call `@N{returns 0}`.

}

```
@APIEntry{void lua_rawset (lua_State *L, int index);|
@apii{2,0,m}
```

Similar to `@Lid{lua_settable}`, but does a raw assignment  
 (i.e., without metamethods).  
 The value at `@id{index}` must  
 be a table.

}

```
@APIEntry{void lua_rawseti (lua_State *L, int index, lua_Integer i);|
@apii{1,0,m}
```

Does the equivalent of `@T{t[i] = v}`,  
 where `@id{t}` is the table at the given index  
 and `@id{v}` is the value on the top of the stack.

This function pops the value from the stack.  
 The assignment is raw,  
 that is, it does not use the `@idx{__newindex}` metavalue.

}

```
@APIEntry{void lua_rawsetp (lua_State *L, int index, const void *p);|
@apii{1,0,m}
```

Does the equivalent of `@T{t[p] = v}`,  
 where `@id{t}` is the table at the given index,  
`@id{p}` is encoded as a light userdata,  
 and `@id{v}` is the value on the top of the stack.

This function pops the value from the stack.  
 The assignment is raw,  
 that is, it does not use the `@idx{__newindex}` metavalue.

}

```
@APIEntry{
```

```
typedef const char * (*lua_Reader) (lua_State *L,
                                     void *data,
                                     size_t *size);|
```

The reader function used by @Lid{lua\_load}.

Every time @Lid{lua\_load} needs another piece of the chunk, it calls the reader, passing along its @id{data} parameter.

The reader must return a pointer to a block of memory with a new piece of the chunk and set @id{size} to the block size.

The block must exist until the reader function is called again.

To signal the end of the chunk, the reader must return @id{NULL} or set @id{size} to zero.

The reader function may return pieces of any size greater than zero.

```
}
```

```
@APIEntry{void lua_register (lua_State *L, const char *name, lua_CFunction f);|
@apii{0,0,e}
```

Sets the @N{C function} @id{f} as the new value of global @id{name}.

It is defined as a macro:

```
@verbatim{
#define lua_register(L,n,f) \
    (lua_pushcfunction(L, f), lua_setglobal(L, n))
}
```

```
}
```

```
@APIEntry{void lua_remove (lua_State *L, int index);|
@apii{1,0,-}
```

Removes the element at the given valid index, shifting down the elements above this index to fill the gap.

This function cannot be called with a pseudo-index, because a pseudo-index is not an actual stack position.

```
}
```

```
@APIEntry{void
lua_replace (lua_State *L, int index);|
@apii{1,0,-}
```

Moves the top element into the given valid index without shifting any element (therefore replacing the value at that given index),

and then pops the top element.

```
}
```

```
@APIEntry{int lua_resetthread (lua_State *L);|
@apii{0,?,-}}
```

This function is deprecated;  
it is equivalent to @Lid{lua\_closethread} with  
@id{from} being @id{NULL}.

```
}
```

```
@APIEntry{int lua_resume (lua_State *L, lua_State *from, int nargs,
                          int *nresults);|
@apii{?,?,-}}
```

Starts and resumes a coroutine in the given thread @id{L}.

To start a coroutine,  
you push the main function plus any arguments  
onto the empty stack of the thread.  
then you call @Lid{lua\_resume},  
with @id{nargs} being the number of arguments.  
This call returns when the coroutine suspends or finishes its execution.  
When it returns,  
@id{\*nresults} is updated and  
the top of the stack contains  
the @id{\*nresults} values passed to @Lid{lua\_yield}  
or returned by the body function.  
@Lid{lua\_resume}  
returns  
@Lid{LUA\_YIELD} if the coroutine yields,  
@Lid{LUA\_OK} if the coroutine finishes its execution  
without errors,  
or an error code in case of errors @see{statuscodes}.  
In case of errors,  
the error object is on the top of the stack.

To resume a coroutine,  
you remove the @id{\*nresults} yielded values from its stack,  
push the values to be passed as results from @id{yield},  
and then call @Lid{lua\_resume}.

The parameter @id{from} represents the coroutine that is resuming @id{L}.  
If there is no such coroutine,  
this parameter can be @id{NULL}.



```
}
```

```
@APIEntry{void lua_rotate (lua_State *L, int idx, int n);|  
@apii{0,0,-}}
```

Rotates the stack elements between the valid index @id{idx}  
and the top of the stack.

The elements are rotated @id{n} positions in the direction of the top,  
for a positive @id{n},  
or @T{-n} positions in the direction of the bottom,  
for a negative @id{n}.

The absolute value of @id{n} must not be greater than the size  
of the slice being rotated.

This function

cannot be called with a pseudo-index,  
because a pseudo-index is not an actual stack position.

```
}
```

```
@APIEntry{void lua_setallocf (lua_State *L, lua_Alloc f, void *ud);|  
@apii{0,0,-}}
```

Changes the @x{allocator function} of a given state to @id{f}  
with user data @id{ud}.

```
}
```

```
@APIEntry{void lua_setfield (lua_State *L, int index, const char *k);|  
@apii{1,0,e}}
```

Does the equivalent to @T{t[k] = v},  
where @id{t} is the value at the given index  
and @id{v} is the value on the top of the stack.

This function pops the value from the stack.

As in Lua, this function may trigger a metamethod  
for the @Q{newindex} event @see{metatable}.

```
}
```

```
@APIEntry{void lua_setglobal (lua_State *L, const char *name);|  
@apii{1,0,e}}
```

Pops a value from the stack and  
sets it as the new value of global @id{name}.

```
}
```

```
@APIEntry{void lua_seti (lua_State *L, int index, lua_Integer n);|
@apii{1,0,e}
```

Does the equivalent to  $@T\{t[n] = v\}$ ,  
where  $@id\{t\}$  is the value at the given index  
and  $@id\{v\}$  is the value on the top of  
the stack.

This function pops the value from the stack.  
As in Lua, this function may trigger a metamethod  
for the  $@Q\{newindex\}$  event  $@see\{metatable\}$ .

```
}
```

```
@APIEntry{int lua_setiuservalue (lua_State *L, int index, int n);|
@apii{1,0,-}
```

Pops a value from the stack and sets it as  
the new  $@id\{n\}$ -th user value associated to the  
full userdata at the given index.  
Returns 0 if the userdata does not have that value.

```
}
```

```
@APIEntry{int lua_setmetatable (lua_State *L, int index);|
@apii{1,0,-}
```

Pops a table or  $@nil$  from the stack and  
sets that value as the new metatable for the value at the given index.  
( $@nil$  means no metatable.)

(For historical reasons, this function returns an  $@id\{int\}$ ,  
which now is always 1.)

```
}
```

```
@APIEntry{void lua_settable (lua_State *L, int index);|
@apii{2,0,e}
```

Does the equivalent to  $@T\{t[k] = v\}$ ,  
where  $@id\{t\}$  is the value at the given index,  
 $@id\{v\}$  is the value on the top of the stack,  
and  $@id\{k\}$  is the value just below the top.

This function pops both the key and the value  
from the stack.  
As in Lua, this function may trigger a metamethod  
for the  $@Q\{newindex\}$  event  $@see\{metatable\}$ .

```
}
```

```
@APIEntry{void lua_settop (lua_State *L, int index);|  
@apii{?,?,e}
```

Accepts any index, @N{or 0},  
and sets the stack top to this index.  
If the new top is greater than the old one,  
then the new elements are filled with @nil.  
If @id{index} @N{is 0}, then all stack elements are removed.

This function can run arbitrary code when removing an index  
marked as to-be-closed from the stack.

```
}
```

```
@APIEntry{void lua_setwarnf (lua_State *L, lua_WarnFunction f, void *ud);|  
@apii{0,0,-}
```

Sets the @x{warning function} to be used by Lua to emit warnings  
@see{lua\_WarnFunction}.  
The @id{ud} parameter sets the value @id{ud} passed to  
the warning function.

```
}
```

```
@APIEntry{typedef struct lua_State lua_State;|
```

An opaque structure that points to a thread and indirectly  
(through the thread) to the whole state of a Lua interpreter.  
The Lua library is fully reentrant:  
it has no global variables.  
All  
information about a state is accessible through this structure.

A pointer to this structure must be passed as the first argument to  
every function in the library, except to @Lid{lua\_newstate},  
which creates a Lua state from scratch.

```
}
```

```
@APIEntry{int lua_status (lua_State *L);|  
@apii{0,0,-}
```

Returns the status of the thread @id{L}.

The status can be @Lid{LUA\_OK} for a normal thread,

an error code if the thread finished the execution  
of a @Lid{lua\_resume} with an error,  
or @Lid{LUA\_YIELD} if the thread is suspended.

You can call functions only in threads with status @Lid{LUA\_OK}.  
You can resume threads with status @Lid{LUA\_OK}  
(to start a new coroutine) or @Lid{LUA\_YIELD}  
(to resume a coroutine).

}

@APIEntry{size\_t lua\_stringtonumber (lua\_State \*L, const char \*s);|  
@apii{0,1,-}}

Converts the zero-terminated string @id{s} to a number,  
pushes that number into the stack,  
and returns the total size of the string,  
that is, its length plus one.  
The conversion can result in an integer  
or a float,  
according to the lexical conventions of Lua @see{lexical}.  
The string may have leading and trailing whitespaces and a sign.  
If the string is not a valid numeral,  
returns 0 and pushes nothing.  
(Note that the result can be used as a boolean,  
true if the conversion succeeds.)

}

@APIEntry{int lua\_toboolean (lua\_State \*L, int index);|  
@apii{0,0,-}}

Converts the Lua value at the given index to a @N{C boolean}  
value (@N{0 or 1}).  
Like all tests in Lua,  
@Lid{lua\_toboolean} returns true for any Lua value  
different from @false and @nil;  
otherwise it returns false.  
(If you want to accept only actual boolean values,  
use @Lid{lua\_isboolean} to test the value's type.)

}

@APIEntry{lua\_CFunction lua\_tocfunction (lua\_State \*L, int index);|  
@apii{0,0,-}}

Converts a value at the given index to a @N{C function}.  
That value must be a @N{C function};

otherwise, returns @id{NULL}.

}

```
@APIEntry{void lua_toclose (lua_State *L, int index);|
@apii{0,0,v}
```

Marks the given index in the stack as a  
to-be-closed

slot @see{to-be-closed}.

Like a to-be-closed variable in Lua,  
the value at that slot in the stack will be closed  
when it goes out of scope.

Here, in the context of a C function,  
to go out of scope means that the running function returns to Lua,  
or there is an error,  
or the slot is removed from the stack through  
@Lid{lua\_settop} or @Lid{lua\_pop},  
or there is a call to @Lid{lua\_closeslot}.

A slot marked as to-be-closed should not be removed from the stack  
by any other function in the API except @Lid{lua\_settop} or @Lid{lua\_pop},  
unless previously deactivated by @Lid{lua\_closeslot}.

This function raises an error if the value at the given slot  
neither has a @idx{\_\_close} metamethod nor is a false value.

This function should not be called for an index  
that is equal to or below an active to-be-closed slot.

Note that, both in case of errors and of a regular return,  
by the time the @idx{\_\_close} metamethod runs,  
the @N{C stack} was already unwound,  
so that any automatic @N{C variable}  
declared in the calling function  
(e.g., a buffer) will be out of scope.

}

```
@APIEntry{lua_Integer lua_tointeger (lua_State *L, int index);|
@apii{0,0,-}
```

Equivalent to @Lid{lua\_tointegerx} with @id{isnum} equal to @id{NULL}.

}

```
@APIEntry{lua_Integer lua_tointegerx (lua_State *L, int index, int *isnum);|
@apii{0,0,-}
```

Converts the Lua value at the given index  
to the signed integral type @Lid{lua\_Integer}.  
The Lua value must be an integer,  
or a number or string convertible to an integer @see{coercion};  
otherwise, @id{lua\_tointegerx} @N{returns 0}.

If @id{isnum} is not @id{NULL},  
its referent is assigned a boolean value that  
indicates whether the operation succeeded.

}

@APIEntry{const char \*lua\_tolstring (lua\_State \*L, int index, size\_t \*len);|  
@apii{0,0,m}}

Converts the Lua value at the given index to a @N{C string}.  
If @id{len} is not @id{NULL},  
it sets @T{\*len} with the string length.  
The Lua value must be a string or a number;  
otherwise, the function returns @id{NULL}.  
If  
the value is a number,  
then @id{lua\_tolstring} also  
@emph{changes the actual value in the stack to a string}.  
(This change confuses @Lid{lua\_next}  
when @id{lua\_tolstring} is applied to keys during a table traversal.)

@id{lua\_tolstring} returns a pointer  
to a string inside the Lua state @see{constchar}.  
This string always has a zero (@Char{0})  
after its last character (as @N{in C}),  
but can contain other zeros in its body.

This function can raise memory errors only  
when converting a number to a string  
(as then it may create a new string).

}

@APIEntry{lua\_Number lua\_tonumber (lua\_State \*L, int index);|  
@apii{0,0,-}}

Equivalent to @Lid{lua\_tonumberx} with @id{isnum} equal to @id{NULL}.

}

@APIEntry{lua\_Number lua\_tonumberx (lua\_State \*L, int index, int \*isnum);|  
@apii{0,0,-}}

Converts the Lua value at the given index  
to the @N{C type} @Lid{lua\_Number} @seeC{lua\_Number}.  
The Lua value must be a number or a string convertible to a number  
@see{coercion};  
otherwise, @Lid{lua\_tonumberx}  
@N{returns 0}.

If @id{isnum} is not @id{NULL},  
its referent is assigned a boolean value that  
indicates whether the operation succeeded.

}

@APIEntry{const void \*lua\_topointer (lua\_State \*L, int index);|  
@apii{0,0,-}}

Converts the value at the given index to a generic  
@N{C pointer} (@T{void\*}).  
The value can be a userdata, a table, a thread, a string, or a function;  
otherwise, @id{lua\_topointer} returns @id{NULL}.  
Different objects will give different pointers.  
There is no way to convert the pointer back to its original value.

Typically this function is used only for hashing and debug information.

}

@APIEntry{const char \*lua\_tostring (lua\_State \*L, int index);|  
@apii{0,0,m}}

Equivalent to @Lid{lua\_tolstring} with @id{len} equal to @id{NULL}.

}

@APIEntry{lua\_State \*lua\_tothread (lua\_State \*L, int index);|  
@apii{0,0,-}}

Converts the value at the given index to a Lua thread  
(represented as @T{lua\_State\*}).  
This value must be a thread;  
otherwise, the function returns @id{NULL}.

}

@APIEntry{void  
\*lua\_touserdata (lua\_State \*L, int index);|  
@apii{0,0,-}}

If the value at the given index is a full userdata,  
returns its memory-block address.  
If the value is a light userdata,  
returns its value (a pointer).  
Otherwise, returns @id{NULL}.

}

```
@APIEntry{int lua_type (lua_State *L, int index);|
@apii{0,0,-}
```

Returns the type of the value in the given valid index,  
or @id{LUA\_TNONE} for a non-valid but acceptable index.  
The types returned by @Lid{lua\_type} are coded by the following constants  
defined in @id{lua.h}:

```
@defid{LUA_TNIL},
@defid{LUA_TNUMBER},
@defid{LUA_TBOOLEAN},
@defid{LUA_TSTRING},
@defid{LUA_TTABLE},
@defid{LUA_TFUNCTION},
@defid{LUA_TUSERDATA},
@defid{LUA_TTHREAD},
and
@defid{LUA_TLIGHTUSERDATA}.
```

}

```
@APIEntry{const char *lua_typename (lua_State *L, int tp);|
@apii{0,0,-}
```

Returns the name of the type encoded by the value @id{tp},  
which must be one the values returned by @Lid{lua\_type}.

}

```
@APIEntry{typedef @ldots lua_Unsigned;|
```

The unsigned version of @Lid{lua\_Integer}.

}

```
@APIEntry{int
lua_upvalueindex (int i);|
@apii{0,0,-}
```

Returns the pseudo-index that represents the @id{i}-th upvalue of



the running function @see{c-closure}.  
@id{i} must be in the range @M{[1,256]}.

}

@APIEntry{lua\_Number lua\_version (lua\_State \*L);|  
@apii{0,0,-}}

Returns the version number of this core.

}

@APIEntry{  
typedef void (\*lua\_WarnFunction) (void \*ud, const char \*msg, int tocont);|

The type of @x{warning function}s, called by Lua to emit warnings.

The first parameter is an opaque pointer  
set by @Lid{lua\_setwarnf}.

The second parameter is the warning message.

The third parameter is a boolean that  
indicates whether the message is  
to be continued by the message in the next call.

See @Lid{warn} for more details about warnings.

}

@APIEntry{  
void lua\_warning (lua\_State \*L, const char \*msg, int tocont);|  
@apii{0,0,-}}

Emits a warning with the given message.

A message in a call with @id{tocont} true should be  
continued in another call to this function.

See

@Lid{warn} for more details about warnings.

}

@APIEntry{  
typedef int (\*lua\_Writer) (lua\_State \*L,  
                  const void\* p,  
                  size\_t sz,  
                  void\* ud);|

The type of the writer function used by @Lid{lua\_dump}.

Every time @Lid{lua\_dump} produces another piece of chunk,

it calls the writer,  
passing along the buffer to be written (@id{p}),  
its size (@id{sz}),  
and the @id{ud} parameter supplied to @Lid{lua\_dump}.

The writer returns an error code:

@N{0 means} no errors;  
any other value means an error and stops @Lid{lua\_dump} from  
calling the writer again.

}

@APIEntry{void lua\_xmove (lua\_State \*from, lua\_State \*to, int n);|  
@apii{?,?,-}}

Exchange values between different threads of the same state.

This function pops @id{n} values from the stack @id{from},  
and pushes them onto the stack @id{to}.

}

@APIEntry{int lua\_yield (lua\_State \*L, int nresults);|  
@apii{?,?,v}}

This function is equivalent to @Lid{lua\_yieldk},  
but it has

no continuation @see{continuations}.

Therefore, when the thread resumes,  
it continues the function that called  
the function calling @id{lua\_yield}.

To avoid surprises,  
this function should be called only in a tail call.

}

@APIEntry{  
int lua\_yieldk (lua\_State \*L,  
int nresults,  
lua\_KContext ctx,  
lua\_KFunction k);|  
@apii{?,?,v}}

Yields a coroutine (thread).

When a @N{C function} calls @Lid{lua\_yieldk},  
the running coroutine suspends its execution,

and the call to `@Lid{lua_resume}` that started this coroutine returns. The parameter `@id{nresults}` is the number of values from the stack that will be passed as results to `@Lid{lua_resume}`.

When the coroutine is resumed again, Lua calls the given `@x{continuation function} @id{k}` to continue the execution of the `@N{C function}` that yielded `@see{continuations}`. This continuation function receives the same stack from the previous function, with the `@id{n}` results removed and replaced by the arguments passed to `@Lid{lua_resume}`. Moreover, the continuation function receives the value `@id{ctx}` that was passed to `@Lid{lua_yieldk}`.

Usually, this function does not return; when the coroutine eventually resumes, it continues executing the continuation function. However, there is one special case, which is when this function is called from inside a line or a count hook `@see{debugI}`. In that case, `@id{lua_yieldk}` should be called with no continuation (probably in the form of `@Lid{lua_yield}`) and no results, and the hook should return immediately after the call. Lua will yield and, when the coroutine resumes again, it will continue the normal execution of the (Lua) function that triggered the hook.

This function can raise an error if it is called from a thread with a pending C call with no continuation function (what is called a `@emphx{C-call boundary}`), or it is called from a thread that is not running inside a resume (typically the main thread).

}

}

`@sect2{debugI| @title{The Debug Interface}`

Lua has no built-in debugging facilities. Instead, it offers a special interface by means of functions and `@emph{hooks}`. This interface allows the construction of different kinds of debuggers, profilers, and other tools

that need @Q{inside information} from the interpreter.

```
@APIEntry{
typedef struct lua_Debug {
    int event;
    const char *name;          /* (n) */
    const char *namewhat;     /* (n) */
    const char *what;         /* (S) */
    const char *source;       /* (S) */
    size_t srclen;            /* (S) */
    int currentline;          /* (l) */
    int linedefined;          /* (S) */
    int lastlinedefined;      /* (S) */
    unsigned char nups;       /* (u) number of upvalues */
    unsigned char nparams;    /* (u) number of parameters */
    char isvararg;            /* (u) */
    char istailcall;          /* (t) */
    unsigned short ftransfer; /* (r) index of first value transferred */
    unsigned short ntransfer; /* (r) number of transferred values */
    char short_src[LUA_IDSIZE]; /* (S) */
    /* private part */
    @rep{other fields}
} lua_Debug;
|
```

A structure used to carry different pieces of information about a function or an activation record.

@Lid{lua\_getstack} fills only the private part of this structure, for later use.

To fill the other fields of @Lid{lua\_Debug} with useful information, you must call @Lid{lua\_getinfo} with an appropriate parameter. (Specifically, to get a field, you must add the letter between parentheses in the field's comment to the parameter @id{what} of @Lid{lua\_getinfo}.)

The fields of @Lid{lua\_Debug} have the following meaning:

@description{

@item{@id{source}|

the source of the chunk that created the function.

If @T{source} starts with a @Char{@At},

it means that the function was defined in a file where the file name follows the @Char{@At}.

If @T{source} starts with a @Char{=},

the remainder of its contents describes the source in a user-dependent manner.

Otherwise,

the function was defined in a string  
where  
@T{source} is that string.  
}

@item{@id{srclen}|  
The length of the string @id{source}.  
}

@item{@id{short\_src}|  
a @Q{printable} version of @T{source}, to be used in error messages.  
}

@item{@id{linedefined}|  
the line number where the definition of the function starts.  
}

@item{@id{lastlinedefined}|  
the line number where the definition of the function ends.  
}

@item{@id{what}|  
the string @T{"Lua"} if the function is a Lua function,  
@T{"C"} if it is a @N{C function},  
@T{"main"} if it is the main part of a chunk.  
}

@item{@id{currentline}|  
the current line where the given function is executing.  
When no line information is available,  
@T{currentline} is set to @num{-1}.  
}

@item{@id{name}|  
a reasonable name for the given function.  
Because functions in Lua are first-class values,  
they do not have a fixed name:  
some functions can be the value of multiple global variables,  
while others can be stored only in a table field.  
The @T{lua\_getinfo} function checks how the function was  
called  
to find a suitable name.  
If it cannot find a name,  
then @id{name} is set to @id{NULL}.  
}

@item{@id{namewhat}|  
explains the @T{name} field.

The value of `@T{namewhat}` can be  
`@T{"global"}`, `@T{"local"}`, `@T{"method"}`,  
`@T{"field"}`, `@T{"upvalue"}`, or `@T{""}` (the empty string),  
according to how the function was called.  
(Lua uses the empty string when no other option seems to apply.)  
}

`@item{@id{istailcall}|`  
true if this function invocation was called by a tail call.  
In this case, the caller of this level is not in the stack.  
}

`@item{@id{nups}|`  
the number of upvalues of the function.  
}

`@item{@id{nparams}|`  
the number of parameters of the function  
(always `@N{0}` for `@N{C}` functions).  
}

`@item{@id{isvararg}|`  
true if the function is a variadic function  
(always true for `@N{C}` functions).  
}

`@item{@id{fttransfer}|`  
the index in the stack of the first value being `@Q{transferred}`,  
that is, parameters in a call or return values in a return.  
(The other values are in consecutive indices.)  
Using this  
index, you can access and modify these values  
through `@Lid{lua_getlocal}` and `@Lid{lua_setlocal}`.  
This field is only meaningful during a  
call hook, denoting the first parameter,  
or a return hook, denoting the first value being returned.  
(For call hooks, this value is always 1.)  
}

`@item{@id{ntransfer}|`  
The number of values being transferred (see previous item).  
(For calls of Lua functions,  
this value is always equal to `@id{nparams}`.)  
}

}

}

```
@APIEntry{lua_Hook lua_gethook (lua_State *L);|
@apii{0,0,-}}
```

Returns the current hook function.

```
}
```

```
@APIEntry{int lua_gethookcount (lua_State *L);|
@apii{0,0,-}}
```

Returns the current hook count.

```
}
```

```
@APIEntry{int lua_gethookmask (lua_State *L);|
@apii{0,0,-}}
```

Returns the current hook mask.

```
}
```

```
@APIEntry{int lua_getinfo (lua_State *L, const char *what, lua_Debug *ar);|
@apii{0|1,0|1|2,m}}
```

Gets information about a specific function or function invocation.

To get information about a function invocation,  
the parameter `@id{ar}` must be a valid activation  
record that was  
filled by a previous call to `@Lid{lua_getstack}` or  
given as argument to a hook `@seeC{lua_Hook}`.

To get information about a function, you push it onto the stack  
and start the `@id{what}` string with the character `@Char{>}`.  
(In that case,  
`@id{lua_getinfo}` pops the function from the top of the stack.)  
For instance, to know in which line a function `@id{f}` was defined,  
you can write the following code:

```
@verbatim{
lua_Debug ar;
lua_getglobal(L, "f"); /* get global 'f' */
lua_getinfo(L, ">S", &ar);
printf("%d\n", ar.linedefined);
}
```

Each character in the string `@id{what}`  
selects some fields of the structure `@id{ar}` to be filled or

a value to be pushed on the stack.  
(These characters are also documented in the declaration of the structure @Lid{lua\_Debug},  
between parentheses in the comments following each field.)  
@description{

@item{@Char{f}|  
pushes onto the stack the function that is  
running at the given level;  
}

@item{@Char{l}| fills in the field @id{currentline};  
}

@item{@Char{n}|  
fills in the fields @id{name} and @id{namewhat};  
}

@item{@Char{r}| fills in the fields @id{ftransfer} and @id{ntransfer};  
}

@item{@Char{S}|  
fills in the fields @id{source}, @id{short\_src},  
@id{linedefined}, @id{lastlinedefined}, and @id{what};  
}

@item{@Char{t}| fills in the field @id{istailcall};  
}

@item{@Char{u}| fills in the fields  
@id{nups}, @id{nparams}, and @id{isvararg};  
}

@item{@Char{L}|  
pushes onto the stack a table whose indices are  
the lines on the function with some associated code,  
that is, the lines where you can put a break point.  
(Lines with no code include empty lines and comments.)  
If this option is given together with option @Char{f},  
its table is pushed after the function.  
This is the only option that can raise a memory error.  
}

}

This function returns 0 to signal an invalid option in @id{what};  
even then the valid options are handled correctly.



}

```
@APIEntry{const char *lua_getlocal (lua_State *L, const lua_Debug *ar, int n);|
@apii{0,0|1,-}}
```

Gets

information about a local variable or a temporary value  
of a given activation record or a given function.

In the first case,  
the parameter @id{ar} must be a valid activation record that was  
filled by a previous call to @Lid{lua\_getstack} or  
given as argument to a hook @seeC{lua\_Hook}.  
The index @id{n} selects which local variable to inspect;  
see @Lid{debug.getlocal} for details about variable indices  
and names.

@Lid{lua\_getlocal} pushes the variable's value onto the stack  
and returns its name.

In the second case, @id{ar} must be @id{NULL} and the function  
to be inspected must be on the top of the stack.

In this case, only parameters of Lua functions are visible  
(as there is no information about what variables are active)  
and no values are pushed onto the stack.

Returns @id{NULL} (and pushes nothing)  
when the index is greater than  
the number of active local variables.

}

```
@APIEntry{int lua_getstack (lua_State *L, int level, lua_Debug *ar);|
@apii{0,0,-}}
```

Gets information about the  
interpreter runtime stack.

This function fills parts of a @Lid{lua\_Debug} structure with  
an identification of the @emph{activation record}  
of the function executing at a given level.  
@N{Level 0} is the current running function,  
whereas level @M{n+1} is the function that has called level @M{n}  
(except for tail calls, which do not count in the stack).  
When called with a level greater than the stack depth,  
@Lid{lua\_getstack} returns 0;  
otherwise it returns 1.

}

```
@APIEntry{const char *lua_getupvalue (lua_State *L, int funcindex, int n);|
@apii{0,0|1,-}
```

Gets information about the @id{n}-th upvalue  
of the closure at index @id{funcindex}.

It pushes the upvalue's value onto the stack  
and returns its name.

Returns @id{NULL} (and pushes nothing)  
when the index @id{n} is greater than the number of upvalues.

See @Lid{debug.getupvalue} for more information about upvalues.

}

```
@APIEntry{typedef void (*lua_Hook) (lua_State *L, lua_Debug *ar);|
```

Type for debugging hook functions.

Whenever a hook  
is called, its @id{ar} argument has its field  
@id{event} set to the specific event that triggered the hook.

Lua identifies these events with the following constants:

@defid{LUA\_HOOKCALL}, @defid{LUA\_HOOKRET},  
@defid{LUA\_HOOKTAILCALL}, @defid{LUA\_HOOKLINE},  
and @defid{LUA\_HOOKCOUNT}.

Moreover, for line events, the field @id{currentline} is also set.

To get the value of any other field in @id{ar},  
the hook must call @Lid{lua\_getinfo}.

For call events, @id{event} can be @id{LUA\_HOOKCALL},  
the normal value, or @id{LUA\_HOOKTAILCALL}, for a tail call;  
in this case, there will be no corresponding return event.

While Lua is running a hook, it disables other calls to hooks.  
Therefore, if a hook calls back Lua to execute a function or a chunk,  
this execution occurs without any calls to hooks.

Hook functions cannot have continuations,  
that is, they cannot call @Lid{lua\_yieldk},  
@Lid{lua\_pcallk}, or @Lid{lua\_callk} with a non-null @id{k}.

Hook functions can yield under the following conditions:

Only

count and line events can yield;

to yield, a hook function must finish its execution  
calling @Lid{lua\_yield} with @id{nresults} equal to zero

(that is, with no values).

}

```
@APIEntry{void lua_sethook (lua_State *L, lua_Hook f, int mask, int count);|
@apii{0,0,-}
```

Sets the debugging hook function.

Argument @id{f} is the hook function.

@id{mask} specifies on which events the hook will be called:

it is formed by a bitwise OR of the constants

@defid{LUA\_MASKCALL},

@defid{LUA\_MASKRET},

@defid{LUA\_MASKLINE},

and @defid{LUA\_MASKCOUNT}.

The @id{count} argument is only meaningful when the mask includes @id{LUA\_MASKCOUNT}.

For each event, the hook is called as explained below:

@description{

@item{The call hook| is called when the interpreter calls a function.

The hook is called just after Lua enters the new function.

}

@item{The return hook| is called when the interpreter returns from a function.

The hook is called just before Lua leaves the function.

}

@item{The line hook| is called

when the interpreter is about to

start the execution of a new line of code,

or when it jumps back in the code (even to the same line).

This event only happens while Lua is executing a Lua function.

}

@item{The count hook| is called after the interpreter executes every

@T{count} instructions.

This event only happens while Lua is executing a Lua function.

}

}

Hooks are disabled by setting @id{mask} to zero.

}

```
@APIEntry{const char *lua_setlocal (lua_State *L, const lua_Debug *ar, int n);|
```

@apii{0|1,0,-}

Sets the value of a local variable of a given activation record.  
It assigns the value on the top of the stack  
to the variable and returns its name.  
It also pops the value from the stack.

Returns @id{NULL} (and pops nothing)  
when the index is greater than  
the number of active local variables.

Parameters @id{ar} and @id{n} are as in the function @Lid{lua\_getlocal}.

}

@APIEntry{const char \*lua\_setupvalue (lua\_State \*L, int funcindex, int n);  
@apii{0|1,0,-}

Sets the value of a closure's  
upvalue.  
It assigns the value on the top of the stack  
to the upvalue and returns its name.  
It also pops the value from the stack.

Returns @id{NULL} (and pops nothing)  
when the index @id{n} is greater than the number of upvalues.

Parameters @id{funcindex} and @id{n} are as in  
the function @Lid{lua\_getupvalue}.

}

@APIEntry{void \*lua\_upvalueid (lua\_State \*L, int funcindex, int n);  
@apii{0,0,-}

Returns a unique identifier for the upvalue numbered @id{n}  
from the closure at index @id{funcindex}.

These unique identifiers allow a program to check whether different  
closures share upvalues.

Lua closures that share an upvalue  
(that is, that access a same external local variable)  
will return identical ids for those upvalue indices.

Parameters @id{funcindex} and @id{n} are as in  
the function @Lid{lua\_getupvalue},  
but @id{n} cannot be greater than the number of upvalues.

}

```
@APIEntry{
void lua_upvaluejoin (lua_State *L, int funcindex1, int n1,
                      int
                      funcindex2, int n2);|
@apii{0,0,-}
```

Make the @id{n1}-th upvalue of the Lua closure at index @id{funcindex1}  
refer to the @id{n2}-th upvalue of the Lua closure at index @id{funcindex2}.

}

}

}

```
@C{-----}
@sect1{auxlib|@title{The Auxiliary Library}}
```

```
@simplesect{
```

```
@index{luauxlib.h}
```

The @def{auxiliary library} provides several convenient functions  
to interface C with Lua.

While the basic API provides the primitive functions for all  
interactions between C and Lua,  
the auxiliary library provides higher-level functions for some  
common tasks.

All functions and types from the auxiliary library  
are defined in header file @id{luauxlib.h} and  
have a prefix @id{luaL\_}.

All functions in the auxiliary library are built on  
top of the basic API,  
and so they provide nothing that cannot be done with that API.  
Nevertheless, the use of the auxiliary library ensures  
more consistency to your code.

Several functions in the auxiliary library  
use internally some  
extra stack slots.

When a function in the auxiliary library uses less than five slots,  
it does not check the stack size;  
it simply assumes that there are enough slots.

Several functions in the auxiliary library are used to check @N{C function} arguments. Because the error message is formatted for arguments (e.g., @St{bad argument #1}), you should not use these functions for other stack values.

Functions called @id{luaL\_check\*} always raise an error if the check is not satisfied.

}

@sect2{@title{Functions and Types}}

Here we list all functions and types from the auxiliary library in alphabetical order.

@APIEntry{void luaL\_addchar (luaL\_Buffer \*B, char c);|  
@apii{?,?,m}}

Adds the byte @id{c} to the buffer @id{B}  
@seeC{luaL\_Buffer}.

}

@APIEntry{  
const void luaL\_addgsub (luaL\_Buffer \*B, const char \*s,  
                          const char \*p, const char \*r);|  
@apii{?,?,m}}

Adds a copy of the string @id{s} to the buffer @id{B} @seeC{luaL\_Buffer}, replacing any occurrence of the string @id{p} with the string @id{r}.

}

@APIEntry{void luaL\_addlstring (luaL\_Buffer \*B, const char \*s, size\_t l);|  
@apii{?,?,m}}

Adds the string pointed to by @id{s} with length @id{l} to the buffer @id{B}  
@seeC{luaL\_Buffer}.  
The string can contain @x{embedded zeros}.

}

```
@APIEntry{void luaL_addsize (luaL_Buffer *B, size_t n);|
@apii{?,?,-}}
```

Adds to the buffer @id{B}  
a string of length @id{n} previously copied to the  
buffer area @seeC{luaL\_prepbuffer}.

```
}
```

```
@APIEntry{void luaL_addstring (luaL_Buffer *B, const char *s);|
@apii{?,?,m}}
```

Adds the zero-terminated string pointed to by @id{s}  
to the buffer @id{B}  
@seeC{luaL\_Buffer}.

```
}
```

```
@APIEntry{void luaL_addvalue (luaL_Buffer *B);|
@apii{?,?,m}}
```

Adds the value on the top of the stack  
to the buffer @id{B}  
@seeC{luaL\_Buffer}.  
Pops the value.

This is the only function on string buffers that can (and must)  
be called with an extra element on the stack,  
which is the value to be added to the buffer.

```
}
```

```
@APIEntry{
void luaL_argcheck
(lua_State *L,
    int cond,
    int arg,
    const char *extramsg);|
@apii{0,0,v}}
```

Checks whether @id{cond} is true.  
If it is not, raises an error with a standard message @seeF{luaL\_argerror}.

```
}
```

```
@APIEntry{int luaL_argerror (lua_State *L, int arg, const char *extramsg);|
@apii{0,0,v}}
```

Raises an error reporting a problem with argument @id{arg} of the @N{C function} that called it, using a standard message that includes @id{extrams} as a comment:

```
@verbatim{
bad argument #@rep{arg} to '@rep{funcname}' (@rep{extrams})
}
```

This function never returns.

```
}
```

```
@APIEntry{
void luaL_argexpected (lua_State *L,
    int cond,
    int arg,
    const char *tname);|
@apii{0,0,v}
```

Checks whether @id{cond} is true.  
If it is not, raises an error about the type of the argument @id{arg} with a standard message @seeF{luaL\_typeerror}.

```
}
```

```
@APIEntry{typedef struct luaL_Buffer luaL_Buffer;|
```

Type for  
a @def{string buffer}.

A string buffer allows @N{C code} to build Lua strings piecemeal.  
Its pattern of use is as follows:

```
@itemize{
```

```
@item{First declare a variable @id{b} of type @Lid{luaL_Buffer}.)}
```

```
@item{Then initialize it with a call @T{luaL_buffinit(L, &b)}.)}
```

```
@item{
Then add string pieces to the buffer calling any of
the @id{luaL_add*} functions.
}
```

```
@item{
Finish by calling @T{luaL_pushresult(&b)}.
This call leaves the final string on the top of the stack.
}
```



}

If you know beforehand the maximum size of the resulting string,  
you can use the buffer like this:

@itemize{

@item{First declare a variable @id{b} of type @Lid{luaL\_Buffer}.}

@item{Then initialize it and preallocate a space of  
size @id{sz} with a call @T{luaL\_buffinitsize(L, &b, sz)}.}

@item{Then produce the string into that space.}

@item{  
Finish by calling @T{luaL\_pushresultsize(&b, sz)},  
where @id{sz} is the total size of the resulting string  
copied into that space (which may be less than or  
equal to the preallocated  
size).  
}

}

}

During its normal operation,  
a string buffer uses a variable number of stack slots.  
So, while using a buffer, you cannot assume that you know where  
the top of the stack is.  
You can use the stack between successive calls to buffer operations  
as long as that use is balanced;  
that is,  
when you call a buffer operation,  
the stack is at the same level  
it was immediately after the previous buffer operation.  
(The only exception to this rule is @Lid{luaL\_addvalue}.)  
After calling @Lid{luaL\_pushresult},  
the stack is back to its level when the buffer was initialized,  
plus the final string on its top.

}

@APIEntry{char \*luaL\_buffaddr (luaL\_Buffer \*B);|  
@apii{0,0,-}}

Returns the address of the current content of buffer @id{B}  
@seeC{luaL\_Buffer}.  
Note that any addition to the buffer may invalidate this address.

}

```
@APIEntry{void luaL_buffinit (lua_State *L, luaL_Buffer *B);|
@apii{0,?, -}}
```

Initializes a buffer @id{B}

@seeC{luaL\_Buffer}.

This function does not allocate any space;

the

buffer must be declared as a variable.

```
}
```

```
@APIEntry{size_t luaL_bufflen (luaL_Buffer *B);|
@apii{0,0, -}}
```

Returns the length of the current content of buffer @id{B}

@seeC{luaL\_Buffer}.

```
}
```

```
@APIEntry{char *luaL_buffinitsize (lua_State *L, luaL_Buffer *B, size_t sz);|
@apii{?, ?, m}}
```

Equivalent to the sequence

@Lid{luaL\_buffinit}, @Lid{luaL\_prepbuffsize}.

```
}
```

```
@APIEntry{void luaL_buffsub (luaL_Buffer *B, int n);|
@apii{?, ?, -}}
```

Removes @id{n} bytes from the buffer @id{B}

@seeC{luaL\_Buffer}.

The buffer must have at least that many bytes.

```
}
```

```
@APIEntry{int luaL_callmeta (lua_State *L, int obj, const char *e);|
@apii{0,0|1,e}}
```

Calls a metamethod.

If the object at index @id{obj} has a metatable and this

metatable has a field @id{e},

this function calls this field passing the object as its only argument.

In this case this function returns true and pushes onto the

stack the value returned by the call.

If there is no metatable or no metamethod,

this function returns false without pushing any value on the stack.

```
}
```

```
@APIEntry{void luaL_checkany (lua_State *L, int arg);|
@apii{0,0,v}
```

Checks whether the function has an argument of any type (including @nil) at position @id{arg}.

```
}
```

```
@APIEntry{lua_Integer luaL_checkinteger (lua_State *L, int arg);|
@apii{0,0,v}
```

Checks whether the function argument @id{arg} is an integer (or can be converted to an integer) and returns this integer.

```
}
```

```
@APIEntry{const char *luaL_checklstring (lua_State *L, int arg, size_t *l);|
@apii{0,0,v}
```

Checks whether the function argument @id{arg} is a string and returns this string; if @id{l} is not @id{NULL} fills its referent with the string's length.

This function uses @Lid{lua\_tolstring} to get its result, so all conversions and caveats of that function apply here.

```
}
```

```
@APIEntry{lua_Number luaL_checknumber (lua_State *L, int arg);|
@apii{0,0,v}
```

Checks whether the function argument @id{arg} is a number and returns this number converted to a @id{lua\_Number}.

```
}
```

```
@APIEntry{
int luaL_checkoption (lua_State
*L,
    int arg,
    const char *def,
```

```
const char *const lst[];|
@apii{0,0,v}
```

Checks whether the function argument @id{arg} is a string and searches for this string in the array @id{lst} (which must be NULL-terminated).

Returns the index in the array where the string was found.

Raises an error if the argument is not a string or if the string cannot be found.

If @id{def} is not @id{NULL}, the function uses @id{def} as a default value when there is no argument @id{arg} or when this argument is @nil.

This is a useful function for mapping strings to @N{C enums}. (The usual convention in Lua libraries is to use strings instead of numbers to select options.)

```
}
```

```
@APIEntry{void luaL_checkstack (lua_State *L, int sz, const char *msg);|
@apii{0,0,v}
```

Grows the stack size to @T{top + sz} elements, raising an error if the stack cannot grow to that size. @id{msg} is an additional text to go into the error message (or @id{NULL} for no additional text).

```
}
```

```
@APIEntry{const char *luaL_checkstring (lua_State *L, int arg);|
@apii{0,0,v}
```

Checks whether the function argument @id{arg} is a string and returns this string.

This function uses @Lid{lua\_tolstring} to get its result, so all conversions and caveats of that function apply here.

```
}
```

```
@APIEntry{void luaL_checktype (lua_State *L, int arg, int t);|
@apii{0,0,v}
```

Checks whether the function argument @id{arg} has type @id{t}. See @Lid{lua\_type} for the encoding of types for @id{t}.

```
}
```

```
@APIEntry{void *luaL_checkudata (lua_State *L, int arg, const char *tname);|  
@apii{0,0,v}
```

Checks whether the function argument @id{arg} is a userdata of the type @id{tname} @seeC{luaL\_newmetatable} and returns the userdata's memory-block address @seeC{lua\_touserdata}.

```
}
```

```
@APIEntry{void luaL_checkversion (lua_State *L);|  
@apii{0,0,v}
```

Checks whether the code making the call and the Lua library being called are using the same version of Lua and the same numeric types.

```
}
```

```
@APIEntry{int  
luaL_dofile (lua_State *L, const char *filename);|  
@apii{0,?,m}
```

Loads and runs the given file.

It is defined as the following macro:

```
@verbatim{  
(luaL_loadfile(L, filename) || lua_pcall(L, 0, LUA_MULTRET, 0))  
}
```

It @N{returns 0} (@Lid{LUA\_OK}) if there are no errors, or 1 in case of errors.

```
}
```

```
@APIEntry{int luaL_dostring (lua_State *L, const char *str);|  
@apii{0,?,-}
```

Loads and runs the given string.

It is defined as the following macro:

```
@verbatim{  
(luaL_loadstring(L, str) || lua_pcall(L, 0, LUA_MULTRET, 0))  
}
```

It @N{returns 0} (@Lid{LUA\_OK}) if there are no errors, or 1 in case of errors.

```
}
```

```
@APIEntry{int luaL_error (lua_State *L, const char *fmt, ...);|  
@apii{0,0,v}
```

Raises an error.

The error message format is given by @id{fmt}  
plus any extra arguments,  
following the same rules of @Lid{lua\_pushfstring}.  
It also adds at the beginning of the message the file name and  
the line number where the error occurred,  
if this information is available.

This function never returns,  
but it is an  
idiom to use it in @N{C functions}  
as @T{return luaL\_error(@rep{args})}.

}

@APIEntry{int luaL\_execresult (lua\_State \*L, int stat);|  
@apii{0,3,m}}

This function produces the return values for  
process-related functions in the standard library  
(@Lid{os.execute} and @Lid{io.close}).

}

@APIEntry{  
int luaL\_filresult (lua\_State \*L, int stat, const char \*fname);|  
@apii{0,1|3,m}}

This function produces the return values for  
file-related functions in the standard library  
(@Lid{io.open}, @Lid{os.rename}, @Lid{file:seek}, etc.).

}

@APIEntry{int luaL\_getmetafield (lua\_State \*L, int obj, const char \*e);|  
@apii{0,0|1,m}}

Pushes onto the stack the field @id{e} from the metatable  
of the object at index @id{obj} and returns the type of the pushed value.  
If the object does not have a metatable,  
or if the metatable does not have this field,  
pushes nothing and returns @id{LUA\_TNIL}.

}

@APIEntry{int luaL\_getmetatable (lua\_State \*L, const char \*tname);|  
@apii{0,1,m}}

Pushes onto the stack the metatable  
 associated with the name @id{tname}  
 in the registry @seeC{luaL\_newmetatable},  
 or @nil if there is no metatable associated with that name.  
 Returns the type of the pushed value.

}

@APIEntry{int luaL\_getsubtable (lua\_State \*L, int idx, const char \*fname);|  
 @apii{0,1,e}

Ensures that the value @T{t{fname}},  
 where @id{t} is the value at index @id{idx},  
 is a table,  
 and pushes that table onto the stack.  
 Returns true if it finds a previous table there  
 and false if it creates a new table.

}

@APIEntry{  
 const char \*luaL\_gsub (lua\_State \*L,  
                   const char \*s,  
                   const char \*p,  
                   const char \*r);|  
 @apii{0,1,m}

Creates a copy of string @id{s},  
 replacing any occurrence of the string @id{p}  
 with the string @id{r}.  
 Pushes the resulting string on the stack and returns it.

}

@APIEntry{lua\_Integer luaL\_len (lua\_State \*L, int index);|  
 @apii{0,0,e}

Returns the @Q{length} of the value at the given index  
 as a number;  
 it is equivalent to the  
 @Char{#} operator in Lua @see{len-op}.  
 Raises an error if the result of the operation is not an integer.  
 (This case can only happen through metamethods.)

}

@APIEntry{

```

int luaL_loadbuffer (lua_State *L,
                    const char *buff,
                    size_t sz,
                    const char *name);|
@apii{0,1,-}

```

Equivalent to @Lid{luaL\_loadbufferx} with @id{mode} equal to @id{NULL}.

```

}

```

```

@APIEntry{
int luaL_loadbufferx (lua_State *L,
                    const char *buff,
                    size_t sz,
                    const char *name,
                    const char *mode);|
@apii{0,1,-}

```

Loads a buffer as a Lua chunk.

This function uses @Lid{lua\_load} to load the chunk in the buffer pointed to by @id{buff} with size @id{sz}.

This function returns the same results as @Lid{lua\_load}.

@id{name} is the chunk name, used for debug information and error messages.

The string @id{mode} works as in the function @Lid{lua\_load}.

```

}

```

```

@APIEntry{int luaL_loadfile (lua_State
*L, const char *filename);|
@apii{0,1,m}

```

Equivalent to @Lid{luaL\_loadfilex} with @id{mode} equal to @id{NULL}.

```

}

```

```

@APIEntry{int luaL_loadfilex (lua_State *L, const char *filename,
                             const char *mode);|
@apii{0,1,m}

```

Loads a file as a Lua chunk.

This function uses @Lid{lua\_load} to load the chunk in the file named @id{filename}.

If @id{filename} is @id{NULL}, then it loads from the standard input.



The first line in the file is ignored if it starts with a @T{#}.

The string @id{mode} works as in the function @Lid{lua\_load}.

This function returns the same results as @Lid{lua\_load}  
or @Lid{LUA\_ERRFILE} for file-related errors.

As @Lid{lua\_load}, this function only loads the chunk;  
it does not run it.

}

```
@APIEntry{int luaL_loadstring (lua_State *L, const char *s);|
@apii{0,1,-}}
```

Loads a string as a Lua chunk.

This function uses @Lid{lua\_load} to load the chunk in  
the zero-terminated string @id{s}.

This function returns the same results as  
@Lid{lua\_load}.

Also as @Lid{lua\_load}, this function only loads the chunk;  
it does not run it.

}

```
@APIEntry{void luaL_newlib (lua_State *L, const luaL_Reg l[]);|
@apii{0,1,m}}
```

Creates a new table and registers there  
the functions in the list @id{l}.

It is implemented as the following macro:

```
@verbatim{
(luaL_newlibtable(L,l), luaL_setfuncs(L,l,0))
}
```

The array @id{l} must be the actual array,  
not a pointer to it.

}

```
@APIEntry{void luaL_newlibtable (lua_State *L, const luaL_Reg l[]);|
@apii{0,1,m}}
```

Creates a new table with a size optimized  
to store all entries in the array @id{l}

(but does not actually store them).

It is intended to be used in conjunction with @Lid{luaL\_setfuncs}

@seeF{luaL\_newlib}.

It is implemented as a macro.

The array @id{1} must be the actual array,

not a pointer to it.

}

@APIEntry{int luaL\_newmetatable (lua\_State \*L, const char \*tname);|

@apii{0,1,m}

If the registry already has the key @id{tname},

returns 0.

Otherwise,

creates a new table to be used as a

metatable for userdata,

adds to this new table the pair @T{\_\_name = tname},

adds to the registry the pair @T{[tname] = new table},

and returns 1.

In both cases,

the function pushes onto the stack the final value associated

with @id{tname} in the registry.

}

@APIEntry{lua\_State \*luaL\_newstate (void);|

@apii{0,0,-}

Creates a new Lua state.

It calls @Lid{lua\_newstate} with an

allocator based on the @N{ISO C} allocation functions

and then sets a warning function and a panic function @see{C-error}

that print messages to the standard error output.

Returns the new state,

or @id{NULL} if there is a @x{memory allocation error}.

}

@APIEntry{void luaL\_openlibs (lua\_State \*L);|

@apii{0,0,e}

Opens all standard Lua libraries into the given state.

}

```
@APIEntry{
T luaL_opt (L, func, arg, dflt);|
@apii{0,0,-}
```

This macro is defined as follows:

```
@verbatim{
(lua_isnoneornil(L,(arg)) ? (dflt) : func(L,(arg)))
}
```

In words, if the argument @id{arg} is nil or absent,  
the macro results in the default

@id{dflt}.

Otherwise, it results in the result of calling @id{func}  
with the state @id{L} and the argument index @id{arg} as  
arguments.

Note that it evaluates the expression @id{dflt} only if needed.

```
}
```

```
@APIEntry{
lua_Integer luaL_optinteger (lua_State *L,
                           int arg,
                           lua_Integer d);|
@apii{0,0,v}
```

If the function argument @id{arg} is an integer  
(or it is convertible to an integer),  
returns this integer.

If this argument is absent or is @nil,  
returns @id{d}.

Otherwise, raises an error.

```
}
```

```
@APIEntry{
const char *luaL_optlstring (lua_State *L,
                           int arg,
                           const char *d,
                           size_t *l);|
@apii{0,0,v}
```

If the function argument @id{arg} is a string,  
returns this string.

If this argument is absent or is @nil,  
returns @id{d}.

Otherwise, raises an error.

If @id{l} is not @id{NULL},

fills its referent with the result's length.

If the result is @id{NULL}

(only

possible when returning @id{d} and @T{d == NULL}),

its length is considered zero.

This function uses @Lid{lua\_tolstring} to get its result,

so all conversions and caveats of that function apply here.

}

@APIEntry{lua\_Number luaL\_optnumber (lua\_State \*L, int arg, lua\_Number d);|

@apii{0,0,v}

If the function argument @id{arg} is a number,

returns this number as a @id{lua\_Number}.

If this argument is absent or is @nil,

returns @id{d}.

Otherwise, raises an error.

}

@APIEntry{

const char \*luaL\_optstring (lua\_State \*L,

int arg,

const char \*d);|

@apii{0,0,v}

If the function argument @id{arg} is a string,

returns this string.

If this argument is absent or is @nil,

returns @id{d}.

Otherwise, raises an error.

}

@APIEntry{char \*luaL\_prepbuffer (luaL\_Buffer \*B);|

@apii{?,?,m}

Equivalent to @Lid{luaL\_prepbuffsize}

with the predefined size @defid{LUAL\_BUFFERSIZE}.

}

@APIEntry{char \*luaL\_prepbuffsize (luaL\_Buffer \*B, size\_t sz);|

@apii{?,?,m}

Returns

an address to a space of size @id{sz}  
 where you can copy a string to be added to buffer @id{B}  
 @seeC{luaL\_Buffer}.  
 After copying the string into this space you must call  
 @Lid{luaL\_addsize} with the size of the string to actually add  
 it to the buffer.

}

@APIEntry{void luaL\_pushfail (lua\_State \*L);|  
 @apii{0,1,-}}

Pushes the @fail value onto the stack @see{libraries}.

}

@APIEntry{void luaL\_pushresult (luaL\_Buffer \*B);|  
 @apii{?,1,m}}

Finishes the use of buffer @id{B} leaving the final string on  
 the top of the stack.

}

@APIEntry{void luaL\_pushresults (luaL\_Buffer \*B, size\_t sz);|  
 @apii{?,1,m}}

Equivalent to the sequence @Lid{luaL\_addsize}, @Lid{luaL\_pushresult}.

}

@APIEntry{int luaL\_ref (lua\_State \*L, int t);|  
 @apii{1,0,m}}

Creates and returns a @def{reference},  
 in the table at index @id{t},  
 for the object on the top of the stack (and pops the object).

A reference is a unique integer key.  
 As long as you do not manually add integer keys into the table @id{t},  
 @Lid{luaL\_ref}  
 ensures the uniqueness of the key it returns.  
 You can retrieve an object referred by the reference @id{r}  
 by calling @T{lua\_rawgeti}(L, t, r).  
 The function @Lid{luaL\_unref} frees a reference.

If the object on the top of the stack is @nil,  
 @Lid{luaL\_ref} returns the constant @defid{LUA\_REFNIL}.

The constant @defid{LUA\_NOREF} is guaranteed to be different from any reference returned by @Lid{luaL\_ref}.

}

```
@APIEntry{
typedef struct luaL_Reg {
    const char *name;
    lua_CFunction func;
} luaL_Reg;
|
```

Type for arrays of functions to be registered by

@Lid{luaL\_setfuncs}.

@id{name} is the function name and @id{func} is a pointer to the function.

Any array of @Lid{luaL\_Reg} must end with a sentinel entry in which both @id{name} and @id{func} are @id{NULL}.

}

```
@APIEntry{
void luaL_requiref (lua_State *L, const char *modname,
    luaL_CFunction openf, int glb);|
@apii{0,1,e}
```

If @T{package.loaded[modname]} is not true,  
calls the function @id{openf} with the string @id{modname}  
as an argument  
and sets the call result to @T{package.loaded[modname]},  
as if that function has been called through @Lid{require}.

If @id{glb} is true,  
also stores the module into the global @id{modname}.

Leaves a copy of the module on the stack.

}

```
@APIEntry{void luaL_setfuncs (lua_State *L, const luaL_Reg *l, int nup);|
@apii{nup,0,m}
```

Registers all functions in the array @id{l}  
@seeC{luaL\_Reg} into the table on the top of the stack  
(below optional upvalues, see next).

When @id{nup} is not zero,  
all functions are created with @id{nup} upvalues,

initialized with copies of the @id{nup} values  
previously pushed on the stack  
on top of the library table.  
These values are popped from the stack after the registration.

A function with a @id{NULL} value represents a placeholder,  
which is filled with @false.

}

```
@APIEntry{void luaL_setmetatable (lua_State *L, const char *tname);|
@apii{0,0,-}
```

Sets the metatable of the object on the top of the stack  
as the metatable associated  
with name @id{tname}  
in the registry @seeC{luaL\_newmetatable}.

}

```
@APIEntry{
typedef struct luaL_Stream {
    FILE *f;
    lua_CFunction closef;
} luaL_Stream;
|
```

The standard representation for @x{file handles}  
used by the standard I/O library.

A file handle is implemented as a full userdata,  
with a metatable called @id{LUA\_FILEHANDLE}  
(where @id{LUA\_FILEHANDLE} is a macro with the actual metatable's name).  
The metatable is created by the I/O library  
@seeF{luaL\_newmetatable}.

This userdata must start with the structure @id{luaL\_Stream};  
it can contain other data after this initial structure.  
The field @id{f} points to the corresponding C stream  
(or it can be @id{NULL} to indicate an incompletely created handle).  
The field @id{closef} points to a Lua function  
that will be called to close the stream  
when the handle is closed or collected;  
this function receives the file handle as its sole argument and  
must return either a true value, in case of success,  
or a false value plus an error message,  
in case of error.  
Once Lua calls this field,

it changes the field value to @id{NULL}  
to signal that the handle is closed.

}

```
@APIEntry{void *luaL_testudata (lua_State *L, int arg, const char *tname);|
@apii{0,0,m}
```

This function works like @Lid{luaL\_checkudata},  
except that, when the test fails,  
it returns @id{NULL} instead of raising an error.

}

```
@APIEntry{const char *luaL_tolstring (lua_State *L, int idx, size_t *len);|
@apii{0,1,e}
```

Converts any Lua value at the given index to a @N{C string}  
in a reasonable format.

The resulting string is pushed onto the stack and also  
returned by the function @see{constchar}.

If @id{len} is not @id{NULL},  
the function also sets @T{\*len} with the string length.

If the value has a metatable with a @idx{\_\_tostring} field,  
then @id{luaL\_tolstring} calls the corresponding metamethod  
with the value as argument,  
and uses the result of the call as its result.

}

```
@APIEntry{
void luaL_traceback (lua_State *L, lua_State *L1, const char *msg,

    int level);|
@apii{0,1,m}
```

Creates and pushes a traceback of the stack @id{L1}.

If @id{msg} is not @id{NULL}, it is appended  
at the beginning of the traceback.

The @id{level} parameter tells at which level  
to start the traceback.

}

```
@APIEntry{int luaL_typeerror (lua_State *L, int arg, const char *tname);|
@apii{0,0,v}
```



Raises a type error for the argument @id{arg}  
of the @N{C function} that called it,  
using a standard message;  
@id{tname} is a @Q{name} for the expected type.  
This function never returns.

}

@APIEntry{const char \*luaL\_typename (lua\_State \*L, int index);|  
@apii{0,0,-}}

Returns the name of the type of the value at the given index.

}

@APIEntry{void luaL\_unref (lua\_State \*L, int t, int ref);|  
@apii{0,0,-}}

Releases the reference @id{ref} from the table at index @id{t}  
@seeC{luaL\_unref}.  
The entry is removed from the table,  
so that the referred object can be collected.  
The reference @id{ref} is also freed to be used again.

If @id{ref} is @Lid{LUA\_NOREF} or @Lid{LUA\_REFNIL},  
@Lid{luaL\_unref}  
does nothing.

}

@APIEntry{void luaL\_where (lua\_State \*L, int lvl);|  
@apii{0,1,m}}

Pushes onto the stack a string identifying the current position  
of the control at level @id{lvl} in the call stack.  
Typically this string has the following format:  
@verbatim{  
@rep{chunkname}:@rep{currentline}:  
}  
@N{Level 0} is the running function,  
@N{level 1} is the function that called the running function,  
etc.

This function is used to build a prefix for error messages.

}

}

}

@C{-----}  
@sect1{libraries| @title{The Standard Libraries}}

@simplesect{

The standard Lua libraries provide useful functions that are implemented @N{in C} through the @N{C API}. Some of these functions provide essential services to the language (e.g., @Lid{type} and @Lid{getmetatable}); others provide access to outside services (e.g., I/O); and others could be implemented in Lua itself, but that for different reasons deserve an implementation in C (e.g., @Lid{table.sort}).

All libraries are implemented through the official @N{C API} and are provided as separate @N{C modules}. Unless otherwise noted, these library functions do not adjust its number of arguments to its expected parameters. For instance, a function documented as @T{foo(arg)} should not be called without an argument.

The notation @fail means a false value representing some kind of failure. (Currently, @fail is equal to @nil, but that may change in future versions. The recommendation is to always test the success of these functions with @T{(not status)}, instead of @T{(status == nil)}.)

Currently, Lua has the following standard libraries:

@itemize{

@item{@link{predefined|basic library};}

@item{@link{corolib|coroutine library};}

@item{@link{packlib|package library};}

@item{@link{strlib|string manipulation};}

@item{@link{utf8|basic UTF-8 support};}

```
@item{@link{tablib|table manipulation};}
```

```
@item{@link{mathlib|mathematical functions}
(sin, log, etc.);}
```

```
@item{@link{iolib|input and output};}
```

```
@item{@link{oslib|operating system facilities};}
```

```
@item{@link{debuglib|debug facilities}.}
```

```
}
```

Except for the basic and the package libraries,  
each library provides all its functions as fields of a global table  
or as methods of its objects.

To have access to these libraries,  
the @N{C host} program should call the @Lid{luaL\_openlibs} function,  
which opens all standard libraries.

Alternatively,

the host program can open them individually by using

@Lid{luaL\_requiref} to call

@defid{luaopen\_base} (for the basic library),

@defid{luaopen\_package} (for the package library),

@defid{luaopen\_coroutine} (for the coroutine library),

@defid{luaopen\_string} (for the string library),

@defid{luaopen\_utf8} (for the UTF-8 library),

@defid{luaopen\_table} (for the table library),

@defid{luaopen\_math} (for the mathematical library),

@defid{luaopen\_io} (for the I/O library),

@defid{luaopen\_os} (for the operating system library),

and @defid{luaopen\_debug}

(for the debug library).

These functions are declared in @defid{lualib.h}.

```
}
```

```
@sect2{predefined| @title{Basic Functions}}
```

The basic library provides core functions to Lua.

If you do not include this library in your application,  
you should check carefully whether you need to provide  
implementations for some of its facilities.

```
@LibEntry{assert (v [, message])|
```

Raises an error if  
the value of its argument `@id{v}` is false (i.e., `@nil` or `@false`);  
otherwise, returns all its arguments.  
In case of error,  
`@id{message}` is the error object;  
when absent, it defaults to `@St{assertion failed!}`

}

`@LibEntry{collectgarbage ([opt [, arg]])}`

This function is a generic interface to the garbage collector.  
It performs different functions according to its first argument, `@id{opt}`:  
`@description{`

`@item{@St{collect}}`  
Performs a full garbage-collection cycle.  
This is the default option.

}

`@item{@St{stop}}`  
Stops automatic execution of the garbage collector.  
The collector will run only when explicitly  
invoked,  
until a call to restart it.

}

`@item{@St{restart}}`  
Restarts automatic execution of the garbage collector.

}

`@item{@St{count}}`  
Returns the total memory in use by Lua in Kbytes.  
The value has a fractional part,  
so that it multiplied by 1024  
gives the exact number of bytes in use by Lua.

}

`@item{@St{step}}`  
Performs a garbage-collection step.  
The step `@Q{size}` is controlled by `@id{arg}`.  
With a zero value,  
the collector will perform one basic (indivisible) step.  
For non-zero values,  
the collector will perform as if that amount of memory  
(in Kbytes) had been allocated by Lua.  
Returns `@true` if the step finished a collection cycle.

}

@item{@St{isrunning}|

Returns a boolean that tells whether the collector is running  
(i.e., not stopped).

}

@item{@St{incremental}|

Change the collector mode to incremental.

This option can be followed by three numbers:

the garbage-collector pause,

the step multiplier,

and the step size @see{incmode}.

A zero means to not change that value.

}

@item{@St{generational}|

Change

the collector mode to generational.

This option can be followed by two numbers:

the garbage-collector minor multiplier

and the major multiplier @see{genmode}.

A zero means to not change that value.

}

}

See @See{GC} for more details about garbage collection  
and some of these options.

This function should not be called by a finalizer.

}

@LibEntry{dofile ([filename])|

Opens the named file and executes its content as a Lua chunk.

When called without arguments,

@id{dofile} executes the content of the standard input (@id{stdin}).

Returns all values returned by the chunk.

In case of errors, @id{dofile} propagates the error

to its caller.

(That is, @id{dofile} does not run in protected mode.)

}

@LibEntry{error (message [, level])|

Raises an error @see{error} with @id{message} as the error object.

This function never returns.

Usually, @id{error} adds some information about the error position

at the beginning of the message, if the message is a string.

The @id{level}

argument specifies how to get the error position.

With @N{level 1} (the default), the error position is where the @id{error} function was called.

@N{Level 2} points the error to where the function that called @id{error} was called; and so on.

Passing a @N{level 0} avoids the addition of error position information to the message.

}

@LibEntry{\_G|

A global variable (not a function) that

holds the @x{global environment} @see{globalenv}.

Lua itself does not use this variable;

changing its value does not affect any environment,  
nor vice versa.

}

@LibEntry{getmetatable (object)|

If @id{object} does not have a metatable, returns @nil.

Otherwise,

if the object's metatable has a @idx{\_\_metatable} field,  
returns the associated value.

Otherwise, returns the metatable of the given object.

}

@LibEntry{ipairs (t)|

Returns three values (an iterator function, the table @id{t}, and 0)  
so that the construction

@verbatim{

for i,v in ipairs(t) do @rep{body} end

}

will iterate over the key@En{ }value  
pairs

((@T{1,t[1]}), (@T{2,t[2]}), @ldots,  
up to the first absent index.

}

@LibEntry{load (chunk [, chunkname [, mode [, env]]])|

Loads a chunk.

If `@id{chunk}` is a string, the chunk is this string.  
If `@id{chunk}` is a function,  
`@id{load}` calls it repeatedly to get the chunk pieces.  
Each call to `@id{chunk}` must return a string that concatenates  
with previous results.  
A return of an empty string, `@nil`, or no value signals the end of the chunk.

If there are no syntactic errors,  
`@id{load}` returns the compiled chunk as a function;  
otherwise, it returns `@fail` plus the error message.

When you load a main chunk,  
the resulting function will always have exactly one upvalue,  
the `@id{_ENV}` variable `@see{globalenv}`.  
However,  
when you load a binary chunk created from a function `@seeF{string.dump}`,  
the resulting function can have an arbitrary number of upvalues,  
and there is no guarantee that its first upvalue will be  
the `@id{_ENV}` variable.  
(A non-main function may not even have an `@id{_ENV}`  
upvalue.)

Regardless, if the resulting function has any upvalues,  
its first upvalue is set to the value of `@id{env}`,  
if that parameter is given,  
or to the value of the `@x{global environment}`.  
Other upvalues are initialized with `@nil`.  
All upvalues are fresh, that is,  
they are not shared with any other function.

`@id{chunkname}` is used as the name of the chunk for error messages  
and debug information `@see{debugI}`.  
When absent,  
it defaults to `@id{chunk}`, if `@id{chunk}` is a string,  
or to `@St{=(load)}` otherwise.

The string `@id{mode}` controls whether the chunk can be text or binary  
(that is, a precompiled chunk).  
It may be the string `@St{b}` (only `@x{binary chunk}s`),  
`@St{t}` (only text chunks),  
or `@St{bt}` (both binary and text).  
The default is `@St{bt}`.

It is safe to load malformed binary chunks;  
`@id{load}` signals an appropriate error.  
However,  
Lua does not check the consistency of the code inside binary chunks;

running maliciously crafted bytecode can crash the interpreter.

```
}
```

```
@LibEntry{loadfile  
  ([filename [, mode [, env]]])|
```

Similar to `@Lid{load}`,  
but gets the chunk from file `@id{filename}`  
or from the standard input,  
if no file name is given.

```
}
```

```
@LibEntry{next (table [, index])|
```

Allows a program to traverse all fields of a table.  
Its first argument is a table and its second argument  
is an index in this table.  
A call to `@id{next}` returns the next index of the table  
and its associated value.  
When called with `@nil` as its second argument,  
`@id{next}` returns an initial index  
and its associated value.  
When called with the last index,  
or with `@nil` in an empty table,  
`@id{next}` returns `@nil`.  
If the second argument is absent, then it is interpreted as `@nil`.  
In particular,  
you can use `@T{next(t)}` to check whether a table is empty.

The order in which the indices are enumerated is not specified,  
`@emph{even for numeric indices}`.  
(To traverse a table in numerical order,  
use a numerical `@Rw{for}`.)

You should not assign any value to a non-existent field in a table  
during its traversal.

You  
may however modify existing fields.  
In particular, you may set existing fields to `nil`.

```
}
```

```
@LibEntry{pairs (t)|
```

If `@id{t}` has a metamethod `@idx{__pairs}`,  
calls it with `@id{t}` as argument and returns the first three



results from the call.

Otherwise,

returns three values: the `@Lid{next}` function, the table `@id{t}`, and `@nil`, so that the construction

```
@verbatim{
```

```
for k,v in pairs(t) do @rep{body} end
```

```
}
```

will iterate over all key@En{ }value pairs of table `@id{t}`.

See function `@Lid{next}` for the caveats of modifying the table during its traversal.

```
}
```

```
@LibEntry{pcall (f [, arg1, @Cdots])|
```

Calls the function `@id{f}` with

the given arguments in `@emphx{protected mode}`.

This means that any error `@N{inside @T{f}}` is not propagated;

instead, `@id{pcall}` catches the error

and returns a status code.

Its first result is the status code (a boolean),

which is `@true` if the call succeeds without errors.

In such case, `@id{pcall}` also returns all results from the call,

after this first result.

In

case of any error, `@id{pcall}` returns `@false` plus the error object.

Note that errors caught by `@id{pcall}` do not call a message handler.

```
}
```

```
@LibEntry{print (@Cdots)|
```

Receives any number of arguments

and prints their values to `@id{stdout}`,

converting each argument to a string

following the same rules of `@Lid{tostring}`.

The function `@id{print}` is not intended for formatted output,

but only as a quick way to show a value,

for instance for debugging.

For complete control over the output,

use `@Lid{string.format}` and `@Lid{io.write}`.

```
}
```

```
@LibEntry{rawequal (v1, v2)|
```

Checks whether `@id{v1}` is equal to `@id{v2}`,

without invoking the `@idx{__eq}` metamethod.

Returns a boolean.

}

`@LibEntry{rawget (table, index)|`

Gets the real value of `@T{table[index]}`,

without using the `@idx{__index}` metavalue.

`@id{table}` must be a table;

`@id{index}` may be any value.

}

`@LibEntry{rawlen (v)|`

Returns the length of the object `@id{v}`,

which must be a table or a string,

without invoking the `@idx{__len}` metamethod.

Returns

an integer.

}

`@LibEntry{rawset (table, index, value)|`

Sets the real value of `@T{table[index]}` to `@id{value}`,

without using the `@idx{__newindex}` metavalue.

`@id{table}` must be a table,

`@id{index}` any value different from `@nil` and `@x{NaN}`,

and `@id{value}` any Lua value.

This function returns `@id{table}`.

}

`@LibEntry{select (index, @Cdots)|`

If `@id{index}` is a number,

returns all arguments after argument number `@id{index}`;

a negative number indexes from the end (`@num{-1}` is the last argument).

Otherwise, `@id{index}` must be the string `@T{"#"}`,

and `@id{select}` returns the total number of extra arguments it received.

}

`@LibEntry{setmetatable (table, metatable)|`

Sets the metatable for the given table.

If `@id{metatable}` is `@nil`,

removes the metatable of the given table.

If the original metatable has a `@idx{__metatable}` field,  
raises an error.

This function returns `@id{table}`.

To change the metatable of other types from Lua code,  
you must use the `@link{debuglib|debug library}`.

}

`@LibEntry{tonumber`  
`(e [, base])|`

When called with no `@id{base}`,  
`@id{tonumber}` tries to convert its argument to a number.  
If the argument is already a number or  
a string convertible to a number,  
then `@id{tonumber}` returns this number;  
otherwise, it returns `@fail`.

The conversion of strings can result in integers or floats,  
according to the lexical conventions of Lua `@see{lexical}`.  
The string may have leading and trailing spaces and a sign.

When called with `@id{base}`,  
then `@id{e}` must be a string to be interpreted as  
an integer numeral in that base.  
The base may be any integer between 2 and 36, inclusive.  
In bases `@N{above 10}`, the letter `@Char{A}` (in either upper or lower case)  
`@N{represents 10}`, `@Char{B}` `@N{represents 11}`, and so forth,  
with `@Char{Z}` representing 35.  
If the string `@id{e}` is not a valid numeral in the given base,  
the function returns `@fail`.

}

`@LibEntry{tostring (v)|`

Receives a value of any type and  
converts it to a string in a human-readable format.

If the metatable  
of `@id{v}` has a `@idx{__tostring}` field,  
then `@id{tostring}` calls the corresponding value  
with `@id{v}` as argument,  
and uses the result of the call as its result.  
Otherwise, if the metatable of `@id{v}` has a `@idx{__name}` field  
with a string value,

@id{tostring} may use that string in its final result.

For complete control of how numbers are converted,  
use @Lid{string.format}.

}

@LibEntry{type (v)|

Returns the type of its only argument, coded as a string.

The possible results of this function are

@St{nil} (a string, not the value @nil),

@St{number},

@St{string},

@St{boolean},

@St{table},

@St{function},

@St{thread},

and @St{userdata}.

}

@LibEntry{\_VERSION|

A global variable (not a function) that

holds a string containing the running Lua version.

The current value of this variable is @St{Lua 5.4}.

}

@LibEntry{warn (msg1, @Cdots)|

Emits a warning with a message composed by the concatenation  
of all its arguments (which should be strings).

By convention,

a one-piece message starting

with @Char{@At}

is intended to be a @emph{control message},

which is a message to the warning system itself.

In particular, the standard warning function in Lua

recognizes the control messages @St{@At{}off},

to stop the emission of warnings,

and @St{@At{}on}, to (re)start the emission;

it ignores unknown control messages.

}

```
@LibEntry{xpcall (f, msgh [, arg1, @Cdots])|
```

This function is similar to @Lid{pcall},  
except that it sets a new @x{message handler} @id{msgh}.

```
}
```

```
}
```

```
@sect2{corolib| @title{Coroutine Manipulation}
```

This library comprises the operations to manipulate coroutines,  
which come inside the table @defid{coroutine}.  
See @See{coroutine} for a general description of coroutines.

```
@LibEntry{coroutine.close (co)|
```

Closes coroutine @id{co},  
that is,  
closes all its pending to-be-closed variables  
and puts the coroutine in a dead state.  
The given coroutine must be dead or suspended.  
In case of error  
(either the original error that stopped the coroutine or  
errors in closing  
methods),  
returns @false plus the error object;  
otherwise returns @true.

```
}
```

```
@LibEntry{coroutine.create (f)|
```

Creates a new coroutine, with body @id{f}.  
@id{f} must be a function.  
Returns this new coroutine,  
an object with type @T{"thread"}.

```
}
```

```
@LibEntry{coroutine.isyieldable ([co])|
```

Returns @true when the coroutine @id{co} can yield.  
The default for @id{co} is the running coroutine.

A coroutine is yieldable if it is not the main thread and  
it is not inside a non-yieldable @N{C function}.

```
}
```

```
@LibEntry{coroutine.resume (co [, val1, @Cdots])|
```

Starts or continues the execution of coroutine `@id{co}`.

The first time you resume a coroutine,

it starts running its body.

The values `@id{val1}`, `@ldots` are passed

as the arguments to the body function.

If the coroutine has yielded,

`@id{resume}` restarts it;

the values `@id{val1}`, `@ldots` are passed

as the results from the yield.

If the coroutine runs without any errors,

`@id{resume}` returns `@true` plus any values passed to `@id{yield}`

(when the coroutine

yields) or any values returned by the body function

(when the coroutine terminates).

If there is any error,

`@id{resume}` returns `@false` plus the error message.

```
}
```

```
@LibEntry{coroutine.running ()|
```

Returns the running coroutine plus a boolean,

`@true` when the running coroutine is the main one.

```
}
```

```
@LibEntry{coroutine.status (co)|
```

Returns the status of the coroutine `@id{co}`, as a string:

`@T{"running"}`,

if the coroutine is running

(that is, it is the one that called `@id{status}`);

`@T{"suspended"}`, if the coroutine is suspended in a call to `@id{yield}`,

or if it has not started running yet;

`@T{"normal"}` if the coroutine is active but not running

(that is, it has resumed another coroutine);

and `@T{"dead"}` if the coroutine has finished its body function,

or if it has stopped with an error.

```
}
```

```
@LibEntry{coroutine.wrap (f)|
```

Creates a new coroutine, with body `@id{f}`;  
`@id{f}` must be a function.  
Returns a function that resumes the coroutine each time it is called.  
Any arguments passed to this  
function behave as the  
extra arguments to `@id{resume}`.  
The function returns the same values returned by `@id{resume}`,  
except the first boolean.  
In case of error,  
the function closes the coroutine and propagates the error.

}

`@LibEntry{coroutine.yield (@Cdots)|`

Suspends the execution of the calling coroutine.  
Any arguments to `@id{yield}` are passed as extra results to `@id{resume}`.

}

}

`@sect2{packlib| @title{Modules}`

The package library provides basic  
facilities for loading modules in Lua.  
It exports one function directly in the global environment:  
`@Lid{require}`.  
Everything else is exported in the table `@defid{package}`.

`@LibEntry{require (modname)|`

Loads the given module.  
The function starts by looking into the `@Lid{package.loaded}` table  
to determine whether `@id{modname}` is already loaded.  
If it is, then `@id{require}` returns the value stored  
at `@T{package.loaded[modname]}`.  
(The absence of a second result in this case  
signals that this call did not have to load the module.)  
Otherwise,  
it tries to find a `@emph{loader}` for the module.

To find a loader,  
`@id{require}` is guided by the table `@Lid{package.searchers}`.  
Each item in this table is a search function,  
that searches for the module in a particular way.

By changing this table,  
we can change how `@id{require}` looks for a module.  
The following explanation is based on the default configuration  
for `@Lid{package.searchers}`.

First `@id{require}` queries `@T{package.preload[modname]}`.  
If it has a value,  
this value (which must be a function) is the loader.  
Otherwise `@id{require}` searches for a Lua loader using the  
path stored in `@Lid{package.path}`.  
If that also fails, it searches for a `@N{C loader}` using the  
path stored in `@Lid{package.cpath}`.  
If that also fails,  
it tries an `@emph{all-in-one}` loader `@seeF{package.searchers}`.

Once a loader is found,  
`@id{require}` calls the loader with two arguments:  
`@id{modname}` and an extra value,  
a `@emph{loader data}`,  
also returned by the searcher.  
The loader data can be any value useful  
to the module;  
for the default searchers,  
it indicates where the loader was found.  
(For instance, if the loader came from a file,  
this extra value is the file path.)  
If the loader returns any non-nil value,  
`@id{require}` assigns the returned value to `@T{package.loaded[modname]}`.  
If the loader does not return a non-nil value and  
has not assigned any value to `@T{package.loaded[modname]}`,  
then `@id{require}` assigns `@true` to this entry.  
In any case, `@id{require}` returns the  
final value of `@T{package.loaded[modname]}`.  
Besides that value, `@id{require}` also returns as a second result  
the loader data returned by the searcher,  
which indicates how `@id{require}` found the module.

If there is any error loading or running the module,  
or if it cannot find any loader for the module,  
then `@id{require}` raises an error.

}

`@LibEntry{package.config|`

A string describing some compile-time configurations for packages.  
This string is a sequence of lines:  
`@itemize{`



@item{The first line is the @x{directory separator} string.  
Default is @Char{\} for @x{Windows} and @Char{/} for all other systems.}

@item{The second line is the character that separates templates in a path.  
Default is @Char{;}.}

@item{The third line is the string that marks the substitution points in a template.  
Default is @Char{?}.}

@item{The fourth line is a string that, in a path in @x{Windows}, is replaced by the executable's directory.  
Default is @Char{!}.}

@item{The fifth line is a mark to ignore all text after it when building the @id{luaopen\_} function name.  
Default is @Char{-}.}

}

}

@LibEntry{package.cpath|

A string with the path used by @Lid{require} to search for a @N{C loader}.

Lua initializes the @N{C path} @Lid{package.cpath} in the same way it initializes the Lua path @Lid{package.path}, using the environment variable @defid{LUA\_CPATH\_5\_4}, or the environment variable @defid{LUA\_CPATH}, or a default path defined in @id{luaconf.h}.

}

@LibEntry{package.loaded|

A table used by @Lid{require} to control which modules are already loaded.  
When you require a module @id{modname} and @T{package.loaded[modname]} is not false, @Lid{require} simply returns the value stored there.

This variable is only a reference to the real table; assignments to this variable do not change the

table used by @Lid{require}.

The real table is stored in the C registry @see{registry},  
indexed by the key @defid{LUA\_LOADED\_TABLE}, a string.

}

@LibEntry{package.loadlib (libname, funcname)|

Dynamically links the host program with the @N{C library} @id{libname}.

If @id{funcname} is @St{\*},

then it only links with the library,  
making the symbols exported by the library  
available to other dynamically linked libraries.

Otherwise,

it looks for a function @id{funcname} inside the library  
and returns this function as a @N{C function}.

So, @id{funcname} must follow the @Lid{lua\_CFunction} prototype  
@seeC{lua\_CFunction}.

This is a low-level function.

It completely bypasses the package and module system.

Unlike @Lid{require},

it

does not perform any path searching and  
does not automatically adds extensions.

@id{libname} must be the complete file name of the @N{C library},  
including if necessary a path and an extension.

@id{funcname} must be the exact name exported by the @N{C library}  
(which may depend on the @N{C compiler} and linker used).

This functionality is not supported by @N{ISO C}.

As such, it is only available on some platforms

(Windows, Linux, Mac OS X, Solaris, BSD,  
plus other Unix systems that support the @id{dlfcn} standard).

This function is inherently insecure,  
as it allows Lua to call any function in any readable dynamic  
library in the system.

(Lua calls any function assuming the function  
has a proper prototype and respects a proper protocol  
@see{lua\_CFunction}.

Therefore,

calling an arbitrary function in an arbitrary dynamic library  
more often than not results in an access violation.)

}

@LibEntry{package.path|

A string with the path used by @Lid{require} to search for a Lua loader.

At start-up, Lua initializes this variable with the value of the environment variable @defid{LUA\_PATH\_5\_4} or the environment variable @defid{LUA\_PATH} or with a default path defined in @id{luaconf.h}, if those environment variables are not defined. A @St{;} in the value of the environment variable is replaced by the default path.

}

@LibEntry{package.preload|

A table to store loaders for specific modules @seeF{require}.

This variable is only a reference to the real table; assignments to this variable do not change the table used by @Lid{require}. The real table is stored in the C registry @see{registry}, indexed by the key @defid{LUA\_PRELOAD\_TABLE}, a string.

}

@LibEntry{package.searchers|

A table used by @Lid{require} to control how to find modules.

Each entry in this table is a @def{searcher function}. When looking for a module, @Lid{require} calls each of these searchers in ascending order, with the module name (the argument given to @Lid{require}) as its sole argument. If the searcher finds the module, it returns another function, the module @def{loader}, plus an extra value, a @emph{loader data}, that will be passed to that loader and returned as a second result by @Lid{require}. If it cannot find the module, it returns a string explaining why (or @nil if it has nothing to say).

Lua initializes this table with four searcher functions.

The first searcher simply looks for a loader in the `@Lid{package.preload}` table.

The second searcher looks for a loader as a Lua library, using the path stored at `@Lid{package.path}`. The search is done as described in function `@Lid{package.searchpath}`.

The third searcher looks for a loader as a `@N{C library}`, using the path given by the variable `@Lid{package.cpath}`. Again, the search is done as described in function `@Lid{package.searchpath}`.

For instance,

if the `@N{C path}` is the string

```
@verbatim{
"/?.so;/.?.dll;/usr/local/?/init.so"
}
```

the searcher for module `@id{foo}` will try to open the files `@T{./foo.so}`, `@T{./foo.dll}`, and `@T{/usr/local/foo/init.so}`, in that order.

Once it finds a `@N{C library}`, this searcher first uses a dynamic link facility to link the application with the library.

Then it tries to find a `@N{C function}` inside the library to be used as the loader.

The name of this `@N{C function}` is the string `@St{luaopen_}` concatenated with a copy of the module name where each dot is replaced by an underscore.

Moreover, if the module name has a hyphen, its suffix after (and including) the first hyphen is removed.

For instance, if the module name is `@id{a.b.c-v2.1}`, the function name will be `@id{luaopen_a_b_c}`.

The fourth searcher tries an `@def{all-in-one loader}`.

It searches the `@N{C path}` for a library for the root name of the given module.

For instance, when requiring `@id{a.b.c}`, it will search for a `@N{C library}` for `@id{a}`.

If found, it looks into it for an open function for the submodule;

in our example, that would be `@id{luaopen_a_b_c}`.

With this facility, a package can pack several `@N{C submodules}`

into one single library, with each submodule keeping its original open function.

All searchers except the first one (preload) return as the extra value the file path where the module was found, as returned by `@Lid{package.searchpath}`. The first searcher always returns the string `@St{:preload:}`.

Searchers should raise no errors and have no side effects in Lua. (They may have side effects in C, for instance by linking the application with a library.)

}

`@LibEntry{package.searchpath (name, path [, sep [, rep]])|`

Searches for the given `@id{name}` in the given `@id{path}`.

A path is a string containing a sequence of `@emph{templates}` separated by semicolons. For each template, the function replaces each interrogation mark (if any) in the template with a copy of `@id{name}` wherein all occurrences of `@id{sep}` (a dot, by default) were replaced by `@id{rep}` (the system's directory separator, by default), and then tries to open the resulting file name.

For instance, if the path is the string `@verbatim{"/?.lua;/?..lc;/usr/local/?/init.lua"}` the search for the name `@id{foo.a}` will try to open the files `@T{./foo/a.lua}`, `@T{./foo/a.lc}`, and `@T{/usr/local/foo/a/init.lua}`, in that order.

Returns the resulting name of the first file that it can open in read mode (after closing the file), or `@fail` plus an error message if none succeeds. (This error message lists all file names it tried to open.)

}

}

`@sect2{strlib| @title{String Manipulation}`

`@simplesect{`

This library provides generic functions for string manipulation, such as finding and extracting substrings, and pattern matching. When indexing a string in Lua, the first character is at @N{position 1} (not @N{at 0}, as in C). Indices are allowed to be negative and are interpreted as indexing backwards, from the end of the string. Thus, the last character is at position @num{-1}, and so on.

The string library provides all its functions inside the table @defid{string}. It also sets a @x{metatable for strings} where the @idx{\_\_index} field points to the @id{string} table. Therefore, you can use the string functions in object-oriented style. For instance, @T{string.byte(s,i)} can be written as @T{s:byte(i)}.

The string library assumes one-byte character encodings.

@LibEntry{string.byte (s [, i [, j]])}  
Returns the internal numeric codes of the characters @T{s[i]}, @T{s[i+1]}, @ldots, @T{s[j]}.  
The default value for @id{i} @N{is 1};  
the default value for @id{j} @N{is @id{i}}.  
These indices are corrected following the same rules of function @Lid{string.sub}.

Numeric codes are not necessarily portable across platforms.

}

@LibEntry{string.char (@Cdots)  
Receives zero or more integers.  
Returns a string with length equal to the number of arguments, in which each character has the internal numeric code equal to its corresponding argument.

Numeric codes are not necessarily portable across platforms.

}

@LibEntry{string.dump (function [, strip])}

Returns a string containing a binary representation  
(a @emph{binary chunk})

of the given function,  
so that a later `@Lid{load}` on this string returns  
a copy of the function (but with new upvalues).  
If `@id{strip}` is a true value,  
the binary representation may not include all debug information  
about the function,  
to save space.

Functions with upvalues have only their number of upvalues saved.  
When (re)loaded,  
those upvalues receive fresh instances.  
(See the `@Lid{load}` function for details about  
how these upvalues are initialized.  
You can use the debug library to serialize  
and reload the upvalues of a function  
in a way adequate to your needs.)

}

`@LibEntry{string.find (s, pattern [, init [, plain]])|`

Looks for the first match of  
`@id{pattern}` `@see{pm}` in the string `@id{s}`.  
If it finds a match, then `@id{find}` returns the indices `@N{of @T{s}}`  
where this occurrence starts and ends;  
otherwise, it returns `@fail`.  
A third, optional numeric argument `@id{init}` specifies  
where to start the search;  
its default value `@N{is 1}` and can  
be negative.  
A `@true` as a fourth, optional argument `@id{plain}`  
turns off the pattern matching facilities,  
so the function does a plain `@Q{find substring}` operation,  
with no characters in `@id{pattern}` being considered magic.

If the pattern has captures,  
then in a successful match  
the captured values are also returned,  
after the two indices.

}

`@LibEntry{string.format (formatstring, @Cdots)|`

Returns a formatted version of its variable number of arguments  
following the description given in its first argument,  
which must be a string.  
The format string follows the same rules as the `@ANSI{sprintf}`.

The only differences are that the conversion specifiers and modifiers `@id{F}`, `@id{n}`, `@T{*}`, `@id{h}`, `@id{L}`, and `@id{l}` are not supported and that there is an extra specifier, `@id{q}`. Both width and precision, when present, are limited to two digits.

The specifier `@id{q}` formats booleans, nil, numbers, and strings in a way that the result is a valid constant in Lua source code.

Booleans and nil

are written in the obvious way

(`@id{true}`, `@id{false}`, `@id{nil}`).

Floats are written in hexadecimal, to preserve full precision.

A string is written between double quotes, using escape sequences when necessary to ensure that it can safely be read back by the Lua interpreter.

For instance, the call

```
@verbatim{
string.format('%q', 'a string with "quotes" and \n new line')
}
```

may produce the string:

```
@verbatim{
"a string with \"quotes\" and \
new line"
}
```

This specifier does not support modifiers (flags, width, precision).

The conversion specifiers

`@id{A}`, `@id{a}`, `@id{E}`, `@id{e}`, `@id{f}`, `@id{G}`, and `@id{g}` all expect a number as argument.

The specifiers `@id{c}`, `@id{d}`,

`@id{i}`, `@id{o}`, `@id{u}`, `@id{X}`, and `@id{x}` expect an integer.

When Lua is compiled with a C89 compiler, the specifiers `@id{A}` and `@id{a}` (hexadecimal floats) do not support modifiers.

The specifier `@id{s}` expects a string;

if its argument is not a string,

it is converted to one following the same rules of `@Lid{tostring}`.

If

the specifier has any modifier,

the corresponding string argument should not contain `@x{embedded zeros}`.

The specifier `@id{p}` formats the pointer returned by `@Lid{lua_topointer}`.

That gives a unique string identifier for tables, userdata, threads, strings, and functions.



For other values (numbers, nil, booleans),  
this specifier results in a string representing  
the pointer `@id{NULL}`.

}

`@LibEntry{string.gmatch (s, pattern [, init])}`  
Returns an iterator function that,  
each time it is called,  
returns the next captures from `@id{pattern}` `@see{pm}`  
over the string `@id{s}`.  
If `@id{pattern}` specifies no captures,  
then the whole match is produced in each call.  
A third, optional numeric argument `@id{init}` specifies  
where to start the search;  
its default value `@N{is 1}` and can be negative.

As an example, the following loop  
will iterate over all the words from string `@id{s}`,  
printing one per line:

```
@verbatim{
s = "hello world from Lua"
for w in string.gmatch(s, "%a+") do
  print(w)
end
}
```

The next  
example collects all pairs `@T{key=value}` from the  
given string into a table:

```
@verbatim{
t = {}
s = "from=world, to=Lua"
for k, v in string.gmatch(s, "(%w+)=(%w+)") do
  t[k] = v
end
}
```

For this function, a caret `@Char{^}` at the start of a pattern does not  
work as an anchor, as this would prevent the iteration.

}

`@LibEntry{string.gsub (s, pattern, repl [, n])}`  
Returns a copy of `@id{s}`  
in which all (or the first `@id{n}`, if given)  
occurrences of the `@id{pattern}` `@see{pm}` have been  
replaced by a replacement string specified by `@id{repl}`,  
which can be a string, a table, or a function.

`@id{gsub}` also returns, as its second value,  
the total number of matches that occurred.  
The name `@id{gsub}` comes from `@emph{Global SUBstitution}`.

If `@id{repl}` is a string, then its value is used for replacement.  
The `@N{character @T{%}}` works as an escape character:  
any sequence in `@id{repl}` of the form `@T{%@rep{d}}`,  
with `@rep{d}` between 1 and 9,  
stands for the value of the `@rep{d}`-th captured substring;  
the  
sequence `@T{%0}` stands for the whole match;  
the sequence `@T{%}%` stands for a `@N{single @T{%}}`.

If `@id{repl}` is a table, then the table is queried for every match,  
using the first capture as the key.

If `@id{repl}` is a function, then this function is called every time a  
match occurs, with all captured substrings passed as arguments,  
in order.

In any case,  
if the pattern specifies no captures,  
then it behaves as if the whole pattern was inside a capture.

If the value returned by the table query or by the function call  
is a string or a number,  
then it is used as the replacement string;  
otherwise, if it is `@Rw{false}` or `@nil`,  
then there is no replacement  
(that is, the original match is kept in the string).

Here are some examples:

```
@verbatim{
x = string.gsub("hello world", "(%w+)", "%1 %1")
--> x="hello hello world world"

x = string.gsub("hello world", "%w+", "%0 %0", 1)
--> x="hello hello world"

x = string.gsub("hello world from Lua", "(%w+)%s*(%w+)", "%2 %1")
--> x="world hello Lua
from"

x = string.gsub("home = $HOME, user = $USER", "%$(%w+)", os.getenv)
--> x="home = /home/roberto, user = roberto"

x = string.gsub("4+5 = $return 4+5$", "%$(.)%$", function (s)
    return load(s)()
})
```

```

    end)
--> x="4+5 = 9"

local t = {name="lua", version="5.4"}
x = string.gsub("$name-$version.tar.gz", "%$(%w+)", t)
--> x="lua-5.4.tar.gz"
}

}

```

@LibEntry{string.len (s)|

Receives a string and returns its length.  
The empty string @T{""} has length 0.  
Embedded zeros are counted,  
so @T{"a\000bc\000"} has length 5.

}

@LibEntry{string.lower (s)|

Receives a string and returns a copy of this string with all  
uppercase letters changed to lowercase.  
All other characters are left unchanged.  
The definition of what an uppercase letter is depends on the current locale.

}

@LibEntry{string.match (s, pattern [, init])|

Looks for the first @emph{match} of  
the @id{pattern} @see{pm} in the string @id{s}.  
If it finds one, then @id{match} returns  
the captures from the pattern;  
otherwise it  
returns @fail.  
If @id{pattern} specifies no captures,  
then the whole match is returned.  
A third, optional numeric argument @id{init} specifies  
where to start the search;  
its default value @N{is 1} and can be negative.

}

@LibEntry{string.pack (fmt, v1, v2, @Cdots)|

Returns a binary string containing the values @id{v1}, @id{v2}, etc.  
serialized in binary form (packed)

according to the format string @id{fmt} @see{pack}.

}

@LibEntry{string.packsize (fmt)|

Returns the length of a string resulting from @Lid{string.pack} with the given format.

The format string cannot have the variable-length options @Char{s} or @Char{z} @see{pack}.

}

@LibEntry{string.rep (s, n [, sep])|

Returns a string that is the concatenation of @id{n} copies of the string @id{s} separated by the string @id{sep}.

The default value for @id{sep} is the empty string (that is, no separator).

Returns the empty string if @id{n} is not positive.

(Note that it is very easy to exhaust the memory of your machine with a single call to this function.)

}

@LibEntry{string.reverse (s)|

Returns a string that is the string @id{s} reversed.

}

@LibEntry{string.sub (s, i [, j])|

Returns the substring of @id{s} that starts at @id{i} and continues until @id{j};

@id{i} and @id{j} can be negative.

If @id{j} is absent, then it is assumed to be equal to @num{-1} (which is the same as the string length).

In particular,

the call @T{string.sub(s,1,j)} returns a prefix of @id{s} with length @id{j},

and @T{string.sub(s, -i)} (for a positive @id{i}) returns a suffix of @id{s}

with length @id{i}.

If, after the translation of negative indices,

@id{i} is less than 1,  
it is corrected to 1.  
If @id{j} is greater than the string length,  
it is corrected to that length.  
If, after these corrections,  
@id{i} is greater than @id{j},  
the function returns the empty string.

}

@LibEntry{string.unpack (fmt, s [, pos])|

Returns the values packed in string @id{s} @seeF{string.pack}  
according to the format string @id{fmt} @see{pack}.

An

optional @id{pos} marks where  
to start reading in @id{s} (default is 1).

After the read values,  
this function also returns the index of the first unread byte in @id{s}.

}

@LibEntry{string.upper (s)|

Receives a string and returns a copy of this string with all  
lowercase letters changed to uppercase.  
All other characters are left unchanged.  
The definition of what a lowercase letter is depends on the current locale.

}

}

@sect3{pm| @title{Patterns}

@simplesect{

Patterns in Lua are described by regular strings,  
which are interpreted as patterns by the pattern-matching functions  
@Lid{string.find},  
@Lid{string.gmatch},  
@Lid{string.gsub},  
and @Lid{string.match}.

This section describes the syntax and the meaning  
(that is, what they match) of these strings.

}

@sect4{@title{Character Class:}}

A @def{character class} is used to represent a set of characters.

The following combinations are allowed in describing a character class:

@description{

@item{@rep{x}|

(where @rep{x} is not one

of the @emphx{magic characters}

@T{^\$()%.[]\*+-?})

represents the character @emph{x} itself.

}

@item{@T{.}| (a dot) represents all characters.}

@item{@T{%a}| represents all letters.}

@item{@T{%c}| represents all control characters.}

@item{@T{%d}| represents all digits.}

@item{@T{%g}| represents all printable characters except space.}

@item{@T{%l}| represents all lowercase letters.}

@item{@T{%p}| represents all punctuation characters.}

@item{@T{%s}| represents all space characters.}

@item{@T{%u}| represents all uppercase letters.}

@item{@T{%w}| represents all alphanumeric characters.}

@item{@T{%x}| represents all hexadecimal digits.}

@item{@T{%@rep{x}}| (where @rep{x} is any non-alphanumeric character)

represents the character @rep{x}.

This is the standard way to escape the magic characters.

Any non-alphanumeric character

(including all punctuation characters, even the non-magical)

can be preceded by a @Char{%} to represent itself in a pattern.

}

@item{@T{[@rep{set}]}|

represents

the class which is the union of all

characters in @rep{set}.

A range of characters can be specified by

separating the end characters of the range,  
in ascending order, with a `@Char{-}`.  
All classes `@T{%}@emph{x}` described above can also be used as  
components in `@rep{set}`.  
All other characters in `@rep{set}` represent themselves.  
For example, `@T{[%w_]}` (or `@T{[_%w]}`)  
represents all alphanumeric characters plus the underscore,  
`@T{[0-7]}` represents the octal digits,  
and `@T{[0-7!%-]}` represents the octal digits plus  
the lowercase letters plus the `@Char{-}` character.

You can put a closing square bracket in a set  
by positioning it as the first character in the set.  
You can put a hyphen in a set  
by positioning it as the first or the last character in the set.  
(You can also use an escape for both cases.)

The interaction between ranges and classes is not defined.  
Therefore, patterns like `@T{[%a-z]}` or `@T{[a-%%]}`  
have no meaning.  
}

`@item{@T{[^@rep{set}]}`  
represents the complement of `@rep{set}`,  
where  
`@rep{set}` is interpreted as above.  
}

}

For all classes represented by single letters (`@T{%a}`, `@T{%c}`, etc.),  
the corresponding uppercase letter represents the complement of the class.  
For instance, `@T{%S}` represents all non-space characters.

The definitions of letter, space, and other character groups  
depend on the current locale.  
In particular, the class `@T{[a-z]}` may not be equivalent to `@T{%l}`.

}

`@sect4{@title{Pattern Item:}`  
A `@def{pattern item}` can be  
`@itemize{`

`@item{`  
a single character class,  
which matches any single character in the class;  
}

@item{  
a single character class followed by @Char{\*},  
which matches sequences of zero or more characters in the class.  
These repetition items will always match the longest possible sequence;  
}

@item{  
a single character class followed by @Char{+},  
which matches sequences of one or more characters in the class.  
These repetition items will always match the longest possible sequence;  
}

@item{  
a single character class followed  
by @Char{-},  
which also matches sequences of zero or more characters in the class.  
Unlike @Char{\*},  
these repetition items will always match the shortest possible sequence;  
}

@item{  
a single character class followed by @Char{?},  
which matches zero or one occurrence of a character in the class.  
It always matches one occurrence if possible;  
}

@item{  
@T{%@rep{n}}, for @rep{n} between 1 and 9;  
such item matches a substring equal to the @rep{n}-th captured string  
(see below);  
}

@item{  
@T{%b@rep{xy}}, where @rep{x} and @rep{y} are two distinct characters;  
such item matches strings that start @N{with @rep{x}}, end @N{with @rep{y}},  
and where the @rep{x} and @rep{y} are @emph{balanced}.  
This means that, if one reads the string from left to right,  
counting @M{+1} for an @rep{x} and @M{-1} for a @rep{y},  
the ending @rep{y} is the first @rep{y} where the count reaches 0.  
For instance, the item @T{%b()} matches expressions with  
balanced parentheses.  
}

@item{  
@T{%f[@rep{set}]}, a @def{frontier  
pattern};  
such item matches an empty string at any position such that  
the next character belongs to @rep{set}



and the previous character does not belong to `@rep{set}`.  
The set `@rep{set}` is interpreted as previously described.  
The beginning and the end of the subject are handled as if  
they were the character `@Char{\0}`.

}

}

}

`@sect4{@title{Pattern:}}`

A `@def{pattern}` is a sequence of pattern items.

A caret `@Char{^}` at the beginning of a pattern anchors the match at the  
beginning of the subject string.

A `@Char{$}` at the end of a pattern anchors the match at the  
end of the subject string.

At other positions,

`@Char{^}` and `@Char{$}` have no special meaning and represent themselves.

}

`@sect4{@title{Captures:}}`

A pattern can contain sub-patterns enclosed in parentheses;  
they describe `@def{captures}`.

When a match succeeds, the substrings of the subject string  
that match captures are stored (`@emph{captured}`) for future use.

Captures are numbered according to their left parentheses.

For instance,

in the pattern `@T{"a*(.)%w(%s*)"}`,  
the part of the string matching `@T{"a*(.)%w(%s*)"}` is  
stored as the first capture, and therefore has `@N{number 1}`;  
the character matching `@St{.}` is captured with `@N{number 2}`,  
and the part matching `@St{%s*}` has `@N{number 3}`.

As a special case, the capture `@T{()}` captures  
the current string position (a number).

For instance, if we apply the pattern `@T{"()aa()"}` on the  
string `@T{"flaaap"}`, there will be two captures: `@N{3}` and `@N{5}`.

}

`@sect4{@title{Multiple matches:}}`

The function `@Lid{string.gsub}` and the iterator `@Lid{string.gmatch}`  
match multiple occurrences of the given pattern in the subject.

For these functions,

a new match is considered valid only

if it ends at least one byte after the end of the previous match.

In other words, the pattern machine never accepts the

empty string as a match immediately after another match.

As an example,

consider the results of the following code:

```
@verbatim{
> string.gsub("abc", "()a*()", print);
--> 1 2
--> 3
    3
--> 4 4
}
```

The second and third results come from Lua matching an empty string after `@Char{b}` and another one after `@Char{c}`.

Lua does not match an empty string after `@Char{a}`, because it would end at the same position of the previous match.

```
}
```

```
}
```

```
@sect3{pack| @title{Format Strings for Pack and Unpack}
```

The first argument to `@Lid{string.pack}`,

`@Lid{string.packsize}`, and `@Lid{string.unpack}`

is a format string,

which describes the layout of the structure being created or read.

A format string is a sequence of conversion options.

The conversion options are as follows:

```
@description{
@item{@T{<}|sets little endian}
@item{@T{>}|sets big endian}
@item{@T{=}|sets native endian}
@item{@T{![@rep{n}]}|sets maximum alignment to @id{n}
(default is native alignment)}
@item{@T{b}|a signed byte (@id{char})}
@item{@T{B}|an unsigned byte (@id{char})}
@item{@T{h}|a signed @id{short} (native size)}
@item{@T{H}|an unsigned @id{short} (native size)}
@item{@T{l}|a signed @id{long} (native size)}
@item{@T{L}|an
unsigned @id{long} (native size)}
@item{@T{j}|a @id{lua_Integer}}
@item{@T{J}|a @id{lua_Unsigned}}
@item{@T{T}|a @id{size_t} (native size)}
@item{@T{i[@rep{n}]}|a signed @id{int} with @id{n} bytes
(default is native size)}
@item{@T{I[@rep{n}]}|an unsigned @id{int} with @id{n} bytes
(default is native size)}
```

`@item{@T{f}|a @id{float} (native size)}`  
`@item{@T{d}|a @id{double} (native size)}`  
`@item{@T{n}|a @id{lua_Number}}`  
`@item{@T{c@rep{n}}|a fixed-sized string with @id{n} bytes}`  
`@item{@T{z}|a zero-terminated string}`  
`@item{@T{s[@emph{n}]}|a string preceded by its length`  
 coded as an unsigned integer with `@id{n}` bytes  
 (default is a `@id{size_t}`)  
`@item{@T{x}|one byte of padding}`  
`@item{@T{X@rep{op}}|an empty item that aligns`  
 according to option `@id{op}`  
 (which is otherwise ignored)}  
`@item{@Char{ }|(space) ignored}`  
`}`

(A `@St{[@rep{n}]}` means an optional integral numeral.)

Except for padding, spaces, and configurations

(options `@St{XX <=>!}`),

each option corresponds to an argument in `@Lid{string.pack}`

or

a result in `@Lid{string.unpack}`.

For options `@St{!@rep{n}}`, `@St{s@rep{n}}`, `@St{i@rep{n}}`, and `@St{I@rep{n}}`,

`@id{n}` can be any integer between 1 and 16.

All integral options check overflows;

`@Lid{string.pack}` checks whether the given value fits in the given size;

`@Lid{string.unpack}` checks whether the read value fits in a Lua integer.

For the unsigned options,

Lua integers are treated as unsigned values too.

Any format string starts as if prefixed by `@St{!1=}`,

that is,

with maximum alignment of 1 (no alignment)

and native endianness.

Native endianness assumes that the whole system is

either big or little endian.

The packing functions will not emulate correctly the behavior

of mixed-endian formats.

Alignment works as follows:

For each option,

the format gets extra padding until the data starts

at an offset that is a multiple of the minimum between the

option size and the maximum alignment;

this minimum must be a power of 2.

Options `@St{c}` and `@St{z}` are not aligned;

option

@St{s} follows the alignment of its starting integer.

All padding is filled with zeros by @Lid{string.pack}  
and ignored by @Lid{string.unpack}.

}

}

@sect2{utf8| @title{UTF-8 Support}

This library provides basic support for @x{UTF-8} encoding.  
It provides all its functions inside the table @defid{utf8}.  
This library does not provide any support for @x{Unicode} other  
than the handling of the encoding.  
Any operation that needs the meaning of a character,  
such as character classification, is outside its scope.

Unless stated otherwise,  
all functions that expect a byte position as a parameter  
assume that the given position is either the start of a byte sequence  
or one plus the length of the subject string.  
As in the string library,  
negative indices count from the end of the string.

Functions that create byte sequences  
accept all values up to @T{0x7FFFFFFF},  
as defined in the original UTF-8 specification;  
that implies byte sequences of up to six bytes.

Functions that interpret  
byte sequences only accept  
valid sequences (well formed and not overlong).  
By default, they only accept byte sequences  
that result in valid Unicode code points,  
rejecting values greater than @T{10FFFF} and surrogates.  
A boolean argument @id{lax}, when available,  
lifts these checks,  
so that all values up to @T{0x7FFFFFFF} are accepted.  
(Not well formed and overlong sequences are still rejected.)

@LibEntry{utf8.char (@Cdots)|

Receives zero or more integers,  
converts each one to its corresponding UTF-8 byte sequence  
and returns a string with the concatenation of all these sequences.

```
}
```

```
@LibEntry{utf8.charpattern|
```

The pattern (a string, not a function) `@St{[\0-\x7F\xC2-\xFD][\x80-\xBF]*}`

```
@see{pm},
```

which matches exactly one UTF-8 byte sequence,  
assuming that the subject is a valid UTF-8 string.

```
}
```

```
@LibEntry{utf8.codes (s [, lax])|
```

Returns values so that the construction

```
@verbatim{
```

```
for p, c in utf8.codes(s) do @rep{body} end
```

```
}
```

will iterate over all UTF-8 characters in string `@id{s}`,

with

`@id{p}` being the position (in bytes) and `@id{c}` the code point  
of each character.

It raises an error if it meets any invalid byte sequence.

```
}
```

```
@LibEntry{utf8.codepoint (s [, i [, j [, lax]])]|
```

Returns the code points (as integers) from all characters in `@id{s}`  
that start between byte position `@id{i}` and `@id{j}` (both included).

The default for `@id{i}` is 1 and for `@id{j}` is `@id{i}`.

It raises an error if it meets any invalid byte sequence.

```
}
```

```
@LibEntry{utf8.len (s [, i [, j [, lax]])]|
```

Returns the number of UTF-8 characters in string `@id{s}`

that start between positions `@id{i}` and `@id{j}` (both inclusive).

The default for `@id{i}` is `@num{1}` and for `@id{j}` is `@num{-1}`.

If it finds any invalid byte sequence,  
returns `@fail` plus the position of the first invalid byte.

```
}
```

```
@LibEntry{utf8.offset (s, n [, i)]|
```

Returns the position (in bytes) where the encoding of the

@id{n}-th character of @id{s}  
(counting from position @id{i}) starts.  
A negative @id{n} gets characters before position @id{i}.  
The  
default for @id{i} is 1 when @id{n} is non-negative  
and @T{#s + 1} otherwise,  
so that @T{utf8.offset(s, -n)} gets the offset of the  
@id{n}-th character from the end of the string.  
If the specified character is neither in the subject  
nor right after its end,  
the function returns @fail.

As a special case,  
when @id{n} is 0 the function returns the start of the encoding  
of the character that contains the @id{i}-th byte of @id{s}.

This function assumes that @id{s} is a valid UTF-8 string.

}

}

@sect2{tablib| @title{Table Manipulation}}

This library provides generic functions for table manipulation.  
It provides all its functions inside the table @defid{table}.

Remember that, whenever an operation needs the length of a table,  
all caveats about the length operator apply @see{len-op}.  
All functions ignore non-numeric keys  
in the tables given as arguments.

@LibEntry{table.concat (list [, sep [, i [, j]])}

Given a list where all elements are strings or numbers,  
returns the string

@T{list[i]..sep..list[i+1] @Cdots sep..list[j]}.

The default value for @id{sep} is the empty string,  
the default for @id{i} is 1,  
and the default for @id{j} is @T{#list}.

If @id{i} is greater than @id{j}, returns the empty string.

}

@LibEntry{table.insert (list, [pos,] value)}

Inserts element @id{value} at position @id{pos} in @id{list},

shifting up the elements

`@T{list[pos], list[pos+1], @Cdots, list[#list]}`.

The default value for `@id{pos}` is `@T{#list+1}`,

so that a call `@T{table.insert(t,x)}` inserts `@id{x}` at the end of the list `@id{t}`.

}

`@LibEntry{table.move (a1, f, e, t [,a2])|`

Moves elements from the table `@id{a1}` to the table `@id{a2}`, performing the equivalent to the following multiple assignment:

`@T{a2[t],@Cdots = a1[f],@Cdots,a1[e]}`.

The default for `@id{a2}` is `@id{a1}`.

The destination range can overlap with the source range.

The number of elements to be moved must fit in a Lua integer.

Returns the destination table `@id{a2}`.

}

`@LibEntry{table.pack (@Cdots)|`

Returns

a new table with all arguments stored into keys 1, 2, etc.

and with a field `@St{n}` with the total number of arguments.

Note that the resulting table may not be a sequence,

if some arguments are `@nil`.

}

`@LibEntry{table.remove (list [, pos])|`

Removes from `@id{list}` the element at position `@id{pos}`, returning the value of the removed element.

When `@id{pos}` is an integer between 1 and `@T{#list}`,

it shifts down the elements

`@T{list[pos+1], list[pos+2], @Cdots, list[#list]}`

and erases element `@T{list[#list]}`;

The index `@id{pos}` can also be 0 when `@T{#list}` is 0,

or `@T{#list + 1}`.

The default value for `@id{pos}` is `@T{#list}`,

so that a call `@T{table.remove(l)}` removes the last element of the list `@id{l}`.

}

@LibEntry{table.sort (list [, comp])}

Sorts the list elements in a given order, @emph{in-place},  
from @T{list[1]} to @T{list[#list]}.

If @id{comp} is given,

then it must be a function that receives two list elements  
and returns true when the first element must come  
before the second in  
the final order,

so that, after the sort,

@T{i <= j} implies @T{not comp(list[j],list[i])}.

If @id{comp} is not given,

then the standard Lua operator @T{<} is used instead.

The @id{comp} function must define a consistent order;  
more formally, the function must define a strict weak order.  
(A weak order is similar to a total order,  
but it can equate different elements for comparison purposes.)

The sort algorithm is not stable:

Different elements considered equal by the given order  
may have their relative positions changed by the sort.

}

@LibEntry{table.unpack (list [, i [, j]])}

Returns the elements from the given list.

This function is equivalent to

@verbatim{

return list[i], list[i+1], @Cdots, list[j]

}

By default, @id{i} @N{is 1} and @id{j} is @T{#list}.

}

}

@sect2{mathlib| @title{Mathematical Functions}}

This library provides basic mathematical functions.

It provides all its functions and constants inside the table @defid{math}.

Functions with the annotation @St{integer/float}

give

integer results for integer arguments

and float results for non-integer arguments.

The rounding functions



@Lid{math.ceil}, @Lid{math.floor}, and @Lid{math.modf}  
return an integer when the result fits in the range of an integer,  
or a float otherwise.

@LibEntry{math.abs (x)|

Returns the maximum value between @id{x} and @id{-x}. (integer/float)

}

@LibEntry{math.acos (x)|

Returns the arc cosine of @id{x} (in radians).

}

@LibEntry{math.asin (x)|

Returns the arc sine of @id{x} (in radians).

}

@LibEntry{math.atan (y [, x])|

@index{atan} @index{atan2}

Returns the arc tangent of @T{y/x} (in radians),  
using the signs of both arguments to find the  
quadrant of the result.

It also handles correctly the case of @id{x} being zero.

The default value for @id{x} is 1,  
so that the call @T{math.atan(y)}  
returns the arc tangent of @id{y}.

}

@LibEntry{math.ceil (x)|

Returns the smallest integral value greater than or equal to @id{x}.

}

@LibEntry{math.cos (x)|

Returns the cosine of  
@id{x} (assumed to be in radians).

}

@LibEntry{math.deg (x)|

Converts the angle @id{x} from radians to degrees.

}

@LibEntry{math.exp (x)|

Returns the value @M{e@sp{x}}

(where @id{e} is the base of natural logarithms).

}

@LibEntry{math.floor (x)|

Returns the largest integral value less than or equal to @id{x}.

}

@LibEntry{math.fmod (x, y)|

Returns the remainder of the division of @id{x} by @id{y}  
that rounds the quotient towards zero. (integer/float)

}

@LibEntry{math.huge|

The float value @idx{HUGE\_VAL},  
a value greater than any other numeric value.

}

@LibEntry{math.log (x [, base])|

Returns the logarithm of @id{x} in the given base.  
The default for @id{base} is @M{e}  
(so that the function returns the natural logarithm of @id{x}).

}

@LibEntry{math.max (x, @Cdots)|

Returns the argument with the maximum value,  
according to the Lua operator @T{<}.

}

@LibEntry{math.maxinteger|

An integer with the maximum value for an integer.

}

@LibEntry{math.min (x, @Cdots)|

Returns

the argument with the minimum value,  
according to the Lua operator @T{<}.

}

@LibEntry{math.mininteger|

An integer with the minimum value for an integer.

}

@LibEntry{math.modf (x)|

Returns the integral part of @id{x} and the fractional part of @id{x}.  
Its second result is always a float.

}

@LibEntry{math.pi|

The value of @M{@pi}.

}

@LibEntry{math.rad (x)|

Converts the angle @id{x} from degrees to radians.

}

@LibEntry{math.random ([m [, n]])|

When called without arguments,  
returns a pseudo-random float with uniform distribution  
in the range @C{(} @M{[0,1)}. @C{)}

When called with two integers @id{m} and @id{n},  
@id{math.random} returns a pseudo-random integer  
with uniform distribution in the range @M{[m, n]}.

The call @T{math.random(n)}, for a positive @id{n},  
is equivalent to @T{math.random(1,n)}.

The call `@T{math.random(0)}` produces an integer with all bits (pseudo)random.

This function uses the `@idx{xoshiro256**}` algorithm to produce pseudo-random 64-bit integers, which are the results of calls with `@N{argument 0}`. Other results (ranges and floats) are unbiased extracted from these integers.

Lua initializes its pseudo-random generator with the equivalent of a call to `@Lid{math.randomseed}` with no arguments, so that `@id{math.random}` should generate different sequences of results each time the program runs.

}

`@LibEntry{math.randomseed ([x [, y]])|`

When called with at least one argument, the integer parameters `@id{x}` and `@id{y}` are joined into a 128-bit `@emphx{seed}` that is used to reinitialize the pseudo-random generator; equal seeds produce equal sequences of numbers. The default for `@id{y}` is zero.

When called with no arguments, Lua generates a seed with a weak attempt for randomness.

This function returns the two seed components that were effectively used, so that setting them again repeats the sequence.

To ensure a required level of randomness to the initial state (or contrarily, to have a deterministic sequence, for instance when debugging a program), you should call `@Lid{math.randomseed}` with explicit arguments.

}

`@LibEntry{math.sin (x)|`

Returns the sine of `@id{x}` (assumed to be in radians).

}

@LibEntry{math.sqrt (x)|

Returns the square root of @id{x}.

(You can also use the expression @T{x^0.5} to compute this value.)

}

@LibEntry{math.tan (x)|

Returns the tangent of @id{x} (assumed to be in radians).

}

@LibEntry{math.tointeger (x)|

If the value @id{x} is convertible to an integer,  
returns that integer.

Otherwise, returns @fail.

}

@LibEntry{math.type (x)|

Returns @St{integer} if @id{x} is an integer,

@St{float} if it is a float,

or @fail if @id{x} is not a number.

}

@LibEntry{math.ult (m, n)|

Returns a boolean,

@true if and only if integer @id{m} is below integer @id{n} when  
they are compared as @x{unsigned integers}.

}

}

@sect2{iolib| @title{Input and Output Facilities}}

The I/O library provides two different styles for file manipulation.

The first one uses implicit file handles;

that is, there

are operations to set a default input file and a

default output file,

and all input/output operations are done over these default files.

The second style uses explicit file handles.

When using implicit file handles,  
all operations are supplied by table `@defid{io}`.  
When using explicit file handles,  
the operation `@Lid{io.open}` returns a file handle  
and then all operations are supplied as methods of the file handle.

The metatable for file handles provides metamethods  
for `@idx{__gc}` and `@idx{__close}` that try  
to close the file when called.

The table `@id{io}` also provides  
three predefined file handles with their usual meanings from C:  
`@defid{io.stdin}`, `@defid{io.stdout}`, and `@defid{io.stderr}`.  
The I/O library never closes these files.

Unless otherwise stated,  
all I/O functions return `@fail` on failure,  
plus an error message as a second result and  
a system-dependent error code as a third result,  
and some non-false value on success.  
On non-POSIX systems,  
the computation of the error message  
and error code  
in case of errors  
may be not `@x{thread safe}`,  
because they rely on the global C variable `@id{errno}`.

`@LibEntry{io.close ([file])}`

Equivalent to `@T{file:close()}`.  
Without a `@id{file}`, closes the default output file.

}

`@LibEntry{io.flush ()}`

Equivalent to `@T{io.output():flush()}`.

}

`@LibEntry{io.input ([file])}`

When called with a file name, it opens the named file (in text mode),  
and sets its handle as the default input file.

When called with a file handle,  
it simply sets this file handle as the default input file.

When called without arguments,

it returns the current default input file.

In case of errors this function raises the error,  
instead of returning an error code.

```
}
```

```
@LibEntry{io.lines ([filename, @Cdots])|
```

Opens the given file name in read mode  
and returns an iterator function that  
works like `@T{file:lines(@Cdots)}` over the opened file.

When the iterator function fails to read any value,  
it automatically closes the file.

Besides the iterator function,

`@id{io.lines}`

returns three other values:

two `@nil` values as placeholders,

plus the created file handle.

Therefore, when used in a generic `@Rw{for}` loop,  
the file is closed also if the loop is interrupted by an  
error or a `@Rw{break}`.

The call `@T{io.lines()}` (with no file name) is equivalent

to `@T{io.input():lines("I")}`;

that is, it iterates over the lines of the default input file.

In this case, the iterator does not close the file when the loop ends.

In case of errors opening the file,  
this function raises the error,  
instead of returning an error code.

```
}
```

```
@LibEntry{io.open (filename [, mode])|
```

This function opens a file,  
in the mode specified in the string `@id{mode}`.

In case of success,

it returns a new file handle.

The `@id{mode}` string can be any of the following:

`@description{`

`@item{@St{r}| read mode (the default);}`

`@item{@St{w}| write mode;}`

`@item{@St{a}| append mode;}`

`@item{@St{r+}| update mode, all previous data is preserved;}`

`@item{@St{w+}| update mode, all previous data is`

```

        erased;}
    @item{@St{a+}| append update mode, previous data is preserved,
        writing is only allowed at the end of file.}
}

```

The `@id{mode}` string can also have a `@Char{b}` at the end, which is needed in some systems to open the file in binary mode.

```

}

```

```

@LibEntry{io.output ([file])|

```

Similar to `@Lid{io.input}`, but operates over the default output file.

```

}

```

```

@LibEntry{io.popen (prog [, mode])|

```

This function is system dependent and is not available on all platforms.

Starts the program `@id{prog}` in a separated process and returns a file handle that you can use to read data from this program (if `@id{mode}` is `@T{"r"}`, the default) or to write data to this program (if `@id{mode}` is `@T{"w"}`).

```

}

```

```

@LibEntry{io.read (@Cdots)|

```

Equivalent to `@T{io.input():read(@Cdots)}`.

```

}

```

```

@LibEntry{io.tmpfile ()|

```

In case of success, returns a handle for a temporary file. This file is opened in update mode and it is automatically removed when the program ends.

```

}

```

```

@LibEntry{io.type (obj)|

```

Checks whether `@id{obj}` is a valid file handle. Returns the string `@T{"file"}` if `@id{obj}` is an open file handle,



@T{"closed file"} if @id{obj} is a closed file handle,  
or @fail if @id{obj} is not a file handle.

}

@LibEntry{io.write (@Cdots)|

Equivalent to @T{io.output():write(@Cdots)}.

}

@LibEntry{file:close ()|

Closes @id{file}.

Note that files are automatically closed when  
their handles are garbage collected,  
but that takes an unpredictable amount of time to happen.

When closing a file handle created with @Lid{io.popen},  
@Lid{file:close} returns the same values  
returned by @Lid{os.execute}.

}

@LibEntry{file:flush ()|

Saves any written data to @id{file}.

}

@LibEntry{file:lines (@Cdots)|

Returns an iterator function that,  
each time it is called,  
reads the file according to the given formats.

When no format is given,  
uses @St{1} as a default.

As an example, the construction

```
@verbatim{  
for c in file:lines(1) do @rep{body} end  
}
```

will iterate over all characters of the file,  
starting at the current  
position.

Unlike @Lid{io.lines}, this function does not close the file  
when the loop ends.

}

@LibEntry{file:read (@Cdots)|

Reads the file @id{file},  
according to the given formats, which specify what to read.  
For each format,  
the function returns a string or a number with the characters read,  
or @fail if it cannot read data with the specified format.  
(In this latter case,  
the function does not read subsequent formats.)  
When called without arguments,  
it uses a default format that reads the next line  
(see below).

The available formats are

@description{

@item{@St{n}|

reads a numeral and returns it as a float or an integer,  
following the lexical conventions of Lua.  
(The numeral may have leading whitespaces and a sign.)  
This format always reads the longest input sequence that  
is a valid prefix for a numeral;  
if that prefix does not form a valid numeral  
(e.g., an empty string, @St{0x}, or @St{3.4e-})  
or it is too long (more than 200 characters),  
it is discarded and the format returns @fail.  
}

@item{@St{a}|

reads  
the whole file, starting at the current position.  
On end of file, it returns the empty string;  
this format never fails.  
}

@item{@St{l}|

reads the next line skipping the end of line,  
returning @fail on end of file.  
This is the default format.  
}

@item{@St{L}|

reads the next line keeping the end-of-line character (if present),  
returning @fail on end of file.  
}

```
@item{@emph{number}|
```

reads a string with up to this number of bytes,  
returning @fail on end of file.

If @id{number} is zero,  
it reads nothing and returns an empty string,  
or @fail on end of file.  
}

```
}
```

The formats @St{I} and @St{L} should be used only for text files.

```
}
```

```
@LibEntry{file:seek ([whence [, offset]])|
```

Sets and gets the file position,  
measured from the beginning of the file,  
to the position given by @id{offset} plus a base  
specified by the string @id{whence}, as follows:

```
@description{  
@item{@St{set}| base is position 0 (beginning of the file);}   
@item{@St{cur}| base is current position;}   
@item{@St{end}|   
base is end of file;}   
}
```

In case of success, @id{seek} returns the final file position,  
measured in bytes from the beginning of the file.

If @id{seek} fails, it returns @fail,  
plus a string describing the error.

The default value for @id{whence} is @T{"cur"},  
and for @id{offset} is 0.

Therefore, the call @T{file:seek()} returns the current  
file position, without changing it;

the call @T{file:seek("set")} sets the position to the  
beginning of the file (and returns 0);

and the call @T{file:seek("end")} sets the position to the  
end of the file, and returns its size.

```
}
```

```
@LibEntry{file:setvbuf (mode [, size])|
```

Sets the buffering mode for a file.

There are three available modes:

```
@description{  
@item{@St{no}| no buffering.}   
@item{@St{full}| full buffering.}
```

```
@item{@St{line}| line buffering.}
}
```

For the last two cases,  
@id{size} is a hint for the size of the buffer, in bytes.  
The default is an appropriate size.

The specific behavior of each mode is non portable;  
check the underlying  
@ANSI{setvbuf} in your platform for  
more details.

```
}
```

```
@LibEntry{file:write (@Cdots)|
```

Writes the value of each of its arguments to @id{file}.  
The arguments must be strings or numbers.

In case of success, this function returns @id{file}.

```
}
```

```
}
```

```
@sect2{oslib| @title{Operating System Facilities}
```

This library is implemented through table @defid{os}.

```
@LibEntry{os.clock ()|
```

Returns an approximation of the amount in seconds of CPU time  
used by the program,  
as returned by the underlying @ANSI{clock}.

```
}
```

```
@LibEntry{os.date ([format [, time]])|
```

Returns a string or a table containing date and time,  
formatted according to the given string @id{format}.

If the @id{time} argument is present,  
this is the time to be formatted  
(see the @Lid{os.time} function for a description of this value).  
Otherwise, @id{date} formats the current time.

If `@id{format}` starts with `@Char{!}`,  
then the date is formatted in Coordinated Universal Time.  
After this optional character,  
if `@id{format}` is the string `@St{*t}`,  
then  
`@id{date}` returns a table with the following fields:  
`@id{year}`, `@id{month}` (1@En{ }12), `@id{day}` (1@En{ }31),  
`@id{hour}` (0@En{ }23), `@id{min}` (0@En{ }59),  
`@id{sec}` (0@En{ }61, due to leap seconds),  
`@id{wday}` (weekday, 1@En{ }7, Sunday @N{is 1}),  
`@id{yday}` (day of the year, 1@En{ }366),  
and `@id{isdst}` (daylight saving flag, a boolean).  
This last field may be absent  
if the information is not available.

If `@id{format}` is not `@St{*t}`,  
then `@id{date}` returns the date as a string,  
formatted according to the same rules as the `@ANSI{strftime}`.

If `@id{format}` is absent, it defaults to `@St{%c}`,  
which gives a human-readable date and time representation  
using the current locale.

On non-POSIX systems,  
this function may be not `@x{thread safe}`  
because of its reliance on `@CId{gmtime}` and `@CId{localtime}`.

}

`@LibEntry{os.difftime (t2, t1)|`

Returns the difference, in seconds,  
from time `@id{t1}` to time `@id{t2}`  
(where the times are values returned by `@Lid{os.time}`).  
In `@x{POSIX}`, `@x{Windows}`, and  
some other systems,  
this value is exactly `@id{t2}@M{-}@id{t1}`.

}

`@LibEntry{os.execute ([command])|`

This function is equivalent to the `@ANSI{system}`.  
It passes `@id{command}` to be executed by an operating system shell.  
Its first result is `@true`  
if the command terminated successfully,  
or `@fail` otherwise.  
After this first result

the function returns a string plus a number,  
as follows:

@description{

@item{@St{exit}|

the command terminated normally;

the following number is the exit status of the command.

}

@item{@St{signal}|

the command was terminated by a signal;

the following number is the signal that terminated the command.

}

}

When called without a @id{command},

@id{os.execute} returns a boolean that is true if a shell is available.

}

@LibEntry{os.exit ([code [, close]])|

Calls the @ANSI{exit} to terminate the host program.

If @id{code} is @true,

the returned status is @idx{EXIT\_SUCCESS};

if @id{code} is @false,

the returned status is @idx{EXIT\_FAILURE};

if @id{code} is a number,

the

returned status is this number.

The default value for @id{code} is @true.

If the optional second argument @id{close} is true,

the function closes the Lua state before exiting @seeF{lua\_close}.

}

@LibEntry{os.getenv (varname)|

Returns the value of the process environment variable @id{varname}

or @fail if the variable is not defined.

}

@LibEntry{os.remove (filename)|

Deletes the file (or empty directory, on @x{POSIX} systems)

with the given name.

If this function fails, it returns @fail  
plus a string describing the error and the error code.  
Otherwise, it returns true.

}

@LibEntry{os.rename (oldname, newname)|

Renames the file or directory named @id{oldname} to @id{newname}.  
If this function fails, it returns @fail,  
plus a string describing the error and the error code.  
Otherwise, it returns true.

}

@LibEntry{os.setlocale (locale [, category])|

Sets the current locale of the program.  
@id{locale} is a system-dependent string specifying a locale;  
@id{category} is an optional  
string describing which category to change:  
@T{"all"}, @T{"collate"}, @T{"ctype"},  
@T{"monetary"}, @T{"numeric"}, or @T{"time"};  
the default category is @T{"all".  
The function returns the name of the new locale,  
or @fail if the request cannot be honored.

If @id{locale} is the empty string,  
the current locale is set to an implementation-defined native locale.  
If @id{locale} is the string @St{C},  
the current locale is set to the standard C locale.

When called with @nil as the first argument,  
this function only returns the name of the current locale  
for the given category.

This function may be not @x{thread safe}  
because of its reliance on @CId{setlocale}.

}

@LibEntry{os.time ([table])|

Returns the current time when called without arguments,  
or a time representing the local date and time specified by the given table.  
This table must have fields @id{year}, @id{month}, and @id{day},  
and may have fields

@id{hour} (default is 12),

@id{min} (default is 0),

@id{sec} (default is 0),

and

@id{isdst} (default is @nil).

Other fields are ignored.

For a description of these fields, see the @Lid{os.date} function.

When the function is called,

the values in these fields do not need to be inside their valid ranges.

For instance, if @id{sec} is -10,

it means 10 seconds before the time specified by the other fields;

if @id{hour} is 1000,

it means 1000 hours after the time specified by the other fields.

The returned value is a number, whose meaning depends on your system.

In @x{POSIX}, @x{Windows}, and some other systems,

this number counts the number

of seconds since some given start time (the @Q{epoch}).

In other systems, the meaning is not specified,

and the number returned by @id{time} can be used only as an argument to

@Lid{os.date} and @Lid{os.difftime}.

When called with a table,

@id{os.time} also normalizes all the fields

documented in the @Lid{os.date} function,

so that they represent the same time as before the call

but with values inside their valid ranges.

}

@LibEntry{os.tmpname

()|

Returns a string with a file name that can

be used for a temporary file.

The file must be explicitly opened before its use

and explicitly removed when no longer needed.

In @x{POSIX} systems,

this function also creates a file with that name,

to avoid security risks.

(Someone else might create the file with wrong permissions

in the time between getting the name and creating the file.)

You still have to open the file to use it

and to remove it (even if you do not use it).

When possible,



you may prefer to use `@Lid{io.tmpfile}`,  
which automatically removes the file when the program ends.

}

}

`@sect2{debuglib| @title{The Debug Library}`

This library provides  
the functionality of the `@link{debugI|debug interface}` to Lua programs.  
You should exert care when using this library.  
Several of its functions  
violate basic assumptions about Lua code  
(e.g., that variables local to a function  
cannot be accessed from outside;  
that userdata metatables cannot be changed by Lua  
code;  
that Lua programs do not crash)  
and therefore can compromise otherwise secure code.  
Moreover, some functions in this library may be slow.

All functions in this library are provided  
inside the `@defid{debug}` table.  
All functions that operate over a thread  
have an optional first argument which is the  
thread to operate over.  
The default is always the current thread.

`@LibEntry{debug.debug ()|`

Enters an interactive mode with the user,  
running each string that the user enters.  
Using simple commands and other debug facilities,  
the user can inspect global and local variables,  
change their values, evaluate expressions, and so on.  
A line containing only the word `@id{cont}` finishes this function,  
so that the caller continues its execution.

Note that commands for `@id{debug.debug}` are not lexically nested  
within any function and so have no direct access to local variables.

}

`@LibEntry{debug.gethook ([thread])|`

Returns the current hook settings of the thread, as three values:

the current  
hook function, the current hook mask,  
and the current hook count,  
as set by the `@Lid{debug.sethook}` function.

Returns `@fail` if there is no active hook.

}

`@LibEntry{debug.getinfo ([thread,] f [, what])}`

Returns a table with information about a function.

You can give the function directly

or you can give a number as the value of `@id{f}`,

which means the function running at level `@id{f}` of the call stack  
of the given thread:

`@N{level 0}` is the current function (`@id{getinfo}` itself);

`@N{level 1}` is the function that called `@id{getinfo}`

(except for tail calls, which do not count in the stack);

and so on.

If `@id{f}` is a number greater than the number of active functions,  
then `@id{getinfo}` returns `@fail`.

The returned table can contain all the fields returned by `@Lid{lua_getinfo}`,  
with the string `@id{what}` describing which fields to fill in.

The default for `@id{what}` is to get all information available,  
except the table of valid lines.

The option `@Char{f}`

adds a field named `@id{func}` with  
the function itself.

The option `@Char{L}` adds a field named `@id{activelines}`  
with the table of valid lines,  
provided the function is a Lua function.

If the function has no debug information,  
the table is empty.

For instance, the expression `@T{debug.getinfo(1,"n").name}` returns  
a name for the current function,  
if a reasonable name can be found,  
and the expression `@T{debug.getinfo(print)}`  
returns a table with all available information  
about the `@Lid{print}` function.

}

`@LibEntry{debug.getlocal ([thread,] f, local)}`

This function returns the name and the value of the local variable

with index `@id{local}` of the function at level `@id{f}` of the stack.

This function accesses not only explicit local variables,  
but also parameters and temporary values.

The first parameter or local variable has `@N{index 1}`, and so on,  
following the order that they are declared in the code,  
counting only the variables that are active  
in the current scope of the function.

Compile-time constants may not appear  
in this listing,

if they were optimized away by the compiler.

Negative indices refer to vararg arguments;

`@num{-1}` is the first vararg argument.

The function returns `@fail`

if there is no variable with the given index,

and raises an error when called with a level out of range.

(You can call `@Lid{debug.getinfo}` to check whether the level is valid.)

Variable names starting with `@Char{}` (open parenthesis) `@C{}`

represent variables with no known names

(internal variables such as loop control variables,

and variables from chunks saved without debug information).

The parameter `@id{f}` may also be a function.

In that case, `@id{getlocal}` returns only the name of function parameters.

}

`@LibEntry{debug.getmetatable (value)|`

Returns the metatable of the given `@id{value}`

or `@nil` if it does not have a metatable.

}

`@LibEntry{debug.getregistry ()|`

Returns the registry table `@see{registry}`.

}

`@LibEntry{debug.getupvalue (f, up)|`

This function returns the name and the value of the upvalue  
with

index `@id{up}` of the function `@id{f}`.

The function returns `@fail`

if there is no upvalue with the given index.

(For Lua functions,  
upvalues are the external local variables that the function uses,  
and that are consequently included in its closure.)

For @N{C functions}, this function uses the empty string @T{""}  
as a name for all upvalues.

Variable name @Char{?} (interrogation mark)  
represents variables with no known names  
(variables from chunks saved without debug information).

}

@LibEntry{debug.getuservalue (u, n)|

Returns the @id{n}-th user value associated  
to the userdata @id{u} plus a boolean,  
@false if the userdata does not have that value.

}

@LibEntry{debug.sethook ([thread,] hook, mask [, count])|

Sets the given function as the debug hook.  
The string @id{mask} and the number @id{count} describe  
when the hook will be called.  
The string mask may have any combination of the following characters,  
with the given meaning:  
@description{  
@item{@Char{c}| the hook is called every  
time Lua calls a function;}  
@item{@Char{r}| the hook is called every time Lua returns from a function;}  
@item{@Char{l}| the hook is called every time Lua enters a new line of code.}  
}

Moreover,  
with a @id{count} different from zero,  
the hook is called also after every @id{count} instructions.

When called without arguments,  
@Lid{debug.sethook} turns off the hook.

When the hook is called, its first parameter is a string  
describing the event that has triggered its call:  
@T{"call"}, @T{"tail call"}, @T{"return"},  
@T{"line"}, and @T{"count"}.  
For line events,  
the hook also gets the new line number as its second parameter.

Inside a hook,  
you can call `@id{getinfo}` with `@N{level 2}` to get more information about  
the running function.

(`@N{Level 0}` is the `@id{getinfo}` function,  
and `@N{level 1}` is the hook function.)

}

`@LibEntry{debug.setlocal ([thread,] level, local, value)|`

This function assigns the value `@id{value}` to the local variable  
with index `@id{local}` of the function at level `@id{level}`  
of the stack.

The function returns `@fail` if there is no local  
variable with the given index,  
and raises an error when called with a `@id{level}` out of range.  
(You can call `@id{getinfo}` to check whether the level is valid.)  
Otherwise, it returns the name of the local variable.

See `@Lid{debug.getlocal}` for more information about  
variable indices and names.

}

`@LibEntry{debug.setmetatable (value, table)|`

Sets the metatable for the given `@id{value}` to the given `@id{table}`  
(which can be `@nil`).  
Returns `@id{value}`.

}

`@LibEntry{debug.setupvalue (f, up, value)|`

This function assigns the value `@id{value}` to the upvalue  
with index `@id{up}` of the function `@id{f}`.  
The function returns `@fail` if there is no upvalue  
with the given index.  
Otherwise, it returns the name of the upvalue.

See `@Lid{debug.getupvalue}` for more information about upvalues.

}

`@LibEntry{debug.setuservalue (udata, value, n)|`

Sets the given `@id{value}` as  
the `@id{n}`-th user value associated to the given `@id{udata}`.

@id{udata}  
must be a full userdata.

Returns @id{udata},  
or @fail if the userdata does not have that value.

}

@LibEntry{debug.traceback ([thread,] [message [, level]])|

If @id{message} is present but is neither a string nor @nil,  
this function returns @id{message} without further processing.

Otherwise,

it returns a string with a traceback of the call stack.

The optional @id{message} string is appended  
at the beginning of the traceback.

An optional @id{level} number tells at which level  
to start the traceback  
(default is 1, the function calling @id{traceback}).

}

@LibEntry{debug.upvalueid (f, n)|

Returns a unique identifier (as a light userdata)  
for the upvalue numbered @id{n}  
from the given function.

These unique identifiers allow a program to check whether different  
closures share upvalues.

Lua closures that share an upvalue  
(that is, that access a same external local variable)  
will return identical ids for those upvalue indices.

}

@LibEntry{debug.upvaluejoin (f1, n1, f2, n2)|

Make

the @id{n1}-th upvalue of the Lua closure @id{f1}  
refer to the @id{n2}-th upvalue of the Lua closure @id{f2}.

}

}

}

@C{-----}

@sect1{lua-sa| @title{Lua Standalone}

Although Lua has been designed as an extension language,  
to be embedded in a host @N{C program},  
it is also frequently used as a standalone language.

An interpreter for Lua as a standalone language,  
called simply @id{lua},  
is provided with the standard distribution.

The @x{standalone interpreter} includes  
all standard libraries.

Its usage is:

```
@verbatim{
lua [options] [script [args]]
}
```

The options are:

```
@description{
@item{@T{-e @rep{stat}}| execute string @rep{stat};}
@item{@T{-i}| enter interactive mode after running @rep{script};}
@item{@T{-l @rep{mod}}| @Q{require} @rep{mod} and assign the
result to global @rep{mod};}
@item{@T{-l @rep{g=mod}}| @Q{require} @rep{mod} and assign the
result to global @rep{g};}
@item{@T{-v}| print version information;}
@item{@T{-E}|
ignore environment variables;}
@item{@T{-W}| turn warnings on;}
@item{@T{--}| stop handling options;}
@item{@T{-}| execute @id{stdin} as a file and stop handling options.}
}
```

(The form @T{-l @rep{g=mod}} was introduced in @N{release 5.4.4}.)

After handling its options, @id{lua} runs the given @emph{script}.

When called without arguments,

@id{lua} behaves as @T{lua -v -i}

when the standard input (@id{stdin}) is a terminal,

and as @T{lua -} otherwise.

When called without the option @T{-E},

the interpreter checks for an environment variable @defid{LUA\_INIT\_5\_4}  
(or @defid{LUA\_INIT} if the versioned name is not defined)

before running any argument.

If the variable content has the format @T{@At@rep{filename}},

then @id{lua} executes the file.

Otherwise, @id{lua} executes the string itself.

When called with the option @T{-E},

Lua does not consult any environment variables.

In particular,

the values of `@Lid{package.path}` and `@Lid{package.cpath}` are set with the default paths defined in `@id{luaconf.h}`.

To signal to the libraries that this option is on,

the stand-alone interpreter sets the field

`@idx{"LUA_NOENV"}` in the registry to a true value.

Other libraries may consult this field for the same purpose.

The options `@T{-e}`, `@T{-l}`, and `@T{-W}` are handled in the order they appear.

For instance, an invocation like

```
@verbatim{
$ lua -e 'a=1' -llib1 script.lua
}
```

will first set `@id{a}` to 1, then require the library `@id{lib1}`, and finally run the file `@id{script.lua}` with no arguments.

(Here `@T{$}` is the shell prompt. Your prompt may be different.)

Before running any code,

`@id{lua}` collects all command-line arguments in a global table called `@id{arg}`.

The script name goes to index 0,

the first argument after the script name goes to index 1, and so on.

Any arguments before the script name

(that is, the interpreter name plus its options)

go to negative indices.

For instance, in the call

```
@verbatim{
$ lua -la b.lua t1 t2
}
```

the table is like this:

```
@verbatim{
arg
= { [-2] = "lua", [-1] = "-la",
    [0] = "b.lua",
    [1] = "t1", [2] = "t2" }
}
```

If there is no script in the call,

the interpreter name goes to index 0,

followed by the other arguments.

For instance, the call

```
@verbatim{
$ lua -e "print(arg[1])"
}
```

will print `@St{-e}`.



If there is a script,  
the script is called with arguments  
`@T{arg[1]}, @Cdots, @T{arg[#arg]}`.  
Like all chunks in Lua,  
the script is compiled as a variadic function.

In interactive mode,  
Lua repeatedly prompts and waits for a line.  
After reading a line,  
Lua first try to interpret the line as an expression.  
If it succeeds, it prints its value.  
Otherwise, it interprets the line as a statement.  
If you write an incomplete statement,  
the interpreter waits for its completion  
by issuing a different prompt.

If the global variable `@defid{_PROMPT}` contains a string,  
then its value is used as the prompt.  
Similarly, if the global variable `@defid{_PROMPT2}` contains a string,  
its value is used as the secondary prompt  
(issued  
during incomplete statements).

In case of unprotected errors in the script,  
the interpreter reports the error to the standard error stream.  
If the error object is not a string but  
has a metamethod `@idx{__tostring}`,  
the interpreter calls this metamethod to produce the final message.  
Otherwise, the interpreter converts the error object to a string  
and adds a stack traceback to it.  
When warnings are on,  
they are simply printed in the standard error output.

When finishing normally,  
the interpreter closes its main Lua state  
`@seeF{lua_close}`.  
The script can avoid this step by  
calling `@Lid{os.exit}` to terminate.

To allow the use of Lua as a  
script interpreter in Unix systems,  
Lua skips the first line of a file chunk if it starts with `@T{#}`.  
Therefore, Lua scripts can be made into executable programs  
by using `@T{chmod +x}` and `@N{the @T{#!}}` form,  
as in  
`@verbatim{`  
`#!/usr/local/bin/lua`  
`}`

```

Of course,
the location of the Lua interpreter may be different in your machine.
If @id{lua} is in your
  @id{PATH},
then
  @verbatim{
#!/usr/bin/env lua
  }
is a more portable solution.

}

```

@sect1{incompat| @title{Incompatibilities with the Previous Version}

@simplesect{

Here we list the incompatibilities that you may find when moving a program from @N{Lua 5.3} to @N{Lua 5.4}.

You can avoid some incompatibilities by compiling Lua with appropriate options (see file @id{luaconf.h}).

However,

all these compatibility options will be removed in the future.

More often than not,

compatibility issues arise when these compatibility options are removed.

So, whenever you have the chance,

you should try to test your code with a version of Lua compiled with all compatibility options turned off.

That will ease transitions to newer versions of Lua.

Lua versions can always change the C API in ways that

do not imply source-code changes in a program,

such as the numeric values for constants

or the implementation of functions as macros.

Therefore,

you should never assume that binaries are compatible between different

Lua versions.

Always recompile clients of the Lua API when

using a new version.

Similarly, Lua versions can always change the internal representation

of precompiled chunks;

precompiled chunks are not compatible between different Lua versions.

The standard paths in the official distribution may

change between versions.

}

@sect2{@title{Incompatibilities in the Language}

@itemize{

@item{

The coercion of strings to numbers in arithmetic and bitwise operations has been removed from the core language.

The string library does a similar job for arithmetic (but not for bitwise) operations using the string metamethods.

However, unlike in previous versions, the new implementation preserves the implicit type of the numeral in the string.

For instance, the result of `@T{"1" + "2"}` now is an integer, not a float.

}

@item{

Literal decimal integer constants that overflow are read as floats, instead of wrapping around.

You can use hexadecimal notation for such constants if you want

the old behavior (reading them as integers with wrap around).

}

@item{

The use of the `@idx{__lt}` metamethod to emulate `@idx{__le}` has been removed.

When needed, this metamethod must be explicitly defined.

}

@item{

The semantics of the numerical `@Rw{for}` loop over integers changed in some details.

In particular, the control variable never wraps around.

}

@item{

A label for a `@Rw{goto}` cannot be declared where a label with the same name is visible, even if this other label is declared in an enclosing block.

}

```
@item{
When finalizing an object,
Lua does not ignore @idx{__gc} metamethods that are not functions.
Any value will be called, if present.
(Non-callable values will generate a warning,
like any other error when calling a finalizer.)
}

}

}
```

```
@sect2{@title{Incompatibilities in the Libraries}
@itemize{
```

```
@item{
The function @Lid{print} does not call @Lid{tostring}
to format its arguments;
instead, it has this functionality hardwired.
You should use @idx{__tostring} to modify how values
are printed.
}
```

```
@item{
The pseudo-random number generator used by the function @Lid{math.random}
now starts with a somewhat random seed.
Moreover, it uses a different algorithm.
}
```

```
@item{
By default, the decoding functions in the @Lid{utf8} library
do not accept surrogates as valid code points.
An extra parameter in these functions makes them more permissive.
}
```

```
@item{
The options @St{setpause} and @St{setstepmul}
of the function @Lid{collectgarbage} are deprecated.
You should use the new option @St{incremental} to set them.
}
```

```
@item{
The function @Lid{io.lines} now returns four values,
instead of just one.
That can be a problem when it is used as the sole
argument to another function that has optional parameters,
such as in @T{load(io.lines(filename, "L"))}.
To fix that issue,
```

you can wrap the call into parentheses,  
to adjust its number of results to one.

}

}

}

@sect2{@title{Incompatibilities in the API}

@itemize{

@item{

Full userdata now has an arbitrary number of associated  
user values.

Therefore, the functions @id{lua\_newuserdata},  
@id{lua\_setuservalue}, and @id{lua\_getuservalue} were  
replaced by @Lid{lua\_newuserdatauv},  
@Lid{lua\_setuservalue}, and @Lid{lua\_getuservalue},  
which have an extra argument.

For compatibility, the old names still work as macros assuming  
one single user value.

Note, however, that userdata with zero user values  
are more efficient memory-wise.

}

@item{

The function @Lid{lua\_resume} has an extra parameter.  
This out parameter returns the number of values on  
the top of the stack that were yielded or returned by the coroutine.  
(In previous versions,  
those values were the entire stack.)

}

@item{

The function @Lid{lua\_version} returns the version number,  
instead of an address of the version number.  
The Lua core should work correctly with libraries using their  
own static copies of the same core,  
so there is no need to check whether they are using the same  
address space.

}

@item{

The constant @id{LUA\_ERRGCM} was removed.  
Errors in

finalizers are never propagated;  
instead, they generate a warning.  
}

@item{  
The options @idx{LUA\_GCSETPAUSE} and @idx{LUA\_GCSETSTEPMUL}  
of the function @Lid{lua\_gc} are deprecated.  
You should use the new option @id{LUA\_GCINC} to set them.  
}

}

}

}

@C{[=====]}

@sect1{BNF| @title{The Complete Syntax of Lua}

Here is the complete syntax of Lua in extended BNF.

As usual in extended BNF,

@bnfNter{ {A} } means 0 or more @bnfNter{A}s,  
and @bnfNter{[A]} means an optional @bnfNter{A}.

(For operator precedences, see @See{prec};

for a description of the terminals

@bnfNter{Name}, @bnfNter{Numeral},

and @bnfNter{LiteralString}, see @See{lexical}.)

@index{grammar}

@Produc{

@producname{chunk}@producbody{block}

@producname{block}@producbody{@bnfrep{stat} @bnfoft{retstat}}

@producname{stat}@producbody{

@bnfter{;}

@OrNL varlist @bnfter{=} explist

@OrNL functioncall

@OrNL label

@OrNL @Rw{break}

@OrNL @Rw{goto} Name

@OrNL @Rw{do} block

@Rw{end}

@OrNL @Rw{while} exp @Rw{do} block @Rw{end}

@OrNL @Rw{repeat} block @Rw{until} exp

```

@OrNL @Rw{if} exp @Rw{then} block
@bnfrep{@Rw{elseif} exp @Rw{then} block}
@bnfopt{@Rw{else} block} @Rw{end}
@OrNL @Rw{for} @bnfNter{Name} @bnfter{=} exp @bnfter{,} exp @bnfopt{@bnfter{,} exp}
@Rw{do} block @Rw{end}
@OrNL @Rw{for} namelist @Rw{in} explist @Rw{do} block @Rw{end}
@OrNL @Rw{function} funcname funcbody
@OrNL @Rw{local} @Rw{function} @bnfNter{Name} funcbody
@OrNL @Rw{local} attnamelist @bnfopt{@bnfter{=} explist}
}

@producname{attnamelist}@producbody{
@bnfNter{Name} attrib @bnfrep{@bnfter{,} @bnfNter{Name} attrib}}

@producname{attrib}@producbody{@bnfopt{@bnfter{<} @bnfNter{Name} @bnfter{>}}}

@producname{retstat}@producbody{@Rw{return}
@bnfopt{explist} @bnfopt{@bnfter{;}}}}

@producname{label}@producbody{@bnfter{::} Name @bnfter{::}}

@producname{funcname}@producbody{@bnfNter{Name} @bnfrep{@bnfter{.} @bnfNter{Name}}

@bnfopt{@bnfter{:} @bnfNter{Name}}}}

@producname{varlist}@producbody{var @bnfrep{@bnfter{,} var}}

@producname{var}@producbody{
@bnfNter{Name}
@Or prefixexp @bnfter{[] exp @bnfter{[]}}
@Or prefixexp @bnfter{.} @bnfNter{Name}
}

@producname{namelist}@producbody{@bnfNter{Name} @bnfrep{@bnfter{,} @bnfNter{Name}}}}

@producname{explist}@producbody{exp @bnfrep{@bnfter{,} exp}}

@producname{exp}@producbody{
@Rw{nil}
@Or @Rw{false}
@Or @Rw{true}
@Or @bnfNter{Numeral}
@Or @bnfNter{LiteralString}
@Or @bnfter{...}
@Or functiondef
@OrNL prefixexp
@Or tableconstructor

```

```

@Or exp binop exp
@Or unop exp
}

@producname{prefixexp}@producbody{var @Or functioncall @Or @bnfter{({ exp @bnfter{)}}}

@producname{functioncall}@producbody{
    prefixexp args
@Or prefixexp @bnfter{:} @bnfNter{Name} args
}

@producname{args}@producbody{
    @bnfter{({ @bnfopt{explist} @bnfter{)}}
@Or tableconstructor
@Or @bnfNter{LiteralString}
}

@producname{functiondef}@producbody{@Rw{function} funcbody}

@producname{funcbody}@producbody{@bnfter{({
    @bnfopt{parlist} @bnfter{)}} block @Rw{end}}}

@producname{parlist}@producbody{namelist @bnfopt{@bnfter{,} @bnfter{...}}
@Or @bnfter{...}}

@producname{tableconstructor}@producbody{@bnfter{@Open} @bnfopt{fieldlist} @bnfter{@Close}}

@producname{fieldlist}@producbody{field @bnfrep{fieldsep field} @bnfopt{fieldsep}}

@producname{field}@producbody{@bnfter{[} exp @bnfter{]} @bnfter{=} exp @Or @bnfNter{Name}
@bnfter{=} exp @Or exp}

@producname{fieldsep}@producbody{@bnfter{,} @Or @bnfter{;}}

@producname{binop}@producbody{
    @bnfter{+} @Or @bnfter{-} @Or @bnfter{*} @Or @bnfter{/} @Or @bnfter{//}
    @Or @bnfter{^} @Or @bnfter{%}
    @OrNL
@bnfter{&} @Or @bnfter{~} @Or @bnfter{|} @Or @bnfter{>>} @Or @bnfter{<<}
    @Or @bnfter{..}
    @OrNL
@bnfter{<} @Or @bnfter{<=} @Or @bnfter{>} @Or @bnfter{>=}
    @Or @bnfter{==} @Or @bnfter{~=}
    @OrNL
    @Rw{and} @Or @Rw{or}}

@producname{unop}@producbody{@bnfter{-} @Or @Rw{not} @Or @bnfter{#} @Or
@bnfter{~}}

```



}

}

@C{ }=====}

}

@C{ }-----}

Found

in path(s):

\* /lua-5-4-7-1-tar-gz/lua-5.4.7/manual/manual.of

No license file was found, but licenses were detected in source scan.

/\*\*\*\*\*

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Found in path(s):

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*****
]]

```

Found in path(s):

```
* /lua-5-4-7-1-tar-gz/lua-5.4.7/testes/all.lua
```

No license file was found, but licenses were detected in source scan.

```
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```

```
header = string.gsub(header, "All rights reserved",
```

Found in path(s):

```
* /lua-5-4-7-1-tar-gz/lua-5.4.7/manual/2html
```

## 1.205 python-certifi 2024.08.30

### 1.205.1 Available under license :

This package contains a modified version of ca-bundle.crt:

```
ca-bundle.crt -- Bundle of CA Root Certificates
```

This is a bundle of X.509 certificates of public Certificate Authorities (CA). These were automatically extracted from Mozilla's root certificates file (certdata.txt). This file can be found in the mozilla source tree:

```
https://hg.mozilla.org/mozilla-central/file/tip/security/nss/lib/ckfw/builtins/certdata.txt
```

It contains the certificates in PEM format and therefore can be directly used with curl / libcurl / php\_curl, or with an Apache+mod\_ssl webserver for SSL client authentication. Just configure this file as the SSLCACertificateFile.#

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@(#) \$RCSfile: certdata.txt,v \$ \$Revision: 1.80 \$ \$Date: 2011/11/03 15:11:58 \$

# 1.206 dhcping 1.2-r3

## 1.206.1 Available under license :

Non Maintainer Upload of this Package

-----

If you plan to work on an NMU for this package, read the following closely. It can save you and me some grief.

1. At first, contact the maintainer (i.e. send a mail to [joey@debian.org](mailto:joey@debian.org), do not cc or bounce a mail, send a plain mail, not copied to any mailing list or the BTS) and ask about the status of the bug you are considering to work on.
2. In this mail include all information relevant for this problem, i.e. include a description of the bug and not only its bug number.
3. If the maintainer is not able or willing to fix the problem or does not respond within four days, continue with step 4.
4. Work on the bug and prepare a patch. Do not upload into the Debian archive.
5. Send the entire patch, together with enough explanations, to the maintainer for reviewing and ask him for permission of an NMU using this patch.
6. IF AND ONLY IF the maintainer approves the patch (or doesn't respond within four days), upload the NMU to the incoming directory and send the patch to the BTS. If the NMU is not approved, go back to 4. or add the NMU to your homepage, but do not upload it to the Debian archive.
7. Properly sized and well-written patches sent to the BTS are always appreciated, even if they are rejected later. They demonstrate a potential solution which could probably improved into a real solution.

8. NEVER change the way a package is maintainer in an NMU, i.e. don't remove dh\_\* stuff or switch to dh\_\* respectively. This rule applies to all NMU's, not only to an NMU for this package.

These rules always apply. They even apply if somebody declares NMUs as ok and reduces regular NMU rules to a delay of zero days. Unless I'm on vacation or on a show I am reachable via mail, so there is hardly a reason not to contact me.

This is the Debian GNU prepackaged version of dhcpping, an administrative tool for finding out if a DHCP server is still up and running.

The source of the Debian package is managed through CVS. It is publically available at <<http://cvs.infodrom.org/dhcpping/?cvsroot=debian>> or as <:pserver:anonymous@cvs.infodrom.org/var/cvs/debian/dhcpping/>.

This package was put together by Martin Schulze <[joey@debian.org](mailto:joey@debian.org)>, from sources obtained from:

<http://www.mavetju.org/download/dhcpping-1.2.tar.gz>

dhcpping has been released under the BSD license as quoted below.

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# 1.207 pcre2 10.43-r0

## 1.207.1 Available under license :

### PCRE2 LICENCE

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End

PCRE2 LICENCE

-----

PCRE2 is a library of functions to support regular expressions whose syntax and semantics are as close as possible to those of the Perl 5 language.

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The basic library functions are written in C and are freestanding. Also included in the distribution is a just-in-time compiler that can be used to optimize pattern matching. This is an optional feature that can be omitted when the library is built.

### THE BASIC LIBRARY FUNCTIONS

-----

Written by: Philip Hazel  
Email local part: Philip.Hazel  
Email domain: gmail.com

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Written by: Zoltan Herczeg  
Email local part: hzmester

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# 1.208 tomli 2.0.1

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## 1.209 py3-pip 24.3.1-r0

### 1.209.1 Available under license :

#### A. HISTORY OF THE SOFTWARE

=====

Python was created in the early 1990s by Guido van Rossum at Stichting Mathematisch Centrum (CWI, see <http://www.cwi.nl>) in the Netherlands as a successor of a language called ABC. Guido remains Python's principal author, although it includes many contributions from others.

In 1995, Guido continued his work on Python at the Corporation for National Research Initiatives (CNRI, see <http://www.cnri.reston.va.us>) in Reston, Virginia where he released several versions of the software.

In May 2000, Guido and the Python core development team moved to BeOpen.com to form the BeOpen PythonLabs team. In October of the same year, the PythonLabs team moved to Digital Creations (now Zope Corporation, see <http://www.zope.com>). In 2001, the Python Software Foundation (PSF, see <http://www.python.org/psf/>) was formed, a non-profit organization created specifically to own Python-related Intellectual Property. Zope Corporation is a sponsoring member of the PSF.

All Python releases are Open Source (see <http://www.opensource.org> for the Open Source Definition). Historically, most, but not all, Python releases have also been GPL-compatible; the table below summarizes the various releases.

| Release        | Derived from | Year      | Owner      | GPL-compatible? (1) |
|----------------|--------------|-----------|------------|---------------------|
| 0.9.0 thru 1.2 |              | 1991-1995 | CWI        | yes                 |
| 1.3 thru 1.5.2 | 1.2          | 1995-1999 | CNRI       | yes                 |
| 1.6            | 1.5.2        | 2000      | CNRI       | no                  |
| 2.0            | 1.6          | 2000      | BeOpen.com | no                  |
| 1.6.1          | 1.6          | 2001      | CNRI       | yes (2)             |
| 2.1            | 2.0+1.6.1    | 2001      | PSF        | no                  |
| 2.0.1          | 2.0+1.6.1    | 2001      | PSF        | yes                 |
| 2.1.1          | 2.1+2.0.1    | 2001      | PSF        | yes                 |
| 2.2            | 2.1.1        | 2001      | PSF        | yes                 |
| 2.1.2          | 2.1.1        | 2002      | PSF        | yes                 |
| 2.1.3          |              |           |            |                     |
| 2.1.2          | 2002         | PSF       | yes        |                     |
| 2.2.1          | 2.2          | 2002      | PSF        | yes                 |
| 2.2.2          | 2.2.1        | 2002      | PSF        | yes                 |
| 2.2.3          | 2.2.2        | 2003      | PSF        | yes                 |
| 2.3            | 2.2.2        | 2002-2003 | PSF        | yes                 |
| 2.3.1          | 2.3          | 2002-2003 | PSF        | yes                 |
| 2.3.2          | 2.3.1        | 2002-2003 | PSF        | yes                 |
| 2.3.3          | 2.3.2        | 2002-2003 | PSF        | yes                 |
| 2.3.4          | 2.3.3        | 2004      | PSF        | yes                 |
| 2.3.5          | 2.3.4        | 2005      | PSF        | yes                 |
| 2.4            | 2.3          | 2004      | PSF        | yes                 |
| 2.4.1          | 2.4          | 2005      | PSF        | yes                 |
| 2.4.2          | 2.4.1        | 2005      | PSF        | yes                 |

|       |       |      |     |     |
|-------|-------|------|-----|-----|
| 2.4.3 | 2.4.2 | 2006 | PSF | yes |
| 2.4.4 | 2.4.3 | 2006 | PSF | yes |
| 2.5   | 2.4   | 2006 | PSF | yes |
| 2.5.1 | 2.5   | 2007 | PSF | yes |
| 2.5.2 | 2.5.1 | 2008 | PSF | yes |
| 2.5.3 | 2.5.2 | 2008 | PSF | yes |
| 2.6   | 2.5   | 2008 | PSF | yes |
| 2.6.1 | 2.6   | 2008 | PSF | yes |
| 2.6.2 | 2.6.1 | 2009 | PSF | yes |
| 2.6.3 | 2.6.2 | 2009 | PSF | yes |
| 2.6.4 | 2.6.3 | 2009 | PSF | yes |
| 2.6.5 | 2.6.4 | 2010 | PSF | yes |
| 3.0   | 2.6   | 2008 | PSF | yes |
| 3.0.1 | 3.0   | 2009 | PSF | yes |
| 3.1   | 3.0.1 | 2009 | PSF | yes |
| 3.1.1 | 3.1   | 2009 | PSF | yes |
| 3.1.2 | 3.1   | 2010 | PSF | yes |
| 3.2   | 3.1   | 2010 | PSF | yes |

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A. HISTORY OF THE SOFTWARE

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Python was created in the early 1990s by Guido van Rossum at Stichting Mathematisch Centrum (CWI, see <https://www.cwi.nl>) in the Netherlands as a successor of a language called ABC. Guido remains Python's principal author, although it includes many contributions from others.

In 1995, Guido continued his work on Python at the Corporation for National Research Initiatives (CNRI, see <https://www.cnri.reston.va.us>) in Reston, Virginia where he released several versions of the software.

In May 2000, Guido and the Python core development team moved to BeOpen.com to form the BeOpen PythonLabs team. In October of the same year, the PythonLabs team moved to Digital Creations, which became Zope Corporation. In 2001, the Python Software Foundation (PSF, see <https://www.python.org/psf/>) was formed, a non-profit organization created specifically to own Python-related Intellectual Property. Zope Corporation was a sponsoring member of the PSF.

All

Python releases are Open Source (see <https://opensource.org> for the Open Source Definition). Historically, most, but not all, Python releases have also been GPL-compatible; the table below summarizes the various releases.

| Release        | Derived from | Year      | Owner      | GPL-compatible? (1) |
|----------------|--------------|-----------|------------|---------------------|
| 0.9.0 thru 1.2 |              | 1991-1995 | CWI        | yes                 |
| 1.3 thru 1.5.2 | 1.2          | 1995-1999 | CNRI       | yes                 |
| 1.6            | 1.5.2        | 2000      | CNRI       | no                  |
| 2.0            | 1.6          | 2000      | BeOpen.com | no                  |
| 1.6.1          | 1.6          | 2001      | CNRI       | yes (2)             |
| 2.1            | 2.0+1.6.1    | 2001      | PSF        | no                  |
| 2.0.1          | 2.0+1.6.1    | 2001      | PSF        | yes                 |
| 2.1.1          | 2.1+2.0.1    | 2001      | PSF        | yes                 |
| 2.1.2          | 2.1.1        | 2002      | PSF        | yes                 |
| 2.1.3          | 2.1.2        | 2002      | PSF        | yes                 |
| 2.2 and above  | 2.1.1        | 2001-now  |            |                     |
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## 1.211 libmd 1.1.0-r0

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Authors:

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## 1.214 tomli 2.2.1

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Ty Coon, President of Vice
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# 1.216 mpdecimal 4.0.0-r0

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# 1.219 fdisk 2.40.4

## 1.219.1 Available under license :

```
NR  START  END  SECTORS  SIZE  NAME  UUID
1   32  7679   7648 3.7M   8f8378c0-01
2  7680 16383   8704 4.3M   8f8378c0-02
5  7936 12799   4864 2.4M
6 12544 16127   3584 1.8M
```

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(For example, a function in a library to compute square roots has a purpose that is entirely well-defined independent of the application. Therefore, Subsection 2d requires that any application-supplied function or table used by this function must be optional: if the application does not supply it, the square root function must still compute square roots.)

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## 1.220 pyparsing 3.1.4

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Version 3, 29 June 2007

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## 1.224 fstrm 0.6.1-r4

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## 1.225 llvm 18.1.8-r2

### 1.225.1 Available under license :

; NOTE: Assertions have been autogenerated by utils/update\_llc\_test\_checks.py  
; RUN: llc < %s -mtriple=aarch64-- | FileCheck %s

; A shuffle mask with all undef elements is always legal.

```
define <4 x i32> @PR41535(<2 x i32> %p1, <2 x i32> %p2) {  
; CHECK-LABEL: PR41535:  
; CHECK:      // %bb.0:  
; CHECK-NEXT:  ext v0.8b, v0.8b, v1.8b, #4  
; CHECK-NEXT:  mov v0.d[1], v0.d[0]  
; CHECK-NEXT:  ret  
%cat1 = shufflevector <2 x i32> %p1, <2 x i32> undef, <4 x i32> <i32 undef, i32 1, i32 undef, i32 undef>  
%cat2 = shufflevector <2 x i32> %p2, <2 x i32> undef, <4 x i32> <i32 0, i32 undef, i32 undef, i32 undef>  
%r = shufflevector <4 x i32> %cat1, <4 x i32> %cat2, <4 x i32> <i32 undef, i32 undef, i32 1, i32 4>  
ret <4 x i32> %r  
}  
# RUN: llc -O0 -mtriple=m68k -start-after=prologuepillog -verify-machineinstrs %s -o - | FileCheck %s
```

name: is-pcrel-register-operand-legal

body: |

bb.0.entry:

```
; CHECK: move.l (0,%pc,%a0), (%a1)  
; CHECK: move.l (%a0), (0,%pc,%a1)
```

MOV32jk \$a1, 0, \$a0, implicit-def \$ccr

MOV32kj 0, \$a1, \$a0, implicit-def \$ccr

; NOTE: Assertions have been autogenerated by utils/update\_llc\_test\_checks.py

; RUN: llc -mtriple=amdgcn -mcpu=fiji < %s | FileCheck -enable-var-scope --check-prefixes=GCN,GCN-SAFE,VI,VI-SAFE %s

; RUN: llc -enable-no-signed-zeros-fp-math -mtriple=amdgcn -mcpu=fiji < %s | FileCheck -enable-var-scope --check-prefixes=GCN,GCN-NSZ,VI,VI-NSZ %s

```
; -----  
; rcp tests  
; -----
```

```
define half @v_fneg_rcp_f16(half %a) #0 {  
; GCN-LABEL: v_fneg_rcp_f16:  
; GCN:      ; %bb.0:  
; GCN-NEXT:  s_waitcnt vmcnt(0) expcnt(0) lgkmcnt(0)
```

```

; GCN-NEXT:  v_rcp_f16_e64 v0, -v0
; GCN-NEXT:  s_setpc_b64 s[30:31]
%rcp = call half @llvm.amdgcn.rcp.f16(half %a)
%fneg = fneg half %rcp
ret half %fneg
}

define half @v_fneg_rcp_fneg_f16(half %a) #0 {
; GCN-LABEL: v_fneg_rcp_fneg_f16:
; GCN:      ; %bb.0:
; GCN-NEXT:  s_waitcnt vmcnt(0) expcnt(0) lgkmcnt(0)
; GCN-NEXT:
    v_rcp_f16_e32 v0, v0
; GCN-NEXT:  s_setpc_b64 s[30:31]
%fneg.a = fneg half %a
%rcp = call half @llvm.amdgcn.rcp.f16(half %fneg.a)
%fneg = fneg half %rcp
ret half %fneg
}

define { half, half } @v_fneg_rcp_store_use_fneg_f16(half %a) #0 {
; GCN-LABEL: v_fneg_rcp_store_use_fneg_f16:
; GCN:      ; %bb.0:
; GCN-NEXT:  s_waitcnt vmcnt(0) expcnt(0) lgkmcnt(0)
; GCN-NEXT:  v_rcp_f16_e32 v2, v0
; GCN-NEXT:  v_xor_b32_e32 v1, 0x8000, v0
; GCN-NEXT:  v_mov_b32_e32 v0, v2
; GCN-NEXT:  s_setpc_b64 s[30:31]
%fneg.a = fneg half %a
%rcp = call half @llvm.amdgcn.rcp.f16(half %fneg.a)
%fneg = fneg half %rcp
%insert.0 = insertvalue { half, half } poison, half %fneg, 0
%insert.1 = insertvalue { half, half } %insert.0, half %fneg.a, 1
ret { half, half } %insert.1
}

define { half, half } @v_fneg_rcp_multi_use_fneg_f16(half %a, half %c) #0 {
; GCN-LABEL: v_fneg_rcp_multi_use_fneg_f16:
; GCN:      ; %bb.0:
; GCN-NEXT:  s_waitcnt vmcnt(0) expcnt(0) lgkmcnt(0)
; GCN-NEXT:
    v_rcp_f16_e32 v2, v0
; GCN-NEXT:  v_mul_f16_e64 v1, -v0, v1
; GCN-NEXT:  v_mov_b32_e32 v0, v2
; GCN-NEXT:  s_setpc_b64 s[30:31]
%fneg.a = fneg half %a
%rcp = call half @llvm.amdgcn.rcp.f16(half %fneg.a)
%fneg = fneg half %rcp

```

```

%use1 = fmul half %fneg.a, %c
%insert.0 = insertvalue { half, half } poison, half %fneg, 0
%insert.1 = insertvalue { half, half } %insert.0, half %use1, 1
ret { half, half } %insert.1
}

; -----
; sin tests
; -----

define half @v_fneg_amdgc_n_sin_f16(half %a) #0 {
; GCN-LABEL: v_fneg_amdgc_n_sin_f16:
; GCN:      ; %bb.0:
; GCN-NEXT:  s_waitcnt vmcnt(0) expcnt(0) lgkmcnt(0)
; GCN-NEXT:  v_sin_f16_e64 v0, -v0
; GCN-NEXT:  s_setpc_b64 s[30:31]
%sin = call half @llvm.amdgc_n.sin.f16(half %a)
%fneg = fneg half %sin
ret half %fneg
}

; -----
;
; vinterp tests
; -----

define { float, float } @v_fneg_interp_p1_f16(float %a, float %b) #0 {
; GCN-LABEL: v_fneg_interp_p1_f16:
; GCN:      ; %bb.0:
; GCN-NEXT:  s_waitcnt vmcnt(0) expcnt(0) lgkmcnt(0)
; GCN-NEXT:  v_mul_f32_e64 v1, v0, -v1
; GCN-NEXT:  s_mov_b32 m0, 0
; GCN-NEXT:  s_setreg_imm32_b32 hwreg(HW_REG_MODE, 2, 2), 3
; GCN-NEXT:  v_interp_p1ll_f16 v0, v1, attr0.x
; GCN-NEXT:  v_interp_p1ll_f16 v1, v1, attr0.y
; GCN-NEXT:  s_setpc_b64 s[30:31]
%mul = fmul float %a, %b
%fneg = fneg float %mul
%interp0 = call float @llvm.amdgc_n.interp.p1.f16(float %fneg, i32 0, i32 0, i1 false, i32 0)
%interp1 = call float @llvm.amdgc_n.interp.p1.f16(float %fneg, i32 1, i32 0, i1 false, i32 0)
%insert.0 = insertvalue { float, float } poison, float %interp0, 0
%insert.1 = insertvalue { float, float } %insert.0, float %interp1, 1
ret { float, float } %insert.1
}

define
{ half, half } @v_fneg_interp_p2_f16(float %a, float %b) #0 {
; GCN-LABEL: v_fneg_interp_p2_f16:

```

```

; GCN:      ; %bb.0:
; GCN-NEXT:  s_waitcnt vmcnt(0) expcnt(0) lgkmcnt(0)
; GCN-NEXT:  v_mul_f32_e64 v1, v0, -v1
; GCN-NEXT:  v_mov_b32_e32 v2, 4.0
; GCN-NEXT:  s_mov_b32 m0, 0
; GCN-NEXT:  s_setreg_imm32_b32 hwreg(HW_REG_MODE, 2, 2), 3
; GCN-NEXT:  v_interp_p2_f16 v0, v1, attr0.x, v2
; GCN-NEXT:  v_interp_p2_f16 v1, v1, attr0.y, v2
; GCN-NEXT:  s_setpc_b64 s[30:31]
%mul = fmul float %a, %b
%fneg = fneg float %mul
%intrap0 = call half @llvm.amdgcn.interp.p2.f16(float 4.0, float %fneg, i32 0, i32 0, i1 false, i32 0)
%intrap1 = call half @llvm.amdgcn.interp.p2.f16(float 4.0, float %fneg, i32 1, i32 0, i1 false, i32 0)
%insert.0 = insertvalue { half, half } poison, half %intrap0, 0
%insert.1 = insertvalue { half, half } %insert.0, half %intrap1, 1
ret { half, half } %insert.1
}

```

```

; -----
;
; arithmetic.fence tests
; -----

```

```

; FIXME: Legalization/promote is broken
define half @v_fneg_arithmetic_fence_f16(half %a) #0 {
; GCN-LABEL: v_fneg_arithmetic_fence_f16:
; GCN:      ; %bb.0:
; GCN-NEXT:  ; ARITH_FENCE
; GCN-NEXT:  s_waitcnt vmcnt(0) expcnt(0) lgkmcnt(0)
; GCN-NEXT:  v_xor_b32_e32 v0, 0x8000, v0
; GCN-NEXT:  s_setpc_b64 s[30:31]
%fence = call half @llvm.arithmetic.fence.f16(half %a)
%fneg = fneg half %fence
ret half %fneg
}

```

```

define half @v_fneg_arithmetic_fence_fmuls_f16(half %a, half %b) #0 {
; GCN-LABEL: v_fneg_arithmetic_fence_fmuls_f16:
; GCN:      ; %bb.0:
; GCN-NEXT:  s_waitcnt vmcnt(0) expcnt(0) lgkmcnt(0)
; GCN-NEXT:  v_mul_f16_e32 v0, v0, v1
; GCN-NEXT:  ; ARITH_FENCE
; GCN-NEXT:  v_xor_b32_e32 v0, 0x8000, v0
; GCN-NEXT:  s_setpc_b64 s[30:31]
%mul = fmul half %a, %b
%fence = call half @llvm.arithmetic.fence.f16(half %mul)
%fneg = fneg half %fence
ret half

```



```

%fneg
}

declare half @llvm.amdgcn.rcp.f16(half) #1
declare half @llvm.amdgcn.sin.f16(half) #1
declare half @llvm.arithmetic.fence.f16(half) #1
declare float @llvm.amdgcn.interp.p1.f16(float, i32, i32, i1, i32) #0
declare half @llvm.amdgcn.interp.p2.f16(float, float, i32, i32, i1, i32) #0

attributes #0 = { nounwind "denormal-fp-math-f32"="preserve-sign,preserve-sign" }
attributes #1 = { nounwind readnone }
attributes #2 = { nounwind "unsafe-fp-math"="true" }
attributes #3 = { nounwind "no-signed-zeros-fp-math"="true" }
attributes #4 = { nounwind "amdgpu-ieee"="false" "denormal-fp-math-f32"="preserve-sign,preserve-sign" }
;; NOTE: These prefixes are unused and the list is autogenerated. Do not add tests below this line:
; GCN-NSZ: {{.*}}
; GCN-SAFE: {{.*}}
; VI: {{.*}}
; VI-NSZ: {{.*}}
; VI-SAFE: {{.*}}
; NOTE: Assertions have been autogenerated by utils/update_test_checks.py UTC_ARGS: --function-signature --
check-attributes --check-globals
; RUN: opt -aa-pipeline=basic-aa -passes=attributor -attributor-manifest-internal -attributor-annotate-decl-cs -S <
%s | FileCheck %s --check-prefixes=CHECK,TUNIT
; RUN: opt -aa-pipeline=basic-aa -passes=attributor-cgscs -attributor-manifest-internal -attributor-annotate-decl-cs -
S < %s | FileCheck %s --check-prefixes=CHECK,CGSCC
; Test that we only promote arguments when the caller/callee have compatible
; function attributes.

target triple = "x86_64-unknown-linux-gnu"

; This should promote
define internal fastcc void @callee_avx512_legal512_prefer512_call_avx512_legal512_prefer512(ptr %arg, ptr
readonly %arg1) #0 {
;
; CHECK: Function Attrs: inlinehint mustprogress norecurse nosync nounwind willreturn memory(argmem:
readwrite) uwtable
; CHECK-LABEL: define {{^@+}}@callee_avx512_legal512_prefer512_call_avx512_legal512_prefer512
; CHECK-SAME:
(ptr noalias nocapture norecurse noundef nonnull writeonly align 64 dereferenceable(64) [[ARG:%.*]], <8 x i64>
[[TMP0:%.*]]) #[[ATTR0:[0-9]+]] {
; CHECK-NEXT: bb:
; CHECK-NEXT: [[ARG1_PRIV:%.*]] = alloca <8 x i64>, align 64
; CHECK-NEXT: store <8 x i64> [[TMP0]], ptr [[ARG1_PRIV]], align 64
; CHECK-NEXT: [[TMP:%.*]] = load <8 x i64>, ptr [[ARG1_PRIV]], align 64
; CHECK-NEXT: store <8 x i64> [[TMP]], ptr [[ARG]], align 64
; CHECK-NEXT: ret void
;

```

```

bb:
    %tmp = load <8 x i64>, ptr %arg1
    store <8 x i64> %tmp, ptr %arg
    ret void
}

define void @avx512_legal512_prefer512_call_avx512_legal512_prefer512(ptr %arg) #0 {
;
; TUNIT: Function Attrs: inlinehint mustprogress norecurse nosync nounwind willreturn memory(argmem:
readwrite) uwtable
; TUNIT-LABEL: define { { (^@)+ } } @avx512_legal512_prefer512_call_avx512_legal512_prefer512
; TUNIT-SAME: (ptr nocapture norecurse writeonly [[ARG:%.*]]) # [[ATTR0]] {
; TUNIT-NEXT: bb:
; TUNIT-NEXT: [[TMP:%.*]] = alloca <8 x i64>, align
32
; TUNIT-NEXT: [[TRUETMP2:%.*]] = alloca <8 x i64>, align 32
; TUNIT-NEXT: call void @llvm.memset.p0.i64(ptr noalias nocapture norecurse noundef nonnull writeonly align 32
dereferenceable(64) [[TMP]], i8 noundef 0, i64 noundef 32, i1 noundef false) # [[ATTR5:[0-9]+]]
; TUNIT-NEXT: [[TMP0:%.*]] = load <8 x i64>, ptr [[TMP]], align 64
; TUNIT-NEXT: call fastcc void @callee_avx512_legal512_prefer512_call_avx512_legal512_prefer512(ptr
noalias nocapture norecurse noundef nonnull writeonly align 64 dereferenceable(64) [[TRUETMP2]], <8 x i64>
[[TMP0]]) # [[ATTR6:[0-9]+]]
; TUNIT-NEXT: [[TRUETMP4:%.*]] = load <8 x i64>, ptr [[TRUETMP2]], align 64
; TUNIT-NEXT: store <8 x i64> [[TRUETMP4]], ptr [[ARG]], align 2
; TUNIT-NEXT: ret void
;
; CGSCC: Function Attrs: inlinehint mustprogress norecurse nosync nounwind willreturn memory(argmem:
readwrite) uwtable
; CGSCC-LABEL: define { { (^@)+ } } @avx512_legal512_prefer512_call_avx512_legal512_prefer512
; CGSCC-SAME: (ptr nocapture
norecurse noundef nonnull writeonly align 2 dereferenceable(64) [[ARG:%.*]]) # [[ATTR0]] {
; CGSCC-NEXT: bb:
; CGSCC-NEXT: [[TMP:%.*]] = alloca <8 x i64>, align 32
; CGSCC-NEXT: [[TRUETMP2:%.*]] = alloca <8 x i64>, align 32
; CGSCC-NEXT: call void @llvm.memset.p0.i64(ptr noalias nocapture norecurse noundef nonnull writeonly align 64
dereferenceable(64) [[TMP]], i8 noundef 0, i64 noundef 32, i1 noundef false) # [[ATTR5:[0-9]+]]
; CGSCC-NEXT: [[TMP0:%.*]] = load <8 x i64>, ptr [[TMP]], align 64
; CGSCC-NEXT: call fastcc void @callee_avx512_legal512_prefer512_call_avx512_legal512_prefer512(ptr
noalias nocapture norecurse noundef nonnull writeonly align 64 dereferenceable(64) [[TRUETMP2]], <8 x i64>
[[TMP0]]) # [[ATTR6:[0-9]+]]
; CGSCC-NEXT: [[TRUETMP4:%.*]] = load <8 x i64>, ptr [[TRUETMP2]], align 64
; CGSCC-NEXT: store <8 x i64> [[TRUETMP4]], ptr [[ARG]], align 2
; CGSCC-NEXT: ret void
;
bb:
    %tmp = alloca <8 x i64>, align 32
    %tmp2 = alloca <8 x i64>, align 32
    call void

```

```

@llvm.memset.p0.i64(ptr align 32 %tmp, i8 0, i64 32, i1 false)
call fastcc void @callee_avx512_legal512_prefer512_call_avx512_legal512_prefer512(ptr %tmp2, ptr %tmp)
%tmp4 = load <8 x i64>, ptr %tmp2, align 32
store <8 x i64> %tmp4, ptr %arg, align 2
ret void
}

; This should promote
define internal fastcc void @callee_avx512_legal512_prefer256_call_avx512_legal512_prefer256(ptr %arg, ptr
readonly %arg1) #1 {
;
; CHECK: Function Attrs: inlinehint mustprogress nofree norecurse nosync nounwind willreturn memory(argmem:
readwrite) uwtable
; CHECK-LABEL: define {{{^@}+}}@callee_avx512_legal512_prefer256_call_avx512_legal512_prefer256
; CHECK-SAME: (ptr noalias nocapture nofree noundef nonnull writeonly align 64 dereferenceable(64)
[[ARG:%.*]], <8 x i64> [[TMP0:%.*]]) #[[ATTR1:[0-9]+]] {
; CHECK-NEXT: bb:
; CHECK-NEXT: [[ARG1_PRIV:%.*]] = alloca <8 x i64>, align 64
; CHECK-NEXT: store <8 x i64> [[TMP0]], ptr [[ARG1_PRIV]], align 64
; CHECK-NEXT: [[TMP:%.*]] = load <8 x
i64>, ptr [[ARG1_PRIV]], align 64
; CHECK-NEXT: store <8 x i64> [[TMP]], ptr [[ARG]], align 64
; CHECK-NEXT: ret void
;
bb:
%tmp = load <8 x i64>, ptr %arg1
store <8 x i64> %tmp, ptr %arg
ret void
}

define void @avx512_legal512_prefer256_call_avx512_legal512_prefer256(ptr %arg) #1 {
;
; TUNIT: Function Attrs: inlinehint mustprogress nofree norecurse nosync nounwind willreturn memory(argmem:
readwrite) uwtable
; TUNIT-LABEL: define {{{^@}+}}@avx512_legal512_prefer256_call_avx512_legal512_prefer256
; TUNIT-SAME: (ptr nocapture nofree writeonly [[ARG:%.*]]) #[[ATTR1]] {
; TUNIT-NEXT: bb:
; TUNIT-NEXT: [[TMP:%.*]] = alloca <8 x i64>, align 32
; TUNIT-NEXT: [[TRUETMP2:%.*]] = alloca <8 x i64>, align 32
; TUNIT-NEXT: call void @llvm.memset.p0.i64(ptr noalias nocapture nofree noundef nonnull writeonly align 32
dereferenceable(64) [[TMP]], i8 noundef 0, i64 noundef 32, i1 noundef false) #[[ATTR5]]
; TUNIT-NEXT: [[TMP0:%.*]] = load <8 x i64>, ptr [[TMP]], align 64
; TUNIT-NEXT:
call fastcc void @callee_avx512_legal512_prefer256_call_avx512_legal512_prefer256(ptr noalias nocapture
nofree noundef nonnull writeonly align 64 dereferenceable(64) [[TRUETMP2]], <8 x i64> [[TMP0]]) #[[ATTR6]]
; TUNIT-NEXT: [[TRUETMP4:%.*]] = load <8 x i64>, ptr [[TRUETMP2]], align 64
; TUNIT-NEXT: store <8 x i64> [[TRUETMP4]], ptr [[ARG]], align 2
; TUNIT-NEXT: ret void

```

```

;
; CGSCC: Function Attrs: inlinehint mustprogress norecurse nosync nounwind willreturn memory(argmem:
readwrite) uwtable
; CGSCC-LABEL: define {{{^@}+}}@avx512_legal512_prefer256_call_avx512_legal512_prefer256
; CGSCC-SAME: (ptr nocapture norecurse noundef nonnull writeonly align 2 dereferenceable(64) [[ARG:%.*]])
#[[ATTR1]] {
; CGSCC-NEXT: bb:
; CGSCC-NEXT: [[TMP:%.*]] = alloca <8 x i64>, align 32
; CGSCC-NEXT: [[TRUETMP2:%.*]] = alloca <8 x i64>, align 32
; CGSCC-NEXT: call void @llvm.memset.p0.i64(ptr noalias nocapture norecurse noundef nonnull writeonly align 64
dereferenceable(64)
[[TMP]], i8 noundef 0, i64 noundef 32, i1 noundef false) #[[ATTR5]]
; CGSCC-NEXT: [[TMP0:%.*]] = load <8 x i64>, ptr [[TMP]], align 64
; CGSCC-NEXT: call fastcc void @callee_avx512_legal512_prefer256_call_avx512_legal512_prefer256(ptr
noalias nocapture norecurse noundef nonnull writeonly align 64 dereferenceable(64) [[TRUETMP2]], <8 x i64>
[[TMP0]]) #[[ATTR6]]
; CGSCC-NEXT: [[TRUETMP4:%.*]] = load <8 x i64>, ptr [[TRUETMP2]], align 64
; CGSCC-NEXT: store <8 x i64> [[TRUETMP4]], ptr [[ARG]], align 2
; CGSCC-NEXT: ret void
;
bb:
%tmp = alloca <8 x i64>, align 32
%tmp2 = alloca <8 x i64>, align 32
call void @llvm.memset.p0.i64(ptr align 32 %tmp, i8 0, i64 32, i1 false)
call fastcc void @callee_avx512_legal512_prefer256_call_avx512_legal512_prefer256(ptr %tmp2, ptr %tmp)
%tmp4 = load <8 x i64>, ptr %tmp2, align 32
store <8 x i64> %tmp4, ptr %arg, align 2
ret void
}

; This should promote
define internal fastcc void @callee_avx512_legal512_prefer512_call_avx512_legal512_prefer256(
%arg, ptr readonly %arg1) #1 {
;
; CHECK: Function Attrs: inlinehint mustprogress norecurse nosync nounwind willreturn memory(argmem:
readwrite) uwtable
; CHECK-LABEL: define {{{^@}+}}@callee_avx512_legal512_prefer512_call_avx512_legal512_prefer256
; CHECK-SAME: (ptr noalias nocapture norecurse noundef nonnull writeonly align 64 dereferenceable(64)
[[ARG:%.*]], <8 x i64> [[TMP0:%.*]]) #[[ATTR1]] {
; CHECK-NEXT: bb:
; CHECK-NEXT: [[ARG1_PRIV:%.*]] = alloca <8 x i64>, align 64
; CHECK-NEXT: store <8 x i64> [[TMP0]], ptr [[ARG1_PRIV]], align 64
; CHECK-NEXT: [[TMP:%.*]] = load <8 x i64>, ptr [[ARG1_PRIV]], align 64
; CHECK-NEXT: store <8 x i64> [[TMP]], ptr [[ARG]], align 64
; CHECK-NEXT: ret void
;
bb:
%tmp = load <8 x i64>, ptr %arg1

```

```

store <8 x i64> %tmp, ptr %arg
ret void
}

define void @avx512_legal512_prefer512_call_avx512_legal512_prefer256(ptr %arg) #0 {
;
; TUNIT: Function Attrs: inlinehint mustprogress norecurse nosync nounwind
; willreturn memory(argmem: readwrite) uwtable
; TUNIT-LABEL: define {{^(^@)+}}@avx512_legal512_prefer512_call_avx512_legal512_prefer256
; TUNIT-SAME: (ptr nocapture norecurse writeonly [[ARG:%.*]]) #[[ATTR0]] {
; TUNIT-NEXT: bb:
; TUNIT-NEXT: [[TMP:%.*]] = alloca <8 x i64>, align 32
; TUNIT-NEXT: [[TRUETMP2:%.*]] = alloca <8 x i64>, align 32
; TUNIT-NEXT: call void @llvm.memset.p0.i64(ptr noalias nocapture norecurse noundef nonnull writeonly align 32
dereferenceable(64) [[TMP]], i8 noundef 0, i64 noundef 32, i1 noundef false) #[[ATTR5]]
; TUNIT-NEXT: [[TMP0:%.*]] = load <8 x i64>, ptr [[TMP]], align 64
; TUNIT-NEXT: call fastcc void @callee_avx512_legal512_prefer512_call_avx512_legal512_prefer256(ptr
noalias nocapture norecurse noundef nonnull writeonly align 64 dereferenceable(64) [[TRUETMP2]], <8 x i64>
[[TMP0]]) #[[ATTR6]]
; TUNIT-NEXT: [[TRUETMP4:%.*]] = load <8 x i64>, ptr [[TRUETMP2]], align 64
; TUNIT-NEXT: store <8 x i64> [[TRUETMP4]], ptr [[ARG]], align 2
; TUNIT-NEXT:
ret void
;
; CGSCC: Function Attrs: inlinehint mustprogress norecurse nosync nounwind willreturn memory(argmem:
readwrite) uwtable
; CGSCC-LABEL: define {{^(^@)+}}@avx512_legal512_prefer512_call_avx512_legal512_prefer256
; CGSCC-SAME: (ptr nocapture norecurse noundef nonnull writeonly align 2 dereferenceable(64) [[ARG:%.*]])
#[[ATTR0]] {
; CGSCC-NEXT: bb:
; CGSCC-NEXT: [[TMP:%.*]] = alloca <8 x i64>, align 32
; CGSCC-NEXT: [[TRUETMP2:%.*]] = alloca <8 x i64>, align 32
; CGSCC-NEXT: call void @llvm.memset.p0.i64(ptr noalias nocapture norecurse noundef nonnull writeonly align 64
dereferenceable(64) [[TMP]], i8 noundef 0, i64 noundef 32, i1 noundef false) #[[ATTR5]]
; CGSCC-NEXT: [[TMP0:%.*]] = load <8 x i64>, ptr [[TMP]], align 64
; CGSCC-NEXT: call fastcc void @callee_avx512_legal512_prefer512_call_avx512_legal512_prefer256(ptr
noalias nocapture norecurse noundef nonnull writeonly align 64 dereferenceable(64) [[TRUETMP2]], <8 x i64>
[[TMP0]]) #[[ATTR6]]
; CGSCC-NEXT:
[[TRUETMP4:%.*]] = load <8 x i64>, ptr [[TRUETMP2]], align 64
; CGSCC-NEXT: store <8 x i64> [[TRUETMP4]], ptr [[ARG]], align 2
; CGSCC-NEXT: ret void
;
bb:
%tmp = alloca <8 x i64>, align 32
%tmp2 = alloca <8 x i64>, align 32
call void @llvm.memset.p0.i64(ptr align 32 %tmp, i8 0, i64 32, i1 false)
call fastcc void @callee_avx512_legal512_prefer512_call_avx512_legal512_prefer256(ptr %tmp2, ptr %tmp)

```

```

%tmp4 = load <8 x i64>, ptr %tmp2, align 32
store <8 x i64> %tmp4, ptr %arg, align 2
ret void
}

; This should promote
define internal fastcc void @callee_avx512_legal512_prefer256_call_avx512_legal512_prefer512(ptr %arg, ptr
readonly %arg1) #0 {
;
; CHECK: Function Attrs: inlinehint mustprogress norecurse nosync nounwind willreturn memory(argmem:
readwrite) uwtable
; CHECK-LABEL: define {{^[^@]+}}@callee_avx512_legal512_prefer256_call_avx512_legal512_prefer512
; CHECK-SAME: (ptr noalias nocapture norecurse noundef nonnull writeonly align 64 dereferenceable(64)
[[ARG:%.*]],
<8 x i64> [[TMP0:%.*]]) #[[ATTR0]] {
; CHECK-NEXT: bb:
; CHECK-NEXT: [[ARG1_PRIV:%.*]] = alloca <8 x i64>, align 64
; CHECK-NEXT: store <8 x i64> [[TMP0]], ptr [[ARG1_PRIV]], align 64
; CHECK-NEXT: [[TMP:%.*]] = load <8 x i64>, ptr [[ARG1_PRIV]], align 64
; CHECK-NEXT: store <8 x i64> [[TMP]], ptr [[ARG]], align 64
; CHECK-NEXT: ret void
;
bb:
%tmp = load <8 x i64>, ptr %arg1
store <8 x i64> %tmp, ptr %arg
ret void
}

define void @avx512_legal512_prefer256_call_avx512_legal512_prefer512(ptr %arg) #1 {
;
; TUNIT: Function Attrs: inlinehint mustprogress norecurse nosync nounwind willreturn memory(argmem:
readwrite) uwtable
; TUNIT-LABEL: define {{^[^@]+}}@avx512_legal512_prefer256_call_avx512_legal512_prefer512
; TUNIT-SAME: (ptr nocapture norecurse writeonly [[ARG:%.*]]) #[[ATTR1]] {
; TUNIT-NEXT: bb:
; TUNIT-NEXT: [[TMP:%.*]] = alloca <8 x i64>, align 32
; TUNIT-NEXT: [[TRUETMP2:%.*]] = alloca <8 x i64>, align 32
; TUNIT-NEXT: call void @llvm.memset.p0.i64(ptr
noalias nocapture norecurse noundef nonnull writeonly align 32 dereferenceable(64) [[TMP]], i8 noundef 0, i64
noundef 32, i1 noundef false) #[[ATTR5]]
; TUNIT-NEXT: [[TMP0:%.*]] = load <8 x i64>, ptr [[TMP]], align 64
; TUNIT-NEXT: call fastcc void @callee_avx512_legal512_prefer256_call_avx512_legal512_prefer512(ptr
noalias nocapture norecurse noundef nonnull writeonly align 64 dereferenceable(64) [[TRUETMP2]], <8 x i64>
[[TMP0]]) #[[ATTR6]]
; TUNIT-NEXT: [[TRUETMP4:%.*]] = load <8 x i64>, ptr [[TRUETMP2]], align 64
; TUNIT-NEXT: store <8 x i64> [[TRUETMP4]], ptr [[ARG]], align 2
; TUNIT-NEXT: ret void
;

```

```

; CGSCC: Function Attrs: inlinehint mustprogress norecurse nosync nounwind willreturn memory(argmem:
readwrite) uwtable
; CGSCC-LABEL: define {{^@}+}@avx512_legal512_prefer256_call_avx512_legal512_prefer512
; CGSCC-SAME: (ptr nocapture norecurse noundef nonnull writeonly align 2 dereferenceable(64) [[ARG:%.*]])
#[[ATTR1]] {
; CGSCC-NEXT: bb:
; CGSCC-NEXT:
    [[TMP:%.*]] = alloca <8 x i64>, align 32
; CGSCC-NEXT:  [[TRUETMP2:%.*]] = alloca <8 x i64>, align 32
; CGSCC-NEXT:  call void @llvm.memset.p0.i64(ptr noalias nocapture norecurse noundef nonnull writeonly align 64
dereferenceable(64) [[TMP]], i8 noundef 0, i64 noundef 32, i1 noundef false) #[[ATTR5]]
; CGSCC-NEXT:  [[TMP0:%.*]] = load <8 x i64>, ptr [[TMP]], align 64
; CGSCC-NEXT:  call fastcc void @callee_avx512_legal512_prefer256_call_avx512_legal512_prefer512(ptr
noalias nocapture norecurse noundef nonnull writeonly align 64 dereferenceable(64) [[TRUETMP2]], <8 x i64>
[[TMP0]]) #[[ATTR6]]
; CGSCC-NEXT:  [[TRUETMP4:%.*]] = load <8 x i64>, ptr [[TRUETMP2]], align 64
; CGSCC-NEXT:  store <8 x i64> [[TRUETMP4]], ptr [[ARG]], align 2
; CGSCC-NEXT:  ret void
;
bb:
    %tmp = alloca <8 x i64>, align 32
    %tmp2 = alloca <8 x i64>, align 32
    call void @llvm.memset.p0.i64(ptr align 32 %tmp, i8 0, i64 32, i1 false)
    call fastcc void @callee_avx512_legal512_prefer256_call_avx512_legal512_prefer512(ptr
    %tmp2, ptr %tmp)
    %tmp4 = load <8 x i64>, ptr %tmp2, align 32
    store <8 x i64> %tmp4, ptr %arg, align 2
    ret void
}

; This should not promote
define internal fastcc void @callee_avx512_legal256_prefer256_call_avx512_legal512_prefer256(ptr %arg, ptr
readonly %arg1) #1 {
;
; CHECK: Function Attrs: inlinehint mustprogress norecurse nosync nounwind willreturn memory(argmem:
readwrite) uwtable
; CHECK-LABEL: define {{^@}+}@callee_avx512_legal256_prefer256_call_avx512_legal512_prefer256
; CHECK-SAME: (ptr noalias nocapture norecurse noundef nonnull writeonly align 64 dereferenceable(64)
[[ARG:%.*]], ptr noalias nocapture norecurse noundef nonnull readonly align 64 dereferenceable(64) [[ARG1:%.*]])
#[[ATTR1]] {
; CHECK-NEXT: bb:
; CHECK-NEXT:  [[TMP:%.*]] = load <8 x i64>, ptr [[ARG1]], align 64
; CHECK-NEXT:  store <8 x i64> [[TMP]], ptr [[ARG]], align 64
; CHECK-NEXT:  ret void
;
bb:
    %tmp = load <8 x i64>, ptr %arg1
    store <8 x i64> %tmp, ptr %arg

```

```

ret void
}

define void @avx512_legal256_prefer256_call_avx512_legal512_prefer256(ptr %arg) #2 {
;
; TUNIT: Function Attrs: inlinehint mustprogress norecurse nosync nounwind willreturn memory(argmem:
readwrite) uwtable
; TUNIT-LABEL: define {{{^@+}}} @avx512_legal256_prefer256_call_avx512_legal512_prefer256
; TUNIT-SAME: (ptr nocapture norecurse writeonly [[ARG:%.*]]) #[[ATTR2:[0-9]+]] {
; TUNIT-NEXT: bb:
; TUNIT-NEXT:  [[TMP:%.*]] = alloca <8 x i64>, align 32
; TUNIT-NEXT:  [[TRUETMP2:%.*]] = alloca <8 x i64>, align 32
; TUNIT-NEXT:  call void @llvm.memset.p0.i64(ptr noalias nocapture norecurse noundef nonnull writeonly align 32
dereferenceable(64) [[TMP]], i8 noundef 0, i64 noundef 32, i1 noundef false) #[[ATTR5]]
; TUNIT-NEXT:  call fastcc void @callee_avx512_legal256_prefer256_call_avx512_legal512_prefer256(ptr
noalias nocapture norecurse noundef nonnull writeonly align 64 dereferenceable(64) [[TRUETMP2]], ptr noalias
nocapture norecurse noundef nonnull readonly align 64 dereferenceable(64)
[[TMP]]) #[[ATTR6]]
; TUNIT-NEXT:  [[TRUETMP4:%.*]] = load <8 x i64>, ptr [[TRUETMP2]], align 64
; TUNIT-NEXT:  store <8 x i64> [[TRUETMP4]], ptr [[ARG]], align 2
; TUNIT-NEXT:  ret void
;
; CGSCC: Function Attrs: inlinehint mustprogress norecurse nosync nounwind willreturn memory(argmem:
readwrite) uwtable
; CGSCC-LABEL: define {{{^@+}}} @avx512_legal256_prefer256_call_avx512_legal512_prefer256
; CGSCC-SAME: (ptr nocapture norecurse noundef nonnull writeonly align 2 dereferenceable(64) [[ARG:%.*]])
#[[ATTR2:[0-9]+]] {
; CGSCC-NEXT: bb:
; CGSCC-NEXT:  [[TMP:%.*]] = alloca <8 x i64>, align 32
; CGSCC-NEXT:  [[TRUETMP2:%.*]] = alloca <8 x i64>, align 32
; CGSCC-NEXT:  call void @llvm.memset.p0.i64(ptr noalias nocapture norecurse noundef nonnull writeonly align 64
dereferenceable(64) [[TMP]], i8 noundef 0, i64 noundef 32, i1 noundef false) #[[ATTR5]]
; CGSCC-NEXT:  call fastcc void @callee_avx512_legal256_prefer256_call_avx512_legal512_prefer256(ptr
noalias
nocapture norecurse noundef nonnull writeonly align 64 dereferenceable(64) [[TRUETMP2]], ptr noalias nocapture
norecurse noundef nonnull readonly align 64 dereferenceable(64) [[TMP]]) #[[ATTR6]]
; CGSCC-NEXT:  [[TRUETMP4:%.*]] = load <8 x i64>, ptr [[TRUETMP2]], align 64
; CGSCC-NEXT:  store <8 x i64> [[TRUETMP4]], ptr [[ARG]], align 2
; CGSCC-NEXT:  ret void
;
bb:
%tmp = alloca <8 x i64>, align 32
%tmp2 = alloca <8 x i64>, align 32
call void @llvm.memset.p0.i64(ptr align 32 %tmp, i8 0, i64 32, i1 false)
call fastcc void @callee_avx512_legal256_prefer256_call_avx512_legal512_prefer256(ptr %tmp2, ptr %tmp)
%tmp4 = load <8 x i64>, ptr %tmp2, align 32
store <8 x i64> %tmp4, ptr %arg, align 2
ret void

```



```

}

; This should not promote
define internal fastcc void @callee_avx512_legal512_prefer256_call_avx512_legal256_prefer256(ptr %arg, ptr
readonly %arg1) #2 {
;
; CHECK: Function Attrs: inlinehint mustprogress norecurse nosync nounwind willreturn memory(argmem:
readwrite) uwtable
;
CHECK-LABEL: define {{^@+}}@callee_avx512_legal512_prefer256_call_avx512_legal256_prefer256
; CHECK-SAME: (ptr noalias nocapture norecurse noundef nonnull writeonly align 64 dereferenceable(64)
[[ARG:%.*]], ptr noalias nocapture norecurse noundef nonnull readonly align 64 dereferenceable(64) [[ARG1:%.*]])
#[[ATTR2:[0-9]+]] {
; CHECK-NEXT: bb:
; CHECK-NEXT: [[TMP:%.*]] = load <8 x i64>, ptr [[ARG1]], align 64
; CHECK-NEXT: store <8 x i64> [[TMP]], ptr [[ARG]], align 64
; CHECK-NEXT: ret void
;
bb:
%tmp = load <8 x i64>, ptr %arg1
store <8 x i64> %tmp, ptr %arg
ret void
}

define void @avx512_legal512_prefer256_call_avx512_legal256_prefer256(ptr %arg) #1 {
;
; TUNIT: Function Attrs: inlinehint mustprogress norecurse nosync nounwind willreturn memory(argmem:
readwrite) uwtable
; TUNIT-LABEL: define {{^@+}}@avx512_legal512_prefer256_call_avx512_legal256_prefer256
; TUNIT-SAME: (ptr nocapture norecurse writeonly [[ARG:%.*]]) #[[ATTR1]] {
; TUNIT-NEXT: bb:
; TUNIT-NEXT:
[[TMP:%.*]] = alloca <8 x i64>, align 32
; TUNIT-NEXT: [[TRUETMP2:%.*]] = alloca <8 x i64>, align 32
; TUNIT-NEXT: call void @llvm.memset.p0.i64(ptr noalias nocapture norecurse noundef nonnull writeonly align 32
dereferenceable(64) [[TMP]], i8 noundef 0, i64 noundef 32, i1 noundef false) #[[ATTR5]]
; TUNIT-NEXT: call fastcc void @callee_avx512_legal512_prefer256_call_avx512_legal256_prefer256(ptr
noalias nocapture norecurse noundef nonnull writeonly align 64 dereferenceable(64) [[TRUETMP2]], ptr noalias
nocapture norecurse noundef nonnull readonly align 64 dereferenceable(64) [[TMP]]) #[[ATTR6]]
; TUNIT-NEXT: [[TRUETMP4:%.*]] = load <8 x i64>, ptr [[TRUETMP2]], align 64
; TUNIT-NEXT: store <8 x i64> [[TRUETMP4]], ptr [[ARG]], align 2
; TUNIT-NEXT: ret void
;
; CGSCC: Function Attrs: inlinehint mustprogress norecurse nosync nounwind willreturn memory(argmem:
readwrite) uwtable
; CGSCC-LABEL: define {{^@+}}@avx512_legal512_prefer256_call_avx512_legal256_prefer256
;

```

```

CGSCC-SAME: (ptr nocapture nofree noundef nonnull writeonly align 2 dereferenceable(64) [[ARG:%.*]])
#[[ATTR1]] {
; CGSCC-NEXT: bb:
; CGSCC-NEXT: [[TMP:%.*]] = alloca <8 x i64>, align 32
; CGSCC-NEXT: [[TRUETMP2:%.*]] = alloca <8 x i64>, align 32
; CGSCC-NEXT: call void @llvm.memset.p0.i64(ptr noalias nocapture nofree noundef nonnull writeonly align 64
dereferenceable(64) [[TMP]], i8 noundef 0, i64 noundef 32, i1 noundef false) #[[ATTR5]]
; CGSCC-NEXT: call fastcc void @callee_avx512_legal512_prefer256_call_avx512_legal256_prefer256(ptr
noalias nocapture nofree noundef nonnull writeonly align 64 dereferenceable(64) [[TRUETMP2]], ptr noalias
nocapture nofree noundef nonnull readonly align 64 dereferenceable(64) [[TMP]]) #[[ATTR6]]
; CGSCC-NEXT: [[TRUETMP4:%.*]] = load <8 x i64>, ptr [[TRUETMP2]], align 64
; CGSCC-NEXT: store <8 x i64> [[TRUETMP4]], ptr [[ARG]], align 2
; CGSCC-NEXT: ret void
;
bb:
%tmp = alloca <8 x i64>, align 32
%tmp2 = alloca <8 x i64>,
align 32
call void @llvm.memset.p0.i64(ptr align 32 %tmp, i8 0, i64 32, i1 false)
call fastcc void @callee_avx512_legal512_prefer256_call_avx512_legal256_prefer256(ptr %tmp2, ptr %tmp)
%tmp4 = load <8 x i64>, ptr %tmp2, align 32
store <8 x i64> %tmp4, ptr %arg, align 2
ret void
}

; This should promote
define internal fastcc void @callee_avx2_legal256_prefer256_call_avx2_legal512_prefer256(ptr %arg, ptr readonly
%arg1) #3 {
;
; CHECK: Function Attrs: inlinehint mustprogress nofree norecurse nosync nounwind willreturn memory(argmem:
readwrite) uwtable
; CHECK-LABEL: define { {^[@]+} } @callee_avx2_legal256_prefer256_call_avx2_legal512_prefer256
; CHECK-SAME: (ptr noalias nocapture nofree noundef nonnull writeonly align 64 dereferenceable(64)
[[ARG:%.*]], <8 x i64> [[TMP0:%.*]]) #[[ATTR3:[0-9]+]] {
; CHECK-NEXT: bb:
; CHECK-NEXT: [[ARG1_PRIV:%.*]] = alloca <8 x i64>, align 64
; CHECK-NEXT: store <8 x i64> [[TMP0]], ptr [[ARG1_PRIV]], align 64
; CHECK-NEXT: [[TMP:%.*]]
= load <8 x i64>, ptr [[ARG1_PRIV]], align 64
; CHECK-NEXT: store <8 x i64> [[TMP]], ptr [[ARG]], align 64
; CHECK-NEXT: ret void
;
bb:
%tmp = load <8 x i64>, ptr %arg1
store <8 x i64> %tmp, ptr %arg
ret void
}

```

```

define void @avx2_legal256_prefer256_call_avx2_legal512_prefer256(ptr %arg) #4 {
;
; TUNIT: Function Attrs: inlinehint mustprogress norecurse nosync nounwind willreturn memory(argmem:
readwrite) uwtable
; TUNIT-LABEL: define {{^@+}}@avx2_legal256_prefer256_call_avx2_legal512_prefer256
; TUNIT-SAME: (ptr nocapture norecurse writeonly [[ARG:%.*]]) #[[ATTR3]] {
; TUNIT-NEXT: bb:
; TUNIT-NEXT:  [[TMP:%.*]] = alloca <8 x i64>, align 32
; TUNIT-NEXT:  [[TRUETMP2:%.*]] = alloca <8 x i64>, align 32
; TUNIT-NEXT:  call void @llvm.memset.p0.i64(ptr noalias nocapture norecurse noundef nonnull writeonly align 32
dereferenceable(64) [[TMP]], i8 noundef 0, i64 noundef 32, i1 noundef false) #[[ATTR5]]
; TUNIT-NEXT:  [[TMP0:%.*]] = load <8 x i64>, ptr [[TMP]], align 64
;
; TUNIT-NEXT:  call fastcc void @callee_avx2_legal256_prefer256_call_avx2_legal512_prefer256(ptr noalias
nocapture norecurse noundef nonnull writeonly align 64 dereferenceable(64) [[TRUETMP2]], <8 x i64> [[TMP0]])
#[[ATTR6]]
; TUNIT-NEXT:  [[TRUETMP4:%.*]] = load <8 x i64>, ptr [[TRUETMP2]], align 64
; TUNIT-NEXT:  store <8 x i64> [[TRUETMP4]], ptr [[ARG]], align 2
; TUNIT-NEXT:  ret void
;
; CGSCC: Function Attrs: inlinehint mustprogress norecurse nosync nounwind willreturn memory(argmem:
readwrite) uwtable
; CGSCC-LABEL: define {{^@+}}@avx2_legal256_prefer256_call_avx2_legal512_prefer256
; CGSCC-SAME: (ptr nocapture norecurse noundef nonnull writeonly align 2 dereferenceable(64) [[ARG:%.*]])
#[[ATTR3]] {
; CGSCC-NEXT: bb:
; CGSCC-NEXT:  [[TMP:%.*]] = alloca <8 x i64>, align 32
; CGSCC-NEXT:  [[TRUETMP2:%.*]] = alloca <8 x i64>, align 32
; CGSCC-NEXT:  call void @llvm.memset.p0.i64(ptr noalias nocapture norecurse noundef nonnull writeonly align 64
dereferenceable(64) [[TMP]],
i8 noundef 0, i64 noundef 32, i1 noundef false) #[[ATTR5]]
; CGSCC-NEXT:  [[TMP0:%.*]] = load <8 x i64>, ptr [[TMP]], align 64
; CGSCC-NEXT:  call fastcc void @callee_avx2_legal256_prefer256_call_avx2_legal512_prefer256(ptr noalias
nocapture norecurse noundef nonnull writeonly align 64 dereferenceable(64) [[TRUETMP2]], <8 x i64> [[TMP0]])
#[[ATTR6]]
; CGSCC-NEXT:  [[TRUETMP4:%.*]] = load <8 x i64>, ptr [[TRUETMP2]], align 64
; CGSCC-NEXT:  store <8 x i64> [[TRUETMP4]], ptr [[ARG]], align 2
; CGSCC-NEXT:  ret void
;
bb:
%tmp = alloca <8 x i64>, align 32
%tmp2 = alloca <8 x i64>, align 32
call void @llvm.memset.p0.i64(ptr align 32 %tmp, i8 0, i64 32, i1 false)
call fastcc void @callee_avx2_legal256_prefer256_call_avx2_legal512_prefer256(ptr %tmp2, ptr %tmp)
%tmp4 = load <8 x i64>, ptr %tmp2, align 32
store <8 x i64> %tmp4, ptr %arg, align 2
ret void
}

```

```

; This should promote
define internal fastcc void @callee_avx2_legal512_prefer256_call_avx2_legal256_prefer256(ptr
  %arg, ptr readonly %arg1) #4 {
;
; CHECK: Function Attrs: inlinehint mustprogress norecurse nosync nounwind willreturn memory(argmem:
readwrite) uwtable
; CHECK-LABEL: define {{[^@]+}}@callee_avx2_legal512_prefer256_call_avx2_legal256_prefer256
; CHECK-SAME: (ptr noalias nocapture norecurse noundef nonnull writeonly align 64 dereferenceable(64)
[[ARG:%.*]], <8 x i64> [[TMP0:%.*]]) #[[ATTR3]] {
; CHECK-NEXT: bb:
; CHECK-NEXT: [[ARG1_PRIV:%.*]] = alloca <8 x i64>, align 64
; CHECK-NEXT: store <8 x i64> [[TMP0]], ptr [[ARG1_PRIV]], align 64
; CHECK-NEXT: [[TMP:%.*]] = load <8 x i64>, ptr [[ARG1_PRIV]], align 64
; CHECK-NEXT: store <8 x i64> [[TMP]], ptr [[ARG]], align 64
; CHECK-NEXT: ret void
;
bb:
  %tmp = load <8 x i64>, ptr %arg1
  store <8 x i64> %tmp, ptr %arg
  ret void
}

define void @avx2_legal512_prefer256_call_avx2_legal256_prefer256(ptr %arg) #3 {
;
; TUNIT: Function Attrs: inlinehint mustprogress norecurse nosync nounwind willreturn memory(argmem:
readwrite) uwtable
; TUNIT-LABEL: define {{[^@]+}}@avx2_legal512_prefer256_call_avx2_legal256_prefer256
; TUNIT-SAME: (ptr nocapture norecurse writeonly [[ARG:%.*]]) #[[ATTR3]] {
; TUNIT-NEXT: bb:
; TUNIT-NEXT: [[TMP:%.*]] = alloca <8 x i64>, align 32
; TUNIT-NEXT: [[TRUETMP2:%.*]] = alloca <8 x i64>, align 32
; TUNIT-NEXT: call void @llvm.memset.p0.i64(ptr noalias nocapture norecurse noundef nonnull writeonly align 32
dereferenceable(64) [[TMP]], i8 noundef 0, i64 noundef 32, i1 noundef false) #[[ATTR5]]
; TUNIT-NEXT: [[TMP0:%.*]] = load <8 x i64>, ptr [[TMP]], align 64
; TUNIT-NEXT: call fastcc void @callee_avx2_legal512_prefer256_call_avx2_legal256_prefer256(ptr noalias
nocapture norecurse noundef nonnull writeonly align 64 dereferenceable(64) [[TRUETMP2]], <8 x i64> [[TMP0]])
#[[ATTR6]]
; TUNIT-NEXT: [[TRUETMP4:%.*]] = load <8 x i64>, ptr [[TRUETMP2]], align 64
; TUNIT-NEXT: store <8 x i64> [[TRUETMP4]], ptr [[ARG]], align 2
; TUNIT-NEXT: ret void
;
; CGSCC: Function
  Attrs: inlinehint mustprogress norecurse nosync nounwind willreturn memory(argmem: readwrite) uwtable
; CGSCC-LABEL: define {{[^@]+}}@avx2_legal512_prefer256_call_avx2_legal256_prefer256
; CGSCC-SAME: (ptr nocapture norecurse noundef nonnull writeonly align 2 dereferenceable(64) [[ARG:%.*]])
#[[ATTR3]] {
; CGSCC-NEXT: bb:

```

```

; CGSCC-NEXT: [[TMP:%.*]] = alloca <8 x i64>, align 32
; CGSCC-NEXT: [[TRUETMP2:%.*]] = alloca <8 x i64>, align 32
; CGSCC-NEXT: call void @llvm.memset.p0.i64(ptr noalias nocapture nofree noundef nonnull writeonly align 64
dereferenceable(64) [[TMP]], i8 noundef 0, i64 noundef 32, i1 noundef false) #[[ATTR5]]
; CGSCC-NEXT: [[TMP0:%.*]] = load <8 x i64>, ptr [[TMP]], align 64
; CGSCC-NEXT: call fastcc void @callee_avx2_legal512_prefer256_call_avx2_legal256_prefer256(ptr noalias
nocapture nofree noundef nonnull writeonly align 64 dereferenceable(64) [[TRUETMP2]], <8 x i64> [[TMP0]])
#[[ATTR6]]
; CGSCC-NEXT: [[TRUETMP4:%.*]] = load <8 x i64>,
ptr [[TRUETMP2]], align 64
; CGSCC-NEXT: store <8 x i64> [[TRUETMP4]], ptr [[ARG]], align 2
; CGSCC-NEXT: ret void
;
bb:
%tmp = alloca <8 x i64>, align 32
%tmp2 = alloca <8 x i64>, align 32
call void @llvm.memset.p0.i64(ptr align 32 %tmp, i8 0, i64 32, i1 false)
call fastcc void @callee_avx2_legal512_prefer256_call_avx2_legal256_prefer256(ptr %tmp2, ptr %tmp)
%tmp4 = load <8 x i64>, ptr %tmp2, align 32
store <8 x i64> %tmp4, ptr %arg, align 2
ret void
}

; Function Attrs: argmemonly nounwind
declare void @llvm.memset.p0.i64(ptr nocapture writeonly, i8, i64, i1) #5

attributes #0 = { inlinehint norecurse nounwind uwtable "target-features"="+avx512vl" "min-legal-vector-
width"="512" "prefer-vector-width"="512" }
attributes #1 = { inlinehint norecurse nounwind uwtable "target-features"="+avx512vl" "min-legal-vector-
width"="512" "prefer-vector-width"="256" }
attributes #2 = { inlinehint norecurse nounwind uwtable "target-features"="+avx512vl" "min-legal-vector-
width"="256"
"prefer-vector-width"="256" }
attributes #3 = { inlinehint norecurse nounwind uwtable "target-features"="+avx2" "min-legal-vector-width"="512"
"prefer-vector-width"="256" }
attributes #4 = { inlinehint norecurse nounwind uwtable "target-features"="+avx2" "min-legal-vector-width"="256"
"prefer-vector-width"="256" }
attributes #5 = { argmemonly nounwind }
;
; TUNIT: attributes #[[ATTR0]] = { inlinehint mustprogress nofree norecurse nosync nounwind willreturn
memory(argmem: readwrite) uwtable "min-legal-vector-width"="512" "prefer-vector-width"="512" "target-
features"="+avx512vl" }
; TUNIT: attributes #[[ATTR1]] = { inlinehint mustprogress nofree norecurse nosync nounwind willreturn
memory(argmem: readwrite) uwtable "min-legal-vector-width"="512" "prefer-vector-width"="256" "target-
features"="+avx512vl" }
; TUNIT: attributes #[[ATTR2]] = { inlinehint mustprogress nofree norecurse nosync nounwind willreturn
memory(argmem: readwrite) uwtable "min-legal-vector-width"="256" "prefer-vector-width"="256"

```

```

"target-features"="+avx512vl" }
; TUNIT: attributes #[[ATTR3]] = { inlinehint mustprogress nofree norecurse nosync nounwind willreturn
memory(argmem: readwrite) uwtable "min-legal-vector-width"="512" "prefer-vector-width"="256" "target-
features"="+avx2" }
; TUNIT: attributes #[[ATTR4:[0-9]+]] = { nocallback nofree nounwind willreturn memory(argmem: write) }
; TUNIT: attributes #[[ATTR5]] = { nofree willreturn memory(write) }
; TUNIT: attributes #[[ATTR6]] = { nofree nosync nounwind willreturn }
;
; CGSCC: attributes #[[ATTR0]] = { inlinehint mustprogress nofree norecurse nosync nounwind willreturn
memory(argmem: readwrite) uwtable "min-legal-vector-width"="512" "prefer-vector-width"="512" "target-
features"="+avx512vl" }
; CGSCC: attributes #[[ATTR1]] = { inlinehint mustprogress nofree norecurse nosync nounwind willreturn
memory(argmem: readwrite) uwtable "min-legal-vector-width"="512" "prefer-vector-width"="256" "target-
features"="+avx512vl" }
; CGSCC: attributes #[[ATTR2]]
= { inlinehint mustprogress nofree norecurse nosync nounwind willreturn memory(argmem: readwrite) uwtable
"min-legal-vector-width"="256" "prefer-vector-width"="256" "target-features"="+avx512vl" }
; CGSCC: attributes #[[ATTR3]] = { inlinehint mustprogress nofree norecurse nosync nounwind willreturn
memory(argmem: readwrite) uwtable "min-legal-vector-width"="512" "prefer-vector-width"="256" "target-
features"="+avx2" }
; CGSCC: attributes #[[ATTR4:[0-9]+]] = { nocallback nofree nounwind willreturn memory(argmem: write) }
; CGSCC: attributes #[[ATTR5]] = { nofree willreturn memory(write) }
; CGSCC: attributes #[[ATTR6]] = { nofree nounwind willreturn }
;
; NOTE: Assertions have been autogenerated by utils/update_llc_test_checks.py
; RUN: llc -mtriple=riscv64 -verify-machineinstrs < %s \
; RUN: -riscv-experimental-rv64-legal-i32 | FileCheck %s -check-prefix=RV64I
; RUN: llc -mtriple=riscv64 -mattr=+zbb -verify-machineinstrs < %s \
; RUN: -riscv-experimental-rv64-legal-i32 | FileCheck %s -check-prefix=RV64ZBB

```

```

declare i32 @llvm.ctlz.i32(i32, i1)

```

```

define signext i32 @ctlz_i32(i32 signext %a) nounwind {
; RV64I-LABEL: ctlz_i32:
; RV64I:      # %bb.0:
; RV64I-NEXT: beqz a0, .LBB0_2
; RV64I-NEXT: # %bb.1: # %cond.false
; RV64I-NEXT: addi sp, sp, -16
; RV64I-NEXT: sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT: srlw a1, a0, 1
; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT: srlw a1, a0, 2
; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT: srlw a1, a0, 4
; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT: srlw a1, a0, 8
; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT: srlw a1, a0, 16

```

```

; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:
    not a0, a0
; RV64I-NEXT:  srlw a1, a0, 1
; RV64I-NEXT:  lui a2, 349525
; RV64I-NEXT:  addi a2, a2, 1365
; RV64I-NEXT:  and a1, a1, a2
; RV64I-NEXT:  subw a0, a0, a1
; RV64I-NEXT:  lui a1, 209715
; RV64I-NEXT:  addi a1, a1, 819
; RV64I-NEXT:  and a2, a0, a1
; RV64I-NEXT:  srlw a0, a0, 2
; RV64I-NEXT:  and a0, a0, a1
; RV64I-NEXT:  add a0, a2, a0
; RV64I-NEXT:  srlw a1, a0, 4
; RV64I-NEXT:  addw a0, a0, a1
; RV64I-NEXT:  lui a1, 61681
; RV64I-NEXT:  addiw a1, a1, -241
; RV64I-NEXT:  and a0, a0, a1
; RV64I-NEXT:  lui a1, 4112
; RV64I-NEXT:  addiw a1, a1, 257
; RV64I-NEXT:  call __muldi3
; RV64I-NEXT:  srlw a0, a0, 24
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
; RV64I-NEXT: .LBB0_2:
; RV64I-NEXT:  li a0, 32
; RV64I-NEXT:  ret
;
; RV64ZBB-LABEL: ctlz_i32:
; RV64ZBB:      # %bb.0:
; RV64ZBB-NEXT:  clzw a0, a0
; RV64ZBB-NEXT:  ret
%1 = call i32 @llvm.ctlz.i32(i32 %a, i1 false)
ret i32 %1
}

```

```

define signext i32 @log2_i32(i32 signext %a) nounwind {
; RV64I-LABEL: log2_i32:
; RV64I:      # %bb.0:
; RV64I-NEXT:  beqz a0, .LBB1_2
; RV64I-NEXT:  # %bb.1: # %cond.false
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  srlw a1, a0, 1
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  srlw a1, a0, 2

```

```

; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT: srliw a1, a0, 4
; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT: srliw a1, a0, 8
; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT: srliw a1, a0, 16
; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT: not a0, a0
; RV64I-NEXT: srliw a1, a0, 1
; RV64I-NEXT: lui a2, 349525
; RV64I-NEXT: addi a2, a2, 1365
; RV64I-NEXT: and a1, a1, a2
; RV64I-NEXT: subw a0, a0, a1
; RV64I-NEXT: lui a1, 209715
; RV64I-NEXT: addi a1, a1, 819
; RV64I-NEXT: and a2, a0, a1
; RV64I-NEXT: srliw a0, a0, 2
; RV64I-NEXT: and a0, a0, a1
; RV64I-NEXT: add a0, a2, a0
; RV64I-NEXT:
    srliw a1, a0, 4
; RV64I-NEXT: addw a0, a0, a1
; RV64I-NEXT: lui a1, 61681
; RV64I-NEXT: addiw a1, a1, -241
; RV64I-NEXT: and a0, a0, a1
; RV64I-NEXT: lui a1, 4112
; RV64I-NEXT: addiw a1, a1, 257
; RV64I-NEXT: call __muldi3
; RV64I-NEXT: srliw a0, a0, 24
; RV64I-NEXT: ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT: addi sp, sp, 16
; RV64I-NEXT: j .LBB1_3
; RV64I-NEXT: .LBB1_2:
; RV64I-NEXT: li a0, 32
; RV64I-NEXT: .LBB1_3: # %cond.end
; RV64I-NEXT: li a1, 31
; RV64I-NEXT: subw a0, a1, a0
; RV64I-NEXT: ret
;
; RV64ZBB-LABEL: log2_i32:
; RV64ZBB:    # %bb.0:
; RV64ZBB-NEXT: clzw a0, a0
; RV64ZBB-NEXT: li a1, 31
; RV64ZBB-NEXT: subw a0, a1, a0
; RV64ZBB-NEXT: ret
%1 = call i32 @llvm.ctlz.i32(i32 %a, i1 false)
%2 = sub i32 31, %1
ret i32 %2

```



}

```
define signext i32 @log2_ceil_i32(i32 signext %a) nounwind {
; RV64I-LABEL: log2_ceil_i32:
; RV64I:      # %bb.0:
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra,
; RV64I-NEXT:  8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  sd s0, 0(sp) # 8-byte Folded Spill
; RV64I-NEXT:  addiw a0, a0, -1
; RV64I-NEXT:  li s0, 32
; RV64I-NEXT:  li a1, 32
; RV64I-NEXT:  beqz a0, .LBB2_2
; RV64I-NEXT:  # %bb.1: # %cond.false
; RV64I-NEXT:  srliw a1, a0, 1
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  srliw a1, a0, 2
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  srliw a1, a0, 4
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  srliw a1, a0, 8
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  srliw a1, a0, 16
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  not a0, a0
; RV64I-NEXT:  srliw a1, a0, 1
; RV64I-NEXT:  lui a2, 349525
; RV64I-NEXT:  addi a2, a2, 1365
; RV64I-NEXT:  and a1, a1, a2
; RV64I-NEXT:  subw a0, a0, a1
; RV64I-NEXT:  lui a1, 209715
; RV64I-NEXT:  addi a1, a1, 819
; RV64I-NEXT:  and a2, a0, a1
; RV64I-NEXT:  srliw a0, a0, 2
; RV64I-NEXT:  and a0, a0, a1
; RV64I-NEXT:  add a0, a2, a0
; RV64I-NEXT:  srliw a1, a0, 4
; RV64I-NEXT:
; RV64I-NEXT:  addw a0, a0, a1
; RV64I-NEXT:  lui a1, 61681
; RV64I-NEXT:  addiw a1, a1, -241
; RV64I-NEXT:  and a0, a0, a1
; RV64I-NEXT:  lui a1, 4112
; RV64I-NEXT:  addiw a1, a1, 257
; RV64I-NEXT:  call __muldi3
; RV64I-NEXT:  srliw a1, a0, 24
; RV64I-NEXT:  .LBB2_2: # %cond.end
; RV64I-NEXT:  subw a0, s0, a1
```

```

; RV64I-NEXT: ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT: ld s0, 0(sp) # 8-byte Folded Reload
; RV64I-NEXT: addi sp, sp, 16
; RV64I-NEXT: ret
;
; RV64ZBB-LABEL: log2_ceil_i32:
; RV64ZBB:    # %bb.0:
; RV64ZBB-NEXT: addi a0, a0, -1
; RV64ZBB-NEXT: clzw a0, a0
; RV64ZBB-NEXT: li a1, 32
; RV64ZBB-NEXT: subw a0, a1, a0
; RV64ZBB-NEXT: ret
%1 = sub i32 %a, 1
%2 = call i32 @llvm.ctlz.i32(i32 %1, i1 false)
%3 = sub i32 32, %2
ret i32 %3
}

define signext i32 @findLastSet_i32(i32 signext %a) nounwind {
; RV64I-LABEL: findLastSet_i32:
; RV64I:    # %bb.0:
; RV64I-NEXT: addi sp, sp, -16
; RV64I-NEXT: sd ra, 8(sp) # 8-byte Folded Spill
;
; RV64I-NEXT: sd s0, 0(sp) # 8-byte Folded Spill
; RV64I-NEXT: mv s0, a0
; RV64I-NEXT: srliw a0, a0, 1
; RV64I-NEXT: or a0, s0, a0
; RV64I-NEXT: srliw a1, a0, 2
; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT: srliw a1, a0, 4
; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT: srliw a1, a0, 8
; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT: srliw a1, a0, 16
; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT: not a0, a0
; RV64I-NEXT: srliw a1, a0, 1
; RV64I-NEXT: lui a2, 349525
; RV64I-NEXT: addi a2, a2, 1365
; RV64I-NEXT: and a1, a1, a2
; RV64I-NEXT: subw a0, a0, a1
; RV64I-NEXT: lui a1, 209715
; RV64I-NEXT: addi a1, a1, 819
; RV64I-NEXT: and a2, a0, a1
; RV64I-NEXT: srliw a0, a0, 2
; RV64I-NEXT: and a0, a0, a1
; RV64I-NEXT: add a0, a2, a0

```

```

; RV64I-NEXT: srliw a1, a0, 4
; RV64I-NEXT: addw a0, a0, a1
; RV64I-NEXT: lui a1, 61681
; RV64I-NEXT: addiw a1, a1, -241
; RV64I-NEXT: and a0, a0, a1
; RV64I-NEXT: lui a1, 4112
; RV64I-NEXT:
    addiw a1, a1, 257
; RV64I-NEXT: call __muldi3
; RV64I-NEXT: srliw a0, a0, 24
; RV64I-NEXT: xori a0, a0, 31
; RV64I-NEXT: snez a1, s0
; RV64I-NEXT: addiw a1, a1, -1
; RV64I-NEXT: or a0, a1, a0
; RV64I-NEXT: ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT: ld s0, 0(sp) # 8-byte Folded Reload
; RV64I-NEXT: addi sp, sp, 16
; RV64I-NEXT: ret
;
; RV64ZBB-LABEL: findLastSet_i32:
; RV64ZBB:    # %bb.0:
; RV64ZBB-NEXT: clzw a1, a0
; RV64ZBB-NEXT: xori a1, a1, 31
; RV64ZBB-NEXT: snez a0, a0
; RV64ZBB-NEXT: addiw a0, a0, -1
; RV64ZBB-NEXT: or a0, a0, a1
; RV64ZBB-NEXT: ret
%1 = call i32 @llvmctlz.i32(i32 %a, i1 true)
%2 = xor i32 31, %1
%3 = icmp eq i32 %a, 0
%4 = select i1 %3, i32 -1, i32 %2
ret i32 %4
}

define i32 @ctlz_lshr_i32(i32 signext %a) {
; RV64I-LABEL: ctlz_lshr_i32:
; RV64I:    # %bb.0:
; RV64I-NEXT: srliw a0, a0, 1
; RV64I-NEXT: beqz a0, .LBB4_2
; RV64I-NEXT: # %bb.1: # %cond.false
; RV64I-NEXT: addi sp, sp,
    -16
; RV64I-NEXT: .cfi_def_cfa_offset 16
; RV64I-NEXT: sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT: .cfi_offset ra, -8
; RV64I-NEXT: srliw a1, a0, 1
; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT: srliw a1, a0, 2

```

```

; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT: srliw a1, a0, 4
; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT: srliw a1, a0, 8
; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT: srliw a1, a0, 16
; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT: not a0, a0
; RV64I-NEXT: srliw a1, a0, 1
; RV64I-NEXT: lui a2, 349525
; RV64I-NEXT: addi a2, a2, 1365
; RV64I-NEXT: and a1, a1, a2
; RV64I-NEXT: subw a0, a0, a1
; RV64I-NEXT: lui a1, 209715
; RV64I-NEXT: addi a1, a1, 819
; RV64I-NEXT: and a2, a0, a1
; RV64I-NEXT: srliw a0, a0, 2
; RV64I-NEXT: and a0, a0, a1
; RV64I-NEXT: add a0, a2, a0
; RV64I-NEXT: srliw a1, a0, 4
; RV64I-NEXT: addw a0, a0, a1
; RV64I-NEXT: lui a1, 61681
; RV64I-NEXT: addiw a1, a1, -241
; RV64I-NEXT: and a0,
a0, a1
; RV64I-NEXT: lui a1, 4112
; RV64I-NEXT: addiw a1, a1, 257
; RV64I-NEXT: call __muldi3
; RV64I-NEXT: srliw a0, a0, 24
; RV64I-NEXT: ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT: addi sp, sp, 16
; RV64I-NEXT: ret
; RV64I-NEXT: .LBB4_2:
; RV64I-NEXT: li a0, 32
; RV64I-NEXT: ret
;
; RV64ZBB-LABEL: ctlz_lshr_i32:
; RV64ZBB:    # %bb.0:
; RV64ZBB-NEXT: srliw a0, a0, 1
; RV64ZBB-NEXT: clzw a0, a0
; RV64ZBB-NEXT: ret
%1 = lshr i32 %a, 1
%2 = call i32 @llvm.ctlz.i32(i32 %1, i1 false)
ret i32 %2
}

declare i64 @llvm.ctlz.i64(i64, i1)

```

```

define i64 @ctlz_i64(i64 %a) nounwind {
; RV64I-LABEL: ctlz_i64:
; RV64I:      # %bb.0:
; RV64I-NEXT: beqz a0, .LBB5_2
; RV64I-NEXT: # %bb.1: # %cond.false
; RV64I-NEXT: addi sp, sp, -16
; RV64I-NEXT: sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT: srli a1, a0, 1
; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT: srli a1, a0, 2
; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT: srli a1, a0, 4
; RV64I-NEXT:
    or a0, a0, a1
; RV64I-NEXT: srli a1, a0, 8
; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT: srli a1, a0, 16
; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT: srli a1, a0, 32
; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT: not a0, a0
; RV64I-NEXT: srli a1, a0, 1
; RV64I-NEXT: lui a2, 349525
; RV64I-NEXT: addiw a2, a2, 1365
; RV64I-NEXT: slli a3, a2, 32
; RV64I-NEXT: add a2, a2, a3
; RV64I-NEXT: and a1, a1, a2
; RV64I-NEXT: sub a0, a0, a1
; RV64I-NEXT: lui a1, 209715
; RV64I-NEXT: addiw a1, a1, 819
; RV64I-NEXT: slli a2, a1, 32
; RV64I-NEXT: add a1, a1, a2
; RV64I-NEXT: and a2, a0, a1
; RV64I-NEXT: srli a0, a0, 2
; RV64I-NEXT: and a0, a0, a1
; RV64I-NEXT: add a0, a2, a0
; RV64I-NEXT: srli a1, a0, 4
; RV64I-NEXT: add a0, a0, a1
; RV64I-NEXT: lui a1, 61681
; RV64I-NEXT: addiw a1, a1, -241
; RV64I-NEXT: slli a2, a1, 32
; RV64I-NEXT: add a1, a1, a2
; RV64I-NEXT: and a0, a0, a1
; RV64I-NEXT: lui a1, 4112
; RV64I-NEXT:
    addiw a1, a1, 257
; RV64I-NEXT: slli a2, a1, 32
; RV64I-NEXT: add a1, a1, a2

```

```

; RV64I-NEXT:  call __muldi3
; RV64I-NEXT:  srli a0, a0, 56
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
; RV64I-NEXT:  .LBB5_2:
; RV64I-NEXT:  li a0, 64
; RV64I-NEXT:  ret
;
; RV64ZBB-LABEL: ctlz_i64:
; RV64ZBB:      # %bb.0:
; RV64ZBB-NEXT:  clz a0, a0
; RV64ZBB-NEXT:  ret
%1 = call i64 @llvm.ctlz.i64(i64 %a, i1 false)
ret i64 %1
}

declare i32 @llvm.cttz.i32(i32, i1)

define signext i32 @cttz_i32(i32 signext %a) nounwind {
; RV64I-LABEL: cttz_i32:
; RV64I:      # %bb.0:
; RV64I-NEXT:  beqz a0, .LBB6_2
; RV64I-NEXT:  # %bb.1: # %cond.false
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  negw a1, a0
; RV64I-NEXT:  and a0, a0, a1
; RV64I-NEXT:  lui a1, 30667
; RV64I-NEXT:  addiw a1, a1, 1329
; RV64I-NEXT:  call __muldi3
; RV64I-NEXT:  srliw a0, a0, 27
;
; RV64I-NEXT:  lui a1, %hi(.LCPI6_0)
; RV64I-NEXT:  addi a1, a1, %lo(.LCPI6_0)
; RV64I-NEXT:  add a0, a1, a0
; RV64I-NEXT:  lbu a0, 0(a0)
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
; RV64I-NEXT:  .LBB6_2:
; RV64I-NEXT:  li a0, 32
; RV64I-NEXT:  ret
;
; RV64ZBB-LABEL: cttz_i32:
; RV64ZBB:      # %bb.0:
; RV64ZBB-NEXT:  ctw a0, a0
; RV64ZBB-NEXT:  ret

```

```

%1 = call i32 @llvm.cttz.i32(i32 %a, i1 false)
ret i32 %1
}

define signext i32 @cttz_zero_undef_i32(i32 signext %a) nounwind {
; RV64I-LABEL: cttz_zero_undef_i32:
; RV64I:      # %bb.0:
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  negw a1, a0
; RV64I-NEXT:  and a0, a0, a1
; RV64I-NEXT:  lui a1, 30667
; RV64I-NEXT:  addiw a1, a1, 1329
; RV64I-NEXT:  call __muldi3
; RV64I-NEXT:  srliw a0, a0, 27
; RV64I-NEXT:  lui a1, %hi(LCPI7_0)
; RV64I-NEXT:  addi a1, a1, %lo(LCPI7_0)
; RV64I-NEXT:
    add a0, a1, a0
; RV64I-NEXT:  lbu a0, 0(a0)
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
;
; RV64ZBB-LABEL: cttz_zero_undef_i32:
; RV64ZBB:      # %bb.0:
; RV64ZBB-NEXT:  ctzw a0, a0
; RV64ZBB-NEXT:  ret
%1 = call i32 @llvm.cttz.i32(i32 %a, i1 true)
ret i32 %1
}

define signext i32 @findFirstSet_i32(i32 signext %a) nounwind {
; RV64I-LABEL: findFirstSet_i32:
; RV64I:      # %bb.0:
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  sd s0, 0(sp) # 8-byte Folded Spill
; RV64I-NEXT:  mv s0, a0
; RV64I-NEXT:  negw a0, a0
; RV64I-NEXT:  and a0, s0, a0
; RV64I-NEXT:  lui a1, 30667
; RV64I-NEXT:  addiw a1, a1, 1329
; RV64I-NEXT:  call __muldi3
; RV64I-NEXT:  srliw a0, a0, 27
; RV64I-NEXT:  lui a1, %hi(LCPI8_0)
; RV64I-NEXT:  addi a1, a1, %lo(LCPI8_0)
; RV64I-NEXT:  add a0, a1, a0

```

```

; RV64I-NEXT:  lbu a0, 0(a0)
; RV64I-NEXT:  snez a1, s0
; RV64I-NEXT:
    addi a1, a1, -1
; RV64I-NEXT:  or a0, a1, a0
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT:  ld s0, 0(sp) # 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
;
; RV64ZBB-LABEL: findFirstSet_i32:
; RV64ZBB:      # %bb.0:
; RV64ZBB-NEXT:  ctw a1, a0
; RV64ZBB-NEXT:  snez a0, a0
; RV64ZBB-NEXT:  addiw a0, a0, -1
; RV64ZBB-NEXT:  or a0, a0, a1
; RV64ZBB-NEXT:  ret
%1 = call i32 @llvm.cttz.i32(i32 %a, i1 true)
%2 = icmp eq i32 %a, 0
%3 = select i1 %2, i32 -1, i32 %1
ret i32 %3
}

define signext i32 @ffs_i32(i32 signext %a) nounwind {
; RV64I-LABEL: ffs_i32:
; RV64I:      # %bb.0:
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  sd s0, 0(sp) # 8-byte Folded Spill
; RV64I-NEXT:  mv s0, a0
; RV64I-NEXT:  negw a0, a0
; RV64I-NEXT:  and a0, s0, a0
; RV64I-NEXT:  lui a1, 30667
; RV64I-NEXT:  addiw a1, a1, 1329
; RV64I-NEXT:  call __muldi3
; RV64I-NEXT:
    srlw a0, a0, 27
; RV64I-NEXT:  lui a1, %hi(.LCPI9_0)
; RV64I-NEXT:  addi a1, a1, %lo(.LCPI9_0)
; RV64I-NEXT:  add a0, a1, a0
; RV64I-NEXT:  lbu a0, 0(a0)
; RV64I-NEXT:  addi a0, a0, 1
; RV64I-NEXT:  seqz a1, s0
; RV64I-NEXT:  addi a1, a1, -1
; RV64I-NEXT:  and a0, a1, a0
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  srli a0, a0, 32
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload

```



```

; RV64I-NEXT: ld s0, 0(sp) # 8-byte Folded Reload
; RV64I-NEXT: addi sp, sp, 16
; RV64I-NEXT: ret
;
; RV64ZBB-LABEL: ffs_i32:
; RV64ZBB:      # %bb.0:
; RV64ZBB-NEXT: ctw a1, a0
; RV64ZBB-NEXT: addi a1, a1, 1
; RV64ZBB-NEXT: seqz a0, a0
; RV64ZBB-NEXT: addi a0, a0, -1
; RV64ZBB-NEXT: and a0, a0, a1
; RV64ZBB-NEXT: zext.h a0, a0
; RV64ZBB-NEXT: ret
%1 = call i32 @llvm.cttz.i32(i32 %a, i1 true)
%2 = add i32 %1, 1
%3 = icmp eq i32 %a, 0
%4 = select i1 %3, i32 0, i32 %2
ret i32 %4
}

```

```
declare i64 @llvm.cttz.i64(i64, i1)
```

```

define i64 @cttz_i64(i64
  %a) nounwind {
; RV64I-LABEL: cttz_i64:
; RV64I:      # %bb.0:
; RV64I-NEXT: beqz a0, .LBB10_2
; RV64I-NEXT: # %bb.1: # %cond.false
; RV64I-NEXT: addi sp, sp, -16
; RV64I-NEXT: sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT: neg a1, a0
; RV64I-NEXT: and a0, a0, a1
; RV64I-NEXT: lui a1, %hi(.LCPI10_0)
; RV64I-NEXT: ld a1, %lo(.LCPI10_0)(a1)
; RV64I-NEXT: call __muldi3
; RV64I-NEXT: srli a0, a0, 58
; RV64I-NEXT: lui a1, %hi(.LCPI10_1)
; RV64I-NEXT: addi a1, a1, %lo(.LCPI10_1)
; RV64I-NEXT: add a0, a1, a0
; RV64I-NEXT: lbu a0, 0(a0)
; RV64I-NEXT: ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT: addi sp, sp, 16
; RV64I-NEXT: ret
; RV64I-NEXT: .LBB10_2:
; RV64I-NEXT: li a0, 64
; RV64I-NEXT: ret
;
; RV64ZBB-LABEL: cttz_i64:

```

```

; RV64ZBB:    # %bb.0:
; RV64ZBB-NEXT:  ctz a0, a0
; RV64ZBB-NEXT:  ret
%1 = call i64 @llvm.cttz.i64(i64 %a, i1 false)
ret i64 %1
}

declare i32 @llvm.ctpop.i32(i32)

define signext i32 @ctpop_i32(i32
  signext %a) nounwind {
; RV64I-LABEL: ctpop_i32:
; RV64I:    # %bb.0:
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  srliw a1, a0, 1
; RV64I-NEXT:  lui a2, 349525
; RV64I-NEXT:  addi a2, a2, 1365
; RV64I-NEXT:  and a1, a1, a2
; RV64I-NEXT:  subw a0, a0, a1
; RV64I-NEXT:  lui a1, 209715
; RV64I-NEXT:  addi a1, a1, 819
; RV64I-NEXT:  and a2, a0, a1
; RV64I-NEXT:  srliw a0, a0, 2
; RV64I-NEXT:  and a0, a0, a1
; RV64I-NEXT:  add a0, a2, a0
; RV64I-NEXT:  srliw a1, a0, 4
; RV64I-NEXT:  addw a0, a0, a1
; RV64I-NEXT:  lui a1, 61681
; RV64I-NEXT:  addiw a1, a1, -241
; RV64I-NEXT:  and a0, a0, a1
; RV64I-NEXT:  lui a1, 4112
; RV64I-NEXT:  addiw a1, a1, 257
; RV64I-NEXT:  call __muldi3
; RV64I-NEXT:  srliw a0, a0, 24
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
;
; RV64ZBB-LABEL: ctpop_i32:
; RV64ZBB:    # %bb.0:
; RV64ZBB-NEXT:  cpopw
a0, a0
; RV64ZBB-NEXT:  ret
%1 = call i32 @llvm.ctpop.i32(i32 %a)
ret i32 %1
}

```

```

define signext i32 @ctpop_i32_load(ptr %p) nounwind {
; RV64I-LABEL: ctpop_i32_load:
; RV64I:      # %bb.0:
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  lw a0, 0(a0)
; RV64I-NEXT:  srlw a1, a0, 1
; RV64I-NEXT:  lui a2, 349525
; RV64I-NEXT:  addi a2, a2, 1365
; RV64I-NEXT:  and a1, a1, a2
; RV64I-NEXT:  subw a0, a0, a1
; RV64I-NEXT:  lui a1, 209715
; RV64I-NEXT:  addi a1, a1, 819
; RV64I-NEXT:  and a2, a0, a1
; RV64I-NEXT:  srlw a0, a0, 2
; RV64I-NEXT:  and a0, a0, a1
; RV64I-NEXT:  add a0, a2, a0
; RV64I-NEXT:  srlw a1, a0, 4
; RV64I-NEXT:  addw a0, a0, a1
; RV64I-NEXT:  lui a1, 61681
; RV64I-NEXT:  addiw a1, a1, -241
; RV64I-NEXT:  and a0, a0, a1
; RV64I-NEXT:  lui a1, 4112
; RV64I-NEXT:  addiw a1, a1, 257
; RV64I-NEXT:  call __muldi3
; RV64I-NEXT:  srlw a0, a0, 24
; RV64I-NEXT:  ld ra, 8(sp)
; RV64I-NEXT:  # 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
;
; RV64ZBB-LABEL: ctpop_i32_load:
; RV64ZBB:      # %bb.0:
; RV64ZBB-NEXT:  lw a0, 0(a0)
; RV64ZBB-NEXT:  cpopw a0, a0
; RV64ZBB-NEXT:  ret
;a = load i32, ptr %p
%1 = call i32 @llvm.ctpop.i32(i32 %a)
ret i32 %1
}

```

```

declare i64 @llvm.ctpop.i64(i64)

```

```

define i64 @ctpop_i64(i64 %a) nounwind {
; RV64I-LABEL: ctpop_i64:
; RV64I:      # %bb.0:
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill

```

```

; RV64I-NEXT: srli a1, a0, 1
; RV64I-NEXT: lui a2, 349525
; RV64I-NEXT: addiw a2, a2, 1365
; RV64I-NEXT: slli a3, a2, 32
; RV64I-NEXT: add a2, a2, a3
; RV64I-NEXT: and a1, a1, a2
; RV64I-NEXT: sub a0, a0, a1
; RV64I-NEXT: lui a1, 209715
; RV64I-NEXT: addiw a1, a1, 819
; RV64I-NEXT: slli a2, a1, 32
; RV64I-NEXT: add a1, a1, a2
; RV64I-NEXT: and a2, a0, a1
; RV64I-NEXT: srli a0, a0, 2
; RV64I-NEXT: and a0, a0, a1
; RV64I-NEXT: add a0, a2,
a0
; RV64I-NEXT: srli a1, a0, 4
; RV64I-NEXT: add a0, a0, a1
; RV64I-NEXT: lui a1, 61681
; RV64I-NEXT: addiw a1, a1, -241
; RV64I-NEXT: slli a2, a1, 32
; RV64I-NEXT: add a1, a1, a2
; RV64I-NEXT: and a0, a0, a1
; RV64I-NEXT: lui a1, 4112
; RV64I-NEXT: addiw a1, a1, 257
; RV64I-NEXT: slli a2, a1, 32
; RV64I-NEXT: add a1, a1, a2
; RV64I-NEXT: call __muldi3
; RV64I-NEXT: srli a0, a0, 56
; RV64I-NEXT: ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT: addi sp, sp, 16
; RV64I-NEXT: ret
;
; RV64ZBB-LABEL: ctpop_i64:
; RV64ZBB:    # %bb.0:
; RV64ZBB-NEXT: cpop a0, a0
; RV64ZBB-NEXT: ret
%1 = call i64 @llvm.ctpop.i64(i64 %a)
ret i64 %1
}

define signext i32 @sextb_i32(i32 signext %a) nounwind {
; RV64I-LABEL: sextb_i32:
; RV64I:    # %bb.0:
; RV64I-NEXT: slli a0, a0, 56
; RV64I-NEXT: srai a0, a0, 56
; RV64I-NEXT: ret
;

```

```

; RV64ZBB-LABEL: sextb_i32:
; RV64ZBB:    # %bb.0:
; RV64ZBB-NEXT:  sext.b a0, a0
; RV64ZBB-NEXT:
    ret
%shl = shl i32 %a, 24
%shr = ashr exact i32 %shl, 24
ret i32 %shr
}

define i64 @sextb_i64(i64 %a) nounwind {
; RV64I-LABEL: sextb_i64:
; RV64I:    # %bb.0:
; RV64I-NEXT:  slli a0, a0, 56
; RV64I-NEXT:  srai a0, a0, 56
; RV64I-NEXT:  ret
;
; RV64ZBB-LABEL: sextb_i64:
; RV64ZBB:    # %bb.0:
; RV64ZBB-NEXT:  sext.b a0, a0
; RV64ZBB-NEXT:  ret
%shl = shl i64 %a, 56
%shr = ashr exact i64 %shl, 56
ret i64 %shr
}

define signext i32 @sexth_i32(i32 signext %a) nounwind {
; RV64I-LABEL: sexth_i32:
; RV64I:    # %bb.0:
; RV64I-NEXT:  slli a0, a0, 48
; RV64I-NEXT:  srai a0, a0, 48
; RV64I-NEXT:  ret
;
; RV64ZBB-LABEL: sexth_i32:
; RV64ZBB:    # %bb.0:
; RV64ZBB-NEXT:  sext.h a0, a0
; RV64ZBB-NEXT:  ret
%shl = shl i32 %a, 16
%shr = ashr exact i32 %shl, 16
ret i32 %shr
}

define i64 @sexth_i64(i64 %a) nounwind {
; RV64I-LABEL: sexth_i64:
; RV64I:    # %bb.0:
; RV64I-NEXT:  slli a0, a0, 48
; RV64I-NEXT:  srai a0, a0, 48
; RV64I-NEXT:

```

```

    ret
;
; RV64ZBB-LABEL: sexth_i64:
; RV64ZBB:    # %bb.0:
; RV64ZBB-NEXT:  sext.h a0, a0
; RV64ZBB-NEXT:  ret
%shl = shl i64 %a, 48
%shr = ashr exact i64 %shl, 48
ret i64 %shr
}

define signext i32 @min_i32(i32 signext %a, i32 signext %b) nounwind {
; RV64I-LABEL: min_i32:
; RV64I:    # %bb.0:
; RV64I-NEXT:  blt a0, a1, .LBB18_2
; RV64I-NEXT: # %bb.1:
; RV64I-NEXT:  mv a0, a1
; RV64I-NEXT: .LBB18_2:
; RV64I-NEXT:  ret
;
; RV64ZBB-LABEL: min_i32:
; RV64ZBB:    # %bb.0:
; RV64ZBB-NEXT:  min a0, a0, a1
; RV64ZBB-NEXT:  ret
%cmp = icmp slt i32 %a, %b
%cond = select i1 %cmp, i32 %a, i32 %b
ret i32 %cond
}

define i64 @min_i64(i64 %a, i64 %b) nounwind {
; RV64I-LABEL: min_i64:
; RV64I:    # %bb.0:
; RV64I-NEXT:  blt a0, a1, .LBB19_2
; RV64I-NEXT: # %bb.1:
; RV64I-NEXT:  mv a0, a1
; RV64I-NEXT: .LBB19_2:
; RV64I-NEXT:  ret
;
; RV64ZBB-LABEL: min_i64:
; RV64ZBB:    # %bb.0:
; RV64ZBB-NEXT:  min a0, a0, a1
; RV64ZBB-NEXT:  ret
%cmp = icmp
slt i64 %a, %b
%cond = select i1 %cmp, i64 %a, i64 %b
ret i64 %cond
}

```

```

define signext i32 @max_i32(i32 signext %a, i32 signext %b) nounwind {
; RV64I-LABEL: max_i32:
; RV64I:      # %bb.0:
; RV64I-NEXT:  blt a1, a0, .LBB20_2
; RV64I-NEXT: # %bb.1:
; RV64I-NEXT:  mv a0, a1
; RV64I-NEXT:  .LBB20_2:
; RV64I-NEXT:  ret
;
; RV64ZBB-LABEL: max_i32:
; RV64ZBB:     # %bb.0:
; RV64ZBB-NEXT:  max a0, a0, a1
; RV64ZBB-NEXT:  ret
%cmp = icmp sgt i32 %a, %b
%cond = select i1 %cmp, i32 %a, i32 %b
ret i32 %cond
}

```

```

define i64 @max_i64(i64 %a, i64 %b) nounwind {
; RV64I-LABEL: max_i64:
; RV64I:      # %bb.0:
; RV64I-NEXT:  blt a1, a0, .LBB21_2
; RV64I-NEXT: # %bb.1:
; RV64I-NEXT:  mv a0, a1
; RV64I-NEXT:  .LBB21_2:
; RV64I-NEXT:  ret
;
; RV64ZBB-LABEL: max_i64:
; RV64ZBB:     # %bb.0:
; RV64ZBB-NEXT:  max a0, a0, a1
; RV64ZBB-NEXT:  ret
%cmp = icmp sgt i64 %a, %b
%cond = select i1 %cmp, i64 %a, i64 %b
ret i64 %cond
}

```

```

define signext i32 @minu_i32(i32 signext
%a, i32 signext %b) nounwind {
; RV64I-LABEL: minu_i32:
; RV64I:      # %bb.0:
; RV64I-NEXT:  bltu a0, a1, .LBB22_2
; RV64I-NEXT: # %bb.1:
; RV64I-NEXT:  mv a0, a1
; RV64I-NEXT:  .LBB22_2:
; RV64I-NEXT:  ret
;
; RV64ZBB-LABEL: minu_i32:
; RV64ZBB:     # %bb.0:

```

```

; RV64ZBB-NEXT:  minu a0, a0, a1
; RV64ZBB-NEXT:  ret
%cmp = icmp ult i32 %a, %b
%cond = select i1 %cmp, i32 %a, i32 %b
ret i32 %cond
}

define i64 @minu_i64(i64 %a, i64 %b) nounwind {
; RV64I-LABEL: minu_i64:
; RV64I:      # %bb.0:
; RV64I-NEXT:  bltu a0, a1, .LBB23_2
; RV64I-NEXT:  # %bb.1:
; RV64I-NEXT:  mv a0, a1
; RV64I-NEXT:  .LBB23_2:
; RV64I-NEXT:  ret
;
; RV64ZBB-LABEL: minu_i64:
; RV64ZBB:    # %bb.0:
; RV64ZBB-NEXT:  minu a0, a0, a1
; RV64ZBB-NEXT:  ret
%cmp = icmp ult i64 %a, %b
%cond = select i1 %cmp, i64 %a, i64 %b
ret i64 %cond
}

define signext i32 @maxu_i32(i32 signext %a, i32 signext %b) nounwind {
; RV64I-LABEL: maxu_i32:
; RV64I:      # %bb.0:
; RV64I-NEXT:  bltu a1,
a0, .LBB24_2
; RV64I-NEXT:  # %bb.1:
; RV64I-NEXT:  mv a0, a1
; RV64I-NEXT:  .LBB24_2:
; RV64I-NEXT:  ret
;
; RV64ZBB-LABEL: maxu_i32:
; RV64ZBB:    # %bb.0:
; RV64ZBB-NEXT:  maxu a0, a0, a1
; RV64ZBB-NEXT:  ret
%cmp = icmp ugt i32 %a, %b
%cond = select i1 %cmp, i32 %a, i32 %b
ret i32 %cond
}

define i64 @maxu_i64(i64 %a, i64 %b) nounwind {
; RV64I-LABEL: maxu_i64:
; RV64I:      # %bb.0:
; RV64I-NEXT:  bltu a1, a0, .LBB25_2

```



```

; RV64I-NEXT: # %bb.1:
; RV64I-NEXT: mv a0, a1
; RV64I-NEXT: .LBB25_2:
; RV64I-NEXT: ret
;
; RV64ZBB-LABEL: maxu_i64:
; RV64ZBB: # %bb.0:
; RV64ZBB-NEXT: maxu a0, a0, a1
; RV64ZBB-NEXT: ret
%cmp = icmp ugt i64 %a, %b
%cond = select i1 %cmp, i64 %a, i64 %b
ret i64 %cond
}

declare i32 @llvm.abs.i32(i32, i1 immarg)

define i32 @abs_i32(i32 %x) {
; RV64I-LABEL: abs_i32:
; RV64I: # %bb.0:
; RV64I-NEXT: sraiw a1, a0, 31
; RV64I-NEXT: xor a0, a0, a1
; RV64I-NEXT: subw a0, a0, a1
; RV64I-NEXT: ret
;
; RV64ZBB-LABEL:
abs_i32:
; RV64ZBB: # %bb.0:
; RV64ZBB-NEXT: sraiw a1, a0, 31
; RV64ZBB-NEXT: xor a0, a0, a1
; RV64ZBB-NEXT: subw a0, a0, a1
; RV64ZBB-NEXT: ret
%abs = tail call i32 @llvm.abs.i32(i32 %x, i1 true)
ret i32 %abs
}

define signext i32 @abs_i32_sext(i32 signext %x) {
; RV64I-LABEL: abs_i32_sext:
; RV64I: # %bb.0:
; RV64I-NEXT: sraiw a1, a0, 31
; RV64I-NEXT: xor a0, a0, a1
; RV64I-NEXT: subw a0, a0, a1
; RV64I-NEXT: ret
;
; RV64ZBB-LABEL: abs_i32_sext:
; RV64ZBB: # %bb.0:
; RV64ZBB-NEXT: sraiw a1, a0, 31
; RV64ZBB-NEXT: xor a0, a0, a1
; RV64ZBB-NEXT: subw a0, a0, a1

```

```
; RV64ZBB-NEXT:  ret
%abs = tail call i32 @llvm.abs.i32(i32 %x, i1 true)
ret i32 %abs
}
```

```
declare i64 @llvm.abs.i64(i64, i1 immarg)
```

```
define i64 @abs_i64(i64 %x) {
; RV64I-LABEL: abs_i64:
; RV64I:      # %bb.0:
; RV64I-NEXT:  srai a1, a0, 63
; RV64I-NEXT:  xor a0, a0, a1
; RV64I-NEXT:  sub a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBB-LABEL: abs_i64:
; RV64ZBB:
;   # %bb.0:
; RV64ZBB-NEXT:  neg a1, a0
; RV64ZBB-NEXT:  max a0, a0, a1
; RV64ZBB-NEXT:  ret
%abs = tail call i64 @llvm.abs.i64(i64 %x, i1 true)
ret i64 %abs
}
```

```
define i32 @zexth_i32(i32 %a) nounwind {
; RV64I-LABEL: zexth_i32:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a0, a0, 48
; RV64I-NEXT:  srli a0, a0, 48
; RV64I-NEXT:  ret
;
; RV64ZBB-LABEL: zexth_i32:
; RV64ZBB:      # %bb.0:
; RV64ZBB-NEXT:  slli a0, a0, 48
; RV64ZBB-NEXT:  srli a0, a0, 48
; RV64ZBB-NEXT:  ret
%and = and i32 %a, 65535
ret i32 %and
}
```

```
define i64 @zexth_i64(i64 %a) nounwind {
; RV64I-LABEL: zexth_i64:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a0, a0, 48
; RV64I-NEXT:  srli a0, a0, 48
; RV64I-NEXT:  ret
;
;
```

```
; RV64ZBB-LABEL: zexth_i64:
; RV64ZBB:    # %bb.0:
; RV64ZBB-NEXT:  zext.h a0, a0
; RV64ZBB-NEXT:  ret
%and = and i64 %a, 65535
ret i64 %and
}
```

```
declare i32 @llvm.bswap.i32(i32)
```

```
define signext i32 @bswap_i32(i32 signext %a) nounwind {
; RV64I-LABEL: bswap_i32:
;
; RV64I:    # %bb.0:
; RV64I-NEXT:  srlw a1, a0, 8
; RV64I-NEXT:  lui a2, 16
; RV64I-NEXT:  addiw a2, a2, -256
; RV64I-NEXT:  and a1, a1, a2
; RV64I-NEXT:  srlw a3, a0, 24
; RV64I-NEXT:  or a1, a1, a3
; RV64I-NEXT:  and a2, a0, a2
; RV64I-NEXT:  sllw a2, a2, 8
; RV64I-NEXT:  sllw a0, a0, 24
; RV64I-NEXT:  or a0, a0, a2
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBB-LABEL: bswap_i32:
; RV64ZBB:    # %bb.0:
; RV64ZBB-NEXT:  rev8 a0, a0
; RV64ZBB-NEXT:  srai a0, a0, 32
; RV64ZBB-NEXT:  ret
%1 = tail call i32 @llvm.bswap.i32(i32 %a)
ret i32 %1
}
```

; Similar to bswap\_i32 but the result is not sign extended.

```
define void @bswap_i32_nosext(i32 signext %a, ptr %x) nounwind {
; RV64I-LABEL: bswap_i32_nosext:
; RV64I:    # %bb.0:
; RV64I-NEXT:  srlw a2, a0, 8
; RV64I-NEXT:  lui a3, 16
; RV64I-NEXT:  addi a3, a3, -256
; RV64I-NEXT:  and a2, a2, a3
; RV64I-NEXT:  srlw a4, a0, 24
; RV64I-NEXT:  or a2, a2, a4
; RV64I-NEXT:
```

```

    and a3, a0, a3
; RV64I-NEXT:  slli a3, a3, 8
; RV64I-NEXT:  slli a0, a0, 24
; RV64I-NEXT:  or a0, a0, a3
; RV64I-NEXT:  or a0, a0, a2
; RV64I-NEXT:  sw a0, 0(a1)
; RV64I-NEXT:  ret
;
; RV64ZBB-LABEL: bswap_i32_nosext:
; RV64ZBB:      # %bb.0:
; RV64ZBB-NEXT:  rev8 a0, a0
; RV64ZBB-NEXT:  srli a0, a0, 32
; RV64ZBB-NEXT:  sw a0, 0(a1)
; RV64ZBB-NEXT:  ret
%1 = tail call i32 @llvm.bswap.i32(i32 %a)
store i32 %1, ptr %x
ret void
}

```

```

declare i64 @llvm.bswap.i64(i64)

```

```

define i64 @bswap_i64(i64 %a) {
; RV64I-LABEL: bswap_i64:
; RV64I:      # %bb.0:
; RV64I-NEXT:  srli a1, a0, 40
; RV64I-NEXT:  lui a2, 16
; RV64I-NEXT:  addiw a2, a2, -256
; RV64I-NEXT:  and a1, a1, a2
; RV64I-NEXT:  srli a3, a0, 56
; RV64I-NEXT:  or a1, a1, a3
; RV64I-NEXT:  srli a3, a0, 24
; RV64I-NEXT:  lui a4, 4080
; RV64I-NEXT:  and a3, a3, a4
; RV64I-NEXT:  srli a5, a0, 8
; RV64I-NEXT:  srliw a5, a5, 24
; RV64I-NEXT:  slli a5, a5, 24
; RV64I-NEXT:  or a3, a5, a3
; RV64I-NEXT:
    or a1, a3, a1
; RV64I-NEXT:  and a4, a0, a4
; RV64I-NEXT:  slli a4, a4, 24
; RV64I-NEXT:  srliw a3, a0, 24
; RV64I-NEXT:  slli a3, a3, 32
; RV64I-NEXT:  or a3, a4, a3
; RV64I-NEXT:  and a2, a0, a2
; RV64I-NEXT:  slli a2, a2, 40
; RV64I-NEXT:  slli a0, a0, 56
; RV64I-NEXT:  or a0, a0, a2

```

```

; RV64I-NEXT:  or a0, a0, a3
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBB-LABEL: bswap_i64:
; RV64ZBB:      # %bb.0:
; RV64ZBB-NEXT:  rev8 a0, a0
; RV64ZBB-NEXT:  ret
%1 = call i64 @llvm.bswap.i64(i64 %a)
ret i64 %1
}
; NOTE: Assertions have been autogenerated by utils/update_llc_test_checks.py
; RUN: llc -mtriple=riscv64 -verify-machineinstrs < %s \
; RUN: -riscv-experimental-rv64-legal-i32 | FileCheck %s -check-prefix=RV64I
; RUN: llc -mtriple=riscv64 -mattr=+zbbk -verify-machineinstrs < %s \
; RUN: -riscv-experimental-rv64-legal-i32 | FileCheck %s -check-prefix=RV64ZBKB

```

```

define signext i32 @pack_i32(i32 signext %a, i32 signext %b) nounwind {
; RV64I-LABEL: pack_i32:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a0, a0, 48
; RV64I-NEXT:  srli a0, a0, 48
; RV64I-NEXT:  slliw a1, a1, 16
; RV64I-NEXT:  or a0, a1, a0
; RV64I-NEXT:  ret
;
; RV64ZBKB-LABEL: pack_i32:
; RV64ZBKB:    # %bb.0:
; RV64ZBKB-NEXT:  packw a0, a0, a1
; RV64ZBKB-NEXT:  ret
%shl = and i32 %a, 65535
%shl1 = shl i32 %b, 16
%or = or i32 %shl1, %shl
ret i32 %or
}

```

```

define signext i32 @pack_i32_2(i16 zeroext %a, i16 zeroext %b) nounwind {
; RV64I-LABEL: pack_i32_2:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slliw
a1, a1, 16
; RV64I-NEXT:  or a0, a1, a0
; RV64I-NEXT:  ret
;
; RV64ZBKB-LABEL: pack_i32_2:
; RV64ZBKB:    # %bb.0:
; RV64ZBKB-NEXT:  packw a0, a0, a1
; RV64ZBKB-NEXT:  ret

```

```

%zexta = zext i16 %a to i32
%zextb = zext i16 %b to i32
%shl1 = shl i32 %zextb, 16
%or = or i32 %shl1, %zexta
ret i32 %or
}

```

; Test case where we don't have a sign\_extend\_inreg after the or.

```

define signext i32 @pack_i32_3(i16 zeroext %0, i16 zeroext %1, i32 signext %2) {
; RV64I-LABEL: pack_i32_3:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a0, a0, 16
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  addw a0, a0, a2
; RV64I-NEXT:  ret
;
; RV64ZBKB-LABEL: pack_i32_3:
; RV64ZBKB:    # %bb.0:
; RV64ZBKB-NEXT:  packw a0, a1, a0
; RV64ZBKB-NEXT:  addw a0, a0, a2
; RV64ZBKB-NEXT:  ret
%4 = zext i16 %0 to i32
%5 = shl nuw i32 %4, 16
%6 = zext i16 %1 to i32
%7 = or i32 %5, %6
%8 = add i32 %7, %2
ret i32 %8
}

```

```

define i64 @pack_i64(i64 %a, i64 %b) nounwind {
; RV64I-LABEL: pack_i64:
;
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  srli a0, a0, 32
; RV64I-NEXT:  slli a1, a1, 32
; RV64I-NEXT:  or a0, a1, a0
; RV64I-NEXT:  ret
;
; RV64ZBKB-LABEL: pack_i64:
; RV64ZBKB:    # %bb.0:
; RV64ZBKB-NEXT:  pack a0, a0, a1
; RV64ZBKB-NEXT:  ret
%shl = and i64 %a, 4294967295
%shl1 = shl i64 %b, 32
%or = or i64 %shl1, %shl
ret i64 %or
}

```

```

define i64 @pack_i64_2(i32 signext %a, i32 signext %b) nounwind {
; RV64I-LABEL: pack_i64_2:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  srli a0, a0, 32
; RV64I-NEXT:  slli a1, a1, 32
; RV64I-NEXT:  or a0, a1, a0
; RV64I-NEXT:  ret
;
; RV64ZBKB-LABEL: pack_i64_2:
; RV64ZBKB:    # %bb.0:
; RV64ZBKB-NEXT:  pack a0, a0, a1
; RV64ZBKB-NEXT:  ret
%zexta = zext i32 %a to i64
%zextb = zext i32 %b to i64
%shl1 = shl i64 %zextb, 32
%or = or i64 %shl1, %zexta
ret i64 %or
}

```

```

define i64 @pack_i64_3(ptr %0, ptr %1) {
; RV64I-LABEL: pack_i64_3:
; RV64I:      #
%bb.0:
; RV64I-NEXT:  lw a0, 0(a0)
; RV64I-NEXT:  lwu a1, 0(a1)
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBKB-LABEL: pack_i64_3:
; RV64ZBKB:    # %bb.0:
; RV64ZBKB-NEXT:  lw a0, 0(a0)
; RV64ZBKB-NEXT:  lwu a1, 0(a1)
; RV64ZBKB-NEXT:  pack a0, a1, a0
; RV64ZBKB-NEXT:  ret
%3 = load i32, ptr %0, align 4
%4 = zext i32 %3 to i64
%5 = shl i64 %4, 32
%6 = load i32, ptr %1, align 4
%7 = zext i32 %6 to i64
%8 = or i64 %5, %7
ret i64 %8
}

```

```

define signext i32 @packh_i32(i32 signext %a, i32 signext %b) nounwind {
; RV64I-LABEL: packh_i32:

```

```

; RV64I:    # %bb.0:
; RV64I-NEXT:  andi a0, a0, 255
; RV64I-NEXT:  slli a1, a1, 56
; RV64I-NEXT:  srli a1, a1, 48
; RV64I-NEXT:  or a0, a1, a0
; RV64I-NEXT:  ret
;
; RV64ZBKB-LABEL: packh_i32:
; RV64ZBKB:    # %bb.0:
; RV64ZBKB-NEXT:  packh a0, a0, a1
; RV64ZBKB-NEXT:  ret
%and = and i32 %a, 255
%and1 = shl i32 %b, 8
%shl = and i32 %and1, 65280
%or = or
i32 %shl, %and
ret i32 %or
}

define i32 @packh_i32_2(i32 %a, i32 %b) nounwind {
; RV64I-LABEL: packh_i32_2:
; RV64I:    # %bb.0:
; RV64I-NEXT:  andi a0, a0, 255
; RV64I-NEXT:  andi a1, a1, 255
; RV64I-NEXT:  slliw a1, a1, 8
; RV64I-NEXT:  or a0, a1, a0
; RV64I-NEXT:  ret
;
; RV64ZBKB-LABEL: packh_i32_2:
; RV64ZBKB:    # %bb.0:
; RV64ZBKB-NEXT:  packh a0, a0, a1
; RV64ZBKB-NEXT:  ret
%and = and i32 %a, 255
%and1 = and i32 %b, 255
%shl = shl i32 %and1, 8
%or = or i32 %shl, %and
ret i32 %or
}

define i64 @packh_i64(i64 %a, i64 %b) nounwind {
; RV64I-LABEL: packh_i64:
; RV64I:    # %bb.0:
; RV64I-NEXT:  andi a0, a0, 255
; RV64I-NEXT:  slli a1, a1, 56
; RV64I-NEXT:  srli a1, a1, 48
; RV64I-NEXT:  or a0, a1, a0
; RV64I-NEXT:  ret
;

```



```

; RV64ZBKB-LABEL: packh_i64:
; RV64ZBKB:    # %bb.0:
; RV64ZBKB-NEXT:  packh a0, a0, a1
; RV64ZBKB-NEXT:  ret
%and = and i64 %a, 255
%and1 = shl i64 %b, 8
%shl = and i64 %and1, 65280
%or = or i64 %shl,
%and
ret i64 %or
}

define i64 @packh_i64_2(i64 %a, i64 %b) nounwind {
; RV64I-LABEL: packh_i64_2:
; RV64I:    # %bb.0:
; RV64I-NEXT:  andi a0, a0, 255
; RV64I-NEXT:  andi a1, a1, 255
; RV64I-NEXT:  slli a1, a1, 8
; RV64I-NEXT:  or a0, a1, a0
; RV64I-NEXT:  ret
;
; RV64ZBKB-LABEL: packh_i64_2:
; RV64ZBKB:    # %bb.0:
; RV64ZBKB-NEXT:  packh a0, a0, a1
; RV64ZBKB-NEXT:  ret
%and = and i64 %a, 255
%and1 = and i64 %b, 255
%shl = shl i64 %and1, 8
%or = or i64 %shl, %and
ret i64 %or
}

define zeroext i16 @packh_i16(i8 zeroext %a, i8 zeroext %b) nounwind {
; RV64I-LABEL: packh_i16:
; RV64I:    # %bb.0:
; RV64I-NEXT:  slliw a1, a1, 8
; RV64I-NEXT:  or a0, a1, a0
; RV64I-NEXT:  ret
;
; RV64ZBKB-LABEL: packh_i16:
; RV64ZBKB:    # %bb.0:
; RV64ZBKB-NEXT:  packh a0, a0, a1
; RV64ZBKB-NEXT:  ret
%zext = zext i8 %a to i16
%zext1 = zext i8 %b to i16
%shl = shl i16 %zext1, 8
%or = or i16 %shl, %zext
ret i16 %or
}

```

```
}
```

```
define zeroext i16 @packh_i16_2(i8
  zeroext %0, i8 zeroext %1, i8 zeroext %2) {
; RV64I-LABEL: packh_i16_2:
; RV64I:      # %bb.0:
; RV64I-NEXT:  add a0, a1, a0
; RV64I-NEXT:  slli a0, a0, 8
; RV64I-NEXT:  or a0, a0, a2
; RV64I-NEXT:  slli a0, a0, 48
; RV64I-NEXT:  srli a0, a0, 48
; RV64I-NEXT:  ret
;
; RV64ZBKB-LABEL: packh_i16_2:
; RV64ZBKB:    # %bb.0:
; RV64ZBKB-NEXT:  add a0, a1, a0
; RV64ZBKB-NEXT:  packh a0, a2, a0
; RV64ZBKB-NEXT:  ret
  %4 = add i8 %1, %0
  %5 = zext i8 %4 to i16
  %6 = shl i16 %5, 8
  %7 = zext i8 %2 to i16
  %8 = or i16 %6, %7
  ret i16 %8
}
```

```
define i64 @pack_i64_allWUsers(i32 signext %0, i32 signext %1, i32 signext %2) {
; RV64I-LABEL: pack_i64_allWUsers:
; RV64I:      # %bb.0:
; RV64I-NEXT:  add a0, a1, a0
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  slli a2, a2, 32
; RV64I-NEXT:  srli a2, a2, 32
; RV64I-NEXT:  or a0, a0, a2
; RV64I-NEXT:  ret
;
; RV64ZBKB-LABEL: pack_i64_allWUsers:
; RV64ZBKB:    # %bb.0:
; RV64ZBKB-NEXT:  add a0, a1, a0
; RV64ZBKB-NEXT:
  pack a0, a2, a0
; RV64ZBKB-NEXT:  ret
  %4 = add i32 %1, %0
  %5 = zext i32 %4 to i64
  %6 = shl i64 %5, 32
  %7 = zext i32 %2 to i64
  %8 = or i64 %6, %7
  ret i64 %8
}
```

```
}
```

```
define signext i32 @pack_i32_allWUsers(i16 zeroext %0, i16 zeroext %1, i16 zeroext %2) {  
; RV64I-LABEL: pack_i32_allWUsers:  
; RV64I:    # %bb.0:  
; RV64I-NEXT:  add a0, a1, a0  
; RV64I-NEXT:  slliw a0, a0, 16  
; RV64I-NEXT:  or a0, a0, a2  
; RV64I-NEXT:  ret  
;  
; RV64ZBKB-LABEL: pack_i32_allWUsers:  
; RV64ZBKB:    # %bb.0:  
; RV64ZBKB-NEXT:  add a0, a1, a0  
; RV64ZBKB-NEXT:  packw a0, a2, a0  
; RV64ZBKB-NEXT:  ret  
%4 = add i16 %1, %0  
%5 = zext i16 %4 to i32  
%6 = shl i32 %5, 16  
%7 = zext i16 %2 to i32  
%8 = or i32 %6, %7  
ret i32 %8  
}
```

```
define i64 @pack_i64_imm() {  
; RV64I-LABEL: pack_i64_imm:  
; RV64I:    # %bb.0:  
; RV64I-NEXT:  lui a0, 65793  
; RV64I-NEXT:  addiw a0, a0, 16  
; RV64I-NEXT:  slli a1, a0, 32  
; RV64I-NEXT:  add a0, a0, a1  
; RV64I-NEXT:  ret  
;  
; RV64ZBKB-LABEL:  
pack_i64_imm:  
; RV64ZBKB:    # %bb.0:  
; RV64ZBKB-NEXT:  lui a0, 65793  
; RV64ZBKB-NEXT:  addi a0, a0, 16  
; RV64ZBKB-NEXT:  pack a0, a0, a0  
; RV64ZBKB-NEXT:  ret  
ret i64 1157442765409226768 ; 0x0101010101010101  
}  
; NOTE: Assertions have been autogenerated by utils/update_llc_test_checks.py  
; RUN: llc -mtriple=riscv64 -verify-machineinstrs < %s \  
; RUN: -riscv-experimental-rv64-legal-i32 | FileCheck -check-prefix=RV64I %s
```

```
; Check indexed and unindexed, sext, zext and anyext loads
```

```
define void @lb(ptr %a, ptr %b) nounwind {
```

```

; RV64I-LABEL: lb:
; RV64I:      # %bb.0:
; RV64I-NEXT: lb a2, 1(a0)
; RV64I-NEXT: lbu zero, 0(a0)
; RV64I-NEXT: sw a2, 0(a1)
; RV64I-NEXT: ret
%1 = getelementptr i8, ptr %a, i32 1
%2 = load i8, ptr %1
%3 = sext i8 %2 to i32
; the unused load will produce an anyext for selection
%4 = load volatile i8, ptr %a
store i32 %3, ptr %b
ret void
}

```

```

define void @lbu(ptr %a, ptr %b) nounwind {
; RV64I-LABEL: lbu:
; RV64I:      # %bb.0:
; RV64I-NEXT: lbu a0, 1(a0)
; RV64I-NEXT: sw a0, 0(a1)
; RV64I-NEXT: ret
%1 = getelementptr i8, ptr %a, i32 1
%2 = load i8, ptr %1
%3 = zext i8 %2 to i32
store i32 %3, ptr %b
ret void
}

```

```

define void @lh(ptr
%a, ptr %b) nounwind {
; RV64I-LABEL: lh:
; RV64I:      # %bb.0:
; RV64I-NEXT: lh a2, 2(a0)
; RV64I-NEXT: lh zero, 0(a0)
; RV64I-NEXT: sw a2, 0(a1)
; RV64I-NEXT: ret
%1 = getelementptr i16, ptr %a, i32 1
%2 = load i16, ptr %1
%3 = sext i16 %2 to i32
; the unused load will produce an anyext for selection
%4 = load volatile i16, ptr %a
store i32 %3, ptr %b
ret void
}

```

```

define void @lhu(ptr %a, ptr %b) nounwind {
; RV64I-LABEL: lhu:
; RV64I:      # %bb.0:

```

```
; RV64I-NEXT:  lhu a0, 2(a0)
; RV64I-NEXT:  sw a0, 0(a1)
; RV64I-NEXT:  ret
%1 = getelementptr i16, ptr %a, i32 1
%2 = load i16, ptr %1
%3 = zext i16 %2 to i32
store i32 %3, ptr %b
ret void
}
```

```
define void @lw(ptr %a, ptr %b) nounwind {
; RV64I-LABEL: lw:
; RV64I:      # %bb.0:
; RV64I-NEXT:  lw a2, 4(a0)
; RV64I-NEXT:  lw zero, 0(a0)
; RV64I-NEXT:  sd a2, 0(a1)
; RV64I-NEXT:  ret
%1 = getelementptr i32, ptr %a, i64 1
%2 = load i32, ptr %1
%3 = sext i32 %2 to i64
; the unused load
will produce an anyext for selection
%4 = load volatile i32, ptr %a
store i64 %3, ptr %b
ret void
}
```

```
define void @lwu(ptr %a, ptr %b) nounwind {
; RV64I-LABEL: lwu:
; RV64I:      # %bb.0:
; RV64I-NEXT:  lwu a0, 4(a0)
; RV64I-NEXT:  sd a0, 0(a1)
; RV64I-NEXT:  ret
%1 = getelementptr i32, ptr %a, i64 1
%2 = load i32, ptr %1
%3 = zext i32 %2 to i64
store i64 %3, ptr %b
ret void
}
```

```
; NOTE: Assertions have been autogenerated by utils/update_llc_test_checks.py
; RUN: llc -mtriple=riscv64 -riscv-disable-using-constant-pool-for-large-ints -verify-machineinstrs < %s \
; RUN: -riscv-experimental-rv64-legal-i32 | FileCheck %s -check-prefixes=RV64I,RV64I-NOPOOL
; RUN: llc -mtriple=riscv64 -verify-machineinstrs < %s \
; RUN: -riscv-experimental-rv64-legal-i32 | FileCheck %s -check-prefixes=RV64I,RV64I-POOL
; RUN: llc -mtriple=riscv64 -riscv-disable-using-constant-pool-for-large-ints -mattr=+zba \
; RUN: -riscv-experimental-rv64-legal-i32 -verify-machineinstrs < %s | FileCheck %s -check-prefix=RV64IZBA
; RUN: llc -mtriple=riscv64 -riscv-disable-using-constant-pool-for-large-ints -mattr=+zbb \
; RUN: -riscv-experimental-rv64-legal-i32 -verify-machineinstrs < %s | FileCheck %s -check-prefix=RV64IZBB
```

```
; RUN: llc -mtriple=riscv64 -riscv-disable-using-constant-pool-for-large-ints -mattr=+zbs \
; RUN: -riscv-experimental-rv64-legal-i32 -verify-machineinstrs < %s | FileCheck
% s -check-prefix=RV64IZBS
; RUN: llc -mtriple=riscv64 -riscv-disable-using-constant-pool-for-large-ints -mattr=+xtheadbb \
; RUN: -riscv-experimental-rv64-legal-i32 -verify-machineinstrs < %s | FileCheck %s -check-
prefix=RV64IXTHEADBB
```

```
; Materializing constants
```

```
; TODO: It would be preferable if anyext constant returns were sign rather
; than zero extended. See PR39092. For now, mark returns as explicitly signext
; (this matches what Clang would generate for equivalent C/C++ anyway).
```

```
define signext i32 @zero() nounwind {
; RV64I-LABEL: zero:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a0, 0
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: zero:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  li a0, 0
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: zero:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  li a0, 0
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: zero:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:  li a0, 0
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: zero:
; RV64IXTHEADBB:  # %bb.0:
;
; RV64IXTHEADBB-NEXT:  li a0, 0
; RV64IXTHEADBB-NEXT:  ret
ret i32 0
}
```

```
define signext i32 @pos_small() nounwind {
; RV64I-LABEL: pos_small:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a0, 2047
; RV64I-NEXT:  ret
;
;
```

```

; RV64IZBA-LABEL: pos_small:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  li a0, 2047
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: pos_small:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  li a0, 2047
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: pos_small:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:  li a0, 2047
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: pos_small:
; RV64IXTHEADBB:  # %bb.0:
; RV64IXTHEADBB-NEXT:  li a0, 2047
; RV64IXTHEADBB-NEXT:  ret
ret i32 2047
}

```

```

define signext i32 @neg_small() nounwind {
; RV64I-LABEL: neg_small:
; RV64I:    # %bb.0:
; RV64I-NEXT:  li a0, -2048
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: neg_small:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  li a0, -2048
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL:
neg_small:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  li a0, -2048
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: neg_small:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:  li a0, -2048
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: neg_small:
; RV64IXTHEADBB:  # %bb.0:
; RV64IXTHEADBB-NEXT:  li a0, -2048
; RV64IXTHEADBB-NEXT:  ret
}

```

```

ret i32 -2048
}

define signext i32 @pos_i32() nounwind {
; RV64I-LABEL: pos_i32:
; RV64I:      # %bb.0:
; RV64I-NEXT:  lui a0, 423811
; RV64I-NEXT:  addiw a0, a0, -1297
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: pos_i32:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  lui a0, 423811
; RV64IZBA-NEXT:  addiw a0, a0, -1297
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: pos_i32:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  lui a0, 423811
; RV64IZBB-NEXT:  addiw a0, a0, -1297
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: pos_i32:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:  lui a0, 423811
; RV64IZBS-NEXT:  addiw a0, a0, -1297
; RV64IZBS-NEXT:
    ret
;
; RV64IXTHEADBB-LABEL: pos_i32:
; RV64IXTHEADBB:    # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 423811
; RV64IXTHEADBB-NEXT:  addiw a0, a0, -1297
; RV64IXTHEADBB-NEXT:  ret
ret i32 1735928559
}

```

```

define signext i32 @neg_i32() nounwind {
; RV64I-LABEL: neg_i32:
; RV64I:      # %bb.0:
; RV64I-NEXT:  lui a0, 912092
; RV64I-NEXT:  addiw a0, a0, -273
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: neg_i32:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  lui a0, 912092
; RV64IZBA-NEXT:  addiw a0, a0, -273

```



```

; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: neg_i32:
; RV64IZBB:      # %bb.0:
; RV64IZBB-NEXT:  lui a0, 912092
; RV64IZBB-NEXT:  addiw a0, a0, -273
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: neg_i32:
; RV64IZBS:      # %bb.0:
; RV64IZBS-NEXT:  lui a0, 912092
; RV64IZBS-NEXT:  addiw a0, a0, -273
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: neg_i32:
; RV64IXTHEADBB:  # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 912092
; RV64IXTHEADBB-NEXT:  addiw a0, a0, -273
;
RV64IXTHEADBB-NEXT:  ret
ret i32 -559038737
}

define signext i32 @pos_i32_hi20_only() nounwind {
; RV64I-LABEL: pos_i32_hi20_only:
; RV64I:      # %bb.0:
; RV64I-NEXT:  lui a0, 16
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: pos_i32_hi20_only:
; RV64IZBA:      # %bb.0:
; RV64IZBA-NEXT:  lui a0, 16
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: pos_i32_hi20_only:
; RV64IZBB:      # %bb.0:
; RV64IZBB-NEXT:  lui a0, 16
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: pos_i32_hi20_only:
; RV64IZBS:      # %bb.0:
; RV64IZBS-NEXT:  lui a0, 16
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: pos_i32_hi20_only:
; RV64IXTHEADBB:  # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 16
; RV64IXTHEADBB-NEXT:  ret

```

```

ret i32 65536 ; 0x10000
}

define signext i32 @neg_i32_hi20_only() nounwind {
; RV64I-LABEL: neg_i32_hi20_only:
; RV64I:      # %bb.0:
; RV64I-NEXT:  lui a0, 1048560
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: neg_i32_hi20_only:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  lui a0,
1048560
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: neg_i32_hi20_only:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  lui a0, 1048560
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: neg_i32_hi20_only:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:  lui a0, 1048560
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: neg_i32_hi20_only:
; RV64IXTHEADBB:  # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 1048560
; RV64IXTHEADBB-NEXT:  ret
ret i32 -65536 ; -0x10000
}

```

; This can be materialized with ADDI+SLLI, improving compressibility.

```

define signext i32 @imm_left_shifted_addi() nounwind {
; RV64I-LABEL: imm_left_shifted_addi:
; RV64I:      # %bb.0:
; RV64I-NEXT:  lui a0, 32
; RV64I-NEXT:  addiw a0, a0, -64
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm_left_shifted_addi:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  lui a0, 32
; RV64IZBA-NEXT:  addiw a0, a0, -64
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm_left_shifted_addi:

```

```

; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  lui a0, 32
;
RV64IZBB-NEXT:  addiw a0, a0, -64
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm_left_shifted_addi:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:  lui a0, 32
; RV64IZBS-NEXT:  addiw a0, a0, -64
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm_left_shifted_addi:
; RV64IXTHEADBB:    # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 32
; RV64IXTHEADBB-NEXT:  addiw a0, a0, -64
; RV64IXTHEADBB-NEXT:  ret
ret i32 131008 ; 0x1FFC0
}

```

; This can be materialized with ADDI+SRLI, improving compressibility.

```

define signext i32 @imm_right_shifted_addi() nounwind {
; RV64I-LABEL: imm_right_shifted_addi:
; RV64I:    # %bb.0:
; RV64I-NEXT:  lui a0, 524288
; RV64I-NEXT:  addiw a0, a0, -1
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm_right_shifted_addi:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  lui a0, 524288
; RV64IZBA-NEXT:  addiw a0, a0, -1
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm_right_shifted_addi:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  lui a0, 524288
; RV64IZBB-NEXT:
    addiw a0, a0, -1
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm_right_shifted_addi:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:  lui a0, 524288
; RV64IZBS-NEXT:  addiw a0, a0, -1
; RV64IZBS-NEXT:  ret
;
}

```

```

; RV64IXTHEADBB-LABEL: imm_right_shifted_addi:
; RV64IXTHEADBB:    # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 524288
; RV64IXTHEADBB-NEXT:  addiw a0, a0, -1
; RV64IXTHEADBB-NEXT:  ret
ret i32 2147483647 ; 0x7FFFFFFF
}

```

; This can be materialized with LUI+SRLI, improving compressibility.

```

define signext i32 @imm_right_shifted_lui() nounwind {
; RV64I-LABEL: imm_right_shifted_lui:
; RV64I:    # %bb.0:
; RV64I-NEXT:  lui a0, 56
; RV64I-NEXT:  addiw a0, a0, 580
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm_right_shifted_lui:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  lui a0, 56
; RV64IZBA-NEXT:  addiw a0, a0, 580
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm_right_shifted_lui:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  lui a0, 56
; RV64IZBB-NEXT:  addiw a0, a0, 580
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm_right_shifted_lui:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:  lui a0, 56
; RV64IZBS-NEXT:  addiw a0, a0, 580
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm_right_shifted_lui:
; RV64IXTHEADBB:    # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 56
; RV64IXTHEADBB-NEXT:  addiw a0, a0, 580
; RV64IXTHEADBB-NEXT:  ret
ret i32 229956 ; 0x38244
}

```

```

define i64 @imm64_1() nounwind {
; RV64I-LABEL: imm64_1:
; RV64I:    # %bb.0:
; RV64I-NEXT:  li a0, 1

```

```

; RV64I-NEXT:  slli a0, a0, 31
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm64_1:
; RV64IZBA:      # %bb.0:
; RV64IZBA-NEXT:  li a0, 1
; RV64IZBA-NEXT:  slli a0, a0, 31
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm64_1:
; RV64IZBB:      # %bb.0:
; RV64IZBB-NEXT:  li a0, 1
; RV64IZBB-NEXT:  slli a0, a0, 31
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm64_1:
; RV64IZBS:      # %bb.0:
; RV64IZBS-NEXT:  bseti a0, zero, 31
; RV64IZBS-NEXT:  ret
;
;
RV64IXTHEADBB-LABEL: imm64_1:
; RV64IXTHEADBB:  # %bb.0:
; RV64IXTHEADBB-NEXT:  li a0, 1
; RV64IXTHEADBB-NEXT:  slli a0, a0, 31
; RV64IXTHEADBB-NEXT:  ret
ret i64 2147483648 ; 0x8000_0000
}

```

```

define i64 @imm64_2() nounwind {
; RV64I-LABEL: imm64_2:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a0, -1
; RV64I-NEXT:  srli a0, a0, 32
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm64_2:
; RV64IZBA:      # %bb.0:
; RV64IZBA-NEXT:  li a0, -1
; RV64IZBA-NEXT:  srli a0, a0, 32
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm64_2:
; RV64IZBB:      # %bb.0:
; RV64IZBB-NEXT:  li a0, -1
; RV64IZBB-NEXT:  srli a0, a0, 32
; RV64IZBB-NEXT:  ret
;
}

```

```

; RV64IZBS-LABEL: imm64_2:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:  li a0, -1
; RV64IZBS-NEXT:  srli a0, a0, 32
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm64_2:
; RV64IXTHEADBB:    # %bb.0:
; RV64IXTHEADBB-NEXT:  li a0, -1
; RV64IXTHEADBB-NEXT:  srli a0, a0, 32
; RV64IXTHEADBB-NEXT:  ret
ret i64 4294967295 ;
0xFFFF_FFFF
}

```

```

define i64 @imm64_3() nounwind {
; RV64I-LABEL: imm64_3:
; RV64I:    # %bb.0:
; RV64I-NEXT:  li a0, 1
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm64_3:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  li a0, 1
; RV64IZBA-NEXT:  slli a0, a0, 32
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm64_3:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  li a0, 1
; RV64IZBB-NEXT:  slli a0, a0, 32
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm64_3:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:  bseti a0, zero, 32
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm64_3:
; RV64IXTHEADBB:    # %bb.0:
; RV64IXTHEADBB-NEXT:  li a0, 1
; RV64IXTHEADBB-NEXT:  slli a0, a0, 32
; RV64IXTHEADBB-NEXT:  ret
ret i64 4294967296 ; 0x1_0000_0000
}

```

```

define i64 @imm64_4() nounwind {

```

```

; RV64I-LABEL: imm64_4:
; RV64I:    # %bb.0:
; RV64I-NEXT:  li a0, -1
; RV64I-NEXT:  slli a0, a0, 63
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm64_4:
; RV64IZBA:
;   # %bb.0:
; RV64IZBA-NEXT:  li a0, -1
; RV64IZBA-NEXT:  slli a0, a0, 63
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm64_4:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  li a0, -1
; RV64IZBB-NEXT:  slli a0, a0, 63
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm64_4:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:  bseti a0, zero, 63
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm64_4:
; RV64IXTHEADBB:    # %bb.0:
; RV64IXTHEADBB-NEXT:  li a0, -1
; RV64IXTHEADBB-NEXT:  slli a0, a0, 63
; RV64IXTHEADBB-NEXT:  ret
ret i64 9223372036854775808 ; 0x8000_0000_0000_0000
}

```

```

define i64 @imm64_5() nounwind {
; RV64I-LABEL: imm64_5:
; RV64I:    # %bb.0:
; RV64I-NEXT:  li a0, -1
; RV64I-NEXT:  slli a0, a0, 63
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm64_5:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  li a0, -1
; RV64IZBA-NEXT:  slli a0, a0, 63
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm64_5:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  li a0, -1

```

```

; RV64IZBB-NEXT:
    slli a0, a0, 63
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm64_5:
; RV64IZBS:      # %bb.0:
; RV64IZBS-NEXT:  bseti a0, zero, 63
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm64_5:
; RV64IXTHEADBB:  # %bb.0:
; RV64IXTHEADBB-NEXT:  li a0, -1
; RV64IXTHEADBB-NEXT:  slli a0, a0, 63
; RV64IXTHEADBB-NEXT:  ret
ret i64 -9223372036854775808 ; 0x8000_0000_0000_0000
}

```

```

define i64 @imm64_6() nounwind {
; RV64I-LABEL: imm64_6:
; RV64I:      # %bb.0:
; RV64I-NEXT:  lui a0, 9321
; RV64I-NEXT:  addi a0, a0, -1329
; RV64I-NEXT:  slli a0, a0, 35
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm64_6:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  lui a0, 9321
; RV64IZBA-NEXT:  addi a0, a0, -1329
; RV64IZBA-NEXT:  slli a0, a0, 35
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm64_6:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  lui a0, 9321
; RV64IZBB-NEXT:  addi a0, a0, -1329
; RV64IZBB-NEXT:  slli a0, a0, 35
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm64_6:
;
RV64IZBS:      # %bb.0:
; RV64IZBS-NEXT:  lui a0, 9321
; RV64IZBS-NEXT:  addi a0, a0, -1329
; RV64IZBS-NEXT:  slli a0, a0, 35
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm64_6:

```



```
; RV64IXTHEADBB:    # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 9321
; RV64IXTHEADBB-NEXT:  addi a0, a0, -1329
; RV64IXTHEADBB-NEXT:  slli a0, a0, 35
; RV64IXTHEADBB-NEXT:  ret
ret i64 1311768464867721216 ; 0x1234_5678_0000_0000
}
```

```
define i64 @imm64_7() nounwind {
; RV64I-LABEL: imm64_7:
; RV64I:    # %bb.0:
; RV64I-NEXT:  li a0, 7
; RV64I-NEXT:  slli a0, a0, 36
; RV64I-NEXT:  addi a0, a0, 11
; RV64I-NEXT:  slli a0, a0, 24
; RV64I-NEXT:  addi a0, a0, 15
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm64_7:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  li a0, 7
; RV64IZBA-NEXT:  slli a0, a0, 36
; RV64IZBA-NEXT:  addi a0, a0, 11
; RV64IZBA-NEXT:  slli a0, a0, 24
; RV64IZBA-NEXT:  addi a0, a0, 15
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm64_7:
; RV64IZBB:    #
%bb.0:
; RV64IZBB-NEXT:  li a0, 7
; RV64IZBB-NEXT:  slli a0, a0, 36
; RV64IZBB-NEXT:  addi a0, a0, 11
; RV64IZBB-NEXT:  slli a0, a0, 24
; RV64IZBB-NEXT:  addi a0, a0, 15
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm64_7:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:  li a0, 7
; RV64IZBS-NEXT:  slli a0, a0, 36
; RV64IZBS-NEXT:  addi a0, a0, 11
; RV64IZBS-NEXT:  slli a0, a0, 24
; RV64IZBS-NEXT:  addi a0, a0, 15
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm64_7:
; RV64IXTHEADBB:    # %bb.0:
```

```
; RV64IXTHEADBB-NEXT: li a0, 7
; RV64IXTHEADBB-NEXT: slli a0, a0, 36
; RV64IXTHEADBB-NEXT: addi a0, a0, 11
; RV64IXTHEADBB-NEXT: slli a0, a0, 24
; RV64IXTHEADBB-NEXT: addi a0, a0, 15
; RV64IXTHEADBB-NEXT: ret
ret i64 8070450532432478223 ; 0x7000_0000_0B00_000F
}
```

; TODO: it can be preferable to put constants that are expensive to materialise  
; into the constant pool, especially for -Os.

```
define i64 @imm64_8() nounwind {
; RV64-NOPOOL-LABEL: imm64_8:
; RV64-NOPOOL:
;   # %bb.0:
; RV64-NOPOOL-NEXT: lui a0, 583
; RV64-NOPOOL-NEXT: addiw a0, a0, -1875
; RV64-NOPOOL-NEXT: slli a0, a0, 14
; RV64-NOPOOL-NEXT: addi a0, a0, -947
; RV64-NOPOOL-NEXT: slli a0, a0, 12
; RV64-NOPOOL-NEXT: addi a0, a0, 1511
; RV64-NOPOOL-NEXT: slli a0, a0, 13
; RV64-NOPOOL-NEXT: addi a0, a0, -272
; RV64-NOPOOL-NEXT: ret
;
; RV64I-POOL-LABEL: imm64_8:
; RV64I-POOL:   # %bb.0:
; RV64I-POOL-NEXT: lui a0, %hi(.LCPI17_0)
; RV64I-POOL-NEXT: ld a0, %lo(.LCPI17_0)(a0)
; RV64I-POOL-NEXT: ret
;
; RV64IZBA-LABEL: imm64_8:
; RV64IZBA:   # %bb.0:
; RV64IZBA-NEXT: lui a0, 596523
; RV64IZBA-NEXT: addi a0, a0, 965
; RV64IZBA-NEXT: slli.uw a0, a0, 13
; RV64IZBA-NEXT: addi a0, a0, -1347
; RV64IZBA-NEXT: slli a0, a0, 12
; RV64IZBA-NEXT: addi a0, a0, -529
; RV64IZBA-NEXT: slli a0, a0, 4
; RV64IZBA-NEXT: ret
;
; RV64IZBB-LABEL: imm64_8:
; RV64IZBB:   # %bb.0:
; RV64IZBB-NEXT: lui a0, 583
; RV64IZBB-NEXT: addiw
a0, a0, -1875
; RV64IZBB-NEXT: slli a0, a0, 14
```

```

; RV64IZBB-NEXT:  addi a0, a0, -947
; RV64IZBB-NEXT:  slli a0, a0, 12
; RV64IZBB-NEXT:  addi a0, a0, 1511
; RV64IZBB-NEXT:  slli a0, a0, 13
; RV64IZBB-NEXT:  addi a0, a0, -272
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm64_8:
; RV64IZBS:      # %bb.0:
; RV64IZBS-NEXT:  lui a0, 583
; RV64IZBS-NEXT:  addiw a0, a0, -1875
; RV64IZBS-NEXT:  slli a0, a0, 14
; RV64IZBS-NEXT:  addi a0, a0, -947
; RV64IZBS-NEXT:  slli a0, a0, 12
; RV64IZBS-NEXT:  addi a0, a0, 1511
; RV64IZBS-NEXT:  slli a0, a0, 13
; RV64IZBS-NEXT:  addi a0, a0, -272
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm64_8:
; RV64IXTHEADBB:  # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 583
; RV64IXTHEADBB-NEXT:  addiw a0, a0, -1875
; RV64IXTHEADBB-NEXT:  slli a0, a0, 14
; RV64IXTHEADBB-NEXT:  addi a0, a0, -947
; RV64IXTHEADBB-NEXT:  slli a0, a0, 12
; RV64IXTHEADBB-NEXT:  addi a0, a0, 1511
; RV64IXTHEADBB-NEXT:  slli a0, a0, 13
; RV64IXTHEADBB-NEXT:
    addi a0, a0, -272
; RV64IXTHEADBB-NEXT:  ret
ret i64 1311768467463790320 ; 0x1234_5678_9ABC_DEF0
}

```

```

define i64 @imm64_9() nounwind {

```

```

; RV64I-LABEL: imm64_9:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a0, -1
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm64_9:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  li a0, -1
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm64_9:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  li a0, -1

```

```

; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm64_9:
; RV64IZBS:      # %bb.0:
; RV64IZBS-NEXT:  li a0, -1
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm64_9:
; RV64IXTHEADBB:  # %bb.0:
; RV64IXTHEADBB-NEXT:  li a0, -1
; RV64IXTHEADBB-NEXT:  ret
ret i64 -1
}

```

; Various cases where extraneous ADDIs can be inserted where a (left shifted)  
; LUI suffices.

```

define i64 @imm_left_shifted_lui_1() nounwind {
; RV64I-LABEL: imm_left_shifted_lui_1:
; RV64I:      # %bb.0:
; RV64I-NEXT:  lui a0, 262145
; RV64I-NEXT:  slli a0, a0, 1
;
RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm_left_shifted_lui_1:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  lui a0, 262145
; RV64IZBA-NEXT:  slli a0, a0, 1
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm_left_shifted_lui_1:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  lui a0, 262145
; RV64IZBB-NEXT:  slli a0, a0, 1
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm_left_shifted_lui_1:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:  lui a0, 262145
; RV64IZBS-NEXT:  slli a0, a0, 1
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm_left_shifted_lui_1:
; RV64IXTHEADBB:  # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 262145
; RV64IXTHEADBB-NEXT:  slli a0, a0, 1
; RV64IXTHEADBB-NEXT:  ret

```

```

ret i64 2147491840 ; 0x8000_2000
}

define i64 @imm_left_shifted_lui_2() nounwind {
; RV64I-LABEL: imm_left_shifted_lui_2:
; RV64I:    # %bb.0:
; RV64I-NEXT:  lui a0, 262145
; RV64I-NEXT:  slli a0, a0, 2
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm_left_shifted_lui_2:
; RV64IZBA:
; %bb.0:
; RV64IZBA-NEXT:  lui a0, 262145
; RV64IZBA-NEXT:  slli a0, a0, 2
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm_left_shifted_lui_2:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  lui a0, 262145
; RV64IZBB-NEXT:  slli a0, a0, 2
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm_left_shifted_lui_2:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:  lui a0, 262145
; RV64IZBS-NEXT:  slli a0, a0, 2
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm_left_shifted_lui_2:
; RV64IXTHEADBB:    # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 262145
; RV64IXTHEADBB-NEXT:  slli a0, a0, 2
; RV64IXTHEADBB-NEXT:  ret
ret i64 4294983680 ; 0x1_0000_4000
}

```

```

define i64 @imm_left_shifted_lui_3() nounwind {
; RV64I-LABEL: imm_left_shifted_lui_3:
; RV64I:    # %bb.0:
; RV64I-NEXT:  lui a0, 4097
; RV64I-NEXT:  slli a0, a0, 20
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm_left_shifted_lui_3:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  lui a0, 4097
; RV64IZBA-NEXT:  slli a0, a0, 20

```

```

;
RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm_left_shifted_lui_3:
; RV64IZBB:      # %bb.0:
; RV64IZBB-NEXT:  lui a0, 4097
; RV64IZBB-NEXT:  slli a0, a0, 20
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm_left_shifted_lui_3:
; RV64IZBS:      # %bb.0:
; RV64IZBS-NEXT:  lui a0, 4097
; RV64IZBS-NEXT:  slli a0, a0, 20
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm_left_shifted_lui_3:
; RV64IXTHEADBB:  # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 4097
; RV64IXTHEADBB-NEXT:  slli a0, a0, 20
; RV64IXTHEADBB-NEXT:  ret
ret i64 17596481011712 ; 0x1001_0000_0000
}

```

; Various cases where extraneous ADDIs can be inserted where a (right shifted)  
; LUI suffices, or where multiple ADDIs can be used instead of a single LUI.

```

define i64 @imm_right_shifted_lui_1() nounwind {
; RV64I-LABEL: imm_right_shifted_lui_1:
; RV64I:      # %bb.0:
; RV64I-NEXT:  lui a0, 983056
; RV64I-NEXT:  srli a0, a0, 16
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm_right_shifted_lui_1:
; RV64IZBA:
;   # %bb.0:
; RV64IZBA-NEXT:  lui a0, 983056
; RV64IZBA-NEXT:  srli a0, a0, 16
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm_right_shifted_lui_1:
; RV64IZBB:      # %bb.0:
; RV64IZBB-NEXT:  lui a0, 983056
; RV64IZBB-NEXT:  srli a0, a0, 16
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm_right_shifted_lui_1:
; RV64IZBS:      # %bb.0:

```

```

; RV64IZBS-NEXT: lui a0, 983056
; RV64IZBS-NEXT: srli a0, a0, 16
; RV64IZBS-NEXT: ret
;
; RV64IXTHEADBB-LABEL: imm_right_shifted_lui_1:
; RV64IXTHEADBB: # %bb.0:
; RV64IXTHEADBB-NEXT: lui a0, 983056
; RV64IXTHEADBB-NEXT: srli a0, a0, 16
; RV64IXTHEADBB-NEXT: ret
ret i64 281474976706561 ; 0xFFFF_FFFF_F001
}

```

```

define i64 @imm_right_shifted_lui_2() nounwind {
; RV64I-LABEL: imm_right_shifted_lui_2:
; RV64I: # %bb.0:
; RV64I-NEXT: lui a0, 1044481
; RV64I-NEXT: slli a0, a0, 12
; RV64I-NEXT: srli a0, a0, 24
; RV64I-NEXT: ret
;
; RV64IZBA-LABEL: imm_right_shifted_lui_2:
; RV64IZBA: # %bb.0:
; RV64IZBA-NEXT:
    lui a0, 1044481
; RV64IZBA-NEXT: slli a0, a0, 12
; RV64IZBA-NEXT: srli a0, a0, 24
; RV64IZBA-NEXT: ret
;
; RV64IZBB-LABEL: imm_right_shifted_lui_2:
; RV64IZBB: # %bb.0:
; RV64IZBB-NEXT: lui a0, 1044481
; RV64IZBB-NEXT: slli a0, a0, 12
; RV64IZBB-NEXT: srli a0, a0, 24
; RV64IZBB-NEXT: ret
;
; RV64IZBS-LABEL: imm_right_shifted_lui_2:
; RV64IZBS: # %bb.0:
; RV64IZBS-NEXT: lui a0, 1044481
; RV64IZBS-NEXT: slli a0, a0, 12
; RV64IZBS-NEXT: srli a0, a0, 24
; RV64IZBS-NEXT: ret
;
; RV64IXTHEADBB-LABEL: imm_right_shifted_lui_2:
; RV64IXTHEADBB: # %bb.0:
; RV64IXTHEADBB-NEXT: lui a0, 1044481
; RV64IXTHEADBB-NEXT: slli a0, a0, 12
; RV64IXTHEADBB-NEXT: srli a0, a0, 24
; RV64IXTHEADBB-NEXT: ret
}

```

```
ret i64 1099511623681 ; 0xFF_FFFF_F001
}
```

; We can materialize the upper bits with a single (shifted) LUI, but that option  
; can be missed due to the lower bits, which aren't just 1s or just 0s.

```
define i64 @imm_decoupled_lui_addi() nounwind
{
; RV64I-LABEL: imm_decoupled_lui_addi:
; RV64I:    # %bb.0:
; RV64I-NEXT:  lui a0, 4097
; RV64I-NEXT:  slli a0, a0, 20
; RV64I-NEXT:  addi a0, a0, -3
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm_decoupled_lui_addi:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  lui a0, 4097
; RV64IZBA-NEXT:  slli a0, a0, 20
; RV64IZBA-NEXT:  addi a0, a0, -3
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm_decoupled_lui_addi:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  lui a0, 4097
; RV64IZBB-NEXT:  slli a0, a0, 20
; RV64IZBB-NEXT:  addi a0, a0, -3
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm_decoupled_lui_addi:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:  lui a0, 4097
; RV64IZBS-NEXT:  slli a0, a0, 20
; RV64IZBS-NEXT:  addi a0, a0, -3
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm_decoupled_lui_addi:
; RV64IXTHEADBB:    # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 4097
; RV64IXTHEADBB-NEXT:  slli a0, a0, 20
; RV64IXTHEADBB-NEXT:  addi a0, a0, -3
; RV64IXTHEADBB-NEXT:
    ret
ret i64 17596481011709 ; 0x1000_FFFF_FFFD
}
```

; This constant can be materialized for RV64 with LUI+SRLI+XORI.



```

define i64 @imm_end_xori_1() nounwind {
; RV64I-LABEL: imm_end_xori_1:
; RV64I:      # %bb.0:
; RV64I-NEXT: lui a0, 983040
; RV64I-NEXT: srli a0, a0, 3
; RV64I-NEXT: not a0, a0
; RV64I-NEXT: ret
;
; RV64IZBA-LABEL: imm_end_xori_1:
; RV64IZBA:   # %bb.0:
; RV64IZBA-NEXT: lui a0, 983040
; RV64IZBA-NEXT: srli a0, a0, 3
; RV64IZBA-NEXT: not a0, a0
; RV64IZBA-NEXT: ret
;
; RV64IZBB-LABEL: imm_end_xori_1:
; RV64IZBB:   # %bb.0:
; RV64IZBB-NEXT: lui a0, 983040
; RV64IZBB-NEXT: srli a0, a0, 3
; RV64IZBB-NEXT: not a0, a0
; RV64IZBB-NEXT: ret
;
; RV64IZBS-LABEL: imm_end_xori_1:
; RV64IZBS:   # %bb.0:
; RV64IZBS-NEXT: lui a0, 983040
; RV64IZBS-NEXT: srli a0, a0, 3
; RV64IZBS-NEXT: not a0, a0
; RV64IZBS-NEXT: ret
;
; RV64IXTHEADBB-LABEL: imm_end_xori_1:
; RV64IXTHEADBB:   # %bb.0:
; RV64IXTHEADBB-NEXT:
    lui a0, 983040
; RV64IXTHEADBB-NEXT: srli a0, a0, 3
; RV64IXTHEADBB-NEXT: not a0, a0
; RV64IXTHEADBB-NEXT: ret
    ret i64 -2305843009180139521 ; 0xE000_0000_01FF_FFFF
}

```

; This constant can be materialized for RV64 with ADDI+SLLI+ADDI+ADDI.

```

define i64 @imm_end_2addi_1() nounwind {
; RV64I-LABEL: imm_end_2addi_1:
; RV64I:      # %bb.0:
; RV64I-NEXT: li a0, -2047
; RV64I-NEXT: slli a0, a0, 39
; RV64I-NEXT: addi a0, a0, -2048
; RV64I-NEXT: addi a0, a0, -1

```

```

; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm_end_2addi_1:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  li a0, -2047
; RV64IZBA-NEXT:  slli a0, a0, 39
; RV64IZBA-NEXT:  addi a0, a0, -2048
; RV64IZBA-NEXT:  addi a0, a0, -1
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm_end_2addi_1:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  li a0, -2047
; RV64IZBB-NEXT:  slli a0, a0, 39
; RV64IZBB-NEXT:  addi a0, a0, -2048
; RV64IZBB-NEXT:  addi a0, a0, -1
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm_end_2addi_1:
;
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:  li a0, -2047
; RV64IZBS-NEXT:  slli a0, a0, 39
; RV64IZBS-NEXT:  addi a0, a0, -2048
; RV64IZBS-NEXT:  addi a0, a0, -1
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm_end_2addi_1:
; RV64IXTHEADBB:    # %bb.0:
; RV64IXTHEADBB-NEXT:  li a0, -2047
; RV64IXTHEADBB-NEXT:  slli a0, a0, 39
; RV64IXTHEADBB-NEXT:  addi a0, a0, -2048
; RV64IXTHEADBB-NEXT:  addi a0, a0, -1
; RV64IXTHEADBB-NEXT:  ret
ret i64 -1125350151030785 ; 0xFFFC_007F_FFFF_F7FF
}

```

; This constant can be more efficiently materialized for RV64 if we use two registers instead of one.

```

define i64 @imm_2reg_1() nounwind {
; RV64I-LABEL: imm_2reg_1:
; RV64I:    # %bb.0:
; RV64I-NEXT:  lui a0, 74565
; RV64I-NEXT:  addiw a0, a0, 1656
; RV64I-NEXT:  slli a1, a0, 57
; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  ret
}

```

```

;
; RV64IZBA-LABEL: imm_2reg_1:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT: lui a0, 74565
; RV64IZBA-NEXT: addiw a0, a0, 1656
; RV64IZBA-NEXT:
    slli a1, a0, 57
; RV64IZBA-NEXT: add a0, a0, a1
; RV64IZBA-NEXT: ret
;
; RV64IZBB-LABEL: imm_2reg_1:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT: lui a0, 74565
; RV64IZBB-NEXT: addiw a0, a0, 1656
; RV64IZBB-NEXT: slli a1, a0, 57
; RV64IZBB-NEXT: add a0, a0, a1
; RV64IZBB-NEXT: ret
;
; RV64IZBS-LABEL: imm_2reg_1:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT: lui a0, 74565
; RV64IZBS-NEXT: addiw a0, a0, 1656
; RV64IZBS-NEXT: slli a1, a0, 57
; RV64IZBS-NEXT: add a0, a0, a1
; RV64IZBS-NEXT: ret
;
; RV64IXTHEADBB-LABEL: imm_2reg_1:
; RV64IXTHEADBB:    # %bb.0:
; RV64IXTHEADBB-NEXT: lui a0, 74565
; RV64IXTHEADBB-NEXT: addiw a0, a0, 1656
; RV64IXTHEADBB-NEXT: slli a1, a0, 57
; RV64IXTHEADBB-NEXT: add a0, a0, a1
; RV64IXTHEADBB-NEXT: ret
ret i64 -1152921504301427080 ; 0xF000_0000_1234_5678
}

```

; FIXME: This should use a single ADDI for the immediate.

```
define void @imm_store_i16_neg1(ptr %p) nounwind {
```

```
; RV64I-LABEL: imm_store_i16_neg1:
```

```
;
```

```
RV64I:    # %bb.0:
```

```
; RV64I-NEXT: li a1, -1
```

```
; RV64I-NEXT: sh a1, 0(a0)
```

```
; RV64I-NEXT: ret
```

```
;
```

```
; RV64IZBA-LABEL: imm_store_i16_neg1:
```

```
; RV64IZBA:    # %bb.0:
```

```
; RV64IZBA-NEXT: li a1, -1
```

```

; RV64IZBA-NEXT:  sh a1, 0(a0)
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm_store_i16_neg1:
; RV64IZBB:      # %bb.0:
; RV64IZBB-NEXT:  li a1, -1
; RV64IZBB-NEXT:  sh a1, 0(a0)
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm_store_i16_neg1:
; RV64IZBS:      # %bb.0:
; RV64IZBS-NEXT:  li a1, -1
; RV64IZBS-NEXT:  sh a1, 0(a0)
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm_store_i16_neg1:
; RV64IXTHEADBB:  # %bb.0:
; RV64IXTHEADBB-NEXT:  li a1, -1
; RV64IXTHEADBB-NEXT:  sh a1, 0(a0)
; RV64IXTHEADBB-NEXT:  ret
store i16 -1, ptr %p
ret void
}

; FIXME: This should use a single ADDI for the immediate.
define void @imm_store_i32_neg1(ptr %p) nounwind {
; RV64I-LABEL: imm_store_i32_neg1:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a1, -1
; RV64I-NEXT:
sw a1, 0(a0)
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm_store_i32_neg1:
; RV64IZBA:      # %bb.0:
; RV64IZBA-NEXT:  li a1, -1
; RV64IZBA-NEXT:  sw a1, 0(a0)
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm_store_i32_neg1:
; RV64IZBB:      # %bb.0:
; RV64IZBB-NEXT:  li a1, -1
; RV64IZBB-NEXT:  sw a1, 0(a0)
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm_store_i32_neg1:
; RV64IZBS:      # %bb.0:
; RV64IZBS-NEXT:  li a1, -1

```

```

; RV64IZBS-NEXT:  sw a1, 0(a0)
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm_store_i32_neg1:
; RV64IXTHEADBB:   # %bb.0:
; RV64IXTHEADBB-NEXT:  li a1, -1
; RV64IXTHEADBB-NEXT:  sw a1, 0(a0)
; RV64IXTHEADBB-NEXT:  ret
store i32 -1, ptr %p
ret void
}

```

```

define i64 @imm_5372288229() {
; RV64I-LABEL: imm_5372288229:
; RV64I:   # %bb.0:
; RV64I-NEXT:  lui a0, 160
; RV64I-NEXT:  addiw a0, a0, 437
; RV64I-NEXT:  slli a0, a0, 13
; RV64I-NEXT:  addi a0, a0, -795
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm_5372288229:
; RV64IZBA:
;   # %bb.0:
; RV64IZBA-NEXT:  lui a0, 655797
; RV64IZBA-NEXT:  slli.uw a0, a0, 1
; RV64IZBA-NEXT:  addi a0, a0, -795
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm_5372288229:
; RV64IZBB:   # %bb.0:
; RV64IZBB-NEXT:  lui a0, 160
; RV64IZBB-NEXT:  addiw a0, a0, 437
; RV64IZBB-NEXT:  slli a0, a0, 13
; RV64IZBB-NEXT:  addi a0, a0, -795
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm_5372288229:
; RV64IZBS:   # %bb.0:
; RV64IZBS-NEXT:  lui a0, 263018
; RV64IZBS-NEXT:  addiw a0, a0, -795
; RV64IZBS-NEXT:  bseti a0, a0, 32
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm_5372288229:
; RV64IXTHEADBB:   # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 160
; RV64IXTHEADBB-NEXT:  addiw a0, a0, 437

```

```

; RV64IXTHEADBB-NEXT: slli a0, a0, 13
; RV64IXTHEADBB-NEXT: addi a0, a0, -795
; RV64IXTHEADBB-NEXT: ret
ret i64 5372288229
}

define i64 @imm_neg_5372288229() {
; RV64I-LABEL: imm_neg_5372288229:
; RV64I:    # %bb.0:
; RV64I-NEXT: lui a0, 1048416
; RV64I-NEXT:
    addiw a0, a0, -437
; RV64I-NEXT: slli a0, a0, 13
; RV64I-NEXT: addi a0, a0, 795
; RV64I-NEXT: ret
;
; RV64IZBA-LABEL: imm_neg_5372288229:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT: lui a0, 611378
; RV64IZBA-NEXT: addiw a0, a0, 265
; RV64IZBA-NEXT: sh1add a0, a0, a0
; RV64IZBA-NEXT: ret
;
; RV64IZBB-LABEL: imm_neg_5372288229:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT: lui a0, 1048416
; RV64IZBB-NEXT: addiw a0, a0, -437
; RV64IZBB-NEXT: slli a0, a0, 13
; RV64IZBB-NEXT: addi a0, a0, 795
; RV64IZBB-NEXT: ret
;
; RV64IZBS-LABEL: imm_neg_5372288229:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT: lui a0, 785558
; RV64IZBS-NEXT: addiw a0, a0, 795
; RV64IZBS-NEXT: bclri a0, a0, 32
; RV64IZBS-NEXT: ret
;
; RV64IXTHEADBB-LABEL: imm_neg_5372288229:
; RV64IXTHEADBB:    # %bb.0:
; RV64IXTHEADBB-NEXT: lui a0, 1048416
; RV64IXTHEADBB-NEXT: addiw a0, a0, -437
; RV64IXTHEADBB-NEXT: slli a0, a0, 13
; RV64IXTHEADBB-NEXT: addi a0, a0,
795
; RV64IXTHEADBB-NEXT: ret
ret i64 -5372288229
}

```

```

define i64 @imm_8953813715() {
; RV64I-LABEL: imm_8953813715:
; RV64I:    # %bb.0:
; RV64I-NEXT:  lui a0, 267
; RV64I-NEXT:  addiw a0, a0, -637
; RV64I-NEXT:  slli a0, a0, 13
; RV64I-NEXT:  addi a0, a0, -1325
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm_8953813715:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  lui a0, 437198
; RV64IZBA-NEXT:  addiw a0, a0, -265
; RV64IZBA-NEXT:  sh2add a0, a0, a0
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm_8953813715:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  lui a0, 267
; RV64IZBB-NEXT:  addiw a0, a0, -637
; RV64IZBB-NEXT:  slli a0, a0, 13
; RV64IZBB-NEXT:  addi a0, a0, -1325
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm_8953813715:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:  lui a0, 88838
; RV64IZBS-NEXT:  addiw a0, a0, -1325
; RV64IZBS-NEXT:  bseti a0, a0, 33
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm_8953813715:
; RV64IXTHEADBB:    # %bb.0:
;
; RV64IXTHEADBB-NEXT:  lui a0, 267
; RV64IXTHEADBB-NEXT:  addiw a0, a0, -637
; RV64IXTHEADBB-NEXT:  slli a0, a0, 13
; RV64IXTHEADBB-NEXT:  addi a0, a0, -1325
; RV64IXTHEADBB-NEXT:  ret
ret i64 8953813715
}

```

```

define i64 @imm_neg_8953813715() {
; RV64I-LABEL: imm_neg_8953813715:
; RV64I:    # %bb.0:
; RV64I-NEXT:  lui a0, 1048309
; RV64I-NEXT:  addiw a0, a0, 637

```

```

; RV64I-NEXT:  slli a0, a0, 13
; RV64I-NEXT:  addi a0, a0, 1325
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm_neg_8953813715:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  lui a0, 611378
; RV64IZBA-NEXT:  addiw a0, a0, 265
; RV64IZBA-NEXT:  sh2add a0, a0, a0
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm_neg_8953813715:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  lui a0, 1048309
; RV64IZBB-NEXT:  addiw a0, a0, 637
; RV64IZBB-NEXT:  slli a0, a0, 13
; RV64IZBB-NEXT:  addi a0, a0, 1325
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm_neg_8953813715:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:
    lui a0, 959738
; RV64IZBS-NEXT:  addiw a0, a0, 1325
; RV64IZBS-NEXT:  bclri a0, a0, 33
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm_neg_8953813715:
; RV64IXTHEADBB:  # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 1048309
; RV64IXTHEADBB-NEXT:  addiw a0, a0, 637
; RV64IXTHEADBB-NEXT:  slli a0, a0, 13
; RV64IXTHEADBB-NEXT:  addi a0, a0, 1325
; RV64IXTHEADBB-NEXT:  ret
ret i64 -8953813715
}

```

```

define i64 @imm_16116864687() {
; RV64I-LABEL: imm_16116864687:
; RV64I:    # %bb.0:
; RV64I-NEXT:  lui a0, 961
; RV64I-NEXT:  addiw a0, a0, -1475
; RV64I-NEXT:  slli a0, a0, 12
; RV64I-NEXT:  addi a0, a0, 1711
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm_16116864687:
; RV64IZBA:    # %bb.0:

```



```

; RV64IZBA-NEXT:  lui a0, 437198
; RV64IZBA-NEXT:  addiw a0, a0, -265
; RV64IZBA-NEXT:  sh3add a0, a0, a0
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm_16116864687:
; RV64IZBB:      # %bb.0:
; RV64IZBB-NEXT:  lui a0, 961
; RV64IZBB-NEXT:  addiw a0, a0, -1475
; RV64IZBB-NEXT:
    slli a0, a0, 12
; RV64IZBB-NEXT:  addi a0, a0, 1711
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm_16116864687:
; RV64IZBS:      # %bb.0:
; RV64IZBS-NEXT:  lui a0, 961
; RV64IZBS-NEXT:  addiw a0, a0, -1475
; RV64IZBS-NEXT:  slli a0, a0, 12
; RV64IZBS-NEXT:  addi a0, a0, 1711
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm_16116864687:
; RV64IXTHEADBB:  # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 961
; RV64IXTHEADBB-NEXT:  addiw a0, a0, -1475
; RV64IXTHEADBB-NEXT:  slli a0, a0, 12
; RV64IXTHEADBB-NEXT:  addi a0, a0, 1711
; RV64IXTHEADBB-NEXT:  ret
ret i64 16116864687
}

```

```

define i64 @imm_neg_16116864687() {
; RV64I-LABEL: imm_neg_16116864687:
; RV64I:      # %bb.0:
; RV64I-NEXT:  lui a0, 1047615
; RV64I-NEXT:  addiw a0, a0, 1475
; RV64I-NEXT:  slli a0, a0, 12
; RV64I-NEXT:  addi a0, a0, -1711
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm_neg_16116864687:
; RV64IZBA:      # %bb.0:
; RV64IZBA-NEXT:  lui a0, 611378
; RV64IZBA-NEXT:
    addiw a0, a0, 265
; RV64IZBA-NEXT:  sh3add a0, a0, a0
; RV64IZBA-NEXT:  ret

```

```

;
; RV64IZBB-LABEL: imm_neg_16116864687:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  lui a0, 1047615
; RV64IZBB-NEXT:  addiw a0, a0, 1475
; RV64IZBB-NEXT:  slli a0, a0, 12
; RV64IZBB-NEXT:  addi a0, a0, -1711
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm_neg_16116864687:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:  lui a0, 1047615
; RV64IZBS-NEXT:  addiw a0, a0, 1475
; RV64IZBS-NEXT:  slli a0, a0, 12
; RV64IZBS-NEXT:  addi a0, a0, -1711
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm_neg_16116864687:
; RV64IXTHEADBB:  # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 1047615
; RV64IXTHEADBB-NEXT:  addiw a0, a0, 1475
; RV64IXTHEADBB-NEXT:  slli a0, a0, 12
; RV64IXTHEADBB-NEXT:  addi a0, a0, -1711
; RV64IXTHEADBB-NEXT:  ret
ret i64 -16116864687
}

```

```

define i64 @imm_2344336315() {
; RV64I-LABEL: imm_2344336315:
; RV64I:    # %bb.0:
; RV64I-NEXT:  lui a0, 143087
; RV64I-NEXT:
    slli a0, a0, 2
; RV64I-NEXT:  addi a0, a0, -1093
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm_2344336315:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  lui a0, 143087
; RV64IZBA-NEXT:  slli a0, a0, 2
; RV64IZBA-NEXT:  addi a0, a0, -1093
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm_2344336315:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  lui a0, 143087
; RV64IZBB-NEXT:  slli a0, a0, 2
; RV64IZBB-NEXT:  addi a0, a0, -1093

```

```

; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm_2344336315:
; RV64IZBS:      # %bb.0:
; RV64IZBS-NEXT:  lui a0, 143087
; RV64IZBS-NEXT:  slli a0, a0, 2
; RV64IZBS-NEXT:  addi a0, a0, -1093
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm_2344336315:
; RV64IXTHEADBB:  # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 143087
; RV64IXTHEADBB-NEXT:  slli a0, a0, 2
; RV64IXTHEADBB-NEXT:  addi a0, a0, -1093
; RV64IXTHEADBB-NEXT:  ret
ret i64 2344336315 ; 0x8bbbbbbb
}

define i64 @imm_70370820078523() {
; RV64-NOPOOL-LABEL: imm_70370820078523:
;
RV64-NOPOOL:      # %bb.0:
; RV64-NOPOOL-NEXT:  lui a0, 256
; RV64-NOPOOL-NEXT:  addiw a0, a0, 31
; RV64-NOPOOL-NEXT:  slli a0, a0, 12
; RV64-NOPOOL-NEXT:  addi a0, a0, -273
; RV64-NOPOOL-NEXT:  slli a0, a0, 14
; RV64-NOPOOL-NEXT:  addi a0, a0, -1093
; RV64-NOPOOL-NEXT:  ret
;
; RV64I-POOL-LABEL: imm_70370820078523:
; RV64I-POOL:      # %bb.0:
; RV64I-POOL-NEXT:  lui a0, %hi(LCPI37_0)
; RV64I-POOL-NEXT:  ld a0, %lo(LCPI37_0)(a0)
; RV64I-POOL-NEXT:  ret
;
; RV64IZBA-LABEL: imm_70370820078523:
; RV64IZBA:      # %bb.0:
; RV64IZBA-NEXT:  lui a0, 256
; RV64IZBA-NEXT:  addiw a0, a0, 31
; RV64IZBA-NEXT:  slli a0, a0, 12
; RV64IZBA-NEXT:  addi a0, a0, -273
; RV64IZBA-NEXT:  slli a0, a0, 14
; RV64IZBA-NEXT:  addi a0, a0, -1093
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm_70370820078523:
; RV64IZBB:      # %bb.0:

```

```

; RV64IZBB-NEXT: lui a0, 256
; RV64IZBB-NEXT: addiw a0, a0, 31
; RV64IZBB-NEXT: slli a0, a0, 12
; RV64IZBB-NEXT: addi a0, a0, -273
;
RV64IZBB-NEXT: slli a0, a0, 14
; RV64IZBB-NEXT: addi a0, a0, -1093
; RV64IZBB-NEXT: ret
;
; RV64IZBS-LABEL: imm_70370820078523:
; RV64IZBS: # %bb.0:
; RV64IZBS-NEXT: lui a0, 506812
; RV64IZBS-NEXT: addiw a0, a0, -1093
; RV64IZBS-NEXT: bseti a0, a0, 46
; RV64IZBS-NEXT: ret
;
; RV64IXTHEADBB-LABEL: imm_70370820078523:
; RV64IXTHEADBB: # %bb.0:
; RV64IXTHEADBB-NEXT: lui a0, 256
; RV64IXTHEADBB-NEXT: addiw a0, a0, 31
; RV64IXTHEADBB-NEXT: slli a0, a0, 12
; RV64IXTHEADBB-NEXT: addi a0, a0, -273
; RV64IXTHEADBB-NEXT: slli a0, a0, 14
; RV64IXTHEADBB-NEXT: addi a0, a0, -1093
; RV64IXTHEADBB-NEXT: ret
ret i64 70370820078523 ; 0x40007bbbbbbb
}

define i64 @imm_neg_9223372034778874949() {
; RV64I-LABEL: imm_neg_9223372034778874949:
; RV64I: # %bb.0:
; RV64I-NEXT: lui a0, 506812
; RV64I-NEXT: addiw a0, a0, -1093
; RV64I-NEXT: slli a1, a0, 63
; RV64I-NEXT: add a0, a0, a1
; RV64I-NEXT: ret
;
; RV64IZBA-LABEL: imm_neg_9223372034778874949:
;
RV64IZBA: # %bb.0:
; RV64IZBA-NEXT: lui a0, 506812
; RV64IZBA-NEXT: addiw a0, a0, -1093
; RV64IZBA-NEXT: slli a1, a0, 63
; RV64IZBA-NEXT: add a0, a0, a1
; RV64IZBA-NEXT: ret
;
; RV64IZBB-LABEL: imm_neg_9223372034778874949:
; RV64IZBB: # %bb.0:

```

```

; RV64IZBB-NEXT: lui a0, 506812
; RV64IZBB-NEXT: addiw a0, a0, -1093
; RV64IZBB-NEXT: slli a1, a0, 63
; RV64IZBB-NEXT: add a0, a0, a1
; RV64IZBB-NEXT: ret
;
; RV64IZBS-LABEL: imm_neg_9223372034778874949:
; RV64IZBS: # %bb.0:
; RV64IZBS-NEXT: lui a0, 506812
; RV64IZBS-NEXT: addiw a0, a0, -1093
; RV64IZBS-NEXT: bseti a0, a0, 63
; RV64IZBS-NEXT: ret
;
; RV64IXTHEADBB-LABEL: imm_neg_9223372034778874949:
; RV64IXTHEADBB: # %bb.0:
; RV64IXTHEADBB-NEXT: lui a0, 506812
; RV64IXTHEADBB-NEXT: addiw a0, a0, -1093
; RV64IXTHEADBB-NEXT: slli a1, a0, 63
; RV64IXTHEADBB-NEXT: add a0, a0, a1
; RV64IXTHEADBB-NEXT: ret
ret i64 -9223372034778874949 ; 0x800000007bbbbbbb
}

```

```

define
i64 @imm_neg_9223301666034697285() {
; RV64-NOPOOL-LABEL: imm_neg_9223301666034697285:
; RV64-NOPOOL: # %bb.0:
; RV64-NOPOOL-NEXT: lui a0, 917505
; RV64-NOPOOL-NEXT: slli a0, a0, 8
; RV64-NOPOOL-NEXT: addi a0, a0, 31
; RV64-NOPOOL-NEXT: slli a0, a0, 12
; RV64-NOPOOL-NEXT: addi a0, a0, -273
; RV64-NOPOOL-NEXT: slli a0, a0, 14
; RV64-NOPOOL-NEXT: addi a0, a0, -1093
; RV64-NOPOOL-NEXT: ret
;
; RV64I-POOL-LABEL: imm_neg_9223301666034697285:
; RV64I-POOL: # %bb.0:
; RV64I-POOL-NEXT: lui a0, %hi(.LCPI39_0)
; RV64I-POOL-NEXT: ld a0, %lo(.LCPI39_0)(a0)
; RV64I-POOL-NEXT: ret
;
; RV64IZBA-LABEL: imm_neg_9223301666034697285:
; RV64IZBA: # %bb.0:
; RV64IZBA-NEXT: lui a0, 917505
; RV64IZBA-NEXT: slli a0, a0, 8
; RV64IZBA-NEXT: addi a0, a0, 31
; RV64IZBA-NEXT: slli a0, a0, 12

```

```

; RV64IZBA-NEXT:  addi a0, a0, -273
; RV64IZBA-NEXT:  slli a0, a0, 14
; RV64IZBA-NEXT:  addi a0, a0, -1093
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL:
imm_neg_9223301666034697285:
; RV64IZBB:      # %bb.0:
; RV64IZBB-NEXT: lui a0, 917505
; RV64IZBB-NEXT: slli a0, a0, 8
; RV64IZBB-NEXT: addi a0, a0, 31
; RV64IZBB-NEXT: slli a0, a0, 12
; RV64IZBB-NEXT: addi a0, a0, -273
; RV64IZBB-NEXT: slli a0, a0, 14
; RV64IZBB-NEXT: addi a0, a0, -1093
; RV64IZBB-NEXT: ret
;
; RV64IZBS-LABEL: imm_neg_9223301666034697285:
; RV64IZBS:      # %bb.0:
; RV64IZBS-NEXT: lui a0, 506812
; RV64IZBS-NEXT: addiw a0, a0, -1093
; RV64IZBS-NEXT: bseti a0, a0, 46
; RV64IZBS-NEXT: bseti a0, a0, 63
; RV64IZBS-NEXT: ret
;
; RV64IXTHEADBB-LABEL: imm_neg_9223301666034697285:
; RV64IXTHEADBB: # %bb.0:
; RV64IXTHEADBB-NEXT: lui a0, 917505
; RV64IXTHEADBB-NEXT: slli a0, a0, 8
; RV64IXTHEADBB-NEXT: addi a0, a0, 31
; RV64IXTHEADBB-NEXT: slli a0, a0, 12
; RV64IXTHEADBB-NEXT: addi a0, a0, -273
; RV64IXTHEADBB-NEXT: slli a0, a0, 14
; RV64IXTHEADBB-NEXT: addi a0, a0, -1093
; RV64IXTHEADBB-NEXT: ret
ret i64 -9223301666034697285 ; 0x800040007bbbbbbb
}

```

```

define i64 @imm_neg_2219066437() {
; RV64I-LABEL: imm_neg_2219066437:
; RV64I:      # %bb.0:
; RV64I-NEXT: lui a0, 913135
; RV64I-NEXT: slli a0, a0, 2
; RV64I-NEXT: addi a0, a0, -1093
; RV64I-NEXT: ret
;
; RV64IZBA-LABEL: imm_neg_2219066437:
; RV64IZBA:   # %bb.0:

```

```

; RV64IZBA-NEXT: lui a0, 913135
; RV64IZBA-NEXT: slli a0, a0, 2
; RV64IZBA-NEXT: addi a0, a0, -1093
; RV64IZBA-NEXT: ret
;
; RV64IZBB-LABEL: imm_neg_2219066437:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT: lui a0, 913135
; RV64IZBB-NEXT: slli a0, a0, 2
; RV64IZBB-NEXT: addi a0, a0, -1093
; RV64IZBB-NEXT: ret
;
; RV64IZBS-LABEL: imm_neg_2219066437:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT: lui a0, 913135
; RV64IZBS-NEXT: slli a0, a0, 2
; RV64IZBS-NEXT: addi a0, a0, -1093
; RV64IZBS-NEXT: ret
;
; RV64IXTHEADBB-LABEL: imm_neg_2219066437:
; RV64IXTHEADBB:    # %bb.0:
; RV64IXTHEADBB-NEXT: lui a0, 913135
; RV64IXTHEADBB-NEXT:
    slli a0, a0, 2
; RV64IXTHEADBB-NEXT: addi a0, a0, -1093
; RV64IXTHEADBB-NEXT: ret
ret i64 -2219066437 ; 0xffffffff7bbbbbbb
}

```

```

define i64 @imm_neg_8798043653189() {
; RV64I-LABEL: imm_neg_8798043653189:
; RV64I:    # %bb.0:
; RV64I-NEXT: lui a0, 917475
; RV64I-NEXT: addiw a0, a0, -273
; RV64I-NEXT: slli a0, a0, 14
; RV64I-NEXT: addi a0, a0, -1093
; RV64I-NEXT: ret
;
; RV64IZBA-LABEL: imm_neg_8798043653189:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT: lui a0, 917475
; RV64IZBA-NEXT: addiw a0, a0, -273
; RV64IZBA-NEXT: slli a0, a0, 14
; RV64IZBA-NEXT: addi a0, a0, -1093
; RV64IZBA-NEXT: ret
;
; RV64IZBB-LABEL: imm_neg_8798043653189:
; RV64IZBB:    # %bb.0:

```

```

; RV64IZBB-NEXT: lui a0, 917475
; RV64IZBB-NEXT: addiw a0, a0, -273
; RV64IZBB-NEXT: slli a0, a0, 14
; RV64IZBB-NEXT: addi a0, a0, -1093
; RV64IZBB-NEXT: ret
;
; RV64IZBS-LABEL: imm_neg_8798043653189:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT: lui a0, 572348
; RV64IZBS-NEXT:
    addiw a0, a0, -1093
; RV64IZBS-NEXT: bclri a0, a0, 43
; RV64IZBS-NEXT: ret
;
; RV64IXTHEADBB-LABEL: imm_neg_8798043653189:
; RV64IXTHEADBB:    # %bb.0:
; RV64IXTHEADBB-NEXT: lui a0, 917475
; RV64IXTHEADBB-NEXT: addiw a0, a0, -273
; RV64IXTHEADBB-NEXT: slli a0, a0, 14
; RV64IXTHEADBB-NEXT: addi a0, a0, -1093
; RV64IXTHEADBB-NEXT: ret
ret i64 -8798043653189 ; 0xffff7ff8bbbbbbb
}

```

```

define i64 @imm_9223372034904144827() {
; RV64I-LABEL: imm_9223372034904144827:
; RV64I:    # %bb.0:
; RV64I-NEXT: lui a0, 572348
; RV64I-NEXT: addiw a0, a0, -1093
; RV64I-NEXT: slli a1, a0, 63
; RV64I-NEXT: add a0, a0, a1
; RV64I-NEXT: ret
;
; RV64IZBA-LABEL: imm_9223372034904144827:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT: lui a0, 572348
; RV64IZBA-NEXT: addiw a0, a0, -1093
; RV64IZBA-NEXT: slli a1, a0, 63
; RV64IZBA-NEXT: add a0, a0, a1
; RV64IZBA-NEXT: ret
;
; RV64IZBB-LABEL: imm_9223372034904144827:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:
    lui a0, 572348
; RV64IZBB-NEXT: addiw a0, a0, -1093
; RV64IZBB-NEXT: slli a1, a0, 63
; RV64IZBB-NEXT: add a0, a0, a1

```



```

; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm_9223372034904144827:
; RV64IZBS:      # %bb.0:
; RV64IZBS-NEXT:  lui a0, 572348
; RV64IZBS-NEXT:  addiw a0, a0, -1093
; RV64IZBS-NEXT:  bclri a0, a0, 63
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm_9223372034904144827:
; RV64IXTHEADBB:  # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 572348
; RV64IXTHEADBB-NEXT:  addiw a0, a0, -1093
; RV64IXTHEADBB-NEXT:  slli a1, a0, 63
; RV64IXTHEADBB-NEXT:  add a0, a0, a1
; RV64IXTHEADBB-NEXT:  ret
ret i64 9223372034904144827 ; 0x7ffffff8bbbbbbb
}

```

```

define i64 @imm_neg_9223354442718100411() {
; RV64-NOPOOL-LABEL: imm_neg_9223354442718100411:
; RV64-NOPOOL:      # %bb.0:
; RV64-NOPOOL-NEXT:  lui a0, 524287
; RV64-NOPOOL-NEXT:  slli a0, a0, 6
; RV64-NOPOOL-NEXT:  addi a0, a0, -29
; RV64-NOPOOL-NEXT:  slli a0, a0, 12
; RV64-NOPOOL-NEXT:
    addi a0, a0, -273
; RV64-NOPOOL-NEXT:  slli a0, a0, 14
; RV64-NOPOOL-NEXT:  addi a0, a0, -1093
; RV64-NOPOOL-NEXT:  ret
;
; RV64I-POOL-LABEL: imm_neg_9223354442718100411:
; RV64I-POOL:      # %bb.0:
; RV64I-POOL-NEXT:  lui a0, %hi(.LCPI43_0)
; RV64I-POOL-NEXT:  ld a0, %lo(.LCPI43_0)(a0)
; RV64I-POOL-NEXT:  ret
;
; RV64IZBA-LABEL: imm_neg_9223354442718100411:
; RV64IZBA:      # %bb.0:
; RV64IZBA-NEXT:  lui a0, 524287
; RV64IZBA-NEXT:  slli a0, a0, 6
; RV64IZBA-NEXT:  addi a0, a0, -29
; RV64IZBA-NEXT:  slli a0, a0, 12
; RV64IZBA-NEXT:  addi a0, a0, -273
; RV64IZBA-NEXT:  slli a0, a0, 14
; RV64IZBA-NEXT:  addi a0, a0, -1093
; RV64IZBA-NEXT:  ret

```

```

;
; RV64IZBB-LABEL: imm_neg_9223354442718100411:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT: lui a0, 524287
; RV64IZBB-NEXT: slli a0, a0, 6
; RV64IZBB-NEXT: addi a0, a0, -29
; RV64IZBB-NEXT: slli a0, a0, 12
; RV64IZBB-NEXT: addi a0, a0, -273
; RV64IZBB-NEXT: slli a0, a0, 14
; RV64IZBB-NEXT:
    addi a0, a0, -1093
; RV64IZBB-NEXT: ret
;
; RV64IZBS-LABEL: imm_neg_9223354442718100411:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT: lui a0, 572348
; RV64IZBS-NEXT: addiw a0, a0, -1093
; RV64IZBS-NEXT: bclri a0, a0, 44
; RV64IZBS-NEXT: bclri a0, a0, 63
; RV64IZBS-NEXT: ret
;
; RV64IXTHEADBB-LABEL: imm_neg_9223354442718100411:
; RV64IXTHEADBB:    # %bb.0:
; RV64IXTHEADBB-NEXT: lui a0, 524287
; RV64IXTHEADBB-NEXT: slli a0, a0, 6
; RV64IXTHEADBB-NEXT: addi a0, a0, -29
; RV64IXTHEADBB-NEXT: slli a0, a0, 12
; RV64IXTHEADBB-NEXT: addi a0, a0, -273
; RV64IXTHEADBB-NEXT: slli a0, a0, 14
; RV64IXTHEADBB-NEXT: addi a0, a0, -1093
; RV64IXTHEADBB-NEXT: ret
    ret i64 9223354442718100411 ; 0x7ffefff8bbbbbbb
}

```

```

define i64 @imm_2863311530() {
; RV64I-LABEL: imm_2863311530:
; RV64I:    # %bb.0:
; RV64I-NEXT: lui a0, 349525
; RV64I-NEXT: addiw a0, a0, 1365
; RV64I-NEXT: slli a0, a0, 1
; RV64I-NEXT: ret
;
; RV64IZBA-LABEL: imm_2863311530:
; RV64IZBA:
    # %bb.0:
; RV64IZBA-NEXT: lui a0, 349525
; RV64IZBA-NEXT: addiw a0, a0, 1365
; RV64IZBA-NEXT: slli a0, a0, 1

```

```

; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm_2863311530:
; RV64IZBB:      # %bb.0:
; RV64IZBB-NEXT:  lui a0, 349525
; RV64IZBB-NEXT:  addiw a0, a0, 1365
; RV64IZBB-NEXT:  slli a0, a0, 1
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm_2863311530:
; RV64IZBS:      # %bb.0:
; RV64IZBS-NEXT:  lui a0, 349525
; RV64IZBS-NEXT:  addiw a0, a0, 1365
; RV64IZBS-NEXT:  slli a0, a0, 1
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm_2863311530:
; RV64IXTHEADBB:  # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 349525
; RV64IXTHEADBB-NEXT:  addiw a0, a0, 1365
; RV64IXTHEADBB-NEXT:  slli a0, a0, 1
; RV64IXTHEADBB-NEXT:  ret
ret i64 2863311530 ; #0xaaaaaaaa
}

```

```

define i64 @imm_neg_2863311530() {
; RV64I-LABEL: imm_neg_2863311530:
; RV64I:      # %bb.0:
; RV64I-NEXT:  lui a0, 699051
; RV64I-NEXT:  addiw a0, a0, -1365
; RV64I-NEXT:  slli a0,
a0, 1
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm_neg_2863311530:
; RV64IZBA:      # %bb.0:
; RV64IZBA-NEXT:  lui a0, 699051
; RV64IZBA-NEXT:  addiw a0, a0, -1365
; RV64IZBA-NEXT:  slli a0, a0, 1
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm_neg_2863311530:
; RV64IZBB:      # %bb.0:
; RV64IZBB-NEXT:  lui a0, 699051
; RV64IZBB-NEXT:  addiw a0, a0, -1365
; RV64IZBB-NEXT:  slli a0, a0, 1
; RV64IZBB-NEXT:  ret
;

```

```
; RV64IZBS-LABEL: imm_neg_2863311530:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:  lui a0, 699051
; RV64IZBS-NEXT:  addiw a0, a0, -1365
; RV64IZBS-NEXT:  slli a0, a0, 1
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm_neg_2863311530:
; RV64IXTHEADBB:    # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 699051
; RV64IXTHEADBB-NEXT:  addiw a0, a0, -1365
; RV64IXTHEADBB-NEXT:  slli a0, a0, 1
; RV64IXTHEADBB-NEXT:  ret
ret i64 -2863311530 ; #0xffffffff55555556
}
```

```
define i64 @imm_2147486378() {
; RV64I-LABEL: imm_2147486378:
; RV64I:    # %bb.0:
; RV64I-NEXT:
    li a0, 1
; RV64I-NEXT:  slli a0, a0, 31
; RV64I-NEXT:  addi a0, a0, 1365
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm_2147486378:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  li a0, 1
; RV64IZBA-NEXT:  slli a0, a0, 31
; RV64IZBA-NEXT:  addi a0, a0, 1365
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm_2147486378:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  li a0, 1
; RV64IZBB-NEXT:  slli a0, a0, 31
; RV64IZBB-NEXT:  addi a0, a0, 1365
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm_2147486378:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:  li a0, 1365
; RV64IZBS-NEXT:  bseti a0, a0, 31
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm_2147486378:
; RV64IXTHEADBB:    # %bb.0:
; RV64IXTHEADBB-NEXT:  li a0, 1
```

```

; RV64IXTHEADBB-NEXT:  slli a0, a0, 31
; RV64IXTHEADBB-NEXT:  addi a0, a0, 1365
; RV64IXTHEADBB-NEXT:  ret
ret i64 2147485013
}

define i64 @imm_neg_2147485013() {
; RV64I-LABEL: imm_neg_2147485013:
; RV64I:      # %bb.0:
; RV64I-NEXT:
    lui a0, 524288
; RV64I-NEXT:  addi a0, a0, -1365
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm_neg_2147485013:
; RV64IZBA:   # %bb.0:
; RV64IZBA-NEXT:  lui a0, 524288
; RV64IZBA-NEXT:  addi a0, a0, -1365
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm_neg_2147485013:
; RV64IZBB:   # %bb.0:
; RV64IZBB-NEXT:  lui a0, 524288
; RV64IZBB-NEXT:  addi a0, a0, -1365
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm_neg_2147485013:
; RV64IZBS:   # %bb.0:
; RV64IZBS-NEXT:  lui a0, 524288
; RV64IZBS-NEXT:  addi a0, a0, -1365
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm_neg_2147485013:
; RV64IXTHEADBB:   # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 524288
; RV64IXTHEADBB-NEXT:  addi a0, a0, -1365
; RV64IXTHEADBB-NEXT:  ret
ret i64 -2147485013
}

define i64 @imm_12900924131259() {
; RV64I-LABEL: imm_12900924131259:
; RV64I:      # %bb.0:
; RV64I-NEXT:  lui a0, 188
; RV64I-NEXT:  addiw a0, a0, -1093
; RV64I-NEXT:  slli a0, a0, 24
; RV64I-NEXT:  addi a0,

```

```

a0, 1979
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm_12900924131259:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  lui a0, 768955
; RV64IZBA-NEXT:  slli.uw a0, a0, 12
; RV64IZBA-NEXT:  addi a0, a0, 1979
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm_12900924131259:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  lui a0, 188
; RV64IZBB-NEXT:  addiw a0, a0, -1093
; RV64IZBB-NEXT:  slli a0, a0, 24
; RV64IZBB-NEXT:  addi a0, a0, 1979
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm_12900924131259:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:  lui a0, 188
; RV64IZBS-NEXT:  addiw a0, a0, -1093
; RV64IZBS-NEXT:  slli a0, a0, 24
; RV64IZBS-NEXT:  addi a0, a0, 1979
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm_12900924131259:
; RV64IXTHEADBB:  # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 188
; RV64IXTHEADBB-NEXT:  addiw a0, a0, -1093
; RV64IXTHEADBB-NEXT:  slli a0, a0, 24
; RV64IXTHEADBB-NEXT:  addi a0, a0, 1979
; RV64IXTHEADBB-NEXT:  ret
ret i64 12900924131259
}

```

```

define
i64 @imm_50394234880() {
; RV64I-LABEL: imm_50394234880:
; RV64I:    # %bb.0:
; RV64I-NEXT:  lui a0, 188
; RV64I-NEXT:  addiw a0, a0, -1093
; RV64I-NEXT:  slli a0, a0, 16
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm_50394234880:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  lui a0, 768955

```

```

; RV64IZBA-NEXT:  slli.uw a0, a0, 4
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm_50394234880:
; RV64IZBB:      # %bb.0:
; RV64IZBB-NEXT:  lui a0, 188
; RV64IZBB-NEXT:  addiw a0, a0, -1093
; RV64IZBB-NEXT:  slli a0, a0, 16
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm_50394234880:
; RV64IZBS:      # %bb.0:
; RV64IZBS-NEXT:  lui a0, 188
; RV64IZBS-NEXT:  addiw a0, a0, -1093
; RV64IZBS-NEXT:  slli a0, a0, 16
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm_50394234880:
; RV64IXTHEADBB:  # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 188
; RV64IXTHEADBB-NEXT:  addiw a0, a0, -1093
; RV64IXTHEADBB-NEXT:  slli a0, a0, 16
; RV64IXTHEADBB-NEXT:  ret
ret
i64 50394234880
}

```

```

define i64 @imm_12900936431479() {
; RV64I-LABEL: imm_12900936431479:
; RV64I:      # %bb.0:
; RV64I-NEXT:  lui a0, 192239
; RV64I-NEXT:  slli a0, a0, 2
; RV64I-NEXT:  addi a0, a0, -1093
; RV64I-NEXT:  slli a0, a0, 12
; RV64I-NEXT:  addi a0, a0, 1911
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm_12900936431479:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  lui a0, 768956
; RV64IZBA-NEXT:  addi a0, a0, -1093
; RV64IZBA-NEXT:  slli.uw a0, a0, 12
; RV64IZBA-NEXT:  addi a0, a0, 1911
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm_12900936431479:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  lui a0, 192239

```

```

; RV64IZBB-NEXT:  slli a0, a0, 2
; RV64IZBB-NEXT:  addi a0, a0, -1093
; RV64IZBB-NEXT:  slli a0, a0, 12
; RV64IZBB-NEXT:  addi a0, a0, 1911
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm_12900936431479:
; RV64IZBS:      # %bb.0:
; RV64IZBS-NEXT:  lui a0, 192239
; RV64IZBS-NEXT:  slli a0, a0, 2
; RV64IZBS-NEXT:  addi a0, a0, -1093
; RV64IZBS-NEXT:
    slli a0, a0, 12
; RV64IZBS-NEXT:  addi a0, a0, 1911
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm_12900936431479:
; RV64IXTHEADBB:  # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 192239
; RV64IXTHEADBB-NEXT:  slli a0, a0, 2
; RV64IXTHEADBB-NEXT:  addi a0, a0, -1093
; RV64IXTHEADBB-NEXT:  slli a0, a0, 12
; RV64IXTHEADBB-NEXT:  addi a0, a0, 1911
; RV64IXTHEADBB-NEXT:  ret
ret i64 12900936431479
}

```

```

define i64 @imm_12900918536874() {
; RV64I-LABEL: imm_12900918536874:
; RV64I:      # %bb.0:
; RV64I-NEXT:  lui a0, 384477
; RV64I-NEXT:  addiw a0, a0, 1365
; RV64I-NEXT:  slli a0, a0, 12
; RV64I-NEXT:  addi a0, a0, 1365
; RV64I-NEXT:  slli a0, a0, 1
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm_12900918536874:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  lui a0, 768955
; RV64IZBA-NEXT:  addi a0, a0, -1365
; RV64IZBA-NEXT:  slli.uw a0, a0, 12
; RV64IZBA-NEXT:  addi a0, a0, -1366
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm_12900918536874:
;

```



```

RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  lui a0, 384477
; RV64IZBB-NEXT:  addiw a0, a0, 1365
; RV64IZBB-NEXT:  slli a0, a0, 12
; RV64IZBB-NEXT:  addi a0, a0, 1365
; RV64IZBB-NEXT:  slli a0, a0, 1
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm_12900918536874:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:  lui a0, 384477
; RV64IZBS-NEXT:  addiw a0, a0, 1365
; RV64IZBS-NEXT:  slli a0, a0, 12
; RV64IZBS-NEXT:  addi a0, a0, 1365
; RV64IZBS-NEXT:  slli a0, a0, 1
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm_12900918536874:
; RV64IXTHEADBB:  # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 384477
; RV64IXTHEADBB-NEXT:  addiw a0, a0, 1365
; RV64IXTHEADBB-NEXT:  slli a0, a0, 12
; RV64IXTHEADBB-NEXT:  addi a0, a0, 1365
; RV64IXTHEADBB-NEXT:  slli a0, a0, 1
; RV64IXTHEADBB-NEXT:  ret
ret i64 12900918536874
}

```

```

define i64 @imm_12900925247761() {
; RV64I-LABEL: imm_12900925247761:
; RV64I:    # %bb.0:
; RV64I-NEXT:  lui a0, 384478
; RV64I-NEXT:  addiw
a0, a0, -1911
; RV64I-NEXT:  slli a0, a0, 13
; RV64I-NEXT:  addi a0, a0, -2048
; RV64I-NEXT:  addi a0, a0, -1775
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm_12900925247761:
; RV64IZBA:  # %bb.0:
; RV64IZBA-NEXT:  lui a0, 768955
; RV64IZBA-NEXT:  addi a0, a0, 273
; RV64IZBA-NEXT:  slli.uw a0, a0, 12
; RV64IZBA-NEXT:  addi a0, a0, 273
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm_12900925247761:

```

```

; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  lui a0, 384478
; RV64IZBB-NEXT:  addiw a0, a0, -1911
; RV64IZBB-NEXT:  slli a0, a0, 13
; RV64IZBB-NEXT:  addi a0, a0, -2048
; RV64IZBB-NEXT:  addi a0, a0, -1775
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm_12900925247761:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:  lui a0, 384478
; RV64IZBS-NEXT:  addiw a0, a0, -1911
; RV64IZBS-NEXT:  slli a0, a0, 13
; RV64IZBS-NEXT:  addi a0, a0, -2048
; RV64IZBS-NEXT:  addi a0, a0, -1775
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm_12900925247761:
; RV64IXTHEADBB:
    # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 384478
; RV64IXTHEADBB-NEXT:  addiw a0, a0, -1911
; RV64IXTHEADBB-NEXT:  slli a0, a0, 13
; RV64IXTHEADBB-NEXT:  addi a0, a0, -2048
; RV64IXTHEADBB-NEXT:  addi a0, a0, -1775
; RV64IXTHEADBB-NEXT:  ret
ret i64 12900925247761
}

```

```

define i64 @imm_7158272001() {
; RV64I-LABEL: imm_7158272001:
; RV64I:    # %bb.0:
; RV64I-NEXT:  lui a0, 427
; RV64I-NEXT:  addiw a0, a0, -1367
; RV64I-NEXT:  slli a0, a0, 12
; RV64I-NEXT:  addi a0, a0, 1
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm_7158272001:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  lui a0, 349525
; RV64IZBA-NEXT:  sh2add a0, a0, a0
; RV64IZBA-NEXT:  addi a0, a0, 1
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm_7158272001:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  lui a0, 427

```

```

; RV64IZBB-NEXT:   addiw a0, a0, -1367
; RV64IZBB-NEXT:   slli a0, a0, 12
; RV64IZBB-NEXT:   addi a0, a0, 1
; RV64IZBB-NEXT:   ret
;
; RV64IZBS-LABEL: imm_7158272001:
; RV64IZBS:
    # %bb.0:
; RV64IZBS-NEXT:   lui a0, 427
; RV64IZBS-NEXT:   addiw a0, a0, -1367
; RV64IZBS-NEXT:   slli a0, a0, 12
; RV64IZBS-NEXT:   addi a0, a0, 1
; RV64IZBS-NEXT:   ret
;
; RV64IXTHEADBB-LABEL: imm_7158272001:
; RV64IXTHEADBB:   # %bb.0:
; RV64IXTHEADBB-NEXT:   lui a0, 427
; RV64IXTHEADBB-NEXT:   addiw a0, a0, -1367
; RV64IXTHEADBB-NEXT:   slli a0, a0, 12
; RV64IXTHEADBB-NEXT:   addi a0, a0, 1
; RV64IXTHEADBB-NEXT:   ret
ret i64 7158272001 ; 0x0000_0001_aaaa_9001
}

```

```

define i64 @imm_12884889601() {
; RV64I-LABEL: imm_12884889601:
; RV64I:   # %bb.0:
; RV64I-NEXT:   lui a0, 768
; RV64I-NEXT:   addiw a0, a0, -3
; RV64I-NEXT:   slli a0, a0, 12
; RV64I-NEXT:   addi a0, a0, 1
; RV64I-NEXT:   ret
;
; RV64IZBA-LABEL: imm_12884889601:
; RV64IZBA:   # %bb.0:
; RV64IZBA-NEXT:   lui a0, 349525
; RV64IZBA-NEXT:   sh3add a0, a0, a0
; RV64IZBA-NEXT:   addi a0, a0, 1
; RV64IZBA-NEXT:   ret
;
; RV64IZBB-LABEL: imm_12884889601:
; RV64IZBB:   # %bb.0:
; RV64IZBB-NEXT:
    lui a0, 768
; RV64IZBB-NEXT:   addiw a0, a0, -3
; RV64IZBB-NEXT:   slli a0, a0, 12
; RV64IZBB-NEXT:   addi a0, a0, 1
; RV64IZBB-NEXT:   ret

```

```

;
; RV64IZBS-LABEL: imm_12884889601:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:  lui a0, 768
; RV64IZBS-NEXT:  addiw a0, a0, -3
; RV64IZBS-NEXT:  slli a0, a0, 12
; RV64IZBS-NEXT:  addi a0, a0, 1
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm_12884889601:
; RV64IXTHEADBB:    # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 768
; RV64IXTHEADBB-NEXT:  addiw a0, a0, -3
; RV64IXTHEADBB-NEXT:  slli a0, a0, 12
; RV64IXTHEADBB-NEXT:  addi a0, a0, 1
; RV64IXTHEADBB-NEXT:  ret
ret i64 12884889601 ; 0x0000_0002_ffff_d001
}

```

```

define i64 @imm_neg_3435982847() {
; RV64I-LABEL: imm_neg_3435982847:
; RV64I:    # %bb.0:
; RV64I-NEXT:  lui a0, 1048371
; RV64I-NEXT:  addiw a0, a0, 817
; RV64I-NEXT:  slli a0, a0, 12
; RV64I-NEXT:  addi a0, a0, 1
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm_neg_3435982847:
; RV64IZBA:
# %bb.0:
; RV64IZBA-NEXT:  lui a0, 768955
; RV64IZBA-NEXT:  sh1add a0, a0, a0
; RV64IZBA-NEXT:  addi a0, a0, 1
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm_neg_3435982847:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  lui a0, 1048371
; RV64IZBB-NEXT:  addiw a0, a0, 817
; RV64IZBB-NEXT:  slli a0, a0, 12
; RV64IZBB-NEXT:  addi a0, a0, 1
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm_neg_3435982847:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:  lui a0, 734001
; RV64IZBS-NEXT:  addiw a0, a0, 1

```

```

; RV64IZBS-NEXT:  bclri a0, a0, 31
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm_neg_3435982847:
; RV64IXTHEADBB:   # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 1048371
; RV64IXTHEADBB-NEXT:  addiw a0, a0, 817
; RV64IXTHEADBB-NEXT:  slli a0, a0, 12
; RV64IXTHEADBB-NEXT:  addi a0, a0, 1
; RV64IXTHEADBB-NEXT:  ret
ret i64 -3435982847 ; 0xffff_ffff_3333_1001
}

```

```

define i64 @imm_neg_5726842879() {
; RV64I-LABEL: imm_neg_5726842879:
; RV64I:   # %bb.0:
; RV64I-NEXT:
    lui a0, 1048235
; RV64I-NEXT:  addiw a0, a0, -1419
; RV64I-NEXT:  slli a0, a0, 12
; RV64I-NEXT:  addi a0, a0, 1
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: imm_neg_5726842879:
; RV64IZBA:   # %bb.0:
; RV64IZBA-NEXT:  lui a0, 768945
; RV64IZBA-NEXT:  sh2add a0, a0, a0
; RV64IZBA-NEXT:  addi a0, a0, 1
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: imm_neg_5726842879:
; RV64IZBB:   # %bb.0:
; RV64IZBB-NEXT:  lui a0, 1048235
; RV64IZBB-NEXT:  addiw a0, a0, -1419
; RV64IZBB-NEXT:  slli a0, a0, 12
; RV64IZBB-NEXT:  addi a0, a0, 1
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: imm_neg_5726842879:
; RV64IZBS:   # %bb.0:
; RV64IZBS-NEXT:  lui a0, 698997
; RV64IZBS-NEXT:  addiw a0, a0, 1
; RV64IZBS-NEXT:  bclri a0, a0, 32
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: imm_neg_5726842879:
; RV64IXTHEADBB:   # %bb.0:
; RV64IXTHEADBB-NEXT:  lui a0, 1048235

```

```
; RV64IXTHEADBB-NEXT: addiw a0, a0, -1419
; RV64IXTHEADBB-NEXT: slli a0, a0, 12
; RV64IXTHEADBB-NEXT:
    addi a0, a0, 1
; RV64IXTHEADBB-NEXT: ret
ret i64 -5726842879 ; 0xffff_fffe_aaa7_5001
}
```

```
define i64 @imm_neg_10307948543() {
; RV64I-LABEL: imm_neg_10307948543:
; RV64I:    # %bb.0:
; RV64I-NEXT: lui a0, 1047962
; RV64I-NEXT: addiw a0, a0, -1645
; RV64I-NEXT: slli a0, a0, 12
; RV64I-NEXT: addi a0, a0, 1
; RV64I-NEXT: ret
;
; RV64IZBA-LABEL: imm_neg_10307948543:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT: lui a0, 768955
; RV64IZBA-NEXT: sh3add a0, a0, a0
; RV64IZBA-NEXT: addi a0, a0, 1
; RV64IZBA-NEXT: ret
;
; RV64IZBB-LABEL: imm_neg_10307948543:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT: lui a0, 1047962
; RV64IZBB-NEXT: addiw a0, a0, -1645
; RV64IZBB-NEXT: slli a0, a0, 12
; RV64IZBB-NEXT: addi a0, a0, 1
; RV64IZBB-NEXT: ret
;
; RV64IZBS-LABEL: imm_neg_10307948543:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT: lui a0, 629139
; RV64IZBS-NEXT: addiw a0, a0, 1
; RV64IZBS-NEXT: bclri a0, a0, 33
; RV64IZBS-NEXT: ret
;
; RV64IXTHEADBB-LABEL:
imm_neg_10307948543:
; RV64IXTHEADBB:    # %bb.0:
; RV64IXTHEADBB-NEXT: lui a0, 1047962
; RV64IXTHEADBB-NEXT: addiw a0, a0, -1645
; RV64IXTHEADBB-NEXT: slli a0, a0, 12
; RV64IXTHEADBB-NEXT: addi a0, a0, 1
; RV64IXTHEADBB-NEXT: ret
ret i64 -10307948543 ; 0xffff_fffd_9999_3001
}
```

```

}

define i64 @li_ori_1() {
; RV64I-LABEL: li_ori_1:
; RV64I:      # %bb.0:
; RV64I-NEXT: li a0, -17
; RV64I-NEXT: slli a0, a0, 43
; RV64I-NEXT: addi a0, a0, -1
; RV64I-NEXT: ret
;
; RV64IZBA-LABEL: li_ori_1:
; RV64IZBA:   # %bb.0:
; RV64IZBA-NEXT: li a0, -17
; RV64IZBA-NEXT: slli a0, a0, 43
; RV64IZBA-NEXT: addi a0, a0, -1
; RV64IZBA-NEXT: ret
;
; RV64IZBB-LABEL: li_ori_1:
; RV64IZBB:   # %bb.0:
; RV64IZBB-NEXT: li a0, -18
; RV64IZBB-NEXT: rori a0, a0, 21
; RV64IZBB-NEXT: ret
;
; RV64IZBS-LABEL: li_ori_1:
; RV64IZBS:   # %bb.0:
; RV64IZBS-NEXT: li a0, -17
; RV64IZBS-NEXT: slli a0, a0, 43
; RV64IZBS-NEXT: addi a0, a0,
-1
; RV64IZBS-NEXT: ret
;
; RV64IXTHEADBB-LABEL: li_ori_1:
; RV64IXTHEADBB:   # %bb.0:
; RV64IXTHEADBB-NEXT: li a0, -18
; RV64IXTHEADBB-NEXT: th.srri a0, a0, 21
; RV64IXTHEADBB-NEXT: ret
ret i64 -149533581377537
}

```

```

define i64 @li_ori_2() {
; RV64I-LABEL: li_ori_2:
; RV64I:      # %bb.0:
; RV64I-NEXT: li a0, -5
; RV64I-NEXT: slli a0, a0, 60
; RV64I-NEXT: addi a0, a0, -6
; RV64I-NEXT: ret
;
; RV64IZBA-LABEL: li_ori_2:

```

```

; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  li a0, -5
; RV64IZBA-NEXT:  slli a0, a0, 60
; RV64IZBA-NEXT:  addi a0, a0, -6
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: li_ropi_2:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  li a0, -86
; RV64IZBB-NEXT:  rori a0, a0, 4
; RV64IZBB-NEXT:  ret
;
; RV64IZBS-LABEL: li_ropi_2:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT:  li a0, -5
; RV64IZBS-NEXT:  slli a0, a0, 60
; RV64IZBS-NEXT:  addi a0, a0, -6
; RV64IZBS-NEXT:  ret
;
; RV64IXTHEADBB-LABEL: li_ropi_2:
; RV64IXTHEADBB:
;   # %bb.0:
; RV64IXTHEADBB-NEXT:  li a0, -86
; RV64IXTHEADBB-NEXT:  th.srri a0, a0, 4
; RV64IXTHEADBB-NEXT:  ret
ret i64 -5764607523034234886
}

```

```

define i64 @li_ropi_3() {
; RV64I-LABEL: li_ropi_3:
; RV64I:    # %bb.0:
; RV64I-NEXT:  li a0, -17
; RV64I-NEXT:  slli a0, a0, 27
; RV64I-NEXT:  addi a0, a0, -1
; RV64I-NEXT:  ret
;
; RV64IZBA-LABEL: li_ropi_3:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT:  li a0, -17
; RV64IZBA-NEXT:  slli a0, a0, 27
; RV64IZBA-NEXT:  addi a0, a0, -1
; RV64IZBA-NEXT:  ret
;
; RV64IZBB-LABEL: li_ropi_3:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT:  li a0, -18
; RV64IZBB-NEXT:  rori a0, a0, 37
; RV64IZBB-NEXT:  ret

```



```

;
; RV64IZBS-LABEL: li_ropi_3:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT: li a0, -17
; RV64IZBS-NEXT: slli a0, a0, 27
; RV64IZBS-NEXT: addi a0, a0, -1
; RV64IZBS-NEXT: ret
;
; RV64IXTHEADBB-LABEL: li_ropi_3:
; RV64IXTHEADBB:    # %bb.0:
; RV64IXTHEADBB-NEXT: li a0, -18
; RV64IXTHEADBB-NEXT: th.srri a0,
a0, 37
; RV64IXTHEADBB-NEXT: ret
ret i64 -2281701377
}

; This used to assert when compiled with Zba.
define i64 @PR54812() {
; RV64I-LABEL: PR54812:
; RV64I:    # %bb.0:
; RV64I-NEXT: lui a0, 1048447
; RV64I-NEXT: addiw a0, a0, 1407
; RV64I-NEXT: slli a0, a0, 12
; RV64I-NEXT: ret
;
; RV64IZBA-LABEL: PR54812:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT: lui a0, 872917
; RV64IZBA-NEXT: sh1add a0, a0, a0
; RV64IZBA-NEXT: ret
;
; RV64IZBB-LABEL: PR54812:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT: lui a0, 1048447
; RV64IZBB-NEXT: addiw a0, a0, 1407
; RV64IZBB-NEXT: slli a0, a0, 12
; RV64IZBB-NEXT: ret
;
; RV64IZBS-LABEL: PR54812:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT: lui a0, 1045887
; RV64IZBS-NEXT: bclri a0, a0, 31
; RV64IZBS-NEXT: ret
;
; RV64IXTHEADBB-LABEL: PR54812:
; RV64IXTHEADBB:    # %bb.0:
; RV64IXTHEADBB-NEXT: lui a0, 1048447

```

```
; RV64IXTHEADBB-NEXT: addiw a0, a0, 1407
; RV64IXTHEADBB-NEXT: slli a0, a0, 12
; RV64IXTHEADBB-NEXT:
    ret
ret i64 -2158497792;
}
```

```
define signext i32 @pos_2048() nounwind {
; RV64I-LABEL: pos_2048:
; RV64I:    # %bb.0:
; RV64I-NEXT: li a0, 1
; RV64I-NEXT: slli a0, a0, 11
; RV64I-NEXT: ret
;
; RV64IZBA-LABEL: pos_2048:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT: li a0, 1
; RV64IZBA-NEXT: slli a0, a0, 11
; RV64IZBA-NEXT: ret
;
; RV64IZBB-LABEL: pos_2048:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT: li a0, 1
; RV64IZBB-NEXT: slli a0, a0, 11
; RV64IZBB-NEXT: ret
;
; RV64IZBS-LABEL: pos_2048:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT: bseti a0, zero, 11
; RV64IZBS-NEXT: ret
;
; RV64IXTHEADBB-LABEL: pos_2048:
; RV64IXTHEADBB:    # %bb.0:
; RV64IXTHEADBB-NEXT: li a0, 1
; RV64IXTHEADBB-NEXT: slli a0, a0, 11
; RV64IXTHEADBB-NEXT: ret
    ret i32 2048
}
```

```
define i64 @imm64_same_lo_hi() nounwind {
; RV64I-LABEL: imm64_same_lo_hi:
; RV64I:    # %bb.0:
; RV64I-NEXT: lui a0, 65793
; RV64I-NEXT: addiw a0, a0, 16
; RV64I-NEXT:
    slli a1, a0, 32
; RV64I-NEXT: add a0, a0, a1
; RV64I-NEXT: ret
}
```

```

;
; RV64IZBA-LABEL: imm64_same_lo_hi:
; RV64IZBA:    # %bb.0:
; RV64IZBA-NEXT: lui a0, 65793
; RV64IZBA-NEXT: addiw a0, a0, 16
; RV64IZBA-NEXT: slli a1, a0, 32
; RV64IZBA-NEXT: add a0, a0, a1
; RV64IZBA-NEXT: ret
;
; RV64IZBB-LABEL: imm64_same_lo_hi:
; RV64IZBB:    # %bb.0:
; RV64IZBB-NEXT: lui a0, 65793
; RV64IZBB-NEXT: addiw a0, a0, 16
; RV64IZBB-NEXT: slli a1, a0, 32
; RV64IZBB-NEXT: add a0, a0, a1
; RV64IZBB-NEXT: ret
;
; RV64IZBS-LABEL: imm64_same_lo_hi:
; RV64IZBS:    # %bb.0:
; RV64IZBS-NEXT: lui a0, 65793
; RV64IZBS-NEXT: addiw a0, a0, 16
; RV64IZBS-NEXT: slli a1, a0, 32
; RV64IZBS-NEXT: add a0, a0, a1
; RV64IZBS-NEXT: ret
;
; RV64IXTHEADBB-LABEL: imm64_same_lo_hi:
; RV64IXTHEADBB:    # %bb.0:
; RV64IXTHEADBB-NEXT: lui a0, 65793
; RV64IXTHEADBB-NEXT: addiw a0, a0, 16
; RV64IXTHEADBB-NEXT: slli a1, a0, 32
; RV64IXTHEADBB-NEXT: add a0, a0, a1
;
RV64IXTHEADBB-NEXT: ret
ret i64 1157442765409226768 ; 0x0101010101010101
}

```

; Same as above with optsize. Make sure we use constant pool on RV64

```
define i64 @imm64_same_lo_hi_optsize() nounwind optsize {
```

```

; RV64-NOPOOL-LABEL: imm64_same_lo_hi_optsize:
; RV64-NOPOOL:    # %bb.0:
; RV64-NOPOOL-NEXT: lui a0, 65793
; RV64-NOPOOL-NEXT: addiw a0, a0, 16
; RV64-NOPOOL-NEXT: slli a1, a0, 32
; RV64-NOPOOL-NEXT: add a0, a0, a1
; RV64-NOPOOL-NEXT: ret
;
; RV64I-POOL-LABEL: imm64_same_lo_hi_optsize:
; RV64I-POOL:    # %bb.0:

```

```

; RV64I-POOL-NEXT: lui a0, %hi(.LCPI64_0)
; RV64I-POOL-NEXT: ld a0, %lo(.LCPI64_0)(a0)
; RV64I-POOL-NEXT: ret
;
; RV64IZBA-LABEL: imm64_same_lo_hi_optsize:
; RV64IZBA: # %bb.0:
; RV64IZBA-NEXT: lui a0, 65793
; RV64IZBA-NEXT: addiw a0, a0, 16
; RV64IZBA-NEXT: slli a1, a0, 32
; RV64IZBA-NEXT: add a0, a0, a1
; RV64IZBA-NEXT: ret
;
; RV64IZBB-LABEL: imm64_same_lo_hi_optsize:
; RV64IZBB: # %bb.0:
; RV64IZBB-NEXT: lui
a0, 65793
; RV64IZBB-NEXT: addiw a0, a0, 16
; RV64IZBB-NEXT: slli a1, a0, 32
; RV64IZBB-NEXT: add a0, a0, a1
; RV64IZBB-NEXT: ret
;
; RV64IZBS-LABEL: imm64_same_lo_hi_optsize:
; RV64IZBS: # %bb.0:
; RV64IZBS-NEXT: lui a0, 65793
; RV64IZBS-NEXT: addiw a0, a0, 16
; RV64IZBS-NEXT: slli a1, a0, 32
; RV64IZBS-NEXT: add a0, a0, a1
; RV64IZBS-NEXT: ret
;
; RV64IXTHEADBB-LABEL: imm64_same_lo_hi_optsize:
; RV64IXTHEADBB: # %bb.0:
; RV64IXTHEADBB-NEXT: lui a0, 65793
; RV64IXTHEADBB-NEXT: addiw a0, a0, 16
; RV64IXTHEADBB-NEXT: slli a1, a0, 32
; RV64IXTHEADBB-NEXT: add a0, a0, a1
; RV64IXTHEADBB-NEXT: ret
ret i64 1157442765409226768 ; 0x0101010101010101
}
; NOTE: Assertions have been autogenerated by utils/update_llc_test_checks.py
; RUN: llc < %s -mtriple=x86_64-linux-android -mattr=+mmx -enable-legalize-types-checking | FileCheck %s
;
; D31946
; Check that we dont end up with the ""LLVM ERROR: Cannot select" error.
; Additionally ensure that the output code actually put fp128 values in SSE registers.

declare fp128 @llvm.fabs.f128(fp128)
declare fp128 @llvm.copysign.f128(fp128, fp128)

```

```

define fp128 @TestSelect(fp128 %a, fp128 %b) {
; CHECK-LABEL: TestSelect:
; CHECK:      # %bb.0:
; CHECK-NEXT: pushq %rbx
; CHECK-NEXT: .cfi_def_cfa_offset 16
; CHECK-NEXT: subq $32, %rsp
; CHECK-NEXT: .cfi_def_cfa_offset 48
; CHECK-NEXT: .cfi_offset %rbx, -16
; CHECK-NEXT: movaps %xmm1, {[[-0-9]+]}(%r{[sb]})p) # 16-byte Spill
; CHECK-NEXT: movaps %xmm0, (%rsp) # 16-byte Spill
; CHECK-NEXT: callq __gttf2@PLT
; CHECK-NEXT: movl %eax, %ebx
; CHECK-NEXT: movaps (%rsp), %xmm0 # 16-byte Reload
; CHECK-NEXT: movaps {[[-0-9]+]}(%r{[sb]})p),
    %xmm1 # 16-byte Reload
; CHECK-NEXT: callq __subtf3@PLT
; CHECK-NEXT: testl %ebx, %ebx
; CHECK-NEXT: jg .LBB0_2
; CHECK-NEXT: # %bb.1:
; CHECK-NEXT: xorps %xmm0, %xmm0
; CHECK-NEXT: .LBB0_2:
; CHECK-NEXT: addq $32, %rsp
; CHECK-NEXT: .cfi_def_cfa_offset 16
; CHECK-NEXT: popq %rbx
; CHECK-NEXT: .cfi_def_cfa_offset 8
; CHECK-NEXT: retq
    %cmp = fcmp ogt fp128 %a, %b
    %sub = fsub fp128 %a, %b
    %res = select i1 %cmp, fp128 %sub, fp128 0xL00000000000000000000000000000000
    ret fp128 %res
}

```

```

define fp128 @TestFabs(fp128 %a) {
; CHECK-LABEL: TestFabs:
; CHECK:      # %bb.0:
; CHECK-NEXT: andps {[\.?LCPI[0-9]+_[0-9]+]}(%rip), %xmm0
; CHECK-NEXT: retq
    %res = call fp128 @llvm.fabs.f128(fp128 %a)
    ret fp128 %res
}

```

```

define fp128 @TestCopysign(fp128 %a, fp128 %b) {
; CHECK-LABEL: TestCopysign:
; CHECK:      # %bb.0:
; CHECK-NEXT: andps {[\.?LCPI[0-9]+_[0-9]+]}(%rip), %xmm1
; CHECK-NEXT: andps {[\.?LCPI[0-9]+_[0-9]+]}(%rip), %xmm0
; CHECK-NEXT:

```

```

    orps %xmm1, %xmm0
; CHECK-NEXT:    retq
%res = call fp128 @llvm.copysign.f128(fp128 %a, fp128 %b)
ret fp128 %res
}

define fp128 @TestFneg(fp128 %a) {
; CHECK-LABEL: TestFneg:
; CHECK:      # %bb.0:
; CHECK-NEXT:    pushq %rax
; CHECK-NEXT:    .cfi_def_cfa_offset 16
; CHECK-NEXT:    movaps %xmm0, %xmm1
; CHECK-NEXT:    callq __multf3@PLT
; CHECK-NEXT:    xorps { {\. ?LCPI[0-9]+ _[0-9]+ } }(%rip), %xmm0
; CHECK-NEXT:    popq %rax
; CHECK-NEXT:    .cfi_def_cfa_offset 8
; CHECK-NEXT:    retq
%mul = fmul fp128 %a, %a
%res = fsub fp128 0xL00000000000000008000000000000000, %mul
ret fp128 %res
}
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```

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=====

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```

*/
; NOTE: Assertions have been autogenerated by utils/update_llc_test_checks.py
; RUN: llc -mtriple=riscv64 -mattr=+zbkb -verify-machineinstrs < %s \
; RUN: | FileCheck %s -check-prefix=RV64ZBKB

```

```

declare i64 @llvm.riscv.brev8.i64(i64)

```

```

define i64 @brev8(i64 %a) nounwind {
; RV64ZBKB-LABEL: brev8:
; RV64ZBKB:      # %bb.0:
; RV64ZBKB-NEXT:  brev8 a0, a0
; RV64ZBKB-NEXT:  ret
  %val = call i64 @llvm.riscv.brev8.i64(i64 %a)
  ret i64 %val
}

```

```

; Test that rev8 is recognized as preserving zero extension.
define zeroext i16 @brev8_knownbits(i16 zeroext %a) nounwind {
; RV64ZBKB-LABEL: brev8_knownbits:
; RV64ZBKB:      # %bb.0:
; RV64ZBKB-NEXT:  brev8 a0, a0
; RV64ZBKB-NEXT:  ret
  %zext = zext i16 %a to i64
  %val = call i64 @llvm.riscv.brev8.i64(i64 %zext)
  %trunc = trunc i64 %val to i16
  ret i16 %trunc
}

```

```

declare i64 @llvm.bswap.i64(i64)

```

```

define i64 @rev8_i64(i64 %a) {
; RV64ZBKB-LABEL: rev8_i64:
; RV64ZBKB:      # %bb.0:
; RV64ZBKB-NEXT:  rev8 a0, a0
; RV64ZBKB-NEXT:  ret
  %1 = call i64 @llvm.bswap.i64(i64 %a)
  ret i64 %1
}

```

```

declare i32 @llvm.riscv.brev8.i32(i32)

```

```

define signext i32 @brev8_i32(i32 signext %a) nounwind {
; RV64ZBKB-LABEL: brev8_i32:
; RV64ZBKB:      # %bb.0:
; RV64ZBKB-NEXT:  brev8 a0, a0
; RV64ZBKB-NEXT:  sext.w a0, a0
; RV64ZBKB-NEXT:  ret
  %val = call i32 @llvm.riscv.brev8.i32(i32 %a)

```



```

ret i32 %val
}

; Test that rev8 is recognized as preserving zero extension.
define zeroext i16 @brev8_i32_knownbits(i16 zeroext %a) nounwind {
; RV64ZBKB-LABEL: brev8_i32_knownbits:
; RV64ZBKB:      # %bb.0:
; RV64ZBKB-NEXT:  brev8 a0, a0
; RV64ZBKB-NEXT:  ret
%zext = zext i16 %a to i32
%val = call i32 @llvm.riscv.brev8.i32(i32 %zext)
%trunc = trunc i32 %val to i16
ret i16 %trunc
}

declare i32 @llvm.bswap.i32(i32)

define signext i32 @rev8_i32(i32 signext %a) {
; RV64ZBKB-LABEL: rev8_i32:
; RV64ZBKB:      # %bb.0:
; RV64ZBKB-NEXT:  rev8 a0, a0
; RV64ZBKB-NEXT:  srai a0, a0, 32
; RV64ZBKB-NEXT:  ret
%1 = call i32 @llvm.bswap.i32(i32
%a)
ret i32 %1
}

; NOTE: Assertions have been autogenerated by utils/update_llc_test_checks.py
; RUN: llc < %s -mtriple=x86_64-unknown-unknown -mcpu=skylake-avx512 -mattr=prefer-256-bit | FileCheck %s
--check-prefixes=CHECK,CHECK-SKX
; RUN: llc < %s -mtriple=x86_64-unknown-unknown -mcpu=skylake-avx512 -mattr=prefer-256-bit,avx512vbmi |
FileCheck %s --check-prefixes=CHECK,CHECK-SKX,CHECK-SKX-VBMI
; Make sure CPUs default to prefer-256-bit. avx512vnni isn't interesting as it just adds an isel peephole for
vpaddwd+vpadd
; RUN: llc < %s -mtriple=x86_64-unknown-unknown -mcpu=skylake-avx512 | FileCheck %s --check-
prefixes=CHECK,CHECK-AVX512
; RUN: llc < %s -mtriple=x86_64-unknown-unknown -mattr=-avx512vnni -mcpu=cascadelake | FileCheck %s --
check-prefixes=CHECK,CHECK-AVX512
; RUN: llc < %s -mtriple=x86_64-unknown-unknown -mattr=-avx512vnni -mcpu=cooperlake | FileCheck %s --
check-prefixes=CHECK,CHECK-AVX512
; RUN: llc < %s -mtriple=x86_64-unknown-unknown -mcpu=cannonlake | FileCheck %s --check-
prefixes=CHECK,CHECK-VBMI
;
; RUN: llc < %s -mtriple=x86_64-unknown-unknown -mattr=-avx512vnni -mcpu=icelake-client | FileCheck %s --
check-prefixes=CHECK,CHECK-VBMI
; RUN: llc < %s -mtriple=x86_64-unknown-unknown -mattr=-avx512vnni -mcpu=icelake-server | FileCheck %s --
check-prefixes=CHECK,CHECK-VBMI
; RUN: llc < %s -mtriple=x86_64-unknown-unknown -mattr=-avx512vnni -mcpu=tigerlake | FileCheck %s --check-

```

prefixes=CHECK,CHECK-VBMM

; This file primarily contains tests for specific places in X86ISelLowering.cpp that needed be made aware of the legalizer not allowing 512-bit vectors due to prefer-256-bit even though AVX512 is enabled.

```
define dso_local void @add256(<16 x i32>* %a, <16 x i32>* %b, <16 x i32>* %c) "min-legal-vector-width"="256" {
; CHECK-LABEL: add256:
; CHECK:      # %bb.0:
; CHECK-NEXT: vmovdqa (%rdi), %ymm0
; CHECK-NEXT: vmovdqa 32(%rdi), %ymm1
; CHECK-NEXT: vpaddd 32(%rsi), %ymm1, %ymm1
; CHECK-NEXT: vpaddd (%rsi), %ymm0, %ymm0
; CHECK-NEXT: vmovdqa %ymm0, (%rdx)
; CHECK-NEXT:
    vmovdqa %ymm1, 32(%rdx)
; CHECK-NEXT: vzeroupper
; CHECK-NEXT: retq
    %d = load <16 x i32>, <16 x i32>* %a
    %e = load <16 x i32>, <16 x i32>* %b
    %f = add <16 x i32> %d, %e
    store <16 x i32> %f, <16 x i32>* %c
    ret void
}
```

```
define dso_local void @add512(<16 x i32>* %a, <16 x i32>* %b, <16 x i32>* %c) "min-legal-vector-width"="512" {
; CHECK-LABEL: add512:
; CHECK:      # %bb.0:
; CHECK-NEXT: vmovdqa64 (%rdi), %zmm0
; CHECK-NEXT: vpaddd (%rsi), %zmm0, %zmm0
; CHECK-NEXT: vmovdqa64 %zmm0, (%rdx)
; CHECK-NEXT: vzeroupper
; CHECK-NEXT: retq
    %d = load <16 x i32>, <16 x i32>* %a
    %e = load <16 x i32>, <16 x i32>* %b
    %f = add <16 x i32> %d, %e
    store <16 x i32> %f, <16 x i32>* %c
    ret void
}
```

```
define dso_local void @avg_v64i8_256(<64 x i8>* %a, <64 x i8>* %b) "min-legal-vector-width"="256" {
; CHECK-LABEL: avg_v64i8_256:
; CHECK:      # %bb.0:
; CHECK-NEXT: vmovdqa (%rsi), %ymm0
; CHECK-NEXT: vmovdqa 32(%rsi), %ymm1
; CHECK-NEXT: vpavgb (%rdi),
```

```
%ymm0, %ymm0  
; CHECK-NEXT:    vpavgb 32(%rdi), %ymm1, %ymm1  
; CHECK-NEXT:    vmovdqu %ymm1, (%rax)  
; CHECK-NEXT:    vmovdqu %ymm0, (%rax)  
; CHECK-NEXT:    vzeroupper  
; CHECK-NEXT:    retq  
  
%1 = load <64 x i8>, <64 x i8>* %a  
%2 = load <64 x i8>, <64 x i8>* %b  
%3 = zext <64 x i8> %1 to <64 x i32>  
%4 = zext <64 x i8> %2 to <64 x i32>  
  
%5 = add nuw nsw <64 x i32> %3, <i32 1, i32 1, i32 1, i32 1, i32 1, i32 1, i32 1, i32 1, i32 1, i32 1, i32 1, i32 1, i32 1,  
i32 1, i32 1, i32 1, i32 1, i32 1, i32 1, i32 1, i32 1, i32 1, i32 1, i32 1, i32 1, i32 1, i32 1, i32 1, i32 1, i32 1, i32 1,  
i32 1, i32 1, i32 1, i32 1, i32 1, i32 1, i32 1, i32 1, i32 1, i32 1, i32 1, i32 1, i32 1, i32 1, i32 1, i32 1, i32 1, i32 1,>  
%6 = add nuw nsw <64 x i32> %5, %4  
%7 = lshr <64 x i32> %6, <i32 1, i32 1, i32 1, i32 1, i32 1, i32 1, i32 1, i32 1, i32 1, i32 1, i32 1, i32 1, i32 1, i32 1, i32 1,  
i32 1, i32 1>  
%8 = trunc <64 x i32> %7 to <64 x i8>  
store <64 x i8> %8, <64 x i8>* undef, align 4  
ret void  
}
```

```

%8 = trunc <64 x i32> %7 to <64 x i8>
store <64 x i8> %8, <64 x i8>* undef,
align 4
ret void
}

```

```

define dso_local void @pmaddwd_32_256(<32 x i16>* %APtr, <32 x i16>* %BPtr, <16 x i32>* %CPtr) "min-
legal-vector-width"="256" {
; CHECK-LABEL: pmaddwd_32_256:
; CHECK:      # %bb.0:
; CHECK-NEXT:  vmovdqa (%rdi), %ymm0
; CHECK-NEXT:  vmovdqa 32(%rdi), %ymm1
; CHECK-NEXT:  vpmaddwd 32(%rsi), %ymm1, %ymm1
; CHECK-NEXT:  vpmaddwd (%rsi), %ymm0, %ymm0
; CHECK-NEXT:  vmovdqa %ymm0, (%rdx)
; CHECK-NEXT:  vmovdqa %ymm1, 32(%rdx)
; CHECK-NEXT:  vzeroupper
; CHECK-NEXT:  retq
    %A = load <32 x i16>, <32 x i16>* %APtr
    %B = load <32 x i16>, <32 x i16>* %BPtr
    %a = sext <32 x i16> %A to <32 x i32>
    %b = sext <32 x i16> %B to <32 x i32>
    %m = mul nsw <32 x i32> %a, %b
    %odd = shufflevector <32 x i32> %m, <32 x i32> undef, <16 x i32> <i32 0, i32 2, i32 4, i32 6, i32 8, i32 10, i32
12, i32 14, i32 16, i32 18, i32 20, i32 22, i32 24, i32 26, i32 28, i32 30>
    %even = shufflevector <32 x i32> %m, <32 x i32> undef, <16 x i32> <i32 1, i32 3, i32 5, i32
7, i32 9, i32 11, i32 13, i32 15, i32 17, i32 19, i32 21, i32 23, i32 25, i32 27, i32 29, i32 31>
    %ret = add <16 x i32> %odd, %even
    store <16 x i32> %ret, <16 x i32>* %CPtr
    ret void
}

```

```

define dso_local void @pmaddwd_32_512(<32 x i16>* %APtr, <32 x i16>* %BPtr, <16 x i32>* %CPtr) "min-
legal-vector-width"="512" {
; CHECK-LABEL: pmaddwd_32_512:
; CHECK:      # %bb.0:
; CHECK-NEXT:  vmovdqa64 (%rdi), %zmm0
; CHECK-NEXT:  vpmaddwd (%rsi), %zmm0, %zmm0
; CHECK-NEXT:  vmovdqa64 %zmm0, (%rdx)
; CHECK-NEXT:  vzeroupper
; CHECK-NEXT:  retq
    %A = load <32 x i16>, <32 x i16>* %APtr
    %B = load <32 x i16>, <32 x i16>* %BPtr
    %a = sext <32 x i16> %A to <32 x i32>
    %b = sext <32 x i16> %B to <32 x i32>
    %m = mul nsw <32 x i32> %a, %b
    %odd = shufflevector <32 x i32> %m, <32 x i32> undef, <16 x i32> <i32 0, i32 2, i32 4, i32 6, i32 8, i32 10, i32
12, i32 14, i32 16, i32 18, i32 20, i32 22, i32 24, i32 26, i32 28, i32 30>

```

```

    %even = shufflevector <32 x i32> %m, <32 x i32>
undef, <16 x i32> <i32 1, i32 3, i32 5, i32 7, i32 9, i32 11, i32 13, i32 15, i32 17, i32 19, i32 21, i32 23, i32 25, i32
27, i32 29, i32 31>
    %ret = add <16 x i32> %odd, %even
    store <16 x i32> %ret, <16 x i32>* %CPtr
    ret void
}

define dso_local void @psubus_64i8_max_256(<64 x i8>* %xptr, <64 x i8>* %yptr, <64 x i8>* %zptr) "min-legal-
vector-width"="256" {
; CHECK-LABEL: psubus_64i8_max_256:
; CHECK:      # %bb.0:
; CHECK-NEXT: vmovdqa (%rdi), %ymm0
; CHECK-NEXT: vmovdqa 32(%rdi), %ymm1
; CHECK-NEXT: vpsubusb 32(%rsi), %ymm1, %ymm1
; CHECK-NEXT: vpsubusb (%rsi), %ymm0, %ymm0
; CHECK-NEXT: vmovdqa %ymm0, (%rdx)
; CHECK-NEXT: vmovdqa %ymm1, 32(%rdx)
; CHECK-NEXT: vzeroupper
; CHECK-NEXT: retq
    %x = load <64 x i8>, <64 x i8>* %xptr
    %y = load <64 x i8>, <64 x i8>* %yptr
    %cmp = icmp ult <64 x i8> %x, %y
    %max = select <64 x i1> %cmp, <64 x i8> %y, <64 x i8> %x
    %res = sub <64 x i8> %max, %y
    store <64 x i8> %res, <64 x i8>* %zptr
    ret void
}

define
dso_local void @psubus_64i8_max_512(<64 x i8>* %xptr, <64 x i8>* %yptr, <64 x i8>* %zptr) "min-legal-
vector-width"="512" {
; CHECK-LABEL: psubus_64i8_max_512:
; CHECK:      # %bb.0:
; CHECK-NEXT: vmovdqa64 (%rdi), %zmm0
; CHECK-NEXT: vpsubusb (%rsi), %zmm0, %zmm0
; CHECK-NEXT: vmovdqa64 %zmm0, (%rdx)
; CHECK-NEXT: vzeroupper
; CHECK-NEXT: retq
    %x = load <64 x i8>, <64 x i8>* %xptr
    %y = load <64 x i8>, <64 x i8>* %yptr
    %cmp = icmp ult <64 x i8> %x, %y
    %max = select <64 x i1> %cmp, <64 x i8> %y, <64 x i8> %x
    %res = sub <64 x i8> %max, %y
    store <64 x i8> %res, <64 x i8>* %zptr
    ret void
}

```

```

define dso_local i32 @_Z9test_charPcS_i_256(i8* nocapture readonly, i8* nocapture readonly, i32) "min-legal-
vector-width"="256" {
; CHECK-SKX-LABEL: _Z9test_charPcS_i_256:
; CHECK-SKX:      # %bb.0: # %entry
; CHECK-SKX-NEXT:  movl %edx, %eax
; CHECK-SKX-NEXT:  vpxor %xmm0, %xmm0, %xmm0
; CHECK-SKX-NEXT:  xorl %ecx, %ecx
; CHECK-SKX-NEXT:  vpxor %xmm1, %xmm1, %xmm1
;
; CHECK-SKX-NEXT:  vpxor %xmm2, %xmm2, %xmm2
; CHECK-SKX-NEXT:  .p2align 4, 0x90
; CHECK-SKX-NEXT:  .LBB8_1: # %vector.body
; CHECK-SKX-NEXT:  # =>This Inner Loop Header: Depth=1
; CHECK-SKX-NEXT:  vpmovsxbw 16(%rdi,%rcx), %ymm3
; CHECK-SKX-NEXT:  vpmovsxbw (%rdi,%rcx), %ymm4
; CHECK-SKX-NEXT:  vpmovsxbw 16(%rsi,%rcx), %ymm5
; CHECK-SKX-NEXT:  vpmaddwd %ymm3, %ymm5, %ymm3
; CHECK-SKX-NEXT:  vpadd %ymm2, %ymm3, %ymm2
; CHECK-SKX-NEXT:  vpmovsxbw (%rsi,%rcx), %ymm3
; CHECK-SKX-NEXT:  vpmaddwd %ymm4, %ymm3, %ymm3
; CHECK-SKX-NEXT:  vpadd %ymm1, %ymm3, %ymm1
; CHECK-SKX-NEXT:  addq $32, %rcx
; CHECK-SKX-NEXT:  cmpq %rcx, %rax
; CHECK-SKX-NEXT:  jne .LBB8_1
; CHECK-SKX-NEXT:  # %bb.2: # %middle.block
; CHECK-SKX-NEXT:  vpadd %ymm0, %ymm1, %ymm1
; CHECK-SKX-NEXT:  vpadd %ymm0, %ymm2, %ymm0
; CHECK-SKX-NEXT:  vpadd %ymm0, %ymm1, %ymm0
; CHECK-SKX-NEXT:  vextracti128 $1, %ymm0, %xmm1
; CHECK-SKX-NEXT:  vpadd %xmm1, %xmm0, %xmm0
; CHECK-SKX-NEXT:
;     vpslq {{.*#+}} %xmm1 = %xmm0[2,3,2,3]
; CHECK-SKX-NEXT:  vpadd %xmm1, %xmm0, %xmm0
; CHECK-SKX-NEXT:  vpsrlq $32, %xmm0, %xmm1
; CHECK-SKX-NEXT:  vpadd %xmm1, %xmm0, %xmm0
; CHECK-SKX-NEXT:  vmovd %xmm0, %eax
; CHECK-SKX-NEXT:  vzeroupper
; CHECK-SKX-NEXT:  retq
;
; CHECK-AVX512-LABEL: _Z9test_charPcS_i_256:
; CHECK-AVX512:    # %bb.0: # %entry
; CHECK-AVX512-NEXT:  movl %edx, %eax
; CHECK-AVX512-NEXT:  vpxor %xmm0, %xmm0, %xmm0
; CHECK-AVX512-NEXT:  xorl %ecx, %ecx
; CHECK-AVX512-NEXT:  vpxor %xmm1, %xmm1, %xmm1
; CHECK-AVX512-NEXT:  vpxor %xmm2, %xmm2, %xmm2
; CHECK-AVX512-NEXT:  .p2align 4, 0x90
; CHECK-AVX512-NEXT:  .LBB8_1: # %vector.body

```

```

; CHECK-AVX512-NEXT: # =>This Inner Loop Header: Depth=1
; CHECK-AVX512-NEXT: vpmovsxbw 16(%rdi,%rcx), %ymm3
; CHECK-AVX512-NEXT: vpmovsxbw (%rdi,%rcx), %ymm4
; CHECK-AVX512-NEXT: vpmovsxbw 16(%rsi,%rcx), %ymm5
; CHECK-AVX512-NEXT: vpmaddwd %ymm3, %ymm5, %ymm3
; CHECK-AVX512-NEXT: vpaddd %ymm2, %ymm3,
%ymm2
; CHECK-AVX512-NEXT: vpmovsxbw (%rsi,%rcx), %ymm3
; CHECK-AVX512-NEXT: vpmaddwd %ymm4, %ymm3, %ymm3
; CHECK-AVX512-NEXT: vpaddd %ymm1, %ymm3, %ymm1
; CHECK-AVX512-NEXT: addq $32, %rcx
; CHECK-AVX512-NEXT: cmpq %rcx, %rax
; CHECK-AVX512-NEXT: jne .LBB8_1
; CHECK-AVX512-NEXT: # %bb.2: # %middle.block
; CHECK-AVX512-NEXT: vpaddd %ymm0, %ymm1, %ymm1
; CHECK-AVX512-NEXT: vpaddd %ymm0, %ymm2, %ymm0
; CHECK-AVX512-NEXT: vpaddd %ymm0, %ymm1, %ymm0
; CHECK-AVX512-NEXT: vextracti128 $1, %ymm0, %xmm1
; CHECK-AVX512-NEXT: vpaddd %xmm1, %xmm0, %xmm0
; CHECK-AVX512-NEXT: vpslufd {{.*#+}} xmm1 = xmm0[2,3,2,3]
; CHECK-AVX512-NEXT: vpaddd %xmm1, %xmm0, %xmm0
; CHECK-AVX512-NEXT: vpsrlq $32, %xmm0, %xmm1
; CHECK-AVX512-NEXT: vpaddd %xmm1, %xmm0, %xmm0
; CHECK-AVX512-NEXT: vmovd %xmm0, %eax
; CHECK-AVX512-NEXT: vzeroupper
; CHECK-AVX512-NEXT: retq
;
; CHECK-VBMI-LABEL: _Z9test_charPcS_i_256:
; CHECK-VBMI: # %bb.0: # %entry
; CHECK-VBMI-NEXT:
movl %edx, %eax
; CHECK-VBMI-NEXT: vpxor %xmm0, %xmm0, %xmm0
; CHECK-VBMI-NEXT: xorl %ecx, %ecx
; CHECK-VBMI-NEXT: vpxor %xmm1, %xmm1, %xmm1
; CHECK-VBMI-NEXT: vpxor %xmm2, %xmm2, %xmm2
; CHECK-VBMI-NEXT: .p2align 4, 0x90
; CHECK-VBMI-NEXT: .LBB8_1: # %vector.body
; CHECK-VBMI-NEXT: # =>This Inner Loop Header: Depth=1
; CHECK-VBMI-NEXT: vpmovsxbw 16(%rdi,%rcx), %ymm3
; CHECK-VBMI-NEXT: vpmovsxbw (%rdi,%rcx), %ymm4
; CHECK-VBMI-NEXT: vpmovsxbw 16(%rsi,%rcx), %ymm5
; CHECK-VBMI-NEXT: vpmaddwd %ymm3, %ymm5, %ymm3
; CHECK-VBMI-NEXT: vpaddd %ymm2, %ymm3, %ymm2
; CHECK-VBMI-NEXT: vpmovsxbw (%rsi,%rcx), %ymm3
; CHECK-VBMI-NEXT: vpmaddwd %ymm4, %ymm3, %ymm3
; CHECK-VBMI-NEXT: vpaddd %ymm1, %ymm3, %ymm1
; CHECK-VBMI-NEXT: addq $32, %rcx
; CHECK-VBMI-NEXT: cmpq %rcx, %rax

```

```
; CHECK-VBMI-NEXT: jne .LBB8_1
; CHECK-VBMI-NEXT: # %bb.2: # %middle.block
; CHECK-VBMI-NEXT: vpaddd %ymm0, %ymm1, %ymm1
; CHECK-VBMI-NEXT: vpaddd %ymm0, %ymm2,
%ymm0
; CHECK-VBMI-NEXT: vpaddd %ymm0, %ymm1, %ymm0
; CHECK-VBMI-NEXT: vextracti128 $1, %ymm0, %xmm1
; CHECK-VBMI-NEXT: vpaddd %xmm1, %xmm0, %xmm0
; CHECK-VBMI-NEXT: vpslufd {{.*#+}} xmm1 = xmm0[2,3,2,3]
; CHECK-VBMI-NEXT: vpaddd %xmm1, %xmm0, %xmm0
; CHECK-VBMI-NEXT: vpslufd {{.*#+}} xmm1 = xmm0[1,1,1,1]
; CHECK-VBMI-NEXT: vpaddd %xmm1, %xmm0, %xmm0
; CHECK-VBMI-NEXT: vmovd %xmm0, %eax
; CHECK-VBMI-NEXT: vzeroupper
; CHECK-VBMI-NEXT: retq
```

entry:

```
%3 = zext i32 %2 to i64
```

```
br label %vector.body
```

vector.body:

```
%index = phi i64 [ %index.next, %vector.body ], [ 0, %entry ]
%vec.phi = phi <32 x i32> [ %11, %vector.body ], [ zeroinitializer, %entry ]
%4 = getelementptr inbounds i8, i8* %0, i64 %index
%5 = bitcast i8* %4 to <32 x i8>*
%wide.load = load <32 x i8>, <32 x i8>* %5, align 1
%6 = sext <32 x i8> %wide.load to <32 x i32>
%7 = getelementptr inbounds i8, i8* %1, i64 %index
%8 = bitcast i8* %7 to <32 x i8>*
%wide.load14 = load <32 x
i8>, <32 x i8>* %8, align 1
%9 = sext <32 x i8> %wide.load14 to <32 x i32>
%10 = mul nsw <32 x i32> %9, %6
%11 = add nsw <32 x i32> %10, %vec.phi
%index.next = add i64 %index, 32
%12 = icmp eq i64 %index.next, %3
br i1 %12, label %middle.block, label %vector.body
```

middle.block:

```
%rdx.shuf1 = shufflevector <32 x i32> %11, <32 x i32> undef, <32 x i32> <i32 16, i32 17, i32 18, i32 19, i32 20,
i32 21, i32 22, i32 23, i32 24, i32 25, i32 26, i32 27, i32 28, i32 29, i32 30, i32 31, i32 undef, i32 undef, i32 undef,
i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32
undef, i32 undef, i32 undef>
%bin.rdx1 = add <32 x i32> %11, %rdx.shuf1
%rdx.shuf = shufflevector <32 x i32> %bin.rdx1, <32 x i32> undef, <32 x i32> <i32 8, i32 9, i32 10, i32 11, i32
12, i32 13, i32 14, i32 15, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef,
i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32
undef, i32 undef, i32 undef>
```





```

; CHECK-SKX-NEXT:  vpsrlq $32, %xmm0, %xmm1
; CHECK-SKX-NEXT:  vpaddq %xmm1, %xmm0, %xmm0
; CHECK-SKX-NEXT:
    vmovd %xmm0, %eax
; CHECK-SKX-NEXT:  vzeroupper
; CHECK-SKX-NEXT:  retq
;
; CHECK-AVX512-LABEL: _Z9test_charPcS_i_512:
; CHECK-AVX512:    # %bb.0: # %entry
; CHECK-AVX512-NEXT:  movl %edx, %eax
; CHECK-AVX512-NEXT:  vpxor %xmm0, %xmm0, %xmm0
; CHECK-AVX512-NEXT:  xorl %ecx, %ecx
; CHECK-AVX512-NEXT:  vpxor %xmm1, %xmm1, %xmm1
; CHECK-AVX512-NEXT:  .p2align 4, 0x90
; CHECK-AVX512-NEXT: .LBB9_1: # %vector.body
; CHECK-AVX512-NEXT: # =>This Inner Loop Header: Depth=1
; CHECK-AVX512-NEXT: vpmovsxbw (%rdi,%rcx), %zmm2
; CHECK-AVX512-NEXT: vpmovsxbw (%rsi,%rcx), %zmm3
; CHECK-AVX512-NEXT: vpmaddwd %zmm2, %zmm3, %zmm2
; CHECK-AVX512-NEXT: vpaddq %zmm1, %zmm2, %zmm1
; CHECK-AVX512-NEXT: addq $32, %rcx
; CHECK-AVX512-NEXT: cmpq %rcx, %rax
; CHECK-AVX512-NEXT: jne .LBB9_1
; CHECK-AVX512-NEXT: # %bb.2: # %middle.block
; CHECK-AVX512-NEXT: vpaddq %zmm0, %zmm1, %zmm0
; CHECK-AVX512-NEXT: vextracti64x4 $1, %zmm0, %ymm1
; CHECK-AVX512-NEXT: vpaddq
    %zmm1, %zmm0, %zmm0
; CHECK-AVX512-NEXT: vextracti128 $1, %ymm0, %xmm1
; CHECK-AVX512-NEXT: vpaddq %xmm1, %xmm0, %xmm0
; CHECK-AVX512-NEXT: vpshufd {{.*#+}} xmm1 = xmm0[2,3,2,3]
; CHECK-AVX512-NEXT: vpaddq %xmm1, %xmm0, %xmm0
; CHECK-AVX512-NEXT: vpsrlq $32, %xmm0, %xmm1
; CHECK-AVX512-NEXT: vpaddq %xmm1, %xmm0, %xmm0
; CHECK-AVX512-NEXT: vmovd %xmm0, %eax
; CHECK-AVX512-NEXT: vzeroupper
; CHECK-AVX512-NEXT: retq
;
; CHECK-VBMI-LABEL: _Z9test_charPcS_i_512:
; CHECK-VBMI:    # %bb.0: # %entry
; CHECK-VBMI-NEXT:  movl %edx, %eax
; CHECK-VBMI-NEXT:  vpxor %xmm0, %xmm0, %xmm0
; CHECK-VBMI-NEXT:  xorl %ecx, %ecx
; CHECK-VBMI-NEXT:  vpxor %xmm1, %xmm1, %xmm1
; CHECK-VBMI-NEXT:  .p2align 4, 0x90
; CHECK-VBMI-NEXT: .LBB9_1: # %vector.body
; CHECK-VBMI-NEXT: # =>This Inner Loop Header: Depth=1
; CHECK-VBMI-NEXT: vpmovsxbw (%rdi,%rcx), %zmm2

```

```

; CHECK-VBMI-NEXT: vpmovsxbw (%rsi,%rcx), %zmm3
; CHECK-VBMI-NEXT: vpmaddwd %zmm2, %zmm3, %zmm2
;
CHECK-VBMI-NEXT: vpaddd %zmm1, %zmm2, %zmm1
; CHECK-VBMI-NEXT: addq $32, %rcx
; CHECK-VBMI-NEXT: cmpq %rcx, %rax
; CHECK-VBMI-NEXT: jne .LBB9_1
; CHECK-VBMI-NEXT: # %bb.2: # %middle.block
; CHECK-VBMI-NEXT: vpaddd %zmm0, %zmm1, %zmm0
; CHECK-VBMI-NEXT: vextracti64x4 $1, %zmm0, %ymm1
; CHECK-VBMI-NEXT: vpaddd %zmm1, %zmm0, %zmm0
; CHECK-VBMI-NEXT: vextracti128 $1, %ymm0, %xmm1
; CHECK-VBMI-NEXT: vpaddd %xmm1, %xmm0, %xmm0
; CHECK-VBMI-NEXT: vpshufd {{.*#+}} xmm1 = xmm0[2,3,2,3]
; CHECK-VBMI-NEXT: vpaddd %xmm1, %xmm0, %xmm0
; CHECK-VBMI-NEXT: vpshufd {{.*#+}} xmm1 = xmm0[1,1,1,1]
; CHECK-VBMI-NEXT: vpaddd %xmm1, %xmm0, %xmm0
; CHECK-VBMI-NEXT: vmovd %xmm0, %eax
; CHECK-VBMI-NEXT: vzeroupper
; CHECK-VBMI-NEXT: retq
entry:
%3 = zext i32 %2 to i64
br label %vector.body

```

vector.body:

```

%index = phi i64 [ %index.next, %vector.body ], [ 0, %entry ]
%vec.phi = phi <32 x i32> [ %11, %vector.body ], [ zeroinitializer, %entry ]
%4 = getelementptr
inbounds i8, i8* %0, i64 %index
%5 = bitcast i8* %4 to <32 x i8>*
%wide.load = load <32 x i8>, <32 x i8>* %5, align 1
%6 = sext <32 x i8> %wide.load to <32 x i32>
%7 = getelementptr inbounds i8, i8* %1, i64 %index
%8 = bitcast i8* %7 to <32 x i8>*
%wide.load14 = load <32 x i8>, <32 x i8>* %8, align 1
%9 = sext <32 x i8> %wide.load14 to <32 x i32>
%10 = mul nsw <32 x i32> %9, %6
%11 = add nsw <32 x i32> %10, %vec.phi
%index.next = add i64 %index, 32
%12 = icmp eq i64 %index.next, %3
br i1 %12, label %middle.block, label %vector.body

```

middle.block:

```

%rdx.shuf1 = shufflevector <32 x i32> %11, <32 x i32> undef, <32 x i32> <i32 16, i32 17, i32 18, i32 19, i32 20,
i32 21, i32 22, i32 23, i32 24, i32 25, i32 26, i32 27, i32 28, i32 29, i32 30, i32 31, i32 undef, i32 undef, i32 undef,
i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef>
undef, i32 undef, i32 undef>
%bin.rdx1 = add <32 x i32> %11, %rdx.shuf1

```

```

%rdx.shuf = shufflevector <32 x i32> %bin.rdx1, <32 x i32> undef, <32 x i32> <i32 8, i32 9, i32 10, i32 11, i32
12, i32 13, i32 14, i32 15, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32
undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef,
i32 undef, i32 undef, i32 undef, i32 undef, i32 undef>
%bin.rdx = add <32 x i32> %bin.rdx1, %rdx.shuf
%rdx.shuf15 = shufflevector <32 x i32> %bin.rdx, <32 x i32> undef, <32 x i32> <i32 4, i32 5, i32 6, i32 7, i32
undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef,
i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef,
i32 undef, i32 undef, i32 undef, i32 undef, i32 undef>
%bin.rdx32 = add <32 x i32> %bin.rdx, %rdx.shuf15
%rdx.shuf17 = shufflevector <32 x i32> %bin.rdx32, <32 x i32> undef,
<32 x i32> <i32 2, i32 3, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32
undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef,
i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef,
i32 undef>
%bin.rdx18 = add <32 x i32> %bin.rdx32, %rdx.shuf17
%rdx.shuf19 = shufflevector <32 x i32> %bin.rdx18, <32 x i32> undef, <32 x i32> <i32 1, i32 undef, i32 undef,
i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef,
i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef,
i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef>
%bin.rdx20 = add <32 x i32> %bin.rdx18, %rdx.shuf19
%13 = extractelement <32 x i32> %bin.rdx20, i32 0
ret i32 %13
}

```

```

@a = dso_local global [1024 x i8]
zeroinitializer, align 16
@b = dso_local global [1024 x i8] zeroinitializer, align 16

```

```

define dso_local i32 @sad_16i8_256() "min-legal-vector-width"="256" {
; CHECK-SKX-LABEL: sad_16i8_256:
; CHECK-SKX:      # %bb.0: # %entry
; CHECK-SKX-NEXT: vpxor %xmm0, %xmm0, %xmm0
; CHECK-SKX-NEXT: movq $-1024, %rax # imm = 0xFC00
; CHECK-SKX-NEXT: vpxor %xmm1, %xmm1, %xmm1
; CHECK-SKX-NEXT: .p2align 4, 0x90
; CHECK-SKX-NEXT: .LBB10_1: # %vector.body
; CHECK-SKX-NEXT: # =>This Inner Loop Header: Depth=1
; CHECK-SKX-NEXT: vmovdqu a+1024(%rax), %xmm2
; CHECK-SKX-NEXT: vpsadbw b+1024(%rax), %xmm2, %xmm2
; CHECK-SKX-NEXT: vpadd %ymm1, %ymm2, %ymm1
; CHECK-SKX-NEXT: addq $4, %rax
; CHECK-SKX-NEXT: jne .LBB10_1
; CHECK-SKX-NEXT: # %bb.2: # %middle.block
; CHECK-SKX-NEXT: vpadd %ymm0, %ymm1, %ymm0
; CHECK-SKX-NEXT: vextracti128 $1, %ymm0, %xmm1
; CHECK-SKX-NEXT: vpadd %xmm1, %xmm0, %xmm0
; CHECK-SKX-NEXT: vpshufd {{.*#+}} xmm1 = xmm0[2,3,2,3]

```

```

; CHECK-SKX-NEXT:
    vpaddd %xmm1, %xmm0, %xmm0
; CHECK-SKX-NEXT:  vpsrlq $32, %xmm0, %xmm1
; CHECK-SKX-NEXT:  vpaddd %xmm1, %xmm0, %xmm0
; CHECK-SKX-NEXT:  vmovd %xmm0, %eax
; CHECK-SKX-NEXT:  vzeroupper
; CHECK-SKX-NEXT:  retq
;
; CHECK-AVX512-LABEL: sad_16i8_256:
; CHECK-AVX512:    # %bb.0: # %entry
; CHECK-AVX512-NEXT:  vpxor %xmm0, %xmm0, %xmm0
; CHECK-AVX512-NEXT:  movq $-1024, %rax # imm = 0xFC00
; CHECK-AVX512-NEXT:  vpxor %xmm1, %xmm1, %xmm1
; CHECK-AVX512-NEXT:  .p2align 4, 0x90
; CHECK-AVX512-NEXT: .LBB10_1: # %vector.body
; CHECK-AVX512-NEXT: # =>This Inner Loop Header: Depth=1
; CHECK-AVX512-NEXT: vmovdqu a+1024(%rax), %xmm2
; CHECK-AVX512-NEXT: vpsadbw b+1024(%rax), %xmm2, %xmm2
; CHECK-AVX512-NEXT: vpaddd %ymm1, %ymm2, %ymm1
; CHECK-AVX512-NEXT: addq $4, %rax
; CHECK-AVX512-NEXT: jne .LBB10_1
; CHECK-AVX512-NEXT: # %bb.2: # %middle.block
; CHECK-AVX512-NEXT: vpaddd %ymm0, %ymm1, %ymm0
; CHECK-AVX512-NEXT: vextracti128 $1, %ymm0, %xmm1
;
CHECK-AVX512-NEXT: vpaddd %xmm1, %xmm0, %xmm0
; CHECK-AVX512-NEXT: vpshufd {{.*#+}} xmm1 = xmm0[2,3,2,3]
; CHECK-AVX512-NEXT: vpaddd %xmm1, %xmm0, %xmm0
; CHECK-AVX512-NEXT: vpsrlq $32, %xmm0, %xmm1
; CHECK-AVX512-NEXT: vpaddd %xmm1, %xmm0, %xmm0
; CHECK-AVX512-NEXT: vmovd %xmm0, %eax
; CHECK-AVX512-NEXT: vzeroupper
; CHECK-AVX512-NEXT: retq
;
; CHECK-VBMI-LABEL: sad_16i8_256:
; CHECK-VBMI:    # %bb.0: # %entry
; CHECK-VBMI-NEXT:  vpxor %xmm0, %xmm0, %xmm0
; CHECK-VBMI-NEXT:  movq $-1024, %rax # imm = 0xFC00
; CHECK-VBMI-NEXT:  vpxor %xmm1, %xmm1, %xmm1
; CHECK-VBMI-NEXT:  .p2align 4, 0x90
; CHECK-VBMI-NEXT: .LBB10_1: # %vector.body
; CHECK-VBMI-NEXT: # =>This Inner Loop Header: Depth=1
; CHECK-VBMI-NEXT: vmovdqu a+1024(%rax), %xmm2
; CHECK-VBMI-NEXT: vpsadbw b+1024(%rax), %xmm2, %xmm2
; CHECK-VBMI-NEXT: vpaddd %ymm1, %ymm2, %ymm1
; CHECK-VBMI-NEXT: addq $4, %rax
; CHECK-VBMI-NEXT: jne .LBB10_1
; CHECK-VBMI-NEXT: # %bb.2: # %middle.block

```

```

;
CHECK-VBMI-NEXT:  vpaddd %ymm0, %ymm1, %ymm0
; CHECK-VBMI-NEXT:  vextracti128 $1, %ymm0, %xmm1
; CHECK-VBMI-NEXT:  vpaddd %xmm1, %xmm0, %xmm0
; CHECK-VBMI-NEXT:  vpshufd {{.*#+}} xmm1 = xmm0[2,3,2,3]
; CHECK-VBMI-NEXT:  vpaddd %xmm1, %xmm0, %xmm0
; CHECK-VBMI-NEXT:  vpshufd {{.*#+}} xmm1 = xmm0[1,1,1,1]
; CHECK-VBMI-NEXT:  vpaddd %xmm1, %xmm0, %xmm0
; CHECK-VBMI-NEXT:  vmovd %xmm0, %eax
; CHECK-VBMI-NEXT:  vzeroupper
; CHECK-VBMI-NEXT:  retq
entry:
br label %vector.body

vector.body:
%index = phi i64 [ 0, %entry ], [ %index.next, %vector.body ]
%vec.phi = phi <16 x i32> [ zeroinitializer, %entry ], [ %10, %vector.body ]
%0 = getelementptr inbounds [1024 x i8], [1024 x i8]* @a, i64 0, i64 %index
%1 = bitcast i8* %0 to <16 x i8>*
%wide.load = load <16 x i8>, <16 x i8>* %1, align 4
%2 = zext <16 x i8> %wide.load to <16 x i32>
%3 = getelementptr inbounds [1024 x i8], [1024 x i8]* @b, i64 0, i64 %index
%4 = bitcast i8* %3 to <16 x i8>*
%wide.load1
= load <16 x i8>, <16 x i8>* %4, align 4
%5 = zext <16 x i8> %wide.load1 to <16 x i32>
%6 = sub nsw <16 x i32> %2, %5
%7 = icmp sgt <16 x i32> %6, <i32 -1, i32 -1, i32 -1, i32 -1, i32 -1, i32 -1, i32 -1, i32 -1, i32 -1, i32 -1, i32 -1, i32 -1, i32 -1, i32 -1, i32 -1, i32 -1>
%8 = sub nsw <16 x i32> zeroinitializer, %6
%9 = select <16 x i1> %7, <16 x i32> %6, <16 x i32> %8
%10 = add nsw <16 x i32> %9, %vec.phi
%index.next = add i64 %index, 4
%11 = icmp eq i64 %index.next, 1024
br i1 %11, label %middle.block, label %vector.body

middle.block:
%rdx.shuf = shufflevector <16 x i32> %10, <16 x i32> undef, <16 x i32> <i32 8, i32 9, i32 10, i32 11, i32 12, i32 13, i32 14, i32 15, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef>
%bin.rdx = add <16 x i32> %10, %rdx.shuf
%rdx.shuf2 = shufflevector <16 x i32> %bin.rdx, <16 x i32> undef, <16 x i32> <i32 4, i32 5, i32 6, i32 7, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef>
%bin.rdx2 = add <16 x i32> %bin.rdx, %rdx.shuf2
%rdx.shuf3 = shufflevector <16 x i32> %bin.rdx2, <16 x i32> undef, <16 x i32> <i32 2, i32 3, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef>
%bin.rdx3 = add <16 x i32> %bin.rdx2, %rdx.shuf3

```

```

%rdx.shuf4 = shufflevector <16 x i32> %bin.rdx3, <16 x i32> undef, <16 x i32> <i32 1, i32 undef, i32 undef, i32
undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef>
%bin.rdx4 = add <16 x i32> %bin.rdx3, %rdx.shuf4
%12 = extractelement <16 x i32> %bin.rdx4, i32 0
ret i32 %12
}

```

```

define dso_local i32 @sad_16i8_512() "min-legal-vector-width"="512" {
; CHECK-SKX-LABEL: sad_16i8_512:
; CHECK-SKX:      # %bb.0: # %entry
; CHECK-SKX-NEXT: vpxor %xmm0, %xmm0, %xmm0
; CHECK-SKX-NEXT:
    movq $-1024, %rax # imm = 0xFC00
; CHECK-SKX-NEXT: .p2align 4, 0x90
; CHECK-SKX-NEXT: .LBB11_1: # %vector.body
; CHECK-SKX-NEXT: # =>This Inner Loop Header: Depth=1
; CHECK-SKX-NEXT: vmovdqu a+1024(%rax), %xmm1
; CHECK-SKX-NEXT: vpsadbw b+1024(%rax), %xmm1, %xmm1
; CHECK-SKX-NEXT: vpaddd %zmm0, %zmm1, %zmm0
; CHECK-SKX-NEXT: addq $4, %rax
; CHECK-SKX-NEXT: jne .LBB11_1
; CHECK-SKX-NEXT: # %bb.2: # %middle.block
; CHECK-SKX-NEXT: vextracti64x4 $1, %zmm0, %ymm1
; CHECK-SKX-NEXT: vpaddd %zmm1, %zmm0, %zmm0
; CHECK-SKX-NEXT: vextracti128 $1, %ymm0, %xmm1
; CHECK-SKX-NEXT: vpaddd %xmm1, %xmm0, %xmm0
; CHECK-SKX-NEXT: vpslufd {{.*#+}} xmm1 = xmm0[2,3,2,3]
; CHECK-SKX-NEXT: vpaddd %xmm1, %xmm0, %xmm0
; CHECK-SKX-NEXT: vpsrlq $32, %xmm0, %xmm1
; CHECK-SKX-NEXT: vpaddd %xmm1, %xmm0, %xmm0
; CHECK-SKX-NEXT: vmovd %xmm0, %eax
; CHECK-SKX-NEXT: vzeroupper
; CHECK-SKX-NEXT: retq
;
; CHECK-AVX512-LABEL: sad_16i8_512:
; CHECK-AVX512:
    # %bb.0: # %entry
; CHECK-AVX512-NEXT: vpxor %xmm0, %xmm0, %xmm0
; CHECK-AVX512-NEXT: movq $-1024, %rax # imm = 0xFC00
; CHECK-AVX512-NEXT: .p2align 4, 0x90
; CHECK-AVX512-NEXT: .LBB11_1: # %vector.body
; CHECK-AVX512-NEXT: # =>This Inner Loop Header: Depth=1
; CHECK-AVX512-NEXT: vmovdqu a+1024(%rax), %xmm1
; CHECK-AVX512-NEXT: vpsadbw b+1024(%rax), %xmm1, %xmm1
; CHECK-AVX512-NEXT: vpaddd %zmm0, %zmm1, %zmm0
; CHECK-AVX512-NEXT: addq $4, %rax
; CHECK-AVX512-NEXT: jne .LBB11_1

```

```

; CHECK-AVX512-NEXT: # %bb.2: # %middle.block
; CHECK-AVX512-NEXT: vextracti64x4 $1, %zmm0, %ymm1
; CHECK-AVX512-NEXT: vpaddd %zmm1, %zmm0, %zmm0
; CHECK-AVX512-NEXT: vextracti128 $1, %ymm0, %xmm1
; CHECK-AVX512-NEXT: vpaddd %xmm1, %xmm0, %xmm0
; CHECK-AVX512-NEXT: vpshufd {{.*#+}} xmm1 = xmm0[2,3,2,3]
; CHECK-AVX512-NEXT: vpaddd %xmm1, %xmm0, %xmm0
; CHECK-AVX512-NEXT: vpsrlq $32, %xmm0, %xmm1
; CHECK-AVX512-NEXT: vpaddd %xmm1, %xmm0, %xmm0
; CHECK-AVX512-NEXT:
    vmovd %xmm0, %eax
; CHECK-AVX512-NEXT: vzeroupper
; CHECK-AVX512-NEXT: retq
;
; CHECK-VBMI-LABEL: sad_16i8_512:
; CHECK-VBMI: # %bb.0: # %entry
; CHECK-VBMI-NEXT: vpxor %xmm0, %xmm0, %xmm0
; CHECK-VBMI-NEXT: movq $-1024, %rax # imm = 0xFC00
; CHECK-VBMI-NEXT: .p2align 4, 0x90
; CHECK-VBMI-NEXT: .LBB11_1: # %vector.body
; CHECK-VBMI-NEXT: # =>This Inner Loop Header: Depth=1
; CHECK-VBMI-NEXT: vmovdqu a+1024(%rax), %xmm1
; CHECK-VBMI-NEXT: vpsadbw b+1024(%rax), %xmm1, %xmm1
; CHECK-VBMI-NEXT: vpaddd %zmm0, %zmm1, %zmm0
; CHECK-VBMI-NEXT: addq $4, %rax
; CHECK-VBMI-NEXT: jne .LBB11_1
; CHECK-VBMI-NEXT: # %bb.2: # %middle.block
; CHECK-VBMI-NEXT: vextracti64x4 $1, %zmm0, %ymm1
; CHECK-VBMI-NEXT: vpaddd %zmm1, %zmm0, %zmm0
; CHECK-VBMI-NEXT: vextracti128 $1, %ymm0, %xmm1
; CHECK-VBMI-NEXT: vpaddd %xmm1, %xmm0, %xmm0
; CHECK-VBMI-NEXT: vpshufd {{.*#+}} xmm1 = xmm0[2,3,2,3]
; CHECK-VBMI-NEXT: vpaddd %xmm1, %xmm0, %xmm0
; CHECK-VBMI-NEXT:
    vpshufd {{.*#+}} xmm1 = xmm0[1,1,1,1]
; CHECK-VBMI-NEXT: vpaddd %xmm1, %xmm0, %xmm0
; CHECK-VBMI-NEXT: vmovd %xmm0, %eax
; CHECK-VBMI-NEXT: vzeroupper
; CHECK-VBMI-NEXT: retq
entry:
br label %vector.body

vector.body:
%index = phi i64 [ 0, %entry ], [ %index.next, %vector.body ]
%vec.phi = phi <16 x i32> [ zeroinitializer, %entry ], [ %10, %vector.body ]
%0 = getelementptr inbounds [1024 x i8], [1024 x i8]* @a, i64 0, i64 %index
%1 = bitcast i8* %0 to <16 x i8>*
%wide.load = load <16 x i8>, <16 x i8>* %1, align 4

```



```

%2 = zext <16 x i8> %wide.load to <16 x i32>
%3 = getelementptr inbounds [1024 x i8], [1024 x i8]* @b, i64 0, i64 %index
%4 = bitcast i8* %3 to <16 x i8>*
%wide.load1 = load <16 x i8>, <16 x i8>* %4, align 4
%5 = zext <16 x i8> %wide.load1 to <16 x i32>
%6 = sub nsw <16 x i32> %2, %5
%7 = icmp sgt <16 x i32> %6, <i32 -1, i32 -1, i32 -1, i32 -1, i32 -1, i32 -1, i32 -1, i32 -1, i32 -1, i32 -1, i32 -1, i32 -1, i32 -1, i32 -1, i32 -1, i32 -1>
br i1 %11, label %middle.block, label %vector.body

```

middle.block:

```

%rdx.shuf = shufflevector <16 x i32> %10, <16 x i32> undef, <16 x i32> <i32 8, i32 9, i32 10, i32 11, i32 12, i32 13, i32 14, i32 15, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef>
%bin.rdx = add <16 x i32> %10, %rdx.shuf
%rdx.shuf2 = shufflevector <16 x i32> %bin.rdx, <16 x i32> undef, <16 x i32> <i32 4, i32 5, i32 6, i32 7, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef>
%bin.rdx2 = add <16 x i32> %bin.rdx, %rdx.shuf2
%rdx.shuf3 = shufflevector <16 x i32> %bin.rdx2, <16 x i32> undef, <16 x i32> <i32 2, i32 3, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef>
%bin.rdx3 = add <16 x i32> %bin.rdx2, %rdx.shuf3
%rdx.shuf4 = shufflevector <16 x i32> %bin.rdx3, <16 x i32> undef, <16 x i32> <i32 1, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef, i32 undef>
%bin.rdx4 = add <16 x i32> %bin.rdx3, %rdx.shuf4
%12 = extractelement <16 x i32> %bin.rdx4, i32 0
ret i32 %12
}

```

```

define dso_local void @sbto16f32_256(<16 x i16> %a, <16 x float>* %res) "min-legal-vector-width"="256" {
; CHECK-LABEL: sbto16f32_256:
; CHECK:      # %bb.0:
; CHECK-NEXT:  vpmovw2m %ymm0, %k0
; CHECK-NEXT:  kshiftrw $8, %k0, %k1
; CHECK-NEXT:  vpmovm2d %k1, %ymm0
; CHECK-NEXT:  vcvtqd2ps %ymm0, %ymm0
; CHECK-NEXT:  vpmovm2d %k0, %ymm1
; CHECK-NEXT:  vcvtqd2ps %ymm1, %ymm1
; CHECK-NEXT:  vmovaps %ymm1, (%rdi)
; CHECK-NEXT:  vmovaps %ymm0, 32(%rdi)
; CHECK-NEXT:

```

```

    vzeroupper
; CHECK-NEXT:    retq
%mask = icmp slt <16 x i16> %a, zeroinitializer
%1 = sitofp <16 x i1> %mask to <16 x float>
store <16 x float> %1, <16 x float>* %res
ret void
}

define dso_local void @sbto16f32_512(<16 x i16> %a, <16 x float>* %res) "min-legal-vector-width"="512" {
; CHECK-LABEL: sbto16f32_512:
; CHECK:      # %bb.0:
; CHECK-NEXT:    vpmovw2m %ymm0, %k0
; CHECK-NEXT:    vpmovm2d %k0, %zmm0
; CHECK-NEXT:    vcvtdq2ps %zmm0, %zmm0
; CHECK-NEXT:    vmovaps %zmm0, (%rdi)
; CHECK-NEXT:    vzeroupper
; CHECK-NEXT:    retq
%mask = icmp slt <16 x i16> %a, zeroinitializer
%1 = sitofp <16 x i1> %mask to <16 x float>
store <16 x float> %1, <16 x float>* %res
ret void
}

define dso_local void @sbto16f64_256(<16 x i16> %a, <16 x double>* %res) "min-legal-vector-width"="256" {
; CHECK-LABEL: sbto16f64_256:
; CHECK:      # %bb.0:
; CHECK-NEXT:    vpmovw2m %ymm0, %k0
; CHECK-NEXT:    kshiftrw $8, %k0, %k1
; CHECK-NEXT:    vpmovm2d %k1, %ymm0
; CHECK-NEXT:
    vcvtdq2pd %xmm0, %ymm1
; CHECK-NEXT:    vextracti128 $1, %ymm0, %xmm0
; CHECK-NEXT:    vcvtdq2pd %xmm0, %ymm0
; CHECK-NEXT:    vpmovm2d %k0, %ymm2
; CHECK-NEXT:    vcvtdq2pd %xmm2, %ymm3
; CHECK-NEXT:    vextracti128 $1, %ymm2, %xmm2
; CHECK-NEXT:    vcvtdq2pd %xmm2, %ymm2
; CHECK-NEXT:    vmovaps %ymm2, 32(%rdi)
; CHECK-NEXT:    vmovaps %ymm3, (%rdi)
; CHECK-NEXT:    vmovaps %ymm0, 96(%rdi)
; CHECK-NEXT:    vmovaps %ymm1, 64(%rdi)
; CHECK-NEXT:    vzeroupper
; CHECK-NEXT:    retq
%mask = icmp slt <16 x i16> %a, zeroinitializer
%1 = sitofp <16 x i1> %mask to <16 x double>
store <16 x double> %1, <16 x double>* %res
ret void
}

```

```

define dso_local void @sbto16f64_512(<16 x i16> %a, <16 x double>* %res) "min-legal-vector-width"="512" {
; CHECK-LABEL: sbto16f64_512:
; CHECK:      # %bb.0:
; CHECK-NEXT:  vpmovw2m %ymm0, %k0
; CHECK-NEXT:  vpmovm2d %k0, %zmm0
; CHECK-NEXT:  vcvtdq2pd %ymm0, %zmm1
; CHECK-NEXT:  vextracti64x4 $1, %zmm0, %ymm0
; CHECK-NEXT:  vcvtdq2pd
               %ymm0, %zmm0
; CHECK-NEXT:  vmovaps %zmm0, 64(%rdi)
; CHECK-NEXT:  vmovaps %zmm1, (%rdi)
; CHECK-NEXT:  vzeroupper
; CHECK-NEXT:  retq
               %mask = icmp slt <16 x i16> %a, zeroinitializer
               %1 = sitofp <16 x i1> %mask to <16 x double>
               store <16 x double> %1, <16 x double>* %res
               ret void
}

```

```

define dso_local void @ubto16f32_256(<16 x i16> %a, <16 x float>* %res) "min-legal-vector-width"="256" {
; CHECK-LABEL: ubto16f32_256:
; CHECK:      # %bb.0:
; CHECK-NEXT:  vpmovw2m %ymm0, %k0
; CHECK-NEXT:  kshiftrw $8, %k0, %k1
; CHECK-NEXT:  vpmovm2d %k1, %ymm0
; CHECK-NEXT:  vpsrld $31, %ymm0, %ymm0
; CHECK-NEXT:  vcvtdq2ps %ymm0, %ymm0
; CHECK-NEXT:  vpmovm2d %k0, %ymm1
; CHECK-NEXT:  vpsrld $31, %ymm1, %ymm1
; CHECK-NEXT:  vcvtdq2ps %ymm1, %ymm1
; CHECK-NEXT:  vmovaps %ymm1, (%rdi)
; CHECK-NEXT:  vmovaps %ymm0, 32(%rdi)
; CHECK-NEXT:  vzeroupper
; CHECK-NEXT:  retq
               %mask = icmp slt <16 x i16> %a, zeroinitializer
               %1 = uitofp <16 x i1> %mask to <16 x float>
               store <16 x float> %1, <16 x float>* %res
               ret void
}

```

```

define dso_local void @ubto16f32_512(<16 x i16> %a, <16 x float>* %res) "min-legal-vector-width"="512" {
; CHECK-LABEL: ubto16f32_512:
; CHECK:      # %bb.0:
; CHECK-NEXT:  vpmovw2m %ymm0, %k0
; CHECK-NEXT:  vpmovm2d %k0, %zmm0
; CHECK-NEXT:  vpsrld $31, %zmm0, %zmm0
; CHECK-NEXT:  vcvtdq2ps %zmm0, %zmm0

```

```

; CHECK-NEXT: vmovaps %zmm0, (%rdi)
; CHECK-NEXT: vzeroupper
; CHECK-NEXT: retq
%mask = icmp slt <16 x i16> %a, zeroinitializer
%1 = uitofp <16 x i1> %mask to <16 x float>
store <16 x float> %1, <16 x float>* %res
ret void
}

```

```

define dso_local void @ubto16f64_256(<16 x i16> %a, <16 x double>* %res) "min-legal-vector-width"="256" {
; CHECK-LABEL: ubto16f64_256:
; CHECK:      # %bb.0:
; CHECK-NEXT: vpmovw2m %ymm0, %k0
; CHECK-NEXT: kshiftrw $8, %k0, %k1
; CHECK-NEXT: vpmovm2d %k1, %ymm0
; CHECK-NEXT: vpsrld $31, %ymm0, %ymm0
; CHECK-NEXT: vcvtdq2pd %xmm0, %ymm1
; CHECK-NEXT: vextracti128
$1, %ymm0, %xmm0
; CHECK-NEXT: vcvtdq2pd %xmm0, %ymm0
; CHECK-NEXT: vpmovm2d %k0, %ymm2
; CHECK-NEXT: vpsrld $31, %ymm2, %ymm2
; CHECK-NEXT: vcvtdq2pd %xmm2, %ymm3
; CHECK-NEXT: vextracti128 $1, %ymm2, %xmm2
; CHECK-NEXT: vcvtdq2pd %xmm2, %ymm2
; CHECK-NEXT: vmovaps %ymm2, 32(%rdi)
; CHECK-NEXT: vmovaps %ymm3, (%rdi)
; CHECK-NEXT: vmovaps %ymm0, 96(%rdi)
; CHECK-NEXT: vmovaps %ymm1, 64(%rdi)
; CHECK-NEXT: vzeroupper
; CHECK-NEXT: retq
%mask = icmp slt <16 x i16> %a, zeroinitializer
%1 = uitofp <16 x i1> %mask to <16 x double>
store <16 x double> %1, <16 x double>* %res
ret void
}

```

```

define dso_local void @ubto16f64_512(<16 x i16> %a, <16 x double>* %res) "min-legal-vector-width"="512" {
; CHECK-LABEL: ubto16f64_512:
; CHECK:      # %bb.0:
; CHECK-NEXT: vpmovw2m %ymm0, %k0
; CHECK-NEXT: vpmovm2d %k0, %zmm0
; CHECK-NEXT: vpsrld $31, %zmm0, %zmm0
; CHECK-NEXT: vcvtdq2pd %ymm0, %zmm1
; CHECK-NEXT: vextracti64x4 $1, %zmm0, %ymm0
; CHECK-NEXT:
vcvtdq2pd %ymm0, %zmm0
; CHECK-NEXT: vmovaps %zmm0, 64(%rdi)

```

```

; CHECK-NEXT: vmovaps %zmm1, (%rdi)
; CHECK-NEXT: vzeroupper
; CHECK-NEXT: retq
%mask = icmp slt <16 x i16> %a, zeroinitializer
%1 = uitofp <16 x i1> %mask to <16 x double>
store <16 x double> %1, <16 x double>* %res
ret void
}

define <16 x i16> @test_16f32toub_256(<16 x float>* %ptr, <16 x i16> %passthru) "min-legal-vector-
width"="256" {
; CHECK-LABEL: test_16f32toub_256:
; CHECK:      # %bb.0:
; CHECK-NEXT: vcvttps2dq (%rdi), %ymm1
; CHECK-NEXT: vpslld $31, %ymm1, %ymm1
; CHECK-NEXT: vpmovd2m %ymm1, %k0
; CHECK-NEXT: vcvttps2dq 32(%rdi), %ymm1
; CHECK-NEXT: vpslld $31, %ymm1, %ymm1
; CHECK-NEXT: vpmovd2m %ymm1, %k1
; CHECK-NEXT: kunpckbw %k0, %k1, %k1
; CHECK-NEXT: vmovdqu16 %ymm0, %ymm0 {%k1} {z}
; CHECK-NEXT: retq
%a = load <16 x float>, <16 x float>* %ptr
%mask = fptoui <16 x float> %a to <16 x i1>
%select = select <16 x i1> %mask, <16 x i16> %passthru,
<16 x i16> zeroinitializer
ret <16 x i16> %select
}

define <16 x i16> @test_16f32toub_512(<16 x float>* %ptr, <16 x i16> %passthru) "min-legal-vector-
width"="512" {
; CHECK-LABEL: test_16f32toub_512:
; CHECK:      # %bb.0:
; CHECK-NEXT: vcvttps2dq (%rdi), %zmm1
; CHECK-NEXT: vpslld $31, %zmm1, %zmm1
; CHECK-NEXT: vpmovd2m %zmm1, %k1
; CHECK-NEXT: vmovdqu16 %ymm0, %ymm0 {%k1} {z}
; CHECK-NEXT: retq
%a = load <16 x float>, <16 x float>* %ptr
%mask = fptoui <16 x float> %a to <16 x i1>
%select = select <16 x i1> %mask, <16 x i16> %passthru, <16 x i16> zeroinitializer
ret <16 x i16> %select
}

define <16 x i16> @test_16f32tosb_256(<16 x float>* %ptr, <16 x i16> %passthru) "min-legal-vector-
width"="256" {
; CHECK-LABEL: test_16f32tosb_256:
; CHECK:      # %bb.0:

```

```

; CHECK-NEXT: vcvttps2dq (%rdi), %ymm1
; CHECK-NEXT: vpmovd2m %ymm1, %k0
; CHECK-NEXT: vcvttps2dq 32(%rdi), %ymm1
; CHECK-NEXT: vpmovd2m %ymm1, %k1
; CHECK-NEXT: kunpckbw %k0, %k1, %k1
; CHECK-NEXT:
    vmovdqu16 %ymm0, %ymm0 {%k1} {z}
; CHECK-NEXT: retq
%a = load <16 x float>, <16 x float>* %ptr
%mask = fptosi <16 x float> %a to <16 x i1>
%select = select <16 x i1> %mask, <16 x i16> %passthru, <16 x i16> zeroinitializer
ret <16 x i16> %select
}

```

```

define <16 x i16> @test_16f32tosb_512(<16 x float>* %ptr, <16 x i16> %passthru) "min-legal-vector-
width"="512" {
; CHECK-LABEL: test_16f32tosb_512:
; CHECK:      # %bb.0:
; CHECK-NEXT: vcvttps2dq (%rdi), %zmm1
; CHECK-NEXT: vpmovd2m %zmm1, %k1
; CHECK-NEXT: vmovdqu16 %ymm0, %ymm0 {%k1} {z}
; CHECK-NEXT: retq
%a = load <16 x float>, <16 x float>* %ptr
%mask = fptosi <16 x float> %a to <16 x i1>
%select = select <16 x i1> %mask, <16 x i16> %passthru, <16 x i16> zeroinitializer
ret <16 x i16> %select
}

```

```

define dso_local void @mul256(<64 x i8>* %a, <64 x i8>* %b, <64 x i8>* %c) "min-legal-vector-width"="256" {
; CHECK-SKX-VBMI-LABEL: mul256:
; CHECK-SKX-VBMI:      # %bb.0:
; CHECK-SKX-VBMI-NEXT: vmovdqa
    (%rdi), %ymm0
; CHECK-SKX-VBMI-NEXT: vmovdqa 32(%rdi), %ymm1
; CHECK-SKX-VBMI-NEXT: vmovdqa (%rsi), %ymm2
; CHECK-SKX-VBMI-NEXT: vmovdqa 32(%rsi), %ymm3
; CHECK-SKX-VBMI-NEXT: vpunpckhbw {{.*#+}} ymm4 =
ymm3[8,8,9,9,10,10,11,11,12,12,13,13,14,14,15,15,24,24,25,25,26,26,27,27,28,28,29,29,30,30,31,31]
; CHECK-SKX-VBMI-NEXT: vpunpckhbw {{.*#+}} ymm5 =
ymm1[8,8,9,9,10,10,11,11,12,12,13,13,14,14,15,15,24,24,25,25,26,26,27,27,28,28,29,29,30,30,31,31]
; CHECK-SKX-VBMI-NEXT: vpmullw %ymm4, %ymm5, %ymm4
; CHECK-SKX-VBMI-NEXT: vpunpcklbw {{.*#+}} ymm3 =
ymm3[0,0,1,1,2,2,3,3,4,4,5,5,6,6,7,7,16,16,17,17,18,18,19,19,20,20,21,21,22,22,23,23]
; CHECK-SKX-VBMI-NEXT: vpunpcklbw {{.*#+}} ymm1 =
ymm1[0,0,1,1,2,2,3,3,4,4,5,5,6,6,7,7,16,16,17,17,18,18,19,19,20,20,21,21,22,22,23,23]
; CHECK-SKX-VBMI-NEXT: vpmullw %ymm3, %ymm1, %ymm1
; CHECK-SKX-VBMI-NEXT: vmovdqa {{.*#+}} ymm3 =
[0,2,4,6,8,10,12,14,32,34,36,38,40,42,44,46,16,18,20,22,24,26,28,30,48,50,52,54,56,58,60,62]

```

```

;
CHECK-SKX-VBMI-NEXT: vpermt2b %ymm4, %ymm3, %ymm1
; CHECK-SKX-VBMI-NEXT: vpunpckhbw {{.*#+}} ymm4 =
ymm2[8,8,9,9,10,10,11,11,12,12,13,13,14,14,15,15,24,24,25,25,26,26,27,27,28,28,29,29,30,30,31,31]
; CHECK-SKX-VBMI-NEXT: vpunpckhbw {{.*#+}} ymm5 =
ymm0[8,8,9,9,10,10,11,11,12,12,13,13,14,14,15,15,24,24,25,25,26,26,27,27,28,28,29,29,30,30,31,31]
; CHECK-SKX-VBMI-NEXT: vpmullw %ymm4, %ymm5, %ymm4
; CHECK-SKX-VBMI-NEXT: vpunpcklbw {{.*#+}} ymm2 =
ymm2[0,0,1,1,2,2,3,3,4,4,5,5,6,6,7,7,16,16,17,17,18,18,19,19,20,20,21,21,22,22,23,23]
; CHECK-SKX-VBMI-NEXT: vpunpcklbw {{.*#+}} ymm0 =
ymm0[0,0,1,1,2,2,3,3,4,4,5,5,6,6,7,7,16,16,17,17,18,18,19,19,20,20,21,21,22,22,23,23]
; CHECK-SKX-VBMI-NEXT: vpmullw %ymm2, %ymm0, %ymm0
; CHECK-SKX-VBMI-NEXT: vpermt2b %ymm4, %ymm3, %ymm0
; CHECK-SKX-VBMI-NEXT: vmovdqa %ymm0, (%rdx)
; CHECK-SKX-VBMI-NEXT: vmovdqa %ymm1, 32(%rdx)
; CHECK-SKX-VBMI-NEXT: vzeroupper
; CHECK-SKX-VBMI-NEXT: retq
;
; CHECK-AVX512-LABEL: mul256:
; CHECK-AVX512:
# %bb.0:
; CHECK-AVX512-NEXT: vmovdqa (%rdi), %ymm0
; CHECK-AVX512-NEXT: vmovdqa 32(%rdi), %ymm1
; CHECK-AVX512-NEXT: vmovdqa (%rsi), %ymm2
; CHECK-AVX512-NEXT: vmovdqa 32(%rsi), %ymm3
; CHECK-AVX512-NEXT: vpunpckhbw {{.*#+}} ymm4 =
ymm3[8,8,9,9,10,10,11,11,12,12,13,13,14,14,15,15,24,24,25,25,26,26,27,27,28,28,29,29,30,30,31,31]
; CHECK-AVX512-NEXT: vpunpckhbw {{.*#+}} ymm5 =
ymm1[8,8,9,9,10,10,11,11,12,12,13,13,14,14,15,15,24,24,25,25,26,26,27,27,28,28,29,29,30,30,31,31]
; CHECK-AVX512-NEXT: vpmullw %ymm4, %ymm5, %ymm4
; CHECK-AVX512-NEXT: vpbroadcastw {{.*#+}} ymm5 =
[255,255,255,255,255,255,255,255,255,255,255,255,255,255,255,255]
; CHECK-AVX512-NEXT: vpand %ymm5, %ymm4, %ymm4
; CHECK-AVX512-NEXT: vpunpcklbw {{.*#+}} ymm3 =
ymm3[0,0,1,1,2,2,3,3,4,4,5,5,6,6,7,7,16,16,17,17,18,18,19,19,20,20,21,21,22,22,23,23]
; CHECK-AVX512-NEXT: vpunpcklbw {{.*#+}} ymm1 =
ymm1[0,0,1,1,2,2,3,3,4,4,5,5,6,6,7,7,16,16,17,17,18,18,19,19,20,20,21,21,22,22,23,23]
;
CHECK-AVX512-NEXT: vpmullw %ymm3, %ymm1, %ymm1
; CHECK-AVX512-NEXT: vpand %ymm5, %ymm1, %ymm1
; CHECK-AVX512-NEXT: vpackuswb %ymm4, %ymm1, %ymm1
; CHECK-AVX512-NEXT: vpunpckhbw {{.*#+}} ymm3 =
ymm2[8,8,9,9,10,10,11,11,12,12,13,13,14,14,15,15,24,24,25,25,26,26,27,27,28,28,29,29,30,30,31,31]
; CHECK-AVX512-NEXT: vpunpckhbw {{.*#+}} ymm4 =
ymm0[8,8,9,9,10,10,11,11,12,12,13,13,14,14,15,15,24,24,25,25,26,26,27,27,28,28,29,29,30,30,31,31]
; CHECK-AVX512-NEXT: vpmullw %ymm3, %ymm4, %ymm3
; CHECK-AVX512-NEXT: vpand %ymm5, %ymm3, %ymm3
; CHECK-AVX512-NEXT: vpunpcklbw {{.*#+}} ymm2 =

```

```

ymm2[0,0,1,1,2,2,3,3,4,4,5,5,6,6,7,7,16,16,17,17,18,18,19,19,20,20,21,21,22,22,23,23]
; CHECK-AVX512-NEXT:  vpunpcklbw {{.*#+}} ymm0 =
ymm0[0,0,1,1,2,2,3,3,4,4,5,5,6,6,7,7,16,16,17,17,18,18,19,19,20,20,21,21,22,22,23,23]
; CHECK-AVX512-NEXT:  vpmullw %ymm2, %ymm0, %ymm0
; CHECK-AVX512-NEXT:  vpand %ymm5, %ymm0, %ymm0
; CHECK-AVX512-NEXT:  vpackuswb %ymm3, %ymm0, %ymm0
; CHECK-AVX512-NEXT:
    vmovdqa %ymm0, (%rdx)
; CHECK-AVX512-NEXT:  vmovdqa %ymm1, 32(%rdx)
; CHECK-AVX512-NEXT:  vzeroupper
; CHECK-AVX512-NEXT:  retq
;
; CHECK-VBMI-LABEL: mul256:
; CHECK-VBMI:        # %bb.0:
; CHECK-VBMI-NEXT:  vmovdqa (%rdi), %ymm0
; CHECK-VBMI-NEXT:  vmovdqa 32(%rdi), %ymm1
; CHECK-VBMI-NEXT:  vmovdqa (%rsi), %ymm2
; CHECK-VBMI-NEXT:  vmovdqa 32(%rsi), %ymm3
; CHECK-VBMI-NEXT:  vpunpckhbw {{.*#+}} ymm4 =
ymm3[8,8,9,9,10,10,11,11,12,12,13,13,14,14,15,15,24,24,25,25,26,26,27,27,28,28,29,29,30,30,31,31]
; CHECK-VBMI-NEXT:  vpunpckhbw {{.*#+}} ymm5 =
ymm1[8,8,9,9,10,10,11,11,12,12,13,13,14,14,15,15,24,24,25,25,26,26,27,27,28,28,29,29,30,30,31,31]
; CHECK-VBMI-NEXT:  vpmullw %ymm4, %ymm5, %ymm4
; CHECK-VBMI-NEXT:  vpunpcklbw {{.*#+}} ymm3 =
ymm3[0,0,1,1,2,2,3,3,4,4,5,5,6,6,7,7,16,16,17,17,18,18,19,19,20,20,21,21,22,22,23,23]
; CHECK-VBMI-NEXT:  vpunpcklbw {{.*#+}} ymm1 =
ymm1[0,0,1,1,2,2,3,3,4,4,5,5,6,6,7,7,16,16,17,17,18,18,19,19,20,20,21,21,22,22,23,23]
;
    CHECK-VBMI-NEXT:  vpmullw %ymm3, %ymm1, %ymm1
; CHECK-VBMI-NEXT:  vmovdqa {{.*#+}} ymm3 =
[0,2,4,6,8,10,12,14,32,34,36,38,40,42,44,46,16,18,20,22,24,26,28,30,48,50,52,54,56,58,60,62]
; CHECK-VBMI-NEXT:  vpermt2b %ymm4, %ymm3, %ymm1
; CHECK-VBMI-NEXT:  vpunpckhbw {{.*#+}} ymm4 =
ymm2[8,8,9,9,10,10,11,11,12,12,13,13,14,14,15,15,24,24,25,25,26,26,27,27,28,28,29,29,30,30,31,31]
; CHECK-VBMI-NEXT:  vpunpckhbw {{.*#+}} ymm5 =
ymm0[8,8,9,9,10,10,11,11,12,12,13,13,14,14,15,15,24,24,25,25,26,26,27,27,28,28,29,29,30,30,31,31]
; CHECK-VBMI-NEXT:  vpmullw %ymm4, %ymm5, %ymm4
; CHECK-VBMI-NEXT:  vpunpcklbw {{.*#+}} ymm2 =
ymm2[0,0,1,1,2,2,3,3,4,4,5,5,6,6,7,7,16,16,17,17,18,18,19,19,20,20,21,21,22,22,23,23]
; CHECK-VBMI-NEXT:  vpunpcklbw {{.*#+}} ymm0 =
ymm0[0,0,1,1,2,2,3,3,4,4,5,5,6,6,7,7,16,16,17,17,18,18,19,19,20,20,21,21,22,22,23,23]
; CHECK-VBMI-NEXT:  vpmullw %ymm2, %ymm0, %ymm0
; CHECK-VBMI-NEXT:  vpermt2b %ymm4, %ymm3, %ymm0
; CHECK-VBMI-NEXT:  vmovdqa %ymm0, (%rdx)
;
    CHECK-VBMI-NEXT:  vmovdqa %ymm1, 32(%rdx)
; CHECK-VBMI-NEXT:  vzeroupper
; CHECK-VBMI-NEXT:  retq

```



```

%d = load <64 x i8>, <64 x i8>* %a
%e = load <64 x i8>, <64 x i8>* %b
%f = mul <64 x i8> %d, %e
store <64 x i8> %f, <64 x i8>* %c
ret void
}

```

```

define dso_local void @mul512(<64 x i8>* %a, <64 x i8>* %b, <64 x i8>* %c) "min-legal-vector-width"="512" {
; CHECK-SKX-VBMI-LABEL: mul512:
; CHECK-SKX-VBMI:      # %bb.0:
; CHECK-SKX-VBMI-NEXT:  vmovdqa64 (%rdi), %zmm0
; CHECK-SKX-VBMI-NEXT:  vmovdqa64 (%rsi), %zmm1
; CHECK-SKX-VBMI-NEXT:  vpunpckhbw {{.*#+}} zmm2 =
zmm1[8,8,9,9,10,10,11,11,12,12,13,13,14,14,15,15,24,24,25,25,26,26,27,27,28,28,29,29,30,30,31,31,40,40,41,41,4
2,42,43,43,44,44,45,45,46,46,47,47,56,56,57,57,58,58,59,59,60,60,61,61,62,62,63,63]
; CHECK-SKX-VBMI-NEXT:  vpunpckhbw {{.*#+}} zmm3 =
zmm0[8,8,9,9,10,10,11,11,12,12,13,13,14,14,15,15,24,24,25,25,26,26,27,27,28,28,29,29,30,30,31,31,40,40,41,41,4
2,42,43,43,44,44,45,45,46,46,47,47,56,56,57,57,58,58,59,59,60,60,61,61,62,62,63,63]
;
; CHECK-SKX-VBMI-NEXT:  vpmullw %zmm2, %zmm3, %zmm2
; CHECK-SKX-VBMI-NEXT:  vpunpcklbw {{.*#+}} zmm1 =
zmm1[0,0,1,1,2,2,3,3,4,4,5,5,6,6,7,7,16,16,17,17,18,18,19,19,20,20,21,21,22,22,23,23,32,32,33,33,34,34,35,35,36,3
6,37,37,38,38,39,39,48,48,49,49,50,50,51,51,52,52,53,53,54,54,55,55]
; CHECK-SKX-VBMI-NEXT:  vpunpcklbw {{.*#+}} zmm0 =
zmm0[0,0,1,1,2,2,3,3,4,4,5,5,6,6,7,7,16,16,17,17,18,18,19,19,20,20,21,21,22,22,23,23,32,32,33,33,34,34,35,35,36,3
6,37,37,38,38,39,39,48,48,49,49,50,50,51,51,52,52,53,53,54,54,55,55]
; CHECK-SKX-VBMI-NEXT:  vpmullw %zmm1, %zmm0, %zmm0
; CHECK-SKX-VBMI-NEXT:  vmovdqa64 {{.*#+}} zmm1 =
[0,2,4,6,8,10,12,14,64,66,68,70,72,74,76,78,16,18,20,22,24,26,28,30,80,82,84,86,88,90,92,94,32,34,36,38,40,42,44,
46,96,98,100,102,104,106,108,110,48,50,52,54,56,58,60,62,112,114,116,118,120,122,124,126]
; CHECK-SKX-VBMI-NEXT:  vpermi2b %zmm2, %zmm0, %zmm1
; CHECK-SKX-VBMI-NEXT:  vmovdqa64 %zmm1, (%rdx)
; CHECK-SKX-VBMI-NEXT:  vzeroupper
;
; CHECK-SKX-VBMI-NEXT:  retq
;
; CHECK-AVX512-LABEL: mul512:
; CHECK-AVX512:      # %bb.0:
; CHECK-AVX512-NEXT:  vmovdqa64 (%rdi), %zmm0
; CHECK-AVX512-NEXT:  vmovdqa64 (%rsi), %zmm1
; CHECK-AVX512-NEXT:  vpunpckhbw {{.*#+}} zmm2 =
zmm1[8,8,9,9,10,10,11,11,12,12,13,13,14,14,15,15,24,24,25,25,26,26,27,27,28,28,29,29,30,30,31,31,40,40,41,41,4
2,42,43,43,44,44,45,45,46,46,47,47,56,56,57,57,58,58,59,59,60,60,61,61,62,62,63,63]
; CHECK-AVX512-NEXT:  vpunpckhbw {{.*#+}} zmm3 =
zmm0[8,8,9,9,10,10,11,11,12,12,13,13,14,14,15,15,24,24,25,25,26,26,27,27,28,28,29,29,30,30,31,31,40,40,41,41,4
2,42,43,43,44,44,45,45,46,46,47,47,56,56,57,57,58,58,59,59,60,60,61,61,62,62,63,63]
; CHECK-AVX512-NEXT:  vpmullw %zmm2, %zmm3, %zmm2
; CHECK-AVX512-NEXT:  vpbroadcastw {{.*#+}} zmm3 =

```



```
ret void
}
```

; This threw an assertion at one point.

```
define <4 x i32> @mload_v4i32(<4 x i32> %trigger, <4 x i32>* %addr, <4 x i32> %dst) "min-legal-vector-
width"="256" {
; CHECK-LABEL: mload_v4i32:
; CHECK:      # %bb.0:
; CHECK-NEXT:  vptestnmd %xmm0, %xmm0, %k1
; CHECK-NEXT:  vpblendmd (%rdi), %xmm1, %xmm0 {%k1}
; CHECK-NEXT:  retq
%mask = icmp eq <4 x i32> %trigger, zeroinitializer
%res = call <4 x i32> @llvm.masked.load.v4i32.p0v4i32(<4 x i32>* %addr, i32 4, <4 x i1> %mask, <4 x i32>
%dst)
ret <4 x i32> %res
}
declare <4 x i32>
@llvm.masked.load.v4i32.p0v4i32(<4 x i32>*, i32, <4 x i1>, <4 x i32>)
```

```
define <16 x i32> @trunc_v16i64_v16i32(<16 x i64>* %x) nounwind "min-legal-vector-width"="256" {
; CHECK-LABEL: trunc_v16i64_v16i32:
; CHECK:      # %bb.0:
; CHECK-NEXT:  vmovdqa (%rdi), %ymm0
; CHECK-NEXT:  vmovdqa 32(%rdi), %ymm1
; CHECK-NEXT:  vmovdqa 64(%rdi), %ymm2
; CHECK-NEXT:  vmovdqa 96(%rdi), %ymm3
; CHECK-NEXT:  vpmovqd %ymm0, %xmm0
; CHECK-NEXT:  vpmovqd %ymm1, %xmm1
; CHECK-NEXT:  vinserti128 $1, %xmm1, %ymm0, %ymm0
; CHECK-NEXT:  vpmovqd %ymm2, %xmm1
; CHECK-NEXT:  vpmovqd %ymm3, %xmm2
; CHECK-NEXT:  vinserti128 $1, %xmm2, %ymm1, %ymm1
; CHECK-NEXT:  retq
%a = load <16 x i64>, <16 x i64>* %x
%b = trunc <16 x i64> %a to <16 x i32>
ret <16 x i32> %b
}
```

```
define <16 x i8> @trunc_v16i64_v16i8(<16 x i64>* %x) nounwind "min-legal-vector-width"="256" {
; CHECK-LABEL: trunc_v16i64_v16i8:
; CHECK:      # %bb.0:
; CHECK-NEXT:  vmovdqa (%rdi), %ymm0
; CHECK-NEXT:  vmovdqa 32(%rdi),
%ymm1
; CHECK-NEXT:  vmovdqa 64(%rdi), %ymm2
; CHECK-NEXT:  vmovdqa 96(%rdi), %ymm3
; CHECK-NEXT:  vpmovqb %ymm3, %xmm3
; CHECK-NEXT:  vpmovqb %ymm2, %xmm2
```

```

; CHECK-NEXT: vpunpckldq {{.*#+}} xmm2 = xmm2[0],xmm3[0],xmm2[1],xmm3[1]
; CHECK-NEXT: vpmovqb %ymm1, %xmm1
; CHECK-NEXT: vpmovqb %ymm0, %xmm0
; CHECK-NEXT: vpunpckldq {{.*#+}} xmm0 = xmm0[0],xmm1[0],xmm0[1],xmm1[1]
; CHECK-NEXT: vpunpckldq {{.*#+}} xmm0 = xmm0[0],xmm2[0]
; CHECK-NEXT: vzeroupper
; CHECK-NEXT: retq
%a = load <16 x i64>, <16 x i64>* %x
%b = trunc <16 x i64> %a to <16 x i8>
ret <16 x i8> %b
}

```

```

define <16 x i8> @trunc_v16i32_v16i8(<16 x i32>* %x) nounwind "min-legal-vector-width"="256" {
; CHECK-LABEL: trunc_v16i32_v16i8:
; CHECK:      # %bb.0:
; CHECK-NEXT: vmovdqa (%rdi), %ymm0
; CHECK-NEXT: vmovdqa 32(%rdi), %ymm1
; CHECK-NEXT: vpmovdb %ymm1, %xmm1
; CHECK-NEXT: vpmovdb %ymm0, %xmm0
; CHECK-NEXT: vpunpckldq {{.*#+}} xmm0 = xmm0[0],xmm1[0]
; CHECK-NEXT: vzeroupper
;
CHECK-NEXT: retq
%a = load <16 x i32>, <16 x i32>* %x
%b = trunc <16 x i32> %a to <16 x i8>
ret <16 x i8> %b
}

```

```

define <8 x i8> @trunc_v8i64_v8i8(<8 x i64>* %x) nounwind "min-legal-vector-width"="256" {
; CHECK-LABEL: trunc_v8i64_v8i8:
; CHECK:      # %bb.0:
; CHECK-NEXT: vmovdqa (%rdi), %ymm0
; CHECK-NEXT: vmovdqa 32(%rdi), %ymm1
; CHECK-NEXT: vpmovqb %ymm1, %xmm1
; CHECK-NEXT: vpmovqb %ymm0, %xmm0
; CHECK-NEXT: vpunpckldq {{.*#+}} xmm0 = xmm0[0],xmm1[0],xmm0[1],xmm1[1]
; CHECK-NEXT: vzeroupper
; CHECK-NEXT: retq
%a = load <8 x i64>, <8 x i64>* %x
%b = trunc <8 x i64> %a to <8 x i8>
ret <8 x i8> %b
}

```

```

define <8 x i16> @trunc_v8i64_v8i16(<8 x i64>* %x) nounwind "min-legal-vector-width"="256" {
; CHECK-LABEL: trunc_v8i64_v8i16:
; CHECK:      # %bb.0:
; CHECK-NEXT: vmovdqa (%rdi), %ymm0
; CHECK-NEXT: vmovdqa 32(%rdi), %ymm1

```

```

; CHECK-NEXT: vpmovqw %ymm1, %xmm1
; CHECK-NEXT: vpmovqw %ymm0, %xmm0
; CHECK-NEXT: vpunpcklqdq {{.*#+}} xmm0
= xmm0[0],xmm1[0]
; CHECK-NEXT: vzeroupper
; CHECK-NEXT: retq
%a = load <8 x i64>, <8 x i64>* %x
%b = trunc <8 x i64> %a to <8 x i16>
ret <8 x i16> %b
}

define <8 x i32> @trunc_v8i64_v8i32_zeroes(<8 x i64>* %x) nounwind "min-legal-vector-width"="256" {
; CHECK-LABEL: trunc_v8i64_v8i32_zeroes:
; CHECK:      # %bb.0:
; CHECK-NEXT: vpsrlq $48, 32(%rdi), %ymm0
; CHECK-NEXT: vpsrlq $48, (%rdi), %ymm1
; CHECK-NEXT: vpackusdw %ymm0, %ymm1, %ymm0
; CHECK-NEXT: vpermq {{.*#+}} ymm0 = ymm0[0,2,1,3]
; CHECK-NEXT: retq
%a = load <8 x i64>, <8 x i64>* %x
%b = lshr <8 x i64> %a, <i64 48, i64 48, i64 48, i64 48, i64 48, i64 48, i64 48, i64 48>
%c = trunc <8 x i64> %b to <8 x i32>
ret <8 x i32> %c
}

define <16 x i16> @trunc_v16i32_v16i16_zeroes(<16 x i32>* %x) nounwind "min-legal-vector-width"="256" {
; CHECK-LABEL: trunc_v16i32_v16i16_zeroes:
; CHECK:      # %bb.0:
; CHECK-NEXT: vmovdqa (%rdi), %ymm1
; CHECK-NEXT: vmovdqa {{.*#+}} ymm0 = [1,3,5,7,9,11,13,15,17,19,21,23,25,27,29,31]
;
CHECK-NEXT: vpermi2w 32(%rdi), %ymm1, %ymm0
; CHECK-NEXT: retq
%a = load <16 x i32>, <16 x i32>* %x
%b = lshr <16 x i32> %a, <i32 16, i32 16, i32 16, i32 16, i32 16, i32 16, i32 16, i32 16, i32 16, i32 16, i32 16, i32 16, i32 16, i32 16, i32 16>
%c = trunc <16 x i32> %b to <16 x i16>
ret <16 x i16> %c
}

define <32 x i8> @trunc_v32i16_v32i8_zeroes(<32 x i16>* %x) nounwind "min-legal-vector-width"="256" {
; CHECK-SKX-VBMI-LABEL: trunc_v32i16_v32i8_zeroes:
; CHECK-SKX-VBMI:      # %bb.0:
; CHECK-SKX-VBMI-NEXT: vmovdqa (%rdi), %ymm1
; CHECK-SKX-VBMI-NEXT: vmovdqa {{.*#+}} ymm0 =
[1,3,5,7,9,11,13,15,17,19,21,23,25,27,29,31,33,35,37,39,41,43,45,47,49,51,53,55,57,59,61,63]
; CHECK-SKX-VBMI-NEXT: vpermi2b 32(%rdi), %ymm1, %ymm0
; CHECK-SKX-VBMI-NEXT: retq

```

```

;
; CHECK-AVX512-LABEL: trunc_v32i16_v32i8_zeroes:
; CHECK-AVX512:    # %bb.0:
; CHECK-AVX512-NEXT:  vpsrlw $8, 32(%rdi), %ymm0
; CHECK-AVX512-NEXT:  vpsrlw $8, (%rdi),
    %ymm1
; CHECK-AVX512-NEXT:  vpackuswb %ymm0, %ymm1, %ymm0
; CHECK-AVX512-NEXT:  vpermq {{.*#+}} ymm0 = ymm0[0,2,1,3]
; CHECK-AVX512-NEXT:  retq
;
; CHECK-VBMI-LABEL: trunc_v32i16_v32i8_zeroes:
; CHECK-VBMI:    # %bb.0:
; CHECK-VBMI-NEXT:  vmovdqa (%rdi), %ymm1
; CHECK-VBMI-NEXT:  vmovdqa {{.*#+}} ymm0 =
[1,3,5,7,9,11,13,15,17,19,21,23,25,27,29,31,33,35,37,39,41,43,45,47,49,51,53,55,57,59,61,63]
; CHECK-VBMI-NEXT:  vperm2b 32(%rdi), %ymm1, %ymm0
; CHECK-VBMI-NEXT:  retq
%a = load <32 x i16>, <32 x i16>* %x
%b = lshr <32 x i16> %a, <i16 8, i16 8, i16 8, i16 8, i16 8, i16 8, i16 8, i16 8, i16 8, i16 8, i16 8, i16 8, i16 8, i16 8, i16 8, i16 8>
%c = trunc <32 x i16> %b to <32 x i8>
ret <32 x i8> %c
}

```

```

define <8 x i32> @trunc_v8i64_v8i32_sign(<8 x i64>* %x) nounwind "min-legal-vector-width"="256" {

```

```

; CHECK-LABEL: trunc_v8i64_v8i32_sign:
; CHECK:
# %bb.0:
; CHECK-NEXT:  vpsraq $48, 32(%rdi), %ymm0
; CHECK-NEXT:  vpsraq $48, (%rdi), %ymm1
; CHECK-NEXT:  vpackssdw %ymm0, %ymm1, %ymm0
; CHECK-NEXT:  vpermq {{.*#+}} ymm0 = ymm0[0,2,1,3]
; CHECK-NEXT:  retq
%a = load <8 x i64>, <8 x i64>* %x
%b = ashr <8 x i64> %a, <i64 48, i64 48, i64 48, i64 48, i64 48, i64 48, i64 48, i64 48>
%c = trunc <8 x i64> %b to <8 x i32>
ret <8 x i32> %c
}

```

```

define <16 x i16> @trunc_v16i32_v16i16_sign(<16 x i32>* %x) nounwind "min-legal-vector-width"="256" {

```

```

; CHECK-LABEL: trunc_v16i32_v16i16_sign:
; CHECK:    # %bb.0:
; CHECK-NEXT:  vmovdqa (%rdi), %ymm1
; CHECK-NEXT:  vmovdqa {{.*#+}} ymm0 = [1,3,5,7,9,11,13,15,17,19,21,23,25,27,29,31]
; CHECK-NEXT:  vperm2w 32(%rdi), %ymm1, %ymm0
; CHECK-NEXT:  retq
%a = load <16 x i32>, <16 x i32>* %x
%b = ashr <16 x i32> %a, <i32 16, i32 16, i32 16, i32 16, i32 16, i32 16, i32 16, i32 16, i32 16, i32 16, i32 16, i32 16>

```

```
16, i32 16, i32 16, i32 16, i32 16>
%c = trunc <16 x i32> %b to <16
x i16>
ret <16 x i16> %c
}
```

```

define <32 x i8> @trunc_v32i16_v32i8_sign(<32 x i16>* %x) nounwind "min-legal-vector-width"="256" {
; CHECK-SKX-VBMI-LABEL: trunc_v32i16_v32i8_sign:
; CHECK-SKX-VBMI:      # %bb.0:
; CHECK-SKX-VBMI-NEXT:  vmovdqa (%rdi), %ymm1
; CHECK-SKX-VBMI-NEXT:  vmovdqa {{.*#+}} ymm0 =
[1,3,5,7,9,11,13,15,17,19,21,23,25,27,29,31,33,35,37,39,41,43,45,47,49,51,53,55,57,59,61,63]
; CHECK-SKX-VBMI-NEXT:  vperm2b 32(%rdi), %ymm1, %ymm0
; CHECK-SKX-VBMI-NEXT:  retq
;
; CHECK-AVX512-LABEL: trunc_v32i16_v32i8_sign:
; CHECK-AVX512:      # %bb.0:
; CHECK-AVX512-NEXT:  vpsrlw $8, 32(%rdi), %ymm0
; CHECK-AVX512-NEXT:  vpsrlw $8, (%rdi), %ymm1
; CHECK-AVX512-NEXT:  vpackuswb %ymm0, %ymm1, %ymm0
; CHECK-AVX512-NEXT:  vpermq {{.*#+}} ymm0 = ymm0[0,2,1,3]
; CHECK-AVX512-NEXT:  retq
;
; CHECK-VBMI-LABEL: trunc_v32i16_v32i8_sign:
; CHECK-VBMI:      # %bb.0:
; CHECK-VBMI-NEXT:  vmovdqa (%rdi), %ymm1
; CHECK-VBMI-NEXT:  vmovdqa {{.*#+}} ymm0 =
[1,3,5,7,9,11,13,15,17,19,21,23,25,27,29,31,33,35,37,39,41,43,45,47,49,51,53,55,57,59,61,63]
;
CHECK-VBMI-NEXT:  vperm2b 32(%rdi), %ymm1, %ymm0
; CHECK-VBMI-NEXT:  retq
%a = load <32 x i16>, <32 x i16>* %x
%b = ashr <32 x i16> %a, <i16 8, i16 8, i16 8, i16 8, i16 8, i16 8, i16 8, i16 8, i16 8, i16 8, i16 8, i16 8, i16 8, i16 8, i16 8, i16 8>
%c = trunc <32 x i16> %b to <32 x i8>
ret <32 x i8> %c
}

```

```
define dso_local void @zext_v16i8_v16i64(<16 x i8> %x, <16 x i64>* %y) nounwind "min-legal-vector-
width"="256" {
; CHECK-LABEL: zext_v16i8_v16i64:
; CHECK:      # %bb.0:
; CHECK-NEXT:  vpmovzxbw {{.*#+}} ymm1 =
xmm0[0],zero,xmm0[1],zero,xmm0[2],zero,xmm0[3],zero,xmm0[4],zero,xmm0[5],zero,xmm0[6],zero,xmm0[7],zer
o,xmm0[8],zero,xmm0[9],zero,xmm0[10],zero,xmm0[11],zero,xmm0[12],zero,xmm0[13],zero,xmm0[14],zero,xm
m0[15],zero
; CHECK-NEXT:  vpslufd {{.*#+}} xmm2 = xmm1[2,3,2,3]
; CHECK-NEXT:
```

```

    vpmovzxwq {{.*#+}} ymm2 =
xmm2[0],zero,zero,zero,xmm2[1],zero,zero,zero,xmm2[2],zero,zero,zero,xmm2[3],zero,zero,zero
; CHECK-NEXT:    vextracti128 $1, %ymm1, %xmm1
; CHECK-NEXT:    vpshufd {{.*#+}} xmm3 = xmm1[2,3,2,3]
; CHECK-NEXT:    vpmovzxwq {{.*#+}} ymm3 =
xmm3[0],zero,zero,zero,xmm3[1],zero,zero,zero,xmm3[2],zero,zero,zero,xmm3[3],zero,zero,zero
; CHECK-NEXT:    vpmovzxwq {{.*#+}} ymm1 =
xmm1[0],zero,zero,zero,xmm1[1],zero,zero,zero,xmm1[2],zero,zero,zero,xmm1[3],zero,zero,zero
; CHECK-NEXT:    vpmovzxbq {{.*#+}} ymm0 =
xmm0[0],zero,zero,zero,zero,zero,zero,zero,xmm0[1],zero,zero,zero,zero,zero,zero,zero,xmm0[2],zero,zero,zero,zero,zero,zero,zero,xmm0[3],zero,zero,zero,zero,zero,zero,zero,zero
; CHECK-NEXT:    vmovdqa %ymm0, (%rdi)
; CHECK-NEXT:    vmovdqa %ymm1, 64(%rdi)
; CHECK-NEXT:    vmovdqa %ymm3, 96(%rdi)
; CHECK-NEXT:    vmovdqa %ymm2, 32(%rdi)
; CHECK-NEXT:    vzeroupper
; CHECK-NEXT:    retq
    %a = zext <16 x i8> %x to <16 x i64>
    store <16 x i64> %a, <16 x i64>*
    %y
    ret void
}

```

```

define dso_local void @sext_v16i8_v16i64(<16 x i8> %x, <16 x i64>* %y) nounwind "min-legal-vector-width"="256" {
; CHECK-LABEL: sext_v16i8_v16i64:
; CHECK:      # %bb.0:
; CHECK-NEXT:    vpmovsxbw %xmm0, %ymm1
; CHECK-NEXT:    vpshufd {{.*#+}} xmm2 = xmm1[2,3,2,3]
; CHECK-NEXT:    vpmovsxbw %xmm2, %ymm2
; CHECK-NEXT:    vextracti128 $1, %ymm1, %xmm1
; CHECK-NEXT:    vpshufd {{.*#+}} xmm3 = xmm1[2,3,2,3]
; CHECK-NEXT:    vpmovsxbw %xmm3, %ymm3
; CHECK-NEXT:    vpmovsxbw %xmm1, %ymm1
; CHECK-NEXT:    vpmovsxbq %xmm0, %ymm0
; CHECK-NEXT:    vmovdqa %ymm0, (%rdi)
; CHECK-NEXT:    vmovdqa %ymm1, 64(%rdi)
; CHECK-NEXT:    vmovdqa %ymm3, 96(%rdi)
; CHECK-NEXT:    vmovdqa %ymm2, 32(%rdi)
; CHECK-NEXT:    vzeroupper
; CHECK-NEXT:    retq
    %a = sext <16 x i8> %x to <16 x i64>
    store <16 x i64> %a, <16 x i64>* %y
    ret void
}

```

```

define dso_local void @vselect_split_v8i16_setcc(<8 x i16> %s, <8 x i16> %t, <8 x i64>* %p, <8 x i64>* %q, <8 x i64>* %r) "min-legal-vector-width"="256"

```



```

{
; CHECK-LABEL: vselect_split_v8i16_setcc:
; CHECK:      # %bb.0:
; CHECK-NEXT: vmovdqa (%rsi), %ymm2
; CHECK-NEXT: vmovdqa 32(%rsi), %ymm3
; CHECK-NEXT: vpcmpeqw %xmm1, %xmm0, %k1
; CHECK-NEXT: kshiftrb $4, %k1, %k2
; CHECK-NEXT: vmovdqa64 32(%rdi), %ymm3 {%k2}
; CHECK-NEXT: vmovdqa64 (%rdi), %ymm2 {%k1}
; CHECK-NEXT: vmovdqa %ymm2, (%rdx)
; CHECK-NEXT: vmovdqa %ymm3, 32(%rdx)
; CHECK-NEXT: vzeroupper
; CHECK-NEXT: retq
%x = load <8 x i64>, <8 x i64>* %p
%y = load <8 x i64>, <8 x i64>* %q
%a = icmp eq <8 x i16> %s, %t
%b = select <8 x i1> %a, <8 x i64> %x, <8 x i64> %y
store <8 x i64> %b, <8 x i64>* %r
ret void
}

```

```

define dso_local void @vselect_split_v8i32_setcc(<8 x i32> %s, <8 x i32> %t, <8 x i64>* %p, <8 x i64>* %q, <8
x i64>* %r) "min-legal-vector-width"="256" {
; CHECK-LABEL: vselect_split_v8i32_setcc:
; CHECK:      # %bb.0:
; CHECK-NEXT: vmovdqa (%rsi), %ymm2
; CHECK-NEXT: vmovdqa 32(%rsi), %ymm3
; CHECK-NEXT: vpcmpeqd %ymm1,
%ymm0, %k1
; CHECK-NEXT: kshiftrb $4, %k1, %k2
; CHECK-NEXT: vmovdqa64 32(%rdi), %ymm3 {%k2}
; CHECK-NEXT: vmovdqa64 (%rdi), %ymm2 {%k1}
; CHECK-NEXT: vmovdqa %ymm2, (%rdx)
; CHECK-NEXT: vmovdqa %ymm3, 32(%rdx)
; CHECK-NEXT: vzeroupper
; CHECK-NEXT: retq
%x = load <8 x i64>, <8 x i64>* %p
%y = load <8 x i64>, <8 x i64>* %q
%a = icmp eq <8 x i32> %s, %t
%b = select <8 x i1> %a, <8 x i64> %x, <8 x i64> %y
store <8 x i64> %b, <8 x i64>* %r
ret void
}

```

```

define dso_local void @vselect_split_v16i8_setcc(<16 x i8> %s, <16 x i8> %t, <16 x i32>* %p, <16 x i32>* %q,
<16 x i32>* %r) "min-legal-vector-width"="256" {
; CHECK-LABEL: vselect_split_v16i8_setcc:
; CHECK:      # %bb.0:

```

```

; CHECK-NEXT: vmovdqa (%rsi), %ymm2
; CHECK-NEXT: vmovdqa 32(%rsi), %ymm3
; CHECK-NEXT: vpcmpeqb %xmm1, %xmm0, %k1
; CHECK-NEXT: kshiftrw $8, %k1, %k2
; CHECK-NEXT: vmovdqa32 32(%rdi), %ymm3 {%k2}
; CHECK-NEXT: vmovdqa32 (%rdi), %ymm2 {%k1}
; CHECK-NEXT: vmovdqa %ymm2,
(%rdx)
; CHECK-NEXT: vmovdqa %ymm3, 32(%rdx)
; CHECK-NEXT: vzeroupper
; CHECK-NEXT: retq
%x = load <16 x i32>, <16 x i32>* %p
%y = load <16 x i32>, <16 x i32>* %q
%a = icmp eq <16 x i8> %s, %t
%b = select <16 x i1> %a, <16 x i32> %x, <16 x i32> %y
store <16 x i32> %b, <16 x i32>* %r
ret void
}

```

```

define dso_local void @vselect_split_v16i16_setcc(<16 x i16> %s, <16 x i16> %t, <16 x i32>* %p, <16 x i32>*
%q, <16 x i32>* %r) "min-legal-vector-width"="256" {
; CHECK-LABEL: vselect_split_v16i16_setcc:
; CHECK:      # %bb.0:
; CHECK-NEXT: vmovdqa (%rsi), %ymm2
; CHECK-NEXT: vmovdqa 32(%rsi), %ymm3
; CHECK-NEXT: vpcmpeqw %ymm1, %ymm0, %k1
; CHECK-NEXT: kshiftrw $8, %k1, %k2
; CHECK-NEXT: vmovdqa32 32(%rdi), %ymm3 {%k2}
; CHECK-NEXT: vmovdqa32 (%rdi), %ymm2 {%k1}
; CHECK-NEXT: vmovdqa %ymm2, (%rdx)
; CHECK-NEXT: vmovdqa %ymm3, 32(%rdx)
; CHECK-NEXT: vzeroupper
; CHECK-NEXT: retq
%x = load <16 x i32>, <16 x i32>* %p
%y = load <16 x i32>,
<16 x i32>* %q
%a = icmp eq <16 x i16> %s, %t
%b = select <16 x i1> %a, <16 x i32> %x, <16 x i32> %y
store <16 x i32> %b, <16 x i32>* %r
ret void
}

```

```

define <16 x i8> @trunc_packus_v16i32_v16i8(<16 x i32>* %p) "min-legal-vector-width"="256" {
; CHECK-LABEL: trunc_packus_v16i32_v16i8:
; CHECK:      # %bb.0:
; CHECK-NEXT: vmovdqa (%rdi), %ymm0
; CHECK-NEXT: vpackusdw 32(%rdi), %ymm0, %ymm0
; CHECK-NEXT: vpermq { {.*,#+} } ymm0 = ymm0[0,2,1,3]

```

```

; CHECK-NEXT:    vpmovuswb %ymm0, %xmm0
; CHECK-NEXT:    vzeroupper
; CHECK-NEXT:    retq
%a = load <16 x i32>, <16 x i32>* %p
%b = icmp slt <16 x i32> %a, <i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255>
%c = select <16 x i1> %b, <16 x i32> %a, <16 x i32> <i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255>
%d = icmp sgt <16 x i32> %c, zeroinitializer
%e = select <16 x i1> %d, <16 x i32> %c, <16 x i32> zeroinitializer
%f = trunc <16 x i32> %e to <16 x i8>
ret <16 x i8> %f
}

```

```

define dso_local void @trunc_packus_v16i32_v16i8_store(<16 x i32>* %p, <16 x i8>* %q) "min-legal-vector-width"="256" {
; CHECK-LABEL: trunc_packus_v16i32_v16i8_store:
; CHECK:      # %bb.0:
; CHECK-NEXT:    vmovdqa (%rdi), %ymm0
; CHECK-NEXT:    vpackusdw 32(%rdi), %ymm0, %ymm0
; CHECK-NEXT:    vpermq { {. *#+} } ymm0 = ymm0[0,2,1,3]
; CHECK-NEXT:    vpmovuswb %ymm0, (%rsi)
; CHECK-NEXT:    vzeroupper
; CHECK-NEXT:    retq
%a = load <16 x i32>, <16 x i32>* %p
%b = icmp slt <16 x i32> %a, <i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255>
%c = select <16 x i1> %b, <16 x i32> %a, <16 x i32> <i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255, i32 255>
%d = icmp sgt <16 x i32> %c, zeroinitializer
%e = select <16 x i1> %d, <16 x i32> %c, <16 x i32> zeroinitializer
%f = trunc <16 x i32> %e to <16 x i8>
store <16 x i8> %f, <16 x i8>* %q
ret void
}

```

```

define <64 x i1> @v64i1_argument_return(<64 x i1> %x) "min-legal-vector-width"="256" {
; CHECK-LABEL: v64i1_argument_return:
; CHECK:      # %bb.0:
; CHECK-NEXT:    retq
ret <64 x i1> %x
}

```

```

define dso_local void @v64i1_shuffle(<64 x i8>* %x, <64 x i8>* %y) "min-legal-vector-width"="256" {
; CHECK-LABEL: v64i1_shuffle:
; CHECK:      # %bb.0: # %entry
; CHECK-NEXT:    vmovdqa (%rdi), %ymm1

```

```

; CHECK-NEXT: vmovdqa 32(%rdi), %ymm0
; CHECK-NEXT: vptestnmb %ymm1, %ymm1, %k0
; CHECK-NEXT: kshiftrd $1, %k0, %k1
; CHECK-NEXT: kshiftrlq $63, %k0, %k2
; CHECK-NEXT: kshiftrq $62, %k2, %k2
; CHECK-NEXT: kshiftrlq $63, %k1, %k1
; CHECK-NEXT: kshiftrq $63, %k1, %k1
; CHECK-NEXT: korq %k2, %k1, %k1
; CHECK-NEXT: movq $-5, %rax
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k1,
%k1
; CHECK-NEXT: kshiftrd $3, %k0, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $61, %k2, %k2
; CHECK-NEXT: korq %k2, %k1, %k1
; CHECK-NEXT: movq $-9, %rax
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k1, %k1
; CHECK-NEXT: kshiftrd $2, %k0, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $60, %k2, %k2
; CHECK-NEXT: korq %k2, %k1, %k1
; CHECK-NEXT: movq $-17, %rax
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k1, %k1
; CHECK-NEXT: kshiftrd $5, %k0, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $59, %k2, %k2
; CHECK-NEXT: korq %k2, %k1, %k1
; CHECK-NEXT: movq $-33, %rax
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k1, %k1
; CHECK-NEXT: kshiftrd $4, %k0, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $58, %k2, %k2
; CHECK-NEXT: korq %k2, %k1, %k1
; CHECK-NEXT: movq $-65, %rax
; CHECK-NEXT: kmovq %rax, %k2
;
CHECK-NEXT: kandq %k2, %k1, %k1
; CHECK-NEXT: kshiftrd $7, %k0, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $57, %k2, %k2
; CHECK-NEXT: korq %k2, %k1, %k1
; CHECK-NEXT: movq $-129, %rax
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k1, %k1

```

```

; CHECK-NEXT: kshiftrd $6, %k0, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $56, %k2, %k2
; CHECK-NEXT: korq %k2, %k1, %k1
; CHECK-NEXT: movq $-257, %rax # imm = 0xFEFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k1, %k1
; CHECK-NEXT: kshiftrd $9, %k0, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $55, %k2, %k2
; CHECK-NEXT: korq %k2, %k1, %k1
; CHECK-NEXT: movq $-513, %rax # imm = 0xFDFD
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k1, %k1
; CHECK-NEXT: kshiftrd $8, %k0, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $54, %k2, %k2
; CHECK-NEXT: korq %k2, %k1, %k1
;
CHECK-NEXT: movq $-1025, %rax # imm = 0xFBFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k1, %k1
; CHECK-NEXT: kshiftrd $11, %k0, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $53, %k2, %k2
; CHECK-NEXT: korq %k2, %k1, %k1
; CHECK-NEXT: movq $-2049, %rax # imm = 0xF7FF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k1, %k1
; CHECK-NEXT: kshiftrd $10, %k0, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $52, %k2, %k2
; CHECK-NEXT: korq %k2, %k1, %k1
; CHECK-NEXT: movq $-4097, %rax # imm = 0xEFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k1, %k1
; CHECK-NEXT: kshiftrd $13, %k0, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $51, %k2, %k2
; CHECK-NEXT: korq %k2, %k1, %k1
; CHECK-NEXT: movq $-8193, %rax # imm = 0xDFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k1, %k1
; CHECK-NEXT: kshiftrd $12, %k0, %k2
; CHECK-NEXT:
    kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $50, %k2, %k2
; CHECK-NEXT: korq %k2, %k1, %k1

```

```

; CHECK-NEXT:  movq $-16385, %rax # imm = 0xBFFF
; CHECK-NEXT:  kmovq %rax, %k2
; CHECK-NEXT:  kandq %k2, %k1, %k1
; CHECK-NEXT:  kshiftrd $15, %k0, %k2
; CHECK-NEXT:  kshiftrlq $63, %k2, %k2
; CHECK-NEXT:  kshiftrq $49, %k2, %k2
; CHECK-NEXT:  korq %k2, %k1, %k1
; CHECK-NEXT:  movq $-32769, %rax # imm = 0xFFFF7FFF
; CHECK-NEXT:  kmovq %rax, %k2
; CHECK-NEXT:  kandq %k2, %k1, %k1
; CHECK-NEXT:  kshiftrd $14, %k0, %k2
; CHECK-NEXT:  kshiftrlq $63, %k2, %k2
; CHECK-NEXT:  kshiftrq $48, %k2, %k2
; CHECK-NEXT:  korq %k2, %k1, %k1
; CHECK-NEXT:  movq $-65537, %rax # imm = 0xFFFFFFFFFF
; CHECK-NEXT:  kmovq %rax, %k2
; CHECK-NEXT:  kandq %k2, %k1, %k1
; CHECK-NEXT:  kshiftrd $17, %k0, %k2
; CHECK-NEXT:  kshiftrlq $63, %k2, %k2
; CHECK-NEXT:  kshiftrq $47, %k2, %k2
; CHECK-NEXT:  korq %k2, %k1, %k1
; CHECK-NEXT:  movq $-131073, %rax # imm = 0xFFFFDFFF
;
CHECK-NEXT:  kmovq %rax, %k2
; CHECK-NEXT:  kandq %k2, %k1, %k1
; CHECK-NEXT:  kshiftrd $16, %k0, %k2
; CHECK-NEXT:  kshiftrlq $63, %k2, %k2
; CHECK-NEXT:  kshiftrq $46, %k2, %k2
; CHECK-NEXT:  korq %k2, %k1, %k1
; CHECK-NEXT:  movq $-262145, %rax # imm = 0xFFFFBFFF
; CHECK-NEXT:  kmovq %rax, %k2
; CHECK-NEXT:  kandq %k2, %k1, %k1
; CHECK-NEXT:  kshiftrd $19, %k0, %k2
; CHECK-NEXT:  kshiftrlq $63, %k2, %k2
; CHECK-NEXT:  kshiftrq $45, %k2, %k2
; CHECK-NEXT:  korq %k2, %k1, %k1
; CHECK-NEXT:  movq $-524289, %rax # imm = 0xFFF7FFFF
; CHECK-NEXT:  kmovq %rax, %k2
; CHECK-NEXT:  kandq %k2, %k1, %k1
; CHECK-NEXT:  kshiftrd $18, %k0, %k2
; CHECK-NEXT:  kshiftrlq $63, %k2, %k2
; CHECK-NEXT:  kshiftrq $44, %k2, %k2
; CHECK-NEXT:  korq %k2, %k1, %k1
; CHECK-NEXT:  movq $-1048577, %rax # imm = 0xFFEFFFFF
; CHECK-NEXT:  kmovq %rax, %k2
; CHECK-NEXT:  kandq %k2, %k1, %k1
; CHECK-NEXT:  kshiftrd $21, %k0, %k2
; CHECK-NEXT:  kshiftrlq $63, %k2, %k2

```

```

; CHECK-NEXT:
    kshiftrq $43, %k2, %k2
; CHECK-NEXT: korq %k2, %k1, %k1
; CHECK-NEXT: movq $-2097153, %rax # imm = 0xFFDFFFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k1, %k1
; CHECK-NEXT: kshiftrd $20, %k0, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $42, %k2, %k2
; CHECK-NEXT: korq %k2, %k1, %k1
; CHECK-NEXT: movq $-4194305, %rax # imm = 0xFFBFFFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k1, %k1
; CHECK-NEXT: kshiftrd $23, %k0, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $41, %k2, %k2
; CHECK-NEXT: korq %k2, %k1, %k1
; CHECK-NEXT: movq $-8388609, %rax # imm = 0xFF7FFFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k1, %k1
; CHECK-NEXT: kshiftrd $22, %k0, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $40, %k2, %k2
; CHECK-NEXT: korq %k2, %k1, %k1
; CHECK-NEXT: movq $-16777217, %rax # imm = 0xFEFFFFFFF
; CHECK-NEXT: kmovq
    %rax, %k2
; CHECK-NEXT: kandq %k2, %k1, %k1
; CHECK-NEXT: kshiftrd $25, %k0, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $39, %k2, %k2
; CHECK-NEXT: korq %k2, %k1, %k1
; CHECK-NEXT: movq $-33554433, %rax # imm = 0xFDFFFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k1, %k1
; CHECK-NEXT: kshiftrd $24, %k0, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $38, %k2, %k2
; CHECK-NEXT: korq %k2, %k1, %k1
; CHECK-NEXT: movq $-67108865, %rax # imm = 0xFBFFFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k1, %k1
; CHECK-NEXT: kshiftrd $27, %k0, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $37, %k2, %k2
; CHECK-NEXT: korq %k2, %k1, %k1
; CHECK-NEXT: movq $-134217729, %rax # imm = 0xF7FFFFFFF
; CHECK-NEXT: kmovq %rax, %k2

```

```

; CHECK-NEXT: kandq %k2, %k1, %k1
; CHECK-NEXT: kshiftrd $26, %k0, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq
$36, %k2, %k2
; CHECK-NEXT: korq %k2, %k1, %k1
; CHECK-NEXT: movq $-268435457, %rax # imm = 0xFFFFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k1, %k1
; CHECK-NEXT: kshiftrd $29, %k0, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $35, %k2, %k2
; CHECK-NEXT: korq %k2, %k1, %k1
; CHECK-NEXT: movq $-536870913, %rax # imm = 0xDFFFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k1, %k1
; CHECK-NEXT: kshiftrd $28, %k0, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $34, %k2, %k2
; CHECK-NEXT: korq %k2, %k1, %k1
; CHECK-NEXT: movq $-1073741825, %rax # imm = 0xBFFFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k1, %k1
; CHECK-NEXT: kshiftrd $31, %k0, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $33, %k2, %k2
; CHECK-NEXT: korq %k2, %k1, %k1
; CHECK-NEXT: movabsq $-2147483649, %rax # imm = 0xFFFFFFFF7FFFFFFF
; CHECK-NEXT:
kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k1, %k2
; CHECK-NEXT: vptestnmb %ymm0, %ymm0, %k1
; CHECK-NEXT: kshiftrd $30, %k0, %k0
; CHECK-NEXT: kshiftrlq $63, %k0, %k0
; CHECK-NEXT: kshiftrq $32, %k0, %k0
; CHECK-NEXT: korq %k0, %k2, %k0
; CHECK-NEXT: movabsq $-4294967297, %rax # imm = 0xFFFFFFFFFFFFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k0, %k0
; CHECK-NEXT: kshiftrd $1, %k1, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $31, %k2, %k2
; CHECK-NEXT: korq %k2, %k0, %k0
; CHECK-NEXT: movabsq $-8589934593, %rax # imm = 0xFFFFFFFFDFFFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k0, %k0
; CHECK-NEXT: kshiftrlq $63, %k1, %k2
; CHECK-NEXT: kshiftrq $30, %k2, %k2

```



```

; CHECK-NEXT:    korq %k2, %k0, %k0
; CHECK-NEXT:    movabsq $-17179869185, %rax # imm = 0xFFFFFFFFBFFFFFFF
; CHECK-NEXT:    kmovq %rax, %k2
; CHECK-NEXT:    kandq %k2, %k0, %k0
; CHECK-NEXT:    kshiftrd $3, %k1, %k2
; CHECK-NEXT:    kshiftrlq $63, %k2, %k2
; CHECK-NEXT:    kshiftrq $29, %k2, %k2
; CHECK-NEXT:    korq %k2, %k0, %k0
; CHECK-NEXT:    movabsq $-34359738369, %rax # imm = 0xFFFFFFFF7FFFFFFF
; CHECK-NEXT:    kmovq %rax, %k2
; CHECK-NEXT:    kandq %k2, %k0, %k0
; CHECK-NEXT:    kshiftrd $2, %k1, %k2
; CHECK-NEXT:    kshiftrlq $63, %k2, %k2
; CHECK-NEXT:    kshiftrq $28, %k2, %k2
; CHECK-NEXT:    korq %k2, %k0, %k0
; CHECK-NEXT:    movabsq $-68719476737, %rax # imm = 0xFFFFFFFFFFFFFFF
; CHECK-NEXT:    kmovq %rax, %k2
; CHECK-NEXT:    kandq %k2, %k0, %k0
; CHECK-NEXT:    kshiftrd $5, %k1, %k2
; CHECK-NEXT:    kshiftrlq $63, %k2, %k2
; CHECK-NEXT:    kshiftrq $27, %k2, %k2
; CHECK-NEXT:    korq %k2, %k0, %k0
; CHECK-NEXT:    movabsq $-137438953473, %rax # imm = 0xFFFFFFFFDFFFFFFF
; CHECK-NEXT:    kmovq %rax, %k2
; CHECK-NEXT:    kandq %k2, %k0, %k0
; CHECK-NEXT:    kshiftrd $4, %k1, %k2
; CHECK-NEXT:    kshiftrlq $63, %k2, %k2
; CHECK-NEXT:    kshiftrq $26, %k2, %k2
; CHECK-NEXT:    korq %k2, %k0, %k0
;
CHECK-NEXT:    movabsq $-274877906945, %rax # imm = 0xFFFFFFFFBFFFFFFF
; CHECK-NEXT:    kmovq %rax, %k2
; CHECK-NEXT:    kandq %k2, %k0, %k0
; CHECK-NEXT:    kshiftrd $7, %k1, %k2
; CHECK-NEXT:    kshiftrlq $63, %k2, %k2
; CHECK-NEXT:    kshiftrq $25, %k2, %k2
; CHECK-NEXT:    korq %k2, %k0, %k0
; CHECK-NEXT:    movabsq $-549755813889, %rax # imm = 0xFFFFFFFF7FFFFFFF
; CHECK-NEXT:    kmovq %rax, %k2
; CHECK-NEXT:    kandq %k2, %k0, %k0
; CHECK-NEXT:    kshiftrd $6, %k1, %k2
; CHECK-NEXT:    kshiftrlq $63, %k2, %k2
; CHECK-NEXT:    kshiftrq $24, %k2, %k2
; CHECK-NEXT:    korq %k2, %k0, %k0
; CHECK-NEXT:    movabsq $-1099511627777, %rax # imm = 0xFFFFFFFFFFFFFFF
; CHECK-NEXT:    kmovq %rax, %k2
; CHECK-NEXT:    kandq %k2, %k0, %k0

```

```

; CHECK-NEXT: kshiftrd $9, %k1, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $23, %k2, %k2
; CHECK-NEXT: korq %k2, %k0, %k0
; CHECK-NEXT: movabsq $-2199023255553, %rax # imm = 0xFFFFFDFFFFFFFFFFFF
; CHECK-NEXT: kmovq %rax, %k2
;
CHECK-NEXT: kandq %k2, %k0, %k0
; CHECK-NEXT: kshiftrd $8, %k1, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $22, %k2, %k2
; CHECK-NEXT: korq %k2, %k0, %k0
; CHECK-NEXT: movabsq $-4398046511105, %rax # imm = 0xFFFFFBFFFFFFFFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k0, %k0
; CHECK-NEXT: kshiftrd $11, %k1, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $21, %k2, %k2
; CHECK-NEXT: korq %k2, %k0, %k0
; CHECK-NEXT: movabsq $-8796093022209, %rax # imm = 0xFFFFF7FFFFFFFFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k0, %k0
; CHECK-NEXT: kshiftrd $10, %k1, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $20, %k2, %k2
; CHECK-NEXT: korq %k2, %k0, %k0
; CHECK-NEXT: movabsq $-17592186044417, %rax # imm = 0xFFFFFEFFFFFFFFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k0, %k0
; CHECK-NEXT: kshiftrd $13, %k1, %k2
; CHECK-NEXT: kshiftrlq
$63, %k2, %k2
; CHECK-NEXT: kshiftrq $19, %k2, %k2
; CHECK-NEXT: korq %k2, %k0, %k0
; CHECK-NEXT: movabsq $-35184372088833, %rax # imm = 0xFFFFDFFFFFFFFFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k0, %k0
; CHECK-NEXT: kshiftrd $12, %k1, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $18, %k2, %k2
; CHECK-NEXT: korq %k2, %k0, %k0
; CHECK-NEXT: movabsq $-70368744177665, %rax # imm = 0xFFFFBFFFFFFFFFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k0, %k0
; CHECK-NEXT: kshiftrd $15, %k1, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $17, %k2, %k2
; CHECK-NEXT: korq %k2, %k0, %k0

```

```

; CHECK-NEXT: movabsq $-140737488355329, %rax # imm = 0xFFFF7FFFFFFFFFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k0, %k0
; CHECK-NEXT: kshiftrd $14, %k1, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $16, %k2, %k2
; CHECK-NEXT: korq %k2, %k0, %k0
; CHECK-NEXT:
    movabsq $-281474976710657, %rax # imm = 0xFFFEFFFFFFFFFFFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k0, %k0
; CHECK-NEXT: kshiftrd $17, %k1, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $15, %k2, %k2
; CHECK-NEXT: korq %k2, %k0, %k0
; CHECK-NEXT: movabsq $-562949953421313, %rax # imm = 0xFFFDFFFFFFFFFFFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k0, %k0
; CHECK-NEXT: kshiftrd $16, %k1, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $14, %k2, %k2
; CHECK-NEXT: korq %k2, %k0, %k0
; CHECK-NEXT: movabsq $-1125899906842625, %rax # imm = 0xFFFBFFFFFFFFFFFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k0, %k0
; CHECK-NEXT: kshiftrd $19, %k1, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $13, %k2, %k2
; CHECK-NEXT: korq %k2, %k0, %k0
; CHECK-NEXT: movabsq $-2251799813685249, %rax # imm = 0xFFF7FFFFFFFFFFFFFFF
; CHECK-NEXT: kmovq
    %rax, %k2
; CHECK-NEXT: kandq %k2, %k0, %k0
; CHECK-NEXT: kshiftrd $18, %k1, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $12, %k2, %k2
; CHECK-NEXT: korq %k2, %k0, %k0
; CHECK-NEXT: movabsq $-4503599627370497, %rax # imm = 0xFFEFFFFFFFFFFFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k0, %k0
; CHECK-NEXT: kshiftrd $21, %k1, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $11, %k2, %k2
; CHECK-NEXT: korq %k2, %k0, %k0
; CHECK-NEXT: movabsq $-9007199254740993, %rax # imm = 0xFFDFFFFFFFFFFFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k0, %k0
; CHECK-NEXT: kshiftrd $20, %k1, %k2

```

```

; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $10, %k2, %k2
; CHECK-NEXT: korq %k2, %k0, %k0
; CHECK-NEXT: movabsq $-18014398509481985, %rax # imm = 0xFFBFFFFFFFFFFFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k0, %k0
; CHECK-NEXT: kshiftrd $23, %k1, %k2
;
CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $9, %k2, %k2
; CHECK-NEXT: korq %k2, %k0, %k0
; CHECK-NEXT: movabsq $-36028797018963969, %rax # imm = 0xFF7FFFFFFFFFFFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k0, %k0
; CHECK-NEXT: kshiftrd $22, %k1, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $8, %k2, %k2
; CHECK-NEXT: korq %k2, %k0, %k0
; CHECK-NEXT: movabsq $-72057594037927937, %rax # imm = 0xFEFFFFFFFFFFFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k0, %k0
; CHECK-NEXT: kshiftrd $25, %k1, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $7, %k2, %k2
; CHECK-NEXT: korq %k2, %k0, %k0
; CHECK-NEXT: movabsq $-144115188075855873, %rax # imm = 0xFDFFFFFFFFFFFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k0, %k0
; CHECK-NEXT: kshiftrd $24, %k1, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $6, %k2, %k2
; CHECK-NEXT:
korq %k2, %k0, %k0
; CHECK-NEXT: movabsq $-288230376151711745, %rax # imm = 0xFBFFFFFFFFFFFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k0, %k0
; CHECK-NEXT: kshiftrd $27, %k1, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $5, %k2, %k2
; CHECK-NEXT: korq %k2, %k0, %k0
; CHECK-NEXT: movabsq $-576460752303423489, %rax # imm = 0xF7FFFFFFFFFFFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k0, %k0
; CHECK-NEXT: kshiftrd $26, %k1, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $4, %k2, %k2
; CHECK-NEXT: korq %k2, %k0, %k0
; CHECK-NEXT: movabsq $-1152921504606846977, %rax # imm = 0xEEFFFFFFFFFFFFFFF

```

```

; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k0, %k0
; CHECK-NEXT: kshiftrd $29, %k1, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $3, %k2, %k2
; CHECK-NEXT: korq %k2, %k0, %k0
; CHECK-NEXT: movabsq $-2305843009213693953, %rax # imm =
0xDFFFFFFFFFFFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k0, %k0
; CHECK-NEXT: kshiftrd $28, %k1, %k2
; CHECK-NEXT: kshiftrlq $63, %k2, %k2
; CHECK-NEXT: kshiftrq $2, %k2, %k2
; CHECK-NEXT: korq %k2, %k0, %k0
; CHECK-NEXT: movabsq $-4611686018427387905, %rax # imm = 0xBFFFFFFFFFFFFFFF
; CHECK-NEXT: kmovq %rax, %k2
; CHECK-NEXT: kandq %k2, %k0, %k0
; CHECK-NEXT: kshiftrd $31, %k1, %k2
; CHECK-NEXT: kshiftrlq $62, %k2, %k2
; CHECK-NEXT: korq %k2, %k0, %k0
; CHECK-NEXT: kshiftrd $30, %k1, %k1
; CHECK-NEXT: kshiftrlq $1, %k0, %k0
; CHECK-NEXT: kshiftrq $1, %k0, %k0
; CHECK-NEXT: kshiftrlq $63, %k1, %k1
; CHECK-NEXT: korq %k1, %k0, %k1
; CHECK-NEXT: vmovdqu8 %ymm1, (%rsi) {%k1}
; CHECK-NEXT: kshiftrq $32, %k1, %k1
; CHECK-NEXT: vmovdqu8 %ymm0, 32(%rsi) {%k1}
; CHECK-NEXT: vzeroupper
; CHECK-NEXT: retq
entry:
%a = load <64 x i8>, <64 x i8>* %x
%b = icmp eq <64 x i8> %a, zeroinitializer
%shuf = shufflevector
<64 x i1> %b, <64 x i1> undef, <64 x i32> <i32 1, i32 0, i32 3, i32 2, i32 5, i32 4, i32 7, i32 6, i32 9, i32 8, i32 11,
i32 10, i32 13, i32 12, i32 15, i32 14, i32 17, i32 16, i32 19, i32 18, i32 21, i32 20, i32 23, i32 22, i32 25, i32 24, i32
27, i32 26, i32 29, i32 28, i32 31, i32 30, i32 33, i32 32, i32 35, i32 34, i32 37, i32 36, i32 39, i32 38, i32 41, i32 40,
i32 43, i32 42, i32 45, i32 44, i32 47, i32 46, i32 49, i32 48, i32 51, i32 50, i32 53, i32 52, i32 55, i32 54, i32 57, i32
56, i32 59, i32 58, i32 61, i32 60, i32 63, i32 62>
call void @llvm.masked.store.v64i8.p0v64i8(<64 x i8> %a, <64 x i8>* %y, i32 1, <64 x i1> %shuf)
ret void
}
declare void @llvm.masked.store.v64i8.p0v64i8(<64 x i8>, <64 x i8>*, i32, <64 x i1>)

@mem64_dst = dso_local global i64 0, align 8
@mem64_src = dso_local global i64 0, align 8
define dso_local i32 @v64i1_inline_asm() "min-legal-vector-width"="256" {
; CHECK-LABEL: v64i1_inline_asm:

```

```

; CHECK:      # %bb.0:
; CHECK-NEXT:  kmovq mem64_src(%rip),
               %k0
; CHECK-NEXT:  #APP
; CHECK-NEXT:  #NO_APP
; CHECK-NEXT:  kmovq %k0, mem64_dst(%rip)
; CHECK-NEXT:  movl -{[0-9]+}}(%rsp), %eax
; CHECK-NEXT:  retq
%1 = alloca i32, align 4
%2 = load i64, i64* @mem64_src, align 8
%3 = call i64 @asm "", "=k,k,~{dirflag},~{fpsr},~{flags}"(i64 %2)
store i64 %3, i64* @mem64_dst, align 8
%4 = load i32, i32* %1, align 4
ret i32 %4
}

```

```

define dso_local void @cmp_v8i64_sext(<8 x i64>* %xptr, <8 x i64>* %yptr, <8 x i64>* %zptr) "min-legal-
vector-width"="256" {

```

```

; CHECK-LABEL: cmp_v8i64_sext:
; CHECK:      # %bb.0:
; CHECK-NEXT:  vmovdqa (%rsi), %ymm0
; CHECK-NEXT:  vmovdqa 32(%rsi), %ymm1
; CHECK-NEXT:  vpcmpgtq 32(%rdi), %ymm1, %ymm1
; CHECK-NEXT:  vpcmpgtq (%rdi), %ymm0, %ymm0
; CHECK-NEXT:  vmovdqa %ymm0, (%rdx)
; CHECK-NEXT:  vmovdqa %ymm1, 32(%rdx)
; CHECK-NEXT:  vzeroupper
; CHECK-NEXT:  retq
%x = load <8 x i64>, <8 x i64>* %xptr
%y = load <8 x i64>, <8 x i64>* %yptr
%cmp = icmp slt <8 x i64> %x, %y
%ext
= sext <8 x i1> %cmp to <8 x i64>
store <8 x i64> %ext, <8 x i64>* %zptr
ret void
}

```

```

define dso_local void @cmp_v8i64_zext(<8 x i64>* %xptr, <8 x i64>* %yptr, <8 x i64>* %zptr) "min-legal-
vector-width"="256" {

```

```

; CHECK-LABEL: cmp_v8i64_zext:
; CHECK:      # %bb.0:
; CHECK-NEXT:  vmovdqa (%rsi), %ymm0
; CHECK-NEXT:  vmovdqa 32(%rsi), %ymm1
; CHECK-NEXT:  vpcmpgtq 32(%rdi), %ymm1, %ymm1
; CHECK-NEXT:  vpcmpgtq (%rdi), %ymm0, %ymm0
; CHECK-NEXT:  vpsrlq $63, %ymm1, %ymm1
; CHECK-NEXT:  vpsrlq $63, %ymm0, %ymm0
; CHECK-NEXT:  vmovdqa %ymm0, (%rdx)

```

```

; CHECK-NEXT: vmovdqa %ymm1, 32(%rdx)
; CHECK-NEXT: vzeroupper
; CHECK-NEXT: retq
%x = load <8 x i64>, <8 x i64>* %xptra
%y = load <8 x i64>, <8 x i64>* %yptra
%cmp = icmp slt <8 x i64> %x, %y
%ext = zext <8 x i1> %cmp to <8 x i64>
store <8 x i64> %ext, <8 x i64>* %zptr
ret void
}

define <16 x i8> @var_rotate_v16i8(<16 x i8> %a, <16 x i8> %b) nounwind "min-legal-vector-width"="256" {
; CHECK-LABEL: var_rotate_v16i8:
;
CHECK:    # %bb.0:
; CHECK-NEXT: vpandd {{\.?LCPI[0-9]+_[0-9]+}}(%rip){1to4}, %xmm1, %xmm1
; CHECK-NEXT: vpxor %xmm2, %xmm2, %xmm2
; CHECK-NEXT: vpunpckhbw {{\.*#+}} %xmm2 =
xmm1[8],xmm2[8],xmm1[9],xmm2[9],xmm1[10],xmm2[10],xmm1[11],xmm2[11],xmm1[12],xmm2[12],xmm1[13],
xmm2[13],xmm1[14],xmm2[14],xmm1[15],xmm2[15]
; CHECK-NEXT: vpunpckhbw {{\.*#+}} %xmm3 = xmm0[8,8,9,9,10,10,11,11,12,12,13,13,14,14,15,15]
; CHECK-NEXT: vpsllvw %xmm2, %xmm3, %xmm2
; CHECK-NEXT: vpsrlw $8, %xmm2, %xmm2
; CHECK-NEXT: vpunpcklbw {{\.*#+}} %xmm0 = xmm0[0,0,1,1,2,2,3,3,4,4,5,5,6,6,7,7]
; CHECK-NEXT: vpmovzxbw {{\.*#+}} %xmm1 =
xmm1[0],zero,xmm1[1],zero,xmm1[2],zero,xmm1[3],zero,xmm1[4],zero,xmm1[5],zero,xmm1[6],zero,xmm1[7],zero
; CHECK-NEXT: vpsllvw %xmm1, %xmm0, %xmm0
; CHECK-NEXT: vpsrlw $8, %xmm0, %xmm0
; CHECK-NEXT: vpackuswb %xmm2, %xmm0, %xmm0
; CHECK-NEXT: retq
%b8 = sub <16 x i8> <i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8>, %b
%shl = shl <16 x i8> %a, %b8
%lshr = lshr <16 x i8> %a, %b8
%or = or <16 x i8> %shl, %lshr
ret <16 x i8> %or
}

define <32 x i8> @var_rotate_v32i8(<32 x i8> %a, <32 x i8> %b) nounwind "min-legal-vector-width"="256" {
; CHECK-LABEL: var_rotate_v32i8:
; CHECK:    # %bb.0:
; CHECK-NEXT: vpandd {{\.?LCPI[0-9]+_[0-9]+}}(%rip){1to8}, %ymm1, %ymm1
; CHECK-NEXT: vpxor %xmm2, %xmm2, %xmm2
; CHECK-NEXT: vpunpckhbw {{\.*#+}} %ymm3 =
ymm1[8],ymm2[8],ymm1[9],ymm2[9],ymm1[10],ymm2[10],ymm1[11],ymm2[11],ymm1[12],ymm2[12],ymm1[13],
ymm2[13],ymm1[14],ymm2[14],ymm1[15],ymm2[15],ymm1[24],ymm2[24],ymm1[25],ymm2[25],ymm1[26],ymm2[26],ymm1[27],ymm2[27],ymm1[28],ymm2[28],ymm1[29],ymm2[29],ymm1[30],ymm2[30],ymm1[31],ymm2[31],ymm1[32],ymm2[32]

```

```

31]
; CHECK-NEXT:    vpunpckhbw {{.*#+}} ymm4 =
ymm0[8,9,9,9,10,10,11,11,12,12,13,13,14,14,15,15,24,24,25,25,26,26,27,27,28,28,29,29,30,30,31,31]
; CHECK-NEXT:    vpsllvw %ymm3, %ymm4, %ymm3
; CHECK-NEXT:    vpsrlw $8, %ymm3, %ymm3
; CHECK-NEXT:    vpunpcklbw
{{.*#+}} ymm1 =
ymm1[0],ymm2[0],ymm1[1],ymm2[1],ymm1[2],ymm2[2],ymm1[3],ymm2[3],ymm1[4],ymm2[4],ymm1[5],ymm2[
5],ymm1[6],ymm2[6],ymm1[7],ymm2[7],ymm1[16],ymm2[16],ymm1[17],ymm2[17],ymm1[18],ymm2[18],ymm1[
19],ymm2[19],ymm1[20],ymm2[20],ymm1[21],ymm2[21],ymm1[22],ymm2[22],ymm1[23],ymm2[23]
; CHECK-NEXT:    vpunpcklbw {{.*#+}} ymm0 =
ymm0[0,0,1,1,2,2,3,3,4,4,5,5,6,6,7,7,16,16,17,17,18,18,19,19,20,20,21,21,22,22,23,23]
; CHECK-NEXT:    vpsllvw %ymm1, %ymm0, %ymm0
; CHECK-NEXT:    vpsrlw $8, %ymm0, %ymm0
; CHECK-NEXT:    vpackuswb %ymm3, %ymm0, %ymm0
; CHECK-NEXT:    retq

%b8 = sub <32 x i8> <i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8, i8 8>, %b
%shl = shl <32 x i8> %a, %b
%lsr = lshr <32 x i8> %a, %b8
%or = or <32 x i8> %shl, %lsr
ret <32 x i8> %or
}

```



```

define <32 x i8> @constant_rotate_v32i8(<32 x i8> %a) nounwind "min-legal-vector-width"="256" {
; CHECK-LABEL: constant_rotate_v32i8:
; CHECK:      # %bb.0:
; CHECK-NEXT:  vpunpckhbw {{.*#+}} ymm1 =
ymm0[8,8,9,9,10,10,11,11,12,12,13,13,14,14,15,15,24,24,25,25,26,26,27,27,28,28,29,29,30,30,31,31]
; CHECK-NEXT:  vpsllvw {{\.?LCPI[0-9]+\_[0-9]+}}(%rip), %ymm1, %ymm1
; CHECK-NEXT:  vpsrlw $8, %ymm1, %ymm1
; CHECK-NEXT:  vpunpcklbw {{.*#+}} ymm0 =
ymm0[0,0,1,1,2,2,3,3,4,4,5,5,6,6,7,7,16,16,17,17,18,18,19,19,20,20,21,21,22,22,23,23]
; CHECK-NEXT:  vpsllvw {{\.?LCPI[0-9]+\_[0-9]+}}(%rip), %ymm0, %ymm0
; CHECK-NEXT:  vpsrlw $8, %ymm0, %ymm0
; CHECK-NEXT:  vpackuswb %ymm1, %ymm0, %ymm0
; CHECK-NEXT:  retq
%shl = shl <32 x i8> %a, <i8 0, i8 1, i8 2, i8 3, i8 4, i8 5, i8 6, i8 7, i8 8, i8 7, i8 6, i8 5, i8 4, i8 3, i8 2, i8 1, i8 0, i8
1, i8 2, i8 3, i8 4, i8 5, i8 6, i8 7, i8
8, i8 7, i8 6, i8 5, i8 4, i8 3, i8 2, i8 1>
%lshr = lshr <32 x i8> %a, <i8 8, i8 7, i8 6, i8 5, i8 4, i8 3, i8 2, i8 1, i8 0, i8 1, i8 2, i8 3, i8 4, i8 5, i8 6, i8 7, i8 8,
i8 7, i8 6, i8 5, i8 4, i8 3, i8 2, i8 1, i8 0, i8 1, i8 2, i8 3, i8 4, i8 5, i8 6, i8 7>
%or = or <32 x i8> %shl, %lshr
ret <32 x i8> %or
}

```

```

define <32 x i8> @splatconstant_rotate_v32i8(<32 x i8> %a) nounwind "min-legal-vector-width"="256" {
; CHECK-LABEL: splatconstant_rotate_v32i8:
; CHECK:      # %bb.0:
; CHECK-NEXT:  vpsllw $4, %ymm0, %ymm1
; CHECK-NEXT:  vpsrlw $4, %ymm0, %ymm0
; CHECK-NEXT:  vpternlogd $216, {{\.?LCPI[0-9]+\_[0-9]+}}(%rip){1to8}, %ymm1, %ymm0
; CHECK-NEXT:  retq
%shl = shl <32 x i8> %a, <i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8
4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4>
%lshr = lshr <32 x i8> %a, <i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8
4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4>
%or = or <32 x i8> %shl, %lshr
ret <32 x i8> %or
}

```

```

define <32 x i8> @splatconstant_rotate_mask_v32i8(<32 x i8> %a) nounwind "min-legal-vector-width"="256" {
; CHECK-LABEL: splatconstant_rotate_mask_v32i8:
; CHECK:      # %bb.0:
; CHECK-NEXT:  vpsllw $4, %ymm0, %ymm1
; CHECK-NEXT:  vpsrlw $4, %ymm0, %ymm0
; CHECK-NEXT:  vpternlogd $216, {{\.?LCPI[0-9]+\_[0-9]+}}(%rip){1to8}, %ymm1, %ymm0
; CHECK-NEXT:  vpandd {{\.?LCPI[0-9]+\_[0-9]+}}(%rip){1to8}, %ymm0, %ymm0
; CHECK-NEXT:  retq
%shl = shl <32 x i8> %a, <i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8
4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4>

```

```
%lshr = lshr <32 x i8> %a, <i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4, i8 4>  
%rmask = and <32 x i8> %lshr, <i8 55, i8 55, i8 55, i8 55, i8 55, i8 55, i8 55, i8 55, i8 55, i8 55, i8 55, i8 55, i8 55, i8 55, i8 55, i8 55, i8 55, i8 55, i8 55, i8 55, i8 55, i8 55, i8 55, i8 55, i8 55, i8 55, i8 55, i8 55, i8 55, i8 55>  
%lmask = and <32 x i8> %shl, <i8 33, i8 33, i8 33, i8 33, i8 33, i8 33, i8 33, i8 33, i8 33, i8 33, i8 33, i8 33, i8 33, i8 33, i8 33, i8 33, i8 33, i8 33, i8 33, i8 33, i8 33, i8 33, i8 33, i8 33, i8 33, i8 33, i8 33, i8 33, i8 33, i8 33>  
%or = or <32 x i8> %lmask, %rmask  
ret <32 x i8> %or  
}
```

```

; FIXME: This one should fold to rcp
define half @select_fneg_posk_src_rcp_f16(i32 %c, half %x, half %y) {
; VI-LABEL: select_fneg_posk_src_rcp_f16:
; VI:      ; %bb.0:
; VI-NEXT:  s_waitcnt vmcnt(0) expcnt(0) lgkmcnt(0)
; VI-NEXT:  v_rcp_f16_e64 v1, -v1
; VI-NEXT:  v_mov_b32_e32 v2, 0x4000
; VI-NEXT:  v_cmp_eq_u32_e32 vcc, 0, v0
; VI-NEXT:  v_cndmask_b32_e32 v0, v2, v1, vcc
; VI-NEXT:  s_setpc_b64 s[30:31]

%cmp = icmp eq i32 %c, 0
%rcp = call half @llvm.amdgcn.rcp.f16(half %x)
%fneg = fneg half %rcp
%select = select i1 %cmp, half %fneg, half 2.0
ret half %select
}

```

```
declare half @llvm.amdgcn.rcp.f16(half) #0
```

```
attributes #0 = { nocallback noreturn nosync nounwind speculatable willreturn memory(none) }
```

```
; NOTE: Assertions have been autogenerated by utils/update_llc_test_checks.py
; RUN: llc -mtriple=riscv64 -verify-machineinstrs < %s \
; RUN: -riscv-experimental-rv64-legal-i32 | FileCheck %s -check-prefixes=CHECK,RV64I
; RUN: llc -mtriple=riscv64 -mattr=+zbb -verify-machineinstrs < %s \
; RUN: -riscv-experimental-rv64-legal-i32 | FileCheck %s -check-prefixes=CHECK,RV64ZBB-ZBKB,RV64ZBB
; RUN: llc -mtriple=riscv64 -mattr=+zbbk -verify-machineinstrs < %s \
; RUN: -riscv-experimental-rv64-legal-i32 | FileCheck %s -check-prefixes=CHECK,RV64ZBB-
ZBKB,RV64ZBKB
```

```
define signext i32 @andn_i32(i32 signext %a, i32 signext %b) nounwind {
; RV64I-LABEL: andn_i32:
; RV64I:      # %bb.0:
; RV64I-NEXT:  not a1, a1
```

```

; RV64I-NEXT:  and a0, a1, a0
; RV64I-NEXT:  ret
;
; RV64ZBB-ZBKB-LABEL: andn_i32:
; RV64ZBB-ZBKB:    # %bb.0:
; RV64ZBB-ZBKB-NEXT:  andn a0, a0, a1
; RV64ZBB-ZBKB-NEXT:  ret
%neg = xor i32 %b, -1
%and = and i32 %neg, %a
ret i32 %and
}

define i64 @andn_i64(i64 %a, i64
%b) nounwind {
; RV64I-LABEL: andn_i64:
; RV64I:    # %bb.0:
; RV64I-NEXT:  not a1, a1
; RV64I-NEXT:  and a0, a1, a0
; RV64I-NEXT:  ret
;
; RV64ZBB-ZBKB-LABEL: andn_i64:
; RV64ZBB-ZBKB:    # %bb.0:
; RV64ZBB-ZBKB-NEXT:  andn a0, a0, a1
; RV64ZBB-ZBKB-NEXT:  ret
%neg = xor i64 %b, -1
%and = and i64 %neg, %a
ret i64 %and
}

define signext i32 @orn_i32(i32 signext %a, i32 signext %b) nounwind {
; RV64I-LABEL: orn_i32:
; RV64I:    # %bb.0:
; RV64I-NEXT:  not a1, a1
; RV64I-NEXT:  or a0, a1, a0
; RV64I-NEXT:  ret
;
; RV64ZBB-ZBKB-LABEL: orn_i32:
; RV64ZBB-ZBKB:    # %bb.0:
; RV64ZBB-ZBKB-NEXT:  orn a0, a0, a1
; RV64ZBB-ZBKB-NEXT:  ret
%neg = xor i32 %b, -1
%or = or i32 %neg, %a
ret i32 %or
}

define i64 @orn_i64(i64 %a, i64 %b) nounwind {
; RV64I-LABEL: orn_i64:
; RV64I:    # %bb.0:

```

```

; RV64I-NEXT:  not a1, a1
; RV64I-NEXT:  or a0, a1, a0
; RV64I-NEXT:  ret
;
; RV64ZBB-ZBKB-LABEL: orn_i64:
; RV64ZBB-ZBKB:    # %bb.0:
; RV64ZBB-ZBKB-NEXT:
    orn a0, a0, a1
; RV64ZBB-ZBKB-NEXT:  ret
%neg = xor i64 %b, -1
%or = or i64 %neg, %a
ret i64 %or
}

```

```

define signext i32 @xnor_i32(i32 signext %a, i32 signext %b) nounwind {
; CHECK-LABEL: xnor_i32:
; CHECK:    # %bb.0:
; CHECK-NEXT:  xor a0, a0, a1
; CHECK-NEXT:  not a0, a0
; CHECK-NEXT:  ret
%neg = xor i32 %a, -1
%xor = xor i32 %neg, %b
ret i32 %xor
}

```

```

define i64 @xnor_i64(i64 %a, i64 %b) nounwind {
; RV64I-LABEL: xnor_i64:
; RV64I:    # %bb.0:
; RV64I-NEXT:  xor a0, a0, a1
; RV64I-NEXT:  not a0, a0
; RV64I-NEXT:  ret
;
; RV64ZBB-ZBKB-LABEL: xnor_i64:
; RV64ZBB-ZBKB:    # %bb.0:
; RV64ZBB-ZBKB-NEXT:  xnor a0, a0, a1
; RV64ZBB-ZBKB-NEXT:  ret
%neg = xor i64 %a, -1
%xor = xor i64 %neg, %b
ret i64 %xor
}

```

```

declare i32 @llvm.fshl.i32(i32, i32, i32)

```

```

define signext i32 @rol_i32(i32 signext %a, i32 signext %b) nounwind {
; RV64I-LABEL: rol_i32:
; RV64I:    # %bb.0:
; RV64I-NEXT:  andi a2, a1, -1
; RV64I-NEXT:  sllw a1, a0, a1

```

```

; RV64I-NEXT:
    negw a2, a2
; RV64I-NEXT:  srlw a0, a0, a2
; RV64I-NEXT:  or a0, a1, a0
; RV64I-NEXT:  ret
;
; RV64ZBB-ZBKB-LABEL: rol_i32:
; RV64ZBB-ZBKB:      # %bb.0:
; RV64ZBB-ZBKB-NEXT:  rolw a0, a0, a1
; RV64ZBB-ZBKB-NEXT:  ret
%1 = tail call i32 @llvm.fshl.i32(i32 %a, i32 %a, i32 %b)
ret i32 %1
}

; Similar to rol_i32, but doesn't sign extend the result.
define void @rol_i32_nosext(i32 signext %a, i32 signext %b, ptr %x) nounwind {
; RV64I-LABEL: rol_i32_nosext:
; RV64I:      # %bb.0:
; RV64I-NEXT:  andi a3, a1, -1
; RV64I-NEXT:  sllw a1, a0, a1
; RV64I-NEXT:  negw a3, a3
; RV64I-NEXT:  srlw a0, a0, a3
; RV64I-NEXT:  or a0, a1, a0
; RV64I-NEXT:  sw a0, 0(a2)
; RV64I-NEXT:  ret
;
; RV64ZBB-ZBKB-LABEL: rol_i32_nosext:
; RV64ZBB-ZBKB:      # %bb.0:
; RV64ZBB-ZBKB-NEXT:  rolw a0, a0, a1
; RV64ZBB-ZBKB-NEXT:  sw a0, 0(a2)
; RV64ZBB-ZBKB-NEXT:  ret
%1 = tail call i32 @llvm.fshl.i32(i32 %a, i32 %a, i32 %b)
store i32 %1, ptr %x
ret void
}

define signext
i32 @rol_i32_neg_constant_rhs(i32 signext %a) nounwind {
; RV64I-LABEL: rol_i32_neg_constant_rhs:
; RV64I:      # %bb.0:
; RV64I-NEXT:  andi a1, a0, -1
; RV64I-NEXT:  li a2, -2
; RV64I-NEXT:  sllw a0, a2, a0
; RV64I-NEXT:  negw a1, a1
; RV64I-NEXT:  srlw a1, a2, a1
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  ret
;

```

```

; RV64ZBB-ZBKB-LABEL: rol_i32_neg_constant_rhs:
; RV64ZBB-ZBKB:      # %bb.0:
; RV64ZBB-ZBKB-NEXT:  li a1, -2
; RV64ZBB-ZBKB-NEXT:  rolw a0, a1, a0
; RV64ZBB-ZBKB-NEXT:  ret
%1 = tail call i32 @llvm.fshl.i32(i32 -2, i32 -2, i32 %a)
ret i32 %1
}

```

```

declare i64 @llvm.fshl.i64(i64, i64, i64)

```

```

define i64 @rol_i64(i64 %a, i64 %b) nounwind {
; RV64I-LABEL: rol_i64:
; RV64I:      # %bb.0:
; RV64I-NEXT:  sll a2, a0, a1
; RV64I-NEXT:  negw a1, a1
; RV64I-NEXT:  srl a0, a0, a1
; RV64I-NEXT:  or a0, a2, a0
; RV64I-NEXT:  ret
;
; RV64ZBB-ZBKB-LABEL: rol_i64:
; RV64ZBB-ZBKB:      # %bb.0:
; RV64ZBB-ZBKB-NEXT:  rol a0, a0, a1
; RV64ZBB-ZBKB-NEXT:
ret
%or = tail call i64 @llvm.fshl.i64(i64 %a, i64 %a, i64 %b)
ret i64 %or
}

```

```

declare i32 @llvm.fshr.i32(i32, i32, i32)

```

```

define signext i32 @ror_i32(i32 signext %a, i32 signext %b) nounwind {
; RV64I-LABEL: ror_i32:
; RV64I:      # %bb.0:
; RV64I-NEXT:  andi a2, a1, -1
; RV64I-NEXT:  srlw a1, a0, a1
; RV64I-NEXT:  negw a2, a2
; RV64I-NEXT:  sllw a0, a0, a2
; RV64I-NEXT:  or a0, a1, a0
; RV64I-NEXT:  ret
;
; RV64ZBB-ZBKB-LABEL: ror_i32:
; RV64ZBB-ZBKB:      # %bb.0:
; RV64ZBB-ZBKB-NEXT:  rorw a0, a0, a1
; RV64ZBB-ZBKB-NEXT:  ret
%1 = tail call i32 @llvm.fshr.i32(i32 %a, i32 %a, i32 %b)
ret i32 %1
}

```

```

; Similar to ror_i32, but doesn't sign extend the result.
define void @ror_i32_nosext(i32 signext %a, i32 signext %b, ptr %x) nounwind {
; RV64I-LABEL: ror_i32_nosext:
; RV64I:      # %bb.0:
; RV64I-NEXT:  andi a3, a1, -1
; RV64I-NEXT:  srlw a1, a0, a1
; RV64I-NEXT:  negw a3, a3
; RV64I-NEXT:  sllw a0, a0, a3
; RV64I-NEXT:  or a0, a1, a0
; RV64I-NEXT:
    sw a0, 0(a2)
; RV64I-NEXT:  ret
;
; RV64ZBB-ZBKB-LABEL: ror_i32_nosext:
; RV64ZBB-ZBKB:      # %bb.0:
; RV64ZBB-ZBKB-NEXT:  rorw a0, a0, a1
; RV64ZBB-ZBKB-NEXT:  sw a0, 0(a2)
; RV64ZBB-ZBKB-NEXT:  ret
    %1 = tail call i32 @llvm.fshr.i32(i32 %a, i32 %a, i32 %b)
    store i32 %1, ptr %x
    ret void
}

```

```

define signext i32 @ror_i32_neg_constant_rhs(i32 signext %a) nounwind {
; RV64I-LABEL: ror_i32_neg_constant_rhs:
; RV64I:      # %bb.0:
; RV64I-NEXT:  andi a1, a0, -1
; RV64I-NEXT:  li a2, -2
; RV64I-NEXT:  srlw a0, a2, a0
; RV64I-NEXT:  negw a1, a1
; RV64I-NEXT:  sllw a1, a2, a1
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBB-ZBKB-LABEL: ror_i32_neg_constant_rhs:
; RV64ZBB-ZBKB:      # %bb.0:
; RV64ZBB-ZBKB-NEXT:  li a1, -2
; RV64ZBB-ZBKB-NEXT:  rorw a0, a1, a0
; RV64ZBB-ZBKB-NEXT:  ret
    %1 = tail call i32 @llvm.fshr.i32(i32 -2, i32 -2, i32 %a)
    ret i32 %1
}

```

```

declare i64 @llvm.fshr.i64(i64, i64, i64)

```

```

define i64 @ror_i64(i64 %a, i64 %b) nounwind {
;

```

```

RV64I-LABEL: ror_i64:
; RV64I:    # %bb.0:
; RV64I-NEXT:  srl a2, a0, a1
; RV64I-NEXT:  negw a1, a1
; RV64I-NEXT:  sll a0, a0, a1
; RV64I-NEXT:  or a0, a2, a0
; RV64I-NEXT:  ret
;
; RV64ZBB-ZBKB-LABEL: ror_i64:
; RV64ZBB-ZBKB:    # %bb.0:
; RV64ZBB-ZBKB-NEXT:  ror a0, a0, a1
; RV64ZBB-ZBKB-NEXT:  ret
%or = tail call i64 @llvm.fshr.i64(i64 %a, i64 %a, i64 %b)
ret i64 %or
}

define signext i32 @rori_i32_fshl(i32 signext %a) nounwind {
; RV64I-LABEL: rori_i32_fshl:
; RV64I:    # %bb.0:
; RV64I-NEXT:  srliw a1, a0, 1
; RV64I-NEXT:  slliw a0, a0, 31
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBB-ZBKB-LABEL: rori_i32_fshl:
; RV64ZBB-ZBKB:    # %bb.0:
; RV64ZBB-ZBKB-NEXT:  roriw a0, a0, 1
; RV64ZBB-ZBKB-NEXT:  ret
%1 = tail call i32 @llvm.fshl.i32(i32 %a, i32 %a, i32 31)
ret i32 %1
}

; Similar to rori_i32_fshl, but doesn't sign extend the result.
define void @rori_i32_fshl_nosext(i32 signext %a, ptr %x) nounwind {
; RV64I-LABEL: rori_i32_fshl_nosext:
;
RV64I:    # %bb.0:
; RV64I-NEXT:  srliw a2, a0, 1
; RV64I-NEXT:  slli a0, a0, 31
; RV64I-NEXT:  or a0, a0, a2
; RV64I-NEXT:  sw a0, 0(a1)
; RV64I-NEXT:  ret
;
; RV64ZBB-ZBKB-LABEL: rori_i32_fshl_nosext:
; RV64ZBB-ZBKB:    # %bb.0:
; RV64ZBB-ZBKB-NEXT:  roriw a0, a0, 1
; RV64ZBB-ZBKB-NEXT:  sw a0, 0(a1)
; RV64ZBB-ZBKB-NEXT:  ret

```



```

%1 = tail call i32 @llvm.fshl.i32(i32 %a, i32 %a, i32 31)
store i32 %1, ptr %x
ret void
}

```

```

define signext i32 @rori_i32_fshr(i32 signext %a) nounwind {
; RV64I-LABEL: rori_i32_fshr:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slliw a1, a0, 1
; RV64I-NEXT:  srlw a0, a0, 31
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBB-ZBKB-LABEL: rori_i32_fshr:
; RV64ZBB-ZBKB:  # %bb.0:
; RV64ZBB-ZBKB-NEXT:  roriw a0, a0, 31
; RV64ZBB-ZBKB-NEXT:  ret
%1 = tail call i32 @llvm.fshr.i32(i32 %a, i32 %a, i32 31)
ret i32 %1
}

```

; Similar to rori\_i32\_fshr, but doesn't sign extend the result.

```

define void @rori_i32_fshr_nosext(i32
signext %a, ptr %x) nounwind {
; RV64I-LABEL: rori_i32_fshr_nosext:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a2, a0, 1
; RV64I-NEXT:  srlw a0, a0, 31
; RV64I-NEXT:  or a0, a0, a2
; RV64I-NEXT:  sw a0, 0(a1)
; RV64I-NEXT:  ret
;
; RV64ZBB-ZBKB-LABEL: rori_i32_fshr_nosext:
; RV64ZBB-ZBKB:  # %bb.0:
; RV64ZBB-ZBKB-NEXT:  roriw a0, a0, 31
; RV64ZBB-ZBKB-NEXT:  sw a0, 0(a1)
; RV64ZBB-ZBKB-NEXT:  ret
%1 = tail call i32 @llvm.fshr.i32(i32 %a, i32 %a, i32 31)
store i32 %1, ptr %x
ret void
}

```

; This test is similar to the type legalized version of the fshl/fshr tests, but

; instead of having the same input to both shifts it has different inputs. Make

; sure we don't match it as a roriw.

```

define signext i32 @not_rori_i32(i32 signext %x, i32 signext %y) nounwind {
; CHECK-LABEL: not_rori_i32:
; CHECK:      # %bb.0:

```

```

; CHECK-NEXT:  slliw a0, a0, 31
; CHECK-NEXT:  srliw a1, a1, 1
; CHECK-NEXT:  or a0, a0, a1
; CHECK-NEXT:  ret
%a = shl
i32 %x, 31
%b = lshr i32 %y, 1
%c = or i32 %a, %b
ret i32 %c
}

```

; This is similar to the type legalized roriw pattern, but the and mask is more  
; than 32 bits so the lshr doesn't shift zeroes into the lower 32 bits. Make  
; sure we don't match it to roriw.

```

define i64 @roriw_bug(i64 %x) nounwind {
; CHECK-LABEL: roriw_bug:
; CHECK:      # %bb.0:
; CHECK-NEXT:  slli a1, a0, 31
; CHECK-NEXT:  andi a2, a0, -2
; CHECK-NEXT:  srli a0, a0, 1
; CHECK-NEXT:  or a0, a1, a0
; CHECK-NEXT:  sext.w a0, a0
; CHECK-NEXT:  xor a0, a2, a0
; CHECK-NEXT:  ret
%a = shl i64 %x, 31
%b = and i64 %x, 18446744073709551614
%c = lshr i64 %b, 1
%d = or i64 %a, %c
%e = shl i64 %d, 32
%f = ashr i64 %e, 32
%g = xor i64 %b, %f ; to increase the use count on %b to disable SimplifyDemandedBits.
ret i64 %g
}

```

```

define i64 @rori_i64_fshl(i64 %a) nounwind {
; RV64I-LABEL: rori_i64_fshl:
; RV64I:      # %bb.0:
; RV64I-NEXT:  srli a1, a0, 1
; RV64I-NEXT:  slli a0, a0, 63
; RV64I-NEXT:
; or a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBB-ZBKB-LABEL: rori_i64_fshl:
; RV64ZBB-ZBKB:  # %bb.0:
; RV64ZBB-ZBKB-NEXT:  rori a0, a0, 1
; RV64ZBB-ZBKB-NEXT:  ret
%1 = tail call i64 @llvm.fshl.i64(i64 %a, i64 %a, i64 63)

```

```

ret i64 %1
}

define i64 @rori_i64_fshr(i64 %a) nounwind {
; RV64I-LABEL: rori_i64_fshr:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a1, a0, 1
; RV64I-NEXT:  srli a0, a0, 63
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBB-ZBKB-LABEL: rori_i64_fshr:
; RV64ZBB-ZBKB:  # %bb.0:
; RV64ZBB-ZBKB-NEXT:  rori a0, a0, 63
; RV64ZBB-ZBKB-NEXT:  ret
%1 = tail call i64 @llvm.fshr.i64(i64 %a, i64 %a, i64 63)
ret i64 %1
}

```

```

define signext i32 @not_shl_one_i32(i32 signext %x) {
; RV64I-LABEL: not_shl_one_i32:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a1, 1
; RV64I-NEXT:  sllw a0, a1, a0
; RV64I-NEXT:  not a0, a0
; RV64I-NEXT:  ret
;
; RV64ZBB-ZBKB-LABEL: not_shl_one_i32:
; RV64ZBB-ZBKB:  # %bb.0:
; RV64ZBB-ZBKB-NEXT:  li a1,
-2
; RV64ZBB-ZBKB-NEXT:  rolw a0, a1, a0
; RV64ZBB-ZBKB-NEXT:  ret
%1 = shl i32 1, %x
%2 = xor i32 %1, -1
ret i32 %2
}

```

```

define i64 @not_shl_one_i64(i64 %x) {
; RV64I-LABEL: not_shl_one_i64:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a1, 1
; RV64I-NEXT:  sll a0, a1, a0
; RV64I-NEXT:  not a0, a0
; RV64I-NEXT:  ret
;
; RV64ZBB-ZBKB-LABEL: not_shl_one_i64:
; RV64ZBB-ZBKB:  # %bb.0:

```

```

; RV64ZBB-ZBKB-NEXT:  li a1, -2
; RV64ZBB-ZBKB-NEXT:  rol a0, a1, a0
; RV64ZBB-ZBKB-NEXT:  ret
%1 = shl i64 1, %x
%2 = xor i64 %1, -1
ret i64 %2
}

```

```

define i8 @srli_i8(i8 %a) nounwind {
; CHECK-LABEL: srli_i8:
; CHECK:      # %bb.0:
; CHECK-NEXT:  slli a0, a0, 56
; CHECK-NEXT:  srli a0, a0, 62
; CHECK-NEXT:  ret
%1 = lshr i8 %a, 6
ret i8 %1
}

```

; We could use sext.b+srai, but slli+srai offers more opportunities for  
; compressed instructions.

```

define i8 @srai_i8(i8 %a) nounwind {
; RV64I-LABEL: srai_i8:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a0, a0, 24
; RV64I-NEXT:
;               sraiw a0, a0, 29
; RV64I-NEXT:  ret
;
; RV64ZBB-LABEL: srai_i8:
; RV64ZBB:    # %bb.0:
; RV64ZBB-NEXT:  slli a0, a0, 56
; RV64ZBB-NEXT:  srai a0, a0, 61
; RV64ZBB-NEXT:  ret
;
; RV64ZBKB-LABEL: srai_i8:
; RV64ZBKB:    # %bb.0:
; RV64ZBKB-NEXT:  slli a0, a0, 24
; RV64ZBKB-NEXT:  sraiw a0, a0, 29
; RV64ZBKB-NEXT:  ret
%1 = ashr i8 %a, 5
ret i8 %1
}

```

; We could use zext.h+srli, but slli+srli offers more opportunities for  
; compressed instructions.

```

define i16 @srli_i16(i16 %a) nounwind {
; CHECK-LABEL: srli_i16:
; CHECK:      # %bb.0:

```

```

; CHECK-NEXT:  slli a0, a0, 48
; CHECK-NEXT:  srli a0, a0, 54
; CHECK-NEXT:  ret
%1 = lshr i16 %a, 6
ret i16 %1
}

```

; We could use sext.h+srai, but slli+srai offers more opportunities for  
; compressed instructions.

```

define i16 @srai_i16(i16 %a) nounwind {
; RV64I-LABEL: srai_i16:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a0, a0, 16
; RV64I-NEXT:  sraiw a0, a0, 25
; RV64I-NEXT:  ret
;
; RV64ZBB-LABEL: srai_i16:
;
; RV64ZBB:     # %bb.0:
; RV64ZBB-NEXT:  slli a0, a0, 48
; RV64ZBB-NEXT:  srai a0, a0, 57
; RV64ZBB-NEXT:  ret
;
; RV64ZBKB-LABEL: srai_i16:
; RV64ZBKB:     # %bb.0:
; RV64ZBKB-NEXT:  slli a0, a0, 16
; RV64ZBKB-NEXT:  sraiw a0, a0, 25
; RV64ZBKB-NEXT:  ret
%1 = ashr i16 %a, 9
ret i16 %1
}

```

```

define i1 @andn_seqz_i32(i32 signext %a, i32 signext %b) nounwind {
; RV64I-LABEL: andn_seqz_i32:
; RV64I:      # %bb.0:
; RV64I-NEXT:  and a0, a0, a1
; RV64I-NEXT:  xor a0, a0, a1
; RV64I-NEXT:  seqz a0, a0
; RV64I-NEXT:  ret
;
; RV64ZBB-ZBKB-LABEL: andn_seqz_i32:
; RV64ZBB-ZBKB:     # %bb.0:
; RV64ZBB-ZBKB-NEXT:  andn a0, a1, a0
; RV64ZBB-ZBKB-NEXT:  seqz a0, a0
; RV64ZBB-ZBKB-NEXT:  ret
%and = and i32 %a, %b
%cmpeq = icmp eq i32 %and, %b
ret i1 %cmpeq
}

```

```
}
```

```
define i1 @andn_seqz_i64(i64 %a, i64 %b) nounwind {  
; RV64I-LABEL: andn_seqz_i64:  
; RV64I:      # %bb.0:  
; RV64I-NEXT: and a0, a0, a1  
; RV64I-NEXT: xor a0, a0, a1  
; RV64I-NEXT: seqz a0, a0  
; RV64I-NEXT:  
    ret  
;  
; RV64ZBB-ZBKB-LABEL: andn_seqz_i64:  
; RV64ZBB-ZBKB:      # %bb.0:  
; RV64ZBB-ZBKB-NEXT: andn a0, a1, a0  
; RV64ZBB-ZBKB-NEXT: seqz a0, a0  
; RV64ZBB-ZBKB-NEXT: ret  
    %and = and i64 %a, %b  
    %cmpeq = icmp eq i64 %and, %b  
    ret i1 %cmpeq  
}
```

```
define i1 @andn_snez_i32(i32 signext %a, i32 signext %b) nounwind {  
; RV64I-LABEL: andn_snez_i32:  
; RV64I:      # %bb.0:  
; RV64I-NEXT: and a0, a0, a1  
; RV64I-NEXT: xor a0, a0, a1  
; RV64I-NEXT: snez a0, a0  
; RV64I-NEXT: ret  
;  
; RV64ZBB-ZBKB-LABEL: andn_snez_i32:  
; RV64ZBB-ZBKB:      # %bb.0:  
; RV64ZBB-ZBKB-NEXT: andn a0, a1, a0  
; RV64ZBB-ZBKB-NEXT: snez a0, a0  
; RV64ZBB-ZBKB-NEXT: ret  
    %and = and i32 %a, %b  
    %cmpeq = icmp ne i32 %and, %b  
    ret i1 %cmpeq  
}
```

```
define i1 @andn_snez_i64(i64 %a, i64 %b) nounwind {  
; RV64I-LABEL: andn_snez_i64:  
; RV64I:      # %bb.0:  
; RV64I-NEXT: and a0, a0, a1  
; RV64I-NEXT: xor a0, a0, a1  
; RV64I-NEXT: snez a0, a0  
; RV64I-NEXT: ret  
;  
; RV64ZBB-ZBKB-LABEL: andn_snez_i64:
```

```

;
RV64ZBB-ZBKB:    # %bb.0:
; RV64ZBB-ZBKB-NEXT:  andn a0, a1, a0
; RV64ZBB-ZBKB-NEXT:  snez a0, a0
; RV64ZBB-ZBKB-NEXT:  ret
%and = and i64 %a, %b
%cmpeq = icmp ne i64 %and, %b
ret i1 %cmpeq
}
; NOTE: Assertions have been autogenerated by utils/update_llc_test_checks.py
; RUN: llc -mtriple=riscv64 -verify-machineinstrs < %s \
; RUN: -riscv-experimental-rv64-legal-i32 | FileCheck -check-prefix=RV64I %s
; RUN: llc -mtriple=riscv64 -mattr=+m -verify-machineinstrs < %s \
; RUN: -riscv-experimental-rv64-legal-i32 | FileCheck -check-prefix=RV64IM %s

```

```

define i32 @urem(i32 %a, i32 %b) nounwind {
; RV64I-LABEL: urem:
; RV64I:    # %bb.0:
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  srli a0, a0, 32
; RV64I-NEXT:  slli a1, a1, 32
; RV64I-NEXT:  srli a1, a1, 32
; RV64I-NEXT:  call __umoddi3
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
;
; RV64IM-LABEL: urem:
; RV64IM:    # %bb.0:
; RV64IM-NEXT:  remuw a0, a0, a1
; RV64IM-NEXT:  ret
%1 = urem i32 %a, %b
ret i32 %1
}

```

```

define i32 @urem_constant_lhs(i32 %a) nounwind {
;
RV64I-LABEL: urem_constant_lhs:
; RV64I:    # %bb.0:
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  srli a1, a0, 32
; RV64I-NEXT:  li a0, 10
; RV64I-NEXT:  call __umoddi3
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload

```

```

; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
;
; RV64IM-LABEL: urem_constant_lhs:
; RV64IM:      # %bb.0:
; RV64IM-NEXT:  li a1, 10
; RV64IM-NEXT:  remuw a0, a1, a0
; RV64IM-NEXT:  ret
%1 = urem i32 10, %a
ret i32 %1
}

define i32 @srem(i32 %a, i32 %b) nounwind {
; RV64I-LABEL: srem:
; RV64I:      # %bb.0:
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  sext.w a0, a0
; RV64I-NEXT:  sext.w a1, a1
; RV64I-NEXT:  call __moddi3
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
;
; RV64IM-LABEL: srem:
; RV64IM:      # %bb.0:
; RV64IM-NEXT:
    remw a0, a0, a1
; RV64IM-NEXT:  ret
%1 = srem i32 %a, %b
ret i32 %1
}

define i32 @srem_pow2(i32 %a) nounwind {
; RV64I-LABEL: srem_pow2:
; RV64I:      # %bb.0:
; RV64I-NEXT:  sraiw a1, a0, 31
; RV64I-NEXT:  srliw a1, a1, 29
; RV64I-NEXT:  add a1, a0, a1
; RV64I-NEXT:  andi a1, a1, -8
; RV64I-NEXT:  subw a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64IM-LABEL: srem_pow2:
; RV64IM:      # %bb.0:
; RV64IM-NEXT:  sraiw a1, a0, 31
; RV64IM-NEXT:  srliw a1, a1, 29
; RV64IM-NEXT:  add a1, a0, a1

```



```
; RV64IM-NEXT: andi a1, a1, -8
; RV64IM-NEXT: subw a0, a0, a1
; RV64IM-NEXT: ret
%1 = srem i32 %a, 8
ret i32 %1
}
```

```
define i32 @srem_pow2_2(i32 %a) nounwind {
; RV64I-LABEL: srem_pow2_2:
; RV64I:    # %bb.0:
; RV64I-NEXT: sraiw a1, a0, 31
; RV64I-NEXT: srlw a1, a1, 16
; RV64I-NEXT: add a1, a0, a1
; RV64I-NEXT: lui a2, 1048560
; RV64I-NEXT: and a1, a1, a2
; RV64I-NEXT: subw a0, a0, a1
; RV64I-NEXT: ret
;
; RV64IM-LABEL: srem_pow2_2:
; RV64IM:
;    # %bb.0:
; RV64IM-NEXT: sraiw a1, a0, 31
; RV64IM-NEXT: srlw a1, a1, 16
; RV64IM-NEXT: add a1, a0, a1
; RV64IM-NEXT: lui a2, 1048560
; RV64IM-NEXT: and a1, a1, a2
; RV64IM-NEXT: subw a0, a0, a1
; RV64IM-NEXT: ret
%1 = srem i32 %a, 65536
ret i32 %1
}
```

```
define i32 @srem_constant_lhs(i32 %a) nounwind {
; RV64I-LABEL: srem_constant_lhs:
; RV64I:    # %bb.0:
; RV64I-NEXT: addi sp, sp, -16
; RV64I-NEXT: sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT: sext.w a1, a0
; RV64I-NEXT: li a0, -10
; RV64I-NEXT: call __moddi3
; RV64I-NEXT: ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT: addi sp, sp, 16
; RV64I-NEXT: ret
;
; RV64IM-LABEL: srem_constant_lhs:
; RV64IM:    # %bb.0:
; RV64IM-NEXT: li a1, -10
; RV64IM-NEXT: remw a0, a1, a0
```

```

; RV64IM-NEXT:  ret
%1 = srem i32 -10, %a
ret i32 %1
}

define i64 @urem64(i64 %a, i64 %b) nounwind {
; RV64I-LABEL: urem64:
; RV64I:      # %bb.0:
; RV64I-NEXT:  tail __umoddi3
;
; RV64IM-LABEL:
urem64:
; RV64IM:      # %bb.0:
; RV64IM-NEXT:  remu a0, a0, a1
; RV64IM-NEXT:  ret
%1 = urem i64 %a, %b
ret i64 %1
}

define i64 @urem64_constant_lhs(i64 %a) nounwind {
; RV64I-LABEL: urem64_constant_lhs:
; RV64I:      # %bb.0:
; RV64I-NEXT:  mv a1, a0
; RV64I-NEXT:  li a0, 10
; RV64I-NEXT:  tail __umoddi3
;
; RV64IM-LABEL: urem64_constant_lhs:
; RV64IM:      # %bb.0:
; RV64IM-NEXT:  li a1, 10
; RV64IM-NEXT:  remu a0, a1, a0
; RV64IM-NEXT:  ret
%1 = urem i64 10, %a
ret i64 %1
}

define i64 @srem64(i64 %a, i64 %b) nounwind {
; RV64I-LABEL: srem64:
; RV64I:      # %bb.0:
; RV64I-NEXT:  tail __moddi3
;
; RV64IM-LABEL: srem64:
; RV64IM:      # %bb.0:
; RV64IM-NEXT:  rem a0, a0, a1
; RV64IM-NEXT:  ret
%1 = srem i64 %a, %b
ret i64 %1
}

```

```

define i64 @srem64_constant_lhs(i64 %a) nounwind {
; RV64I-LABEL: srem64_constant_lhs:
; RV64I:      # %bb.0:
; RV64I-NEXT:  mv a1, a0
; RV64I-NEXT:  li a0, -10
; RV64I-NEXT:  tail __moddi3
;
; RV64IM-LABEL: srem64_constant_lhs:
;
; RV64IM:      # %bb.0:
; RV64IM-NEXT:  li a1, -10
; RV64IM-NEXT:  rem a0, a1, a0
; RV64IM-NEXT:  ret
%1 = srem i64 -10, %a
ret i64 %1
}

```

```

define i8 @urem8(i8 %a, i8 %b) nounwind {
; RV64I-LABEL: urem8:
; RV64I:      # %bb.0:
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  andi a0, a0, 255
; RV64I-NEXT:  andi a1, a1, 255
; RV64I-NEXT:  call __umoddi3
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
;
; RV64IM-LABEL: urem8:
; RV64IM:      # %bb.0:
; RV64IM-NEXT:  andi a1, a1, 255
; RV64IM-NEXT:  andi a0, a0, 255
; RV64IM-NEXT:  remuw a0, a0, a1
; RV64IM-NEXT:  ret
%1 = urem i8 %a, %b
ret i8 %1
}

```

```

define i8 @urem8_constant_lhs(i8 %a) nounwind {
; RV64I-LABEL: urem8_constant_lhs:
; RV64I:      # %bb.0:
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  andi a1, a0, 255
; RV64I-NEXT:
;   li a0, 10
; RV64I-NEXT:  call __umoddi3

```

```

; RV64I-NEXT: ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT: addi sp, sp, 16
; RV64I-NEXT: ret
;
; RV64IM-LABEL: urem8_constant_lhs:
; RV64IM:      # %bb.0:
; RV64IM-NEXT: andi a0, a0, 255
; RV64IM-NEXT: li a1, 10
; RV64IM-NEXT: remuw a0, a1, a0
; RV64IM-NEXT: ret
%1 = urem i8 10, %a
ret i8 %1
}

```

```

define i8 @srem8(i8 %a, i8 %b) nounwind {
; RV64I-LABEL: srem8:
; RV64I:      # %bb.0:
; RV64I-NEXT: addi sp, sp, -16
; RV64I-NEXT: sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT: slli a1, a1, 24
; RV64I-NEXT: sraiw a1, a1, 24
; RV64I-NEXT: slli a0, a0, 24
; RV64I-NEXT: sraiw a0, a0, 24
; RV64I-NEXT: call __moddi3
; RV64I-NEXT: ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT: addi sp, sp, 16
; RV64I-NEXT: ret
;
; RV64IM-LABEL: srem8:
; RV64IM:      # %bb.0:
; RV64IM-NEXT: slli a1, a1, 24
; RV64IM-NEXT: sraiw a1, a1, 24
; RV64IM-NEXT: slli a0, a0, 24
; RV64IM-NEXT: sraiw
a0, a0, 24
; RV64IM-NEXT: remw a0, a0, a1
; RV64IM-NEXT: ret
%1 = srem i8 %a, %b
ret i8 %1
}

```

```

define i8 @srem8_constant_lhs(i8 %a) nounwind {
; RV64I-LABEL: srem8_constant_lhs:
; RV64I:      # %bb.0:
; RV64I-NEXT: addi sp, sp, -16
; RV64I-NEXT: sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT: slli a0, a0, 24

```

```

; RV64I-NEXT:  sraiw a1, a0, 24
; RV64I-NEXT:  li a0, -10
; RV64I-NEXT:  call __moddi3
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
;
; RV64IM-LABEL: srem8_constant_lhs:
; RV64IM:      # %bb.0:
; RV64IM-NEXT:  slli a0, a0, 24
; RV64IM-NEXT:  sraiw a0, a0, 24
; RV64IM-NEXT:  li a1, -10
; RV64IM-NEXT:  remw a0, a1, a0
; RV64IM-NEXT:  ret
%1 = srem i8 -10, %a
ret i8 %1
}

```

```

define i16 @urem16(i16 %a, i16 %b) nounwind {
; RV64I-LABEL: urem16:
; RV64I:      # %bb.0:
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  lui a2, 16
; RV64I-NEXT:
    addiw a2, a2, -1
; RV64I-NEXT:  and a0, a0, a2
; RV64I-NEXT:  and a1, a1, a2
; RV64I-NEXT:  call __umoddi3
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
;
; RV64IM-LABEL: urem16:
; RV64IM:      # %bb.0:
; RV64IM-NEXT:  lui a2, 16
; RV64IM-NEXT:  addi a2, a2, -1
; RV64IM-NEXT:  and a1, a1, a2
; RV64IM-NEXT:  and a0, a0, a2
; RV64IM-NEXT:  remuw a0, a0, a1
; RV64IM-NEXT:  ret
%1 = urem i16 %a, %b
ret i16 %1
}

```

```

define i16 @urem16_constant_lhs(i16 %a) nounwind {
; RV64I-LABEL: urem16_constant_lhs:

```

```

; RV64I:    # %bb.0:
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  slli a0, a0, 48
; RV64I-NEXT:  srli a1, a0, 48
; RV64I-NEXT:  li a0, 10
; RV64I-NEXT:  call __umoddi3
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
;
; RV64IM-LABEL: urem16_constant_lhs:
; RV64IM:    # %bb.0:
;
RV64IM-NEXT:  slli a0, a0, 48
; RV64IM-NEXT:  srli a0, a0, 48
; RV64IM-NEXT:  li a1, 10
; RV64IM-NEXT:  remuw a0, a1, a0
; RV64IM-NEXT:  ret
%1 = urem i16 10, %a
ret i16 %1
}

```

```

define i16 @srem16(i16 %a, i16 %b) nounwind {
; RV64I-LABEL: srem16:
; RV64I:    # %bb.0:
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  slli a1, a1, 16
; RV64I-NEXT:  sraiw a1, a1, 16
; RV64I-NEXT:  slli a0, a0, 16
; RV64I-NEXT:  sraiw a0, a0, 16
; RV64I-NEXT:  call __moddi3
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
;
; RV64IM-LABEL: srem16:
; RV64IM:    # %bb.0:
; RV64IM-NEXT:  slli a1, a1, 16
; RV64IM-NEXT:  sraiw a1, a1, 16
; RV64IM-NEXT:  slli a0, a0, 16
; RV64IM-NEXT:  sraiw a0, a0, 16
; RV64IM-NEXT:  remw a0, a0, a1
; RV64IM-NEXT:  ret
%1 = srem i16 %a, %b
ret i16 %1
}

```

```

define i16 @srem16_constant_lhs(i16 %a) nounwind {
; RV64I-LABEL: srem16_constant_lhs:
;
; RV64I:    # %bb.0:
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  slli a0, a0, 16
; RV64I-NEXT:  sraiw a1, a0, 16
; RV64I-NEXT:  li a0, -10
; RV64I-NEXT:  call __moddi3
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
;
; RV64IM-LABEL: srem16_constant_lhs:
; RV64IM:    # %bb.0:
; RV64IM-NEXT:  slli a0, a0, 16
; RV64IM-NEXT:  sraiw a0, a0, 16
; RV64IM-NEXT:  li a1, -10
; RV64IM-NEXT:  remw a0, a1, a0
; RV64IM-NEXT:  ret
%1 = srem i16 -10, %a
ret i16 %1
}
; NOTE: Assertions have been autogenerated by utils/update_llc_test_checks.py
; RUN: llc -mtriple=riscv64 -verify-machineinstrs < %s \
; RUN: -riscv-experimental-rv64-legal-i32 | FileCheck %s -check-prefixes=CHECK,RV64I
; RUN: llc -mtriple=riscv64 -mattr=+zbs -verify-machineinstrs < %s \
; RUN: -riscv-experimental-rv64-legal-i32 | FileCheck %s -check-prefixes=CHECK,RV64ZBS

```

```

define signext i32 @bclr_i32(i32 signext %a, i32 signext %b) nounwind {
; RV64I-LABEL: bclr_i32:
; RV64I:    # %bb.0:
; RV64I-NEXT:  li a2, 1
; RV64I-NEXT:  sllw a1, a2, a1
; RV64I-NEXT:  not a1, a1
; RV64I-NEXT:  and a0, a1, a0
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: bclr_i32:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT:  andi a1, a1, 31
; RV64ZBS-NEXT:  bclr a0, a0, a1
; RV64ZBS-NEXT:  sext.w a0, a0
; RV64ZBS-NEXT:  ret
%and = and i32 %b, 31
%shl = shl nuw i32 1, %and

```

```

%neg = xor i32 %shl, -1
%and1 = and i32 %neg, %a
ret i32 %and1
}

```

```

define signext i32 @bclr_i32_no_mask(i32 signext %a,
i32 signext %b) nounwind {
; RV64I-LABEL: bclr_i32_no_mask:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a2, 1
; RV64I-NEXT:  sllw a1, a2, a1
; RV64I-NEXT:  not a1, a1
; RV64I-NEXT:  and a0, a1, a0
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: bclr_i32_no_mask:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT:  bclr a0, a0, a1
; RV64ZBS-NEXT:  sext.w a0, a0
; RV64ZBS-NEXT:  ret
%shl = shl i32 1, %b
%neg = xor i32 %shl, -1
%and1 = and i32 %neg, %a
ret i32 %and1
}

```

```

define signext i32 @bclr_i32_load(ptr %p, i32 signext %b) nounwind {
; RV64I-LABEL: bclr_i32_load:
; RV64I:      # %bb.0:
; RV64I-NEXT:  lw a0, 0(a0)
; RV64I-NEXT:  li a2, 1
; RV64I-NEXT:  sllw a1, a2, a1
; RV64I-NEXT:  not a1, a1
; RV64I-NEXT:  and a0, a1, a0
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: bclr_i32_load:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT:  lw a0, 0(a0)
; RV64ZBS-NEXT:  bclr a0, a0, a1
; RV64ZBS-NEXT:  sext.w a0, a0
; RV64ZBS-NEXT:  ret
%a = load i32, ptr %p
%shl = shl i32 1, %b
%neg
= xor i32 %shl, -1
%and1 = and i32 %neg, %a
ret i32 %and1

```



```
}
```

```
define i64 @bclr_i64(i64 %a, i64 %b) nounwind {  
; RV64I-LABEL: bclr_i64:  
; RV64I:      # %bb.0:  
; RV64I-NEXT: li a2, 1  
; RV64I-NEXT: sll a1, a2, a1  
; RV64I-NEXT: not a1, a1  
; RV64I-NEXT: and a0, a1, a0  
; RV64I-NEXT: ret  
;  
; RV64ZBS-LABEL: bclr_i64:  
; RV64ZBS:    # %bb.0:  
; RV64ZBS-NEXT: bclr a0, a0, a1  
; RV64ZBS-NEXT: ret  
%and = and i64 %b, 63  
%shl = shl nuw i64 1, %and  
%neg = xor i64 %shl, -1  
%and1 = and i64 %neg, %a  
ret i64 %and1  
}
```

```
define i64 @bclr_i64_no_mask(i64 %a, i64 %b) nounwind {  
; RV64I-LABEL: bclr_i64_no_mask:  
; RV64I:      # %bb.0:  
; RV64I-NEXT: li a2, 1  
; RV64I-NEXT: sll a1, a2, a1  
; RV64I-NEXT: not a1, a1  
; RV64I-NEXT: and a0, a1, a0  
; RV64I-NEXT: ret  
;  
; RV64ZBS-LABEL: bclr_i64_no_mask:  
; RV64ZBS:    # %bb.0:  
; RV64ZBS-NEXT: bclr a0, a0, a1  
; RV64ZBS-NEXT: ret  
%shl = shl i64 1, %b  
%neg = xor i64 %shl, -1  
%and1 = and i64 %neg, %a  
ret i64  
%and1  
}
```

```
define signext i32 @bset_i32(i32 signext %a, i32 signext %b) nounwind {  
; RV64I-LABEL: bset_i32:  
; RV64I:      # %bb.0:  
; RV64I-NEXT: li a2, 1  
; RV64I-NEXT: sllw a1, a2, a1  
; RV64I-NEXT: or a0, a1, a0
```

```

; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: bset_i32:
; RV64ZBS:     # %bb.0:
; RV64ZBS-NEXT:  andi a1, a1, 31
; RV64ZBS-NEXT:  bset a0, a0, a1
; RV64ZBS-NEXT:  sext.w a0, a0
; RV64ZBS-NEXT:  ret
%and = and i32 %b, 31
%shl = shl nuw i32 1, %and
%or = or i32 %shl, %a
ret i32 %or
}

define signext i32 @bset_i32_no_mask(i32 signext %a, i32 signext %b) nounwind {
; RV64I-LABEL: bset_i32_no_mask:
; RV64I:     # %bb.0:
; RV64I-NEXT:  li a2, 1
; RV64I-NEXT:  sllw a1, a2, a1
; RV64I-NEXT:  or a0, a1, a0
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: bset_i32_no_mask:
; RV64ZBS:     # %bb.0:
; RV64ZBS-NEXT:  bset a0, a0, a1
; RV64ZBS-NEXT:  sext.w a0, a0
; RV64ZBS-NEXT:  ret
%shl = shl i32 1, %b
%or = or i32 %shl, %a
ret i32 %or
}

define signext i32
@bset_i32_load(ptr %p, i32 signext %b) nounwind {
; RV64I-LABEL: bset_i32_load:
; RV64I:     # %bb.0:
; RV64I-NEXT:  lw a0, 0(a0)
; RV64I-NEXT:  li a2, 1
; RV64I-NEXT:  sllw a1, a2, a1
; RV64I-NEXT:  or a0, a1, a0
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: bset_i32_load:
; RV64ZBS:     # %bb.0:
; RV64ZBS-NEXT:  lw a0, 0(a0)
; RV64ZBS-NEXT:  bset a0, a0, a1
; RV64ZBS-NEXT:  sext.w a0, a0
; RV64ZBS-NEXT:  ret

```

```

%a = load i32, ptr %p
%shl = shl i32 1, %b
%or = or i32 %shl, %a
ret i32 %or
}

```

; We can use bsetw for  $1 \ll x$  by setting the first source to zero.

```

define signext i32 @bset_i32_zero(i32 signext %a) nounwind {
; RV64I-LABEL: bset_i32_zero:
; RV64I:      # %bb.0:
; RV64I-NEXT: li a1, 1
; RV64I-NEXT: sllw a0, a1, a0
; RV64I-NEXT: ret
;
; RV64ZBS-LABEL: bset_i32_zero:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT: bset a0, zero, a0
; RV64ZBS-NEXT: sext.w a0, a0
; RV64ZBS-NEXT: ret
%shl = shl i32 1, %a
ret i32 %shl
}

```

```

define i64 @bset_i64(i64 %a,
i64 %b) nounwind {
; RV64I-LABEL: bset_i64:
; RV64I:      # %bb.0:
; RV64I-NEXT: li a2, 1
; RV64I-NEXT: sll a1, a2, a1
; RV64I-NEXT: or a0, a1, a0
; RV64I-NEXT: ret
;
; RV64ZBS-LABEL: bset_i64:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT: bset a0, a0, a1
; RV64ZBS-NEXT: ret
%conv = and i64 %b, 63
%shl = shl nuw i64 1, %conv
%or = or i64 %shl, %a
ret i64 %or
}

```

```

define i64 @bset_i64_no_mask(i64 %a, i64 %b) nounwind {
; RV64I-LABEL: bset_i64_no_mask:
; RV64I:      # %bb.0:
; RV64I-NEXT: li a2, 1
; RV64I-NEXT: sll a1, a2, a1
; RV64I-NEXT: or a0, a1, a0

```

```

; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: bset_i64_no_mask:
; RV64ZBS:      # %bb.0:
; RV64ZBS-NEXT:  bset a0, a0, a1
; RV64ZBS-NEXT:  ret
%shl = shl i64 1, %b
%or = or i64 %shl, %a
ret i64 %or
}

```

; We can use bsetw for  $1 \ll x$  by setting the first source to zero.

```

define signext i64 @bset_i64_zero(i64 signext %a) nounwind {
; RV64I-LABEL: bset_i64_zero:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li
a1, 1
; RV64I-NEXT:  sll a0, a1, a0
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: bset_i64_zero:
; RV64ZBS:      # %bb.0:
; RV64ZBS-NEXT:  bset a0, zero, a0
; RV64ZBS-NEXT:  ret
%shl = shl i64 1, %a
ret i64 %shl
}

```

```

define signext i32 @binv_i32(i32 signext %a, i32 signext %b) nounwind {
; RV64I-LABEL: binv_i32:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a2, 1
; RV64I-NEXT:  sllw a1, a2, a1
; RV64I-NEXT:  xor a0, a1, a0
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: binv_i32:
; RV64ZBS:      # %bb.0:
; RV64ZBS-NEXT:  andi a1, a1, 31
; RV64ZBS-NEXT:  binv a0, a0, a1
; RV64ZBS-NEXT:  sext.w a0, a0
; RV64ZBS-NEXT:  ret
%and = and i32 %b, 31
%shl = shl nuw i32 1, %and
%xor = xor i32 %shl, %a
ret i32 %xor
}

```

```

define signext i32 @binv_i32_no_mask(i32 signext %a, i32 signext %b) nounwind {
; RV64I-LABEL: binv_i32_no_mask:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a2, 1
; RV64I-NEXT:  sllw a1, a2, a1
; RV64I-NEXT:  xor a0, a1, a0
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: binv_i32_no_mask:
;
RV64ZBS:      # %bb.0:
; RV64ZBS-NEXT:  binv a0, a0, a1
; RV64ZBS-NEXT:  sext.w a0, a0
; RV64ZBS-NEXT:  ret
%shl = shl i32 1, %b
%xor = xor i32 %shl, %a
ret i32 %xor
}

```

```

define signext i32 @binv_i32_load(ptr %p, i32 signext %b) nounwind {
; RV64I-LABEL: binv_i32_load:
; RV64I:      # %bb.0:
; RV64I-NEXT:  lw a0, 0(a0)
; RV64I-NEXT:  li a2, 1
; RV64I-NEXT:  sllw a1, a2, a1
; RV64I-NEXT:  xor a0, a1, a0
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: binv_i32_load:
; RV64ZBS:      # %bb.0:
; RV64ZBS-NEXT:  lw a0, 0(a0)
; RV64ZBS-NEXT:  binv a0, a0, a1
; RV64ZBS-NEXT:  sext.w a0, a0
; RV64ZBS-NEXT:  ret
%a = load i32, ptr %p
%shl = shl i32 1, %b
%xor = xor i32 %shl, %a
ret i32 %xor
}

```

```

define i64 @binv_i64(i64 %a, i64 %b) nounwind {
; RV64I-LABEL: binv_i64:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a2, 1
; RV64I-NEXT:  sll a1, a2, a1
; RV64I-NEXT:  xor a0, a1, a0
; RV64I-NEXT:  ret
;

```

```

; RV64ZBS-LABEL: binv_i64:
; RV64ZBS:    # %bb.0:
;
RV64ZBS-NEXT:  binv a0, a0, a1
; RV64ZBS-NEXT:  ret
%conv = and i64 %b, 63
%shl = shl nuw i64 1, %conv
%xor = xor i64 %shl, %a
ret i64 %xor
}

define i64 @binv_i64_no_mask(i64 %a, i64 %b) nounwind {
; RV64I-LABEL: binv_i64_no_mask:
; RV64I:    # %bb.0:
; RV64I-NEXT:  li a2, 1
; RV64I-NEXT:  sll a1, a2, a1
; RV64I-NEXT:  xor a0, a1, a0
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: binv_i64_no_mask:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT:  binv a0, a0, a1
; RV64ZBS-NEXT:  ret
%shl = shl nuw i64 1, %b
%xor = xor i64 %shl, %a
ret i64 %xor
}

define signext i32 @bext_i32(i32 signext %a, i32 signext %b) nounwind {
; RV64I-LABEL: bext_i32:
; RV64I:    # %bb.0:
; RV64I-NEXT:  srlw a0, a0, a1
; RV64I-NEXT:  andi a0, a0, 1
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: bext_i32:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT:  andi a1, a1, 31
; RV64ZBS-NEXT:  bext a0, a0, a1
; RV64ZBS-NEXT:  ret
%and = and i32 %b, 31
%shr = lshr i32 %a, %and
%and1 = and i32
%shr, 1
ret i32 %and1
}

define signext i32 @bext_i32_no_mask(i32 signext %a, i32 signext %b) nounwind {

```

```

; RV64I-LABEL: bext_i32_no_mask:
; RV64I:    # %bb.0:
; RV64I-NEXT:  srlw a0, a0, a1
; RV64I-NEXT:  andi a0, a0, 1
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: bext_i32_no_mask:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT:  bext a0, a0, a1
; RV64ZBS-NEXT:  ret
%shr = lshr i32 %a, %b
%and1 = and i32 %shr, 1
ret i32 %and1
}

```

; This gets previous converted to (i1 (truncate (srl X, Y))). Make sure we are  
able to use bext.

```
define void @bext_i32_trunc(i32 signext %0, i32 signext %1) {
```

```

; RV64I-LABEL: bext_i32_trunc:
; RV64I:    # %bb.0:
; RV64I-NEXT:  srlw a0, a0, a1
; RV64I-NEXT:  andi a0, a0, 1
; RV64I-NEXT:  beqz a0, .LBB19_2
; RV64I-NEXT:  # %bb.1:
; RV64I-NEXT:  ret
; RV64I-NEXT: .LBB19_2:
; RV64I-NEXT:  tail bar
;
; RV64ZBS-LABEL: bext_i32_trunc:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT:  bext a0, a0, a1
; RV64ZBS-NEXT:  beqz a0, .LBB19_2
; RV64ZBS-NEXT:
# %bb.1:
; RV64ZBS-NEXT:  ret
; RV64ZBS-NEXT: .LBB19_2:
; RV64ZBS-NEXT:  tail bar
%3 = shl i32 1, %1
%4 = and i32 %3, %0
%5 = icmp eq i32 %4, 0
br i1 %5, label %6, label %7

```

```

6:                                ; preds = %2
tail call void @bar()
br label %7

```

```

7:                                ; preds = %6, %2
ret void

```

```
}
```

```
declare void @bar()
```

```
define i64 @bext_i64(i64 %a, i64 %b) nounwind {  
; RV64I-LABEL: bext_i64:  
; RV64I:      # %bb.0:  
; RV64I-NEXT:  srl a0, a0, a1  
; RV64I-NEXT:  andi a0, a0, 1  
; RV64I-NEXT:  ret  
;  
; RV64ZBS-LABEL: bext_i64:  
; RV64ZBS:      # %bb.0:  
; RV64ZBS-NEXT:  bext a0, a0, a1  
; RV64ZBS-NEXT:  ret  
%conv = and i64 %b, 63  
%shr = lshr i64 %a, %conv  
%and1 = and i64 %shr, 1  
ret i64 %and1  
}
```

```
define i64 @bext_i64_no_mask(i64 %a, i64 %b) nounwind {  
; RV64I-LABEL: bext_i64_no_mask:  
; RV64I:      # %bb.0:  
; RV64I-NEXT:  srl a0, a0, a1  
; RV64I-NEXT:  andi a0, a0, 1  
; RV64I-NEXT:  ret  
;  
; RV64ZBS-LABEL:  
  bext_i64_no_mask:  
; RV64ZBS:      # %bb.0:  
; RV64ZBS-NEXT:  bext a0, a0, a1  
; RV64ZBS-NEXT:  ret  
%shr = lshr i64 %a, %b  
%and1 = and i64 %shr, 1  
ret i64 %and1  
}
```

```
define signext i32 @bexti_i32(i32 signext %a) nounwind {  
; RV64I-LABEL: bexti_i32:  
; RV64I:      # %bb.0:  
; RV64I-NEXT:  slli a0, a0, 58  
; RV64I-NEXT:  srli a0, a0, 63  
; RV64I-NEXT:  ret  
;  
; RV64ZBS-LABEL: bexti_i32:  
; RV64ZBS:      # %bb.0:  
; RV64ZBS-NEXT:  bexti a0, a0, 5
```



```
; RV64ZBS-NEXT:  ret
%shr = lshr i32 %a, 5
%and = and i32 %shr, 1
ret i32 %and
}
```

```
define i64 @bexti_i64(i64 %a) nounwind {
; RV64I-LABEL: bexti_i64:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a0, a0, 58
; RV64I-NEXT:  srli a0, a0, 63
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: bexti_i64:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT:  bexti a0, a0, 5
; RV64ZBS-NEXT:  ret
%shr = lshr i64 %a, 5
%and = and i64 %shr, 1
ret i64 %and
}
```

```
define signext i32 @bexti_i32_cmp(i32 signext %a) nounwind {
; CHECK-LABEL: bexti_i32_cmp:
;
CHECK:    # %bb.0:
; CHECK-NEXT:  andi a0, a0, 32
; CHECK-NEXT:  snez a0, a0
; CHECK-NEXT:  ret
%and = and i32 %a, 32
%cmp = icmp ne i32 %and, 0
%zext = zext i1 %cmp to i32
ret i32 %zext
}
```

```
define i64 @bexti_i64_cmp(i64 %a) nounwind {
; RV64I-LABEL: bexti_i64_cmp:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a0, a0, 58
; RV64I-NEXT:  srli a0, a0, 63
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: bexti_i64_cmp:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT:  bexti a0, a0, 5
; RV64ZBS-NEXT:  ret
%and = and i64 %a, 32
%cmp = icmp ne i64 %and, 0
```

```

%zext = zext i1 %cmp to i64
ret i64 %zext
}

define signext i32 @bclri_i32_10(i32 signext %a) nounwind {
; CHECK-LABEL: bclri_i32_10:
; CHECK:      # %bb.0:
; CHECK-NEXT:  andi a0, a0, -1025
; CHECK-NEXT:  ret
%and = and i32 %a, -1025
ret i32 %and
}

define signext i32 @bclri_i32_11(i32 signext %a) nounwind {
; RV64I-LABEL: bclri_i32_11:
; RV64I:      # %bb.0:
; RV64I-NEXT:  lui a1, 1048575
; RV64I-NEXT:  addiw a1,
a1, 2047
; RV64I-NEXT:  and a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: bclri_i32_11:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT:  bclri a0, a0, 11
; RV64ZBS-NEXT:  ret
%and = and i32 %a, -2049
ret i32 %and
}

define signext i32 @bclri_i32_30(i32 signext %a) nounwind {
; RV64I-LABEL: bclri_i32_30:
; RV64I:      # %bb.0:
; RV64I-NEXT:  lui a1, 786432
; RV64I-NEXT:  addiw a1, a1, -1
; RV64I-NEXT:  and a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: bclri_i32_30:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT:  bclri a0, a0, 30
; RV64ZBS-NEXT:  ret
%and = and i32 %a, -1073741825
ret i32 %and
}

define signext i32 @bclri_i32_31(i32 signext %a) nounwind {
; RV64I-LABEL: bclri_i32_31:

```

```

; RV64I:    # %bb.0:
; RV64I-NEXT:  slli a0, a0, 33
; RV64I-NEXT:  srli a0, a0, 33
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: bclri_i32_31:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT:  bclri a0, a0, 31
; RV64ZBS-NEXT:  sext.w a0, a0
; RV64ZBS-NEXT:  ret
%and = and i32 %a,
-2147483649
ret i32 %and
}

```

```

define i64 @bclri_i64_10(i64 %a) nounwind {
; CHECK-LABEL: bclri_i64_10:
; CHECK:    # %bb.0:
; CHECK-NEXT:  andi a0, a0, -1025
; CHECK-NEXT:  ret
%and = and i64 %a, -1025
ret i64 %and
}

```

```

define i64 @bclri_i64_11(i64 %a) nounwind {
; RV64I-LABEL: bclri_i64_11:
; RV64I:    # %bb.0:
; RV64I-NEXT:  lui a1, 1048575
; RV64I-NEXT:  addiw a1, a1, 2047
; RV64I-NEXT:  and a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: bclri_i64_11:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT:  bclri a0, a0, 11
; RV64ZBS-NEXT:  ret
%and = and i64 %a, -2049
ret i64 %and
}

```

```

define i64 @bclri_i64_30(i64 %a) nounwind {
; RV64I-LABEL: bclri_i64_30:
; RV64I:    # %bb.0:
; RV64I-NEXT:  lui a1, 786432
; RV64I-NEXT:  addiw a1, a1, -1
; RV64I-NEXT:  and a0, a0, a1
; RV64I-NEXT:  ret
;

```

```
; RV64ZBS-LABEL: bclri_i64_30:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT:  bclri a0, a0, 30
; RV64ZBS-NEXT:  ret
%and = and i64 %a, -1073741825
ret i64 %and
}
```

```
define
i64 @bclri_i64_31(i64 %a) nounwind {
; RV64I-LABEL: bclri_i64_31:
; RV64I:    # %bb.0:
; RV64I-NEXT:  lui a1, 524288
; RV64I-NEXT:  addi a1, a1, -1
; RV64I-NEXT:  and a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: bclri_i64_31:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT:  bclri a0, a0, 31
; RV64ZBS-NEXT:  ret
%and = and i64 %a, -2147483649
ret i64 %and
}
```

```
define i64 @bclri_i64_62(i64 %a) nounwind {
; RV64I-LABEL: bclri_i64_62:
; RV64I:    # %bb.0:
; RV64I-NEXT:  li a1, -1
; RV64I-NEXT:  slli a1, a1, 62
; RV64I-NEXT:  addi a1, a1, -1
; RV64I-NEXT:  and a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: bclri_i64_62:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT:  bclri a0, a0, 62
; RV64ZBS-NEXT:  ret
%and = and i64 %a, -4611686018427387905
ret i64 %and
}
```

```
define i64 @bclri_i64_63(i64 %a) nounwind {
; RV64I-LABEL: bclri_i64_63:
; RV64I:    # %bb.0:
; RV64I-NEXT:  slli a0, a0, 1
; RV64I-NEXT:  srli a0, a0, 1
; RV64I-NEXT:  ret
}
```

```

;
; RV64ZBS-LABEL:
    bclri_i64_63:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT:  bclri a0, a0, 63
; RV64ZBS-NEXT:  ret
    %and = and i64 %a, -9223372036854775809
    ret i64 %and
}

```

```

define i64 @bclri_i64_large0(i64 %a) nounwind {
; RV64I-LABEL: bclri_i64_large0:
; RV64I:    # %bb.0:
; RV64I-NEXT:  lui a1, 1044480
; RV64I-NEXT:  addiw a1, a1, -256
; RV64I-NEXT:  and a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: bclri_i64_large0:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT:  andi a0, a0, -256
; RV64ZBS-NEXT:  bclri a0, a0, 24
; RV64ZBS-NEXT:  ret
    %and = and i64 %a, -16777472
    ret i64 %and
}

```

```

define i64 @bclri_i64_large1(i64 %a) nounwind {
; RV64I-LABEL: bclri_i64_large1:
; RV64I:    # %bb.0:
; RV64I-NEXT:  lui a1, 1044464
; RV64I-NEXT:  addiw a1, a1, -1
; RV64I-NEXT:  and a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: bclri_i64_large1:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT:  bclri a0, a0, 16
; RV64ZBS-NEXT:  bclri a0, a0, 24
; RV64ZBS-NEXT:  ret
    %and = and i64 %a,
    -16842753
    ret i64 %and
}

```

```

define signext i32 @bseti_i32_10(i32 signext %a) nounwind {
; CHECK-LABEL: bseti_i32_10:
; CHECK:    # %bb.0:

```

```

; CHECK-NEXT:  ori a0, a0, 1024
; CHECK-NEXT:  ret
%or = or i32 %a, 1024
ret i32 %or
}

```

```

define signext i32 @bseti_i32_11(i32 signext %a) nounwind {
; RV64I-LABEL: bseti_i32_11:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a1, 1
; RV64I-NEXT:  slliw a1, a1, 11
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: bseti_i32_11:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT:  bseti a0, a0, 11
; RV64ZBS-NEXT:  ret
%or = or i32 %a, 2048
ret i32 %or
}

```

```

define signext i32 @bseti_i32_30(i32 signext %a) nounwind {
; RV64I-LABEL: bseti_i32_30:
; RV64I:      # %bb.0:
; RV64I-NEXT:  lui a1, 262144
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: bseti_i32_30:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT:  bseti a0, a0, 30
; RV64ZBS-NEXT:  ret
%or = or i32 %a, 1073741824
ret i32 %or
}

```

```

define signext i32
@bseti_i32_31(i32 signext %a) nounwind {
; RV64I-LABEL: bseti_i32_31:
; RV64I:      # %bb.0:
; RV64I-NEXT:  lui a1, 524288
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: bseti_i32_31:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT:  bseti a0, a0, 31

```

```

; RV64ZBS-NEXT:  sext.w a0, a0
; RV64ZBS-NEXT:  ret
%or = or i32 %a, 2147483648
ret i32 %or
}

define i64 @bseti_i64_10(i64 %a) nounwind {
; CHECK-LABEL: bseti_i64_10:
; CHECK:      # %bb.0:
; CHECK-NEXT:  ori a0, a0, 1024
; CHECK-NEXT:  ret
%or = or i64 %a, 1024
ret i64 %or
}

define i64 @bseti_i64_11(i64 %a) nounwind {
; RV64I-LABEL: bseti_i64_11:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a1, 1
; RV64I-NEXT:  slli a1, a1, 11
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: bseti_i64_11:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT:  bseti a0, a0, 11
; RV64ZBS-NEXT:  ret
%or = or i64 %a, 2048
ret i64 %or
}

define i64 @bseti_i64_30(i64 %a) nounwind {
; RV64I-LABEL: bseti_i64_30:
;
; RV64I:      # %bb.0:
; RV64I-NEXT:  lui a1, 262144
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: bseti_i64_30:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT:  bseti a0, a0, 30
; RV64ZBS-NEXT:  ret
%or = or i64 %a, 1073741824
ret i64 %or
}

define i64 @bseti_i64_31(i64 %a) nounwind {

```

```

; RV64I-LABEL: bseti_i64_31:
; RV64I:    # %bb.0:
; RV64I-NEXT:  li a1, 1
; RV64I-NEXT:  slli a1, a1, 31
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: bseti_i64_31:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT:  bseti a0, a0, 31
; RV64ZBS-NEXT:  ret
%or = or i64 %a, 2147483648
ret i64 %or
}

define i64 @bseti_i64_62(i64 %a) nounwind {
; RV64I-LABEL: bseti_i64_62:
; RV64I:    # %bb.0:
; RV64I-NEXT:  li a1, 1
; RV64I-NEXT:  slli a1, a1, 62
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: bseti_i64_62:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT:  bseti a0, a0, 62
; RV64ZBS-NEXT:  ret
%or = or i64 %a,
4611686018427387904
ret i64 %or
}

define i64 @bseti_i64_63(i64 %a) nounwind {
; RV64I-LABEL: bseti_i64_63:
; RV64I:    # %bb.0:
; RV64I-NEXT:  li a1, -1
; RV64I-NEXT:  slli a1, a1, 63
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: bseti_i64_63:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT:  bseti a0, a0, 63
; RV64ZBS-NEXT:  ret
%or = or i64 %a, 9223372036854775808
ret i64 %or
}

```



```

define signext i32 @binvi_i32_10(i32 signext %a) nounwind {
; CHECK-LABEL: binvi_i32_10:
; CHECK:      # %bb.0:
; CHECK-NEXT:  xori a0, a0, 1024
; CHECK-NEXT:  ret
%xor = xor i32 %a, 1024
ret i32 %xor
}

```

```

define signext i32 @binvi_i32_11(i32 signext %a) nounwind {
; RV64I-LABEL: binvi_i32_11:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a1, 1
; RV64I-NEXT:  slliw a1, a1, 11
; RV64I-NEXT:  xor a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: binvi_i32_11:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT:  binvi a0, a0, 11
; RV64ZBS-NEXT:  ret
%xor = xor i32 %a,
2048
ret i32 %xor
}

```

```

define signext i32 @binvi_i32_30(i32 signext %a) nounwind {
; RV64I-LABEL: binvi_i32_30:
; RV64I:      # %bb.0:
; RV64I-NEXT:  lui a1, 262144
; RV64I-NEXT:  xor a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: binvi_i32_30:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT:  binvi a0, a0, 30
; RV64ZBS-NEXT:  ret
%xor = xor i32 %a, 1073741824
ret i32 %xor
}

```

```

define signext i32 @binvi_i32_31(i32 signext %a) nounwind {
; RV64I-LABEL: binvi_i32_31:
; RV64I:      # %bb.0:
; RV64I-NEXT:  lui a1, 524288
; RV64I-NEXT:  xor a0, a0, a1
; RV64I-NEXT:  ret
;

```

```

; RV64ZBS-LABEL: binvi_i32_31:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT:  binvi a0, a0, 31
; RV64ZBS-NEXT:  sext.w a0, a0
; RV64ZBS-NEXT:  ret
%xor = xor i32 %a, 2147483648
ret i32 %xor
}

define i64 @binvi_i64_10(i64 %a) nounwind {
; CHECK-LABEL: binvi_i64_10:
; CHECK:    # %bb.0:
; CHECK-NEXT:  xori a0, a0, 1024
; CHECK-NEXT:  ret
%xor = xor i64 %a, 1024
ret i64 %xor
}

define i64 @binvi_i64_11(i64
%a) nounwind {
; RV64I-LABEL: binvi_i64_11:
; RV64I:    # %bb.0:
; RV64I-NEXT:  li a1, 1
; RV64I-NEXT:  slli a1, a1, 11
; RV64I-NEXT:  xor a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: binvi_i64_11:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT:  binvi a0, a0, 11
; RV64ZBS-NEXT:  ret
%xor = xor i64 %a, 2048
ret i64 %xor
}

define i64 @binvi_i64_30(i64 %a) nounwind {
; RV64I-LABEL: binvi_i64_30:
; RV64I:    # %bb.0:
; RV64I-NEXT:  lui a1, 262144
; RV64I-NEXT:  xor a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: binvi_i64_30:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT:  binvi a0, a0, 30
; RV64ZBS-NEXT:  ret
%xor = xor i64 %a, 1073741824
ret i64 %xor
}

```

```
}
```

```
define i64 @binvi_i64_31(i64 %a) nounwind {  
; RV64I-LABEL: binvi_i64_31:  
; RV64I:    # %bb.0:  
; RV64I-NEXT:  li a1, 1  
; RV64I-NEXT:  slli a1, a1, 31  
; RV64I-NEXT:  xor a0, a0, a1  
; RV64I-NEXT:  ret  
;  
; RV64ZBS-LABEL: binvi_i64_31:  
; RV64ZBS:    # %bb.0:  
; RV64ZBS-NEXT:  binvi  
a0, a0, 31  
; RV64ZBS-NEXT:  ret  
%xor = xor i64 %a, 2147483648  
ret i64 %xor  
}
```

```
define i64 @binvi_i64_62(i64 %a) nounwind {  
; RV64I-LABEL: binvi_i64_62:  
; RV64I:    # %bb.0:  
; RV64I-NEXT:  li a1, 1  
; RV64I-NEXT:  slli a1, a1, 62  
; RV64I-NEXT:  xor a0, a0, a1  
; RV64I-NEXT:  ret  
;  
; RV64ZBS-LABEL: binvi_i64_62:  
; RV64ZBS:    # %bb.0:  
; RV64ZBS-NEXT:  binvi a0, a0, 62  
; RV64ZBS-NEXT:  ret  
%xor = xor i64 %a, 4611686018427387904  
ret i64 %xor  
}
```

```
define i64 @binvi_i64_63(i64 %a) nounwind {  
; RV64I-LABEL: binvi_i64_63:  
; RV64I:    # %bb.0:  
; RV64I-NEXT:  li a1, -1  
; RV64I-NEXT:  slli a1, a1, 63  
; RV64I-NEXT:  xor a0, a0, a1  
; RV64I-NEXT:  ret  
;  
; RV64ZBS-LABEL: binvi_i64_63:  
; RV64ZBS:    # %bb.0:  
; RV64ZBS-NEXT:  binvi a0, a0, 63  
; RV64ZBS-NEXT:  ret  
%xor = xor i64 %a, 9223372036854775808
```

```

ret i64 %xor
}

define i64 @xor_i64_large(i64 %a) nounwind {
; RV64I-LABEL: xor_i64_large:
; RV64I:      # %bb.0:
; RV64I-NEXT: li a1, 1
; RV64I-NEXT: slli
a1, a1, 32
; RV64I-NEXT: addi a1, a1, 1
; RV64I-NEXT: xor a0, a0, a1
; RV64I-NEXT: ret
;
; RV64ZBS-LABEL: xor_i64_large:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT: binvi a0, a0, 0
; RV64ZBS-NEXT: binvi a0, a0, 32
; RV64ZBS-NEXT: ret
%xor = xor i64 %a, 4294967297
ret i64 %xor
}

define i64 @xor_i64_4099(i64 %a) nounwind {
; RV64I-LABEL: xor_i64_4099:
; RV64I:      # %bb.0:
; RV64I-NEXT: lui a1, 1
; RV64I-NEXT: addiw a1, a1, 3
; RV64I-NEXT: xor a0, a0, a1
; RV64I-NEXT: ret
;
; RV64ZBS-LABEL: xor_i64_4099:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT: xori a0, a0, 3
; RV64ZBS-NEXT: binvi a0, a0, 12
; RV64ZBS-NEXT: ret
%xor = xor i64 %a, 4099
ret i64 %xor
}

define i64 @xor_i64_96(i64 %a) nounwind {
; CHECK-LABEL: xor_i64_96:
; CHECK:      # %bb.0:
; CHECK-NEXT: xori a0, a0, 96
; CHECK-NEXT: ret
%xor = xor i64 %a, 96
ret i64 %xor
}

```

```

define i64 @or_i64_large(i64 %a) nounwind {
; RV64I-LABEL: or_i64_large:
; RV64I:      # %bb.0:
; RV64I-NEXT:
    li a1, 1
; RV64I-NEXT:  slli a1, a1, 32
; RV64I-NEXT:  addi a1, a1, 1
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: or_i64_large:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT:  bseti a0, a0, 0
; RV64ZBS-NEXT:  bseti a0, a0, 32
; RV64ZBS-NEXT:  ret
%or = or i64 %a, 4294967297
ret i64 %or
}

```

```

define i64 @xor_i64_66901(i64 %a) nounwind {
; RV64I-LABEL: xor_i64_66901:
; RV64I:      # %bb.0:
; RV64I-NEXT:  lui a1, 16
; RV64I-NEXT:  addiw a1, a1, 1365
; RV64I-NEXT:  xor a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: xor_i64_66901:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT:  xori a0, a0, 1365
; RV64ZBS-NEXT:  binvi a0, a0, 16
; RV64ZBS-NEXT:  ret
%xor = xor i64 %a, 66901
ret i64 %xor
}

```

```

define i64 @or_i64_4099(i64 %a) nounwind {
; RV64I-LABEL: or_i64_4099:
; RV64I:      # %bb.0:
; RV64I-NEXT:  lui a1, 1
; RV64I-NEXT:  addiw a1, a1, 3
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: or_i64_4099:
; RV64ZBS:
    # %bb.0:
; RV64ZBS-NEXT:  ori a0, a0, 3

```

```

; RV64ZBS-NEXT:  bseti a0, a0, 12
; RV64ZBS-NEXT:  ret
%or = or i64 %a, 4099
ret i64 %or
}

define i64 @or_i64_96(i64 %a) nounwind {
; CHECK-LABEL: or_i64_96:
; CHECK:      # %bb.0:
; CHECK-NEXT:  ori a0, a0, 96
; CHECK-NEXT:  ret
%or = or i64 %a, 96
ret i64 %or
}

define i64 @or_i64_66901(i64 %a) nounwind {
; RV64I-LABEL: or_i64_66901:
; RV64I:      # %bb.0:
; RV64I-NEXT:  lui a1, 16
; RV64I-NEXT:  addiw a1, a1, 1365
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: or_i64_66901:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT:  ori a0, a0, 1365
; RV64ZBS-NEXT:  bseti a0, a0, 16
; RV64ZBS-NEXT:  ret
%or = or i64 %a, 66901
ret i64 %or
}

define signext i32 @bset_trailing_ones_i32_mask(i32 signext %a) nounwind {
; RV64I-LABEL: bset_trailing_ones_i32_mask:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a1, -1
; RV64I-NEXT:  sllw a0, a1, a0
; RV64I-NEXT:  not a0, a0
; RV64I-NEXT:  ret
;
;
RV64ZBS-LABEL: bset_trailing_ones_i32_mask:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT:  andi a0, a0, 31
; RV64ZBS-NEXT:  bset a0, zero, a0
; RV64ZBS-NEXT:  addiw a0, a0, -1
; RV64ZBS-NEXT:  ret
%and = and i32 %a, 31

```

```

%shift = shl nsw i32 -1, %and
%not = xor i32 %shift, -1
ret i32 %not
}

define signext i32 @bset_trailing_ones_i32_no_mask(i32 signext %a) nounwind {
; RV64I-LABEL: bset_trailing_ones_i32_no_mask:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a1, -1
; RV64I-NEXT:  sllw a0, a1, a0
; RV64I-NEXT:  not a0, a0
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: bset_trailing_ones_i32_no_mask:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT:  bset a0, zero, a0
; RV64ZBS-NEXT:  addiw a0, a0, -1
; RV64ZBS-NEXT:  ret
%shift = shl nsw i32 -1, %a
%not = xor i32 %shift, -1
ret i32 %not
}

define signext i64 @bset_trailing_ones_i64_mask(i64 signext %a) nounwind {
; RV64I-LABEL: bset_trailing_ones_i64_mask:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a1, -1
; RV64I-NEXT:  sll
a0, a1, a0
; RV64I-NEXT:  not a0, a0
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: bset_trailing_ones_i64_mask:
; RV64ZBS:    # %bb.0:
; RV64ZBS-NEXT:  bset a0, zero, a0
; RV64ZBS-NEXT:  addi a0, a0, -1
; RV64ZBS-NEXT:  ret
%and = and i64 %a, 63
%shift = shl nsw i64 -1, %and
%not = xor i64 %shift, -1
ret i64 %not
}

define signext i64 @bset_trailing_ones_i64_no_mask(i64 signext %a) nounwind {
; RV64I-LABEL: bset_trailing_ones_i64_no_mask:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a1, -1
; RV64I-NEXT:  sll a0, a1, a0

```

```

; RV64I-NEXT:  not a0, a0
; RV64I-NEXT:  ret
;
; RV64ZBS-LABEL: bset_trailing_ones_i64_no_mask:
; RV64ZBS:      # %bb.0:
; RV64ZBS-NEXT:  bset a0, zero, a0
; RV64ZBS-NEXT:  addi a0, a0, -1
; RV64ZBS-NEXT:  ret
%shift = shl nsw i64 -1, %a
%not = xor i64 %shift, -1
ret i64 %not
}
; NOTE: Assertions have been autogenerated by utils/update_llc_test_checks.py
; RUN: llc -mtriple=aarch64-apple-ios %s -o - | FileCheck %s

```

```

define <16 x double> @test_sitofp_fixed(<16 x i32> %in) {

```

```

; CHECK-LABEL: test_sitofp_fixed:
; CHECK:      ; %bb.0:
; CHECK-NEXT:  sshll.2d v4, v0, #0
; CHECK-NEXT:  sshll.2d v0, v0, #0
; CHECK-NEXT:  sshll.2d v5, v1, #0
; CHECK-NEXT:  sshll.2d v6, v1, #0
; CHECK-NEXT:  sshll.2d v7, v2, #0
; CHECK-NEXT:  sshll.2d v16, v2, #0
; CHECK-NEXT:  sshll.2d v17, v3, #0
; CHECK-NEXT:  sshll.2d v18, v3, #0
; CHECK-NEXT:  scvtf.2d v1, v4, #6
; CHECK-NEXT:  scvtf.2d v0, v0, #6
; CHECK-NEXT:  scvtf.2d v3, v5, #6
; CHECK-NEXT:  scvtf.2d v2, v6, #6
; CHECK-NEXT:  scvtf.2d v4, v7, #6
; CHECK-NEXT:  scvtf.2d v5, v16, #6
; CHECK-NEXT:  scvtf.2d v7, v17, #6
; CHECK-NEXT:  scvtf.2d v6, v18, #6
; CHECK-NEXT:  ret

```

```

%flt = sitofp <16 x i32> %in to <16 x double>
%res = fdiv <16 x double> %flt, <double 64.0, double 64.0, double 64.0,
double 64.0, double 64.0, double 64.0, double 64.0, double 64.0, double
64.0, double 64.0, double 64.0, double 64.0, double 64.0>
ret <16 x double> %res
}

```

; This one is small enough to satisfy isSimple, but still illegally large.

```

define <4 x double> @test_sitofp_fixed_shortish(<4 x i64> %in) {
; CHECK-LABEL: test_sitofp_fixed_shortish:
; CHECK:      ; %bb.0:
; CHECK-NEXT:  scvtf.2d v0, v0, #6

```



```
; CHECK-NEXT:   scvtf.2d v1, v1, #6
; CHECK-NEXT:   ret
```

```
%flt = sitofp <4 x i64> %in to <4 x double>
%res = fdiv <4 x double> %flt, <double 64.0, double 64.0, double 64.0, double 64.0>
ret <4 x double> %res
}
```

```
; NOTE: Assertions have been autogenerated by utils/update_llc_test_checks.py
; RUN: llc -mtriple=riscv64 -verify-machineinstrs < %s \
; RUN: -riscv-experimental-rv64-legal-i32 | FileCheck %s -check-prefix=RV64I
```

```
; These tests are each targeted at a particular RISC-V ALU instruction. Most
; other files in this folder exercise LLVM IR instructions that don't directly
; match a RISC-V instruction.
```

```
; Register-immediate instructions.
```

```
define i32 @addi(i32 %a) nounwind {
; RV64I-LABEL: addi:
; RV64I:      # %bb.0:
; RV64I-NEXT:   addiw a0, a0, 1
; RV64I-NEXT:   ret
%1 = add i32 %a, 1
ret i32 %1
}
```

```
define i32 @slti(i32 %a) nounwind {
; RV64I-LABEL: slti:
; RV64I:      # %bb.0:
; RV64I-NEXT:   sext.w a0, a0
; RV64I-NEXT:   slti a0, a0, 2
; RV64I-NEXT:   ret
%1 = icmp slt i32 %a, 2
%2 = zext i1 %1 to i32
ret i32 %2
}
```

```
define i32 @sltiu(i32 %a) nounwind {
; RV64I-LABEL: sltiu:
; RV64I:      # %bb.0:
; RV64I-NEXT:   sext.w a0, a0
; RV64I-NEXT:   sltiu a0, a0, 3
; RV64I-NEXT:
ret
%1 = icmp ult i32 %a, 3
%2 = zext i1 %1 to i32
ret i32 %2
}
```

```
}
```

```
define i32 @xori(i32 %a) nounwind {  
; RV64I-LABEL: xori:  
; RV64I:      # %bb.0:  
; RV64I-NEXT:  xori a0, a0, 4  
; RV64I-NEXT:  ret  
%1 = xor i32 %a, 4  
ret i32 %1  
}
```

```
define i32 @ori(i32 %a) nounwind {  
; RV64I-LABEL: ori:  
; RV64I:      # %bb.0:  
; RV64I-NEXT:  ori a0, a0, 5  
; RV64I-NEXT:  ret  
%1 = or i32 %a, 5  
ret i32 %1  
}
```

```
define i32 @andi(i32 %a) nounwind {  
; RV64I-LABEL: andi:  
; RV64I:      # %bb.0:  
; RV64I-NEXT:  andi a0, a0, 6  
; RV64I-NEXT:  ret  
%1 = and i32 %a, 6  
ret i32 %1  
}
```

```
define i32 @slli(i32 %a) nounwind {  
; RV64I-LABEL: slli:  
; RV64I:      # %bb.0:  
; RV64I-NEXT:  slliw a0, a0, 7  
; RV64I-NEXT:  ret  
%1 = shl i32 %a, 7  
ret i32 %1  
}
```

```
define i32 @srli(i32 %a) nounwind {  
; RV64I-LABEL: srli:  
; RV64I:      # %bb.0:  
; RV64I-NEXT:  srliw a0, a0, 8  
; RV64I-NEXT:  ret  
%1 = lshr i32 %a, 8  
ret i32 %1  
}
```

```
define i32 @srai(i32 %a) nounwind {
```

```

; RV64I-LABEL: srai:
; RV64I:
    # %bb.0:
; RV64I-NEXT:  sraiw a0, a0, 9
; RV64I-NEXT:  ret
    %1 = ashr i32 %a, 9
    ret i32 %1
}

```

; Register-register instructions

```

define i32 @add(i32 %a, i32 %b) nounwind {
; RV64I-LABEL: add:
; RV64I:      # %bb.0:
; RV64I-NEXT:  addw a0, a0, a1
; RV64I-NEXT:  ret
    %1 = add i32 %a, %b
    ret i32 %1
}

```

```

define i32 @sub(i32 %a, i32 %b) nounwind {
; RV64I-LABEL: sub:
; RV64I:      # %bb.0:
; RV64I-NEXT:  subw a0, a0, a1
; RV64I-NEXT:  ret
    %1 = sub i32 %a, %b
    ret i32 %1
}

```

```

define i32 @sub_negative_constant_lhs(i32 %a) nounwind {
; RV64I-LABEL: sub_negative_constant_lhs:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a1, -2
; RV64I-NEXT:  subw a0, a1, a0
; RV64I-NEXT:  ret
    %1 = sub i32 -2, %a
    ret i32 %1
}

```

```

define i32 @sll(i32 %a, i32 %b) nounwind {
; RV64I-LABEL: sll:
; RV64I:      # %bb.0:
; RV64I-NEXT:  sllw a0, a0, a1
; RV64I-NEXT:  ret
    %1 = shl i32 %a, %b
    ret i32 %1
}

```

; Make sure we don't emit instructions to zero extend the shift amount to i64.

define

```
i32 @sll_shamt_zext(i32 %a, i32 %b) nounwind {  
; RV64I-LABEL: sll_shamt_zext:  
; RV64I:      # %bb.0:  
; RV64I-NEXT:  addi a1, a1, 1  
; RV64I-NEXT:  sllw a0, a0, a1  
; RV64I-NEXT:  ret  
%shamt = add i32 %b, 1  
%1 = shl i32 %a, %shamt  
ret i32 %1  
}
```

define i32 @sll\_negative\_constant\_lhs(i32 %a) nounwind {

```
; RV64I-LABEL: sll_negative_constant_lhs:  
; RV64I:      # %bb.0:  
; RV64I-NEXT:  li a1, -1  
; RV64I-NEXT:  sllw a0, a1, a0  
; RV64I-NEXT:  ret  
%1 = shl i32 -1, %a  
ret i32 %1  
}
```

define i32 @slt(i32 %a, i32 %b) nounwind {

```
; RV64I-LABEL: slt:  
; RV64I:      # %bb.0:  
; RV64I-NEXT:  sext.w a1, a1  
; RV64I-NEXT:  sext.w a0, a0  
; RV64I-NEXT:  slt a0, a0, a1  
; RV64I-NEXT:  ret  
%1 = icmp slt i32 %a, %b  
%2 = zext i1 %1 to i32  
ret i32 %2  
}
```

define i32 @sltu(i32 %a, i32 %b) nounwind {

```
;  
; RV64I-LABEL: sltu:  
; RV64I:      # %bb.0:  
; RV64I-NEXT:  sext.w a1, a1  
; RV64I-NEXT:  sext.w a0, a0  
; RV64I-NEXT:  sltu a0, a0, a1  
; RV64I-NEXT:  ret  
%1 = icmp ult i32 %a,  
%b  
%2 = zext i1 %1 to i32  
ret i32 %2  
}
```

```

define i32 @xor(i32 %a, i32 %b) nounwind {
;
; RV64I-LABEL: xor:
; RV64I:      # %bb.0:
; RV64I-NEXT:  xor a0, a0, a1
; RV64I-NEXT:  ret
%1 = xor i32 %a, %b
ret i32 %1
}

```

```

define i32 @srl(i32 %a, i32 %b) nounwind {
;
; RV64I-LABEL: srl:
; RV64I:      # %bb.0:
; RV64I-NEXT:  srlw a0, a0, a1
; RV64I-NEXT:  ret
%1 = lshr i32 %a, %b
ret i32 %1
}

```

; Make sure we don't emit instructions to zero extend the shift amount to i64.

```

define i32 @srl_shamt_zext(i32 %a, i32 %b) nounwind {
; RV64I-LABEL: srl_shamt_zext:
; RV64I:      # %bb.0:
; RV64I-NEXT:  addi a1, a1, 1
; RV64I-NEXT:  srlw a0, a0, a1
; RV64I-NEXT:  ret
%shamt = add i32 %b, 1
%1 = lshr i32 %a, %shamt
ret i32 %1
}

```

```

define i32 @srl_negative_constant_lhs(i32 %a) nounwind {
;
; RV64I-LABEL: srl_negative_constant_lhs:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a1, -1
; RV64I-NEXT:  srlw a0, a1, a0
; RV64I-NEXT:  ret
%1 = lshr i32 -1, %a
ret i32 %1
}

```

```

define
i32 @sra(i32 %a, i32 %b) nounwind {
;
; RV64I-LABEL: sra:

```

```

; RV64I:    # %bb.0:
; RV64I-NEXT:  sraw a0, a0, a1
; RV64I-NEXT:  ret
%1 = ashr i32 %a, %b
ret i32 %1
}

; Make sure we don't emit instructions to zero extend the shift amount to i64.
define i32 @sra_shamt_zext(i32 %a, i32 %b) nounwind {
; RV64I-LABEL: sra_shamt_zext:
; RV64I:    # %bb.0:
; RV64I-NEXT:  addi a1, a1, 1
; RV64I-NEXT:  sraw a0, a0, a1
; RV64I-NEXT:  ret
%shamt = add i32 %b, 1
%1 = ashr i32 %a, %shamt
ret i32 %1
}

define i32 @sra_negative_constant_lhs(i32 %a) nounwind {
;
; RV64I-LABEL: sra_negative_constant_lhs:
; RV64I:    # %bb.0:
; RV64I-NEXT:  lui a1, 524288
; RV64I-NEXT:  sraw a0, a1, a0
; RV64I-NEXT:  ret
%1 = ashr i32 2147483648, %a
ret i32 %1
}

define i32 @or(i32 %a, i32 %b) nounwind {
;
; RV64I-LABEL: or:
; RV64I:    # %bb.0:
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  ret
%1 = or i32 %a, %b
ret i32 %1
}

define i32 @and(i32 %a, i32 %b) nounwind {
;
; RV64I-LABEL:
and:
; RV64I:    # %bb.0:
; RV64I-NEXT:  and a0, a0, a1
; RV64I-NEXT:  ret
%1 = and i32 %a, %b

```

```

ret i32 %1
}
; NOTE: Assertions have been autogenerated by utils/update_test_checks.py UTC_ARGS: --include-generated-
funcs
; RUN: opt -S -passes=verify,iroutliner -ir-outlining-no-cost < %s | FileCheck %s

; This test checks that we do outline indirect calls when it is not specified
; that we should not.

declare void @f1(ptr, ptr);
declare void @f2(ptr, ptr);

define void @function1(ptr %func) {
entry:
  %a = alloca i32, align 4
  %b = alloca i32, align 4
  %c = alloca i32, align 4
  store i32 2, ptr %a, align 4
  store i32 3, ptr %b, align 4
  store i32 4, ptr %c, align 4
  call void %func()
  %al = load i32, ptr %a
  %bl = load i32, ptr %b
  %cl = load i32, ptr %c
  ret void
}

define void @function2(ptr %func) {
entry:
  %a = alloca i32, align 4
  %b = alloca i32, align 4
  %c = alloca i32, align 4
  store i32 2, ptr %a, align 4
  store i32 3, ptr %b, align 4
  store i32 4, ptr %c, align 4
  call void %func()
  %al = load i32, ptr %a
  %bl = load i32, ptr %b
  %cl = load i32, ptr %c
  ret void
}
;
CHECK-LABEL: @function1(
; CHECK-NEXT: entry:
; CHECK-NEXT:  [[A:%.*]] = alloca i32, align 4
; CHECK-NEXT:  [[B:%.*]] = alloca i32, align 4
; CHECK-NEXT:  [[C:%.*]] = alloca i32, align 4
; CHECK-NEXT:  call void @outlined_ir_func_0(ptr [[A]], ptr [[B]], ptr [[C]], ptr [[FUNC:%.*]])

```

```

; CHECK-NEXT:  ret void
;
;
; CHECK-LABEL: @function2(
; CHECK-NEXT:  entry:
; CHECK-NEXT:  [[A:%.*]] = alloca i32, align 4
; CHECK-NEXT:  [[B:%.*]] = alloca i32, align 4
; CHECK-NEXT:  [[C:%.*]] = alloca i32, align 4
; CHECK-NEXT:  call void @outlined_ir_func_0(ptr [[A]], ptr [[B]], ptr [[C]], ptr [[FUNC:%.*]])
; CHECK-NEXT:  ret void
;
;
; CHECK-LABEL: define internal void @outlined_ir_func_0(
; CHECK-NEXT:  newFuncRoot:
; CHECK-NEXT:  br label [[ENTRY_TO_OUTLINE:%.*]]
; CHECK:      entry_to_outline:
; CHECK-NEXT:  store i32 2, ptr [[TMP0:%.*]], align 4
; CHECK-NEXT:  store i32 3, ptr [[TMP1:%.*]], align 4
; CHECK-NEXT:  store i32 4, ptr [[TMP2:%.*]], align 4
; CHECK-NEXT:
; CHECK-NEXT:  call void [[TMP3:%.*]]()
; CHECK-NEXT:  [[AL:%.*]] = load i32, ptr [[TMP0]], align 4
; CHECK-NEXT:  [[BL:%.*]] = load i32, ptr [[TMP1]], align 4
; CHECK-NEXT:  [[CL:%.*]] = load i32, ptr [[TMP2]], align 4
; CHECK-NEXT:  br label [[ENTRY_AFTER_OUTLINE_EXITSTUB:%.*]]
; CHECK:      entry_after_outline.exitStub:
; CHECK-NEXT:  ret void
;

```

=====

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```
; NOTE: Assertions have been autogenerated by utils/update_llc_test_checks.py
; RUN: llc -mtriple=riscv64 -verify-machineinstrs < %s \
; RUN: -riscv-experimental-rv64-legal-i32 | FileCheck %s -check-prefix=RV64I
; RUN: llc -mtriple=riscv64 -mattr=+xtheadbb -verify-machineinstrs < %s \
; RUN: -riscv-experimental-rv64-legal-i32 | FileCheck %s -check-prefix=RV64XTHEADBB
```

```
declare i32 @llvm.ctlz.i32(i32, i1)
```

```
define signext i32 @ctlz_i32(i32 signext %a) nounwind {
; RV64I-LABEL: ctlz_i32:
; RV64I:      # %bb.0:
; RV64I-NEXT: beqz a0, .LBB0_2
; RV64I-NEXT: # %bb.1: # %cond.false
; RV64I-NEXT: addi sp, sp, -16
; RV64I-NEXT: sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT: srlw a1, a0, 1
; RV64I-NEXT: or a0, a0, a1
```

```

; RV64I-NEXT: srliw a1, a0, 2
; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT: srliw a1, a0, 4
; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT: srliw a1, a0, 8
; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT: srliw a1, a0, 16
; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT:
    not a0, a0
; RV64I-NEXT: srliw a1, a0, 1
; RV64I-NEXT: lui a2, 349525
; RV64I-NEXT: addi a2, a2, 1365
; RV64I-NEXT: and a1, a1, a2
; RV64I-NEXT: subw a0, a0, a1
; RV64I-NEXT: lui a1, 209715
; RV64I-NEXT: addi a1, a1, 819
; RV64I-NEXT: and a2, a0, a1
; RV64I-NEXT: srliw a0, a0, 2
; RV64I-NEXT: and a0, a0, a1
; RV64I-NEXT: add a0, a2, a0
; RV64I-NEXT: srliw a1, a0, 4
; RV64I-NEXT: addw a0, a0, a1
; RV64I-NEXT: lui a1, 61681
; RV64I-NEXT: addiw a1, a1, -241
; RV64I-NEXT: and a0, a0, a1
; RV64I-NEXT: lui a1, 4112
; RV64I-NEXT: addiw a1, a1, 257
; RV64I-NEXT: call __muldi3
; RV64I-NEXT: srliw a0, a0, 24
; RV64I-NEXT: ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT: addi sp, sp, 16
; RV64I-NEXT: ret
; RV64I-NEXT: .LBB0_2:
; RV64I-NEXT: li a0, 32
; RV64I-NEXT: ret
;
; RV64XTHEADBB-LABEL: ctlz_i32:
; RV64XTHEADBB:    # %bb.0:
; RV64XTHEADBB-NEXT:  th.extu a0, a0, 31, 0
; RV64XTHEADBB-NEXT:  th.ff1 a0,
a0
; RV64XTHEADBB-NEXT:  addi a0, a0, -32
; RV64XTHEADBB-NEXT:  ret
%1 = call i32 @llvm.ctlz.i32(i32 %a, i1 false)
ret i32 %1
}

```

```

define signext i32 @log2_i32(i32 signext %a) nounwind {
; RV64I-LABEL: log2_i32:
; RV64I:      # %bb.0:
; RV64I-NEXT: beqz a0, .LBB1_2
; RV64I-NEXT: # %bb.1: # %cond.false
; RV64I-NEXT: addi sp, sp, -16
; RV64I-NEXT: sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT: srliw a1, a0, 1
; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT: srliw a1, a0, 2
; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT: srliw a1, a0, 4
; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT: srliw a1, a0, 8
; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT: srliw a1, a0, 16
; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT: not a0, a0
; RV64I-NEXT: srliw a1, a0, 1
; RV64I-NEXT: lui a2, 349525
; RV64I-NEXT: addi a2, a2, 1365
; RV64I-NEXT: and a1, a1, a2
; RV64I-NEXT: subw a0, a0, a1
; RV64I-NEXT: lui a1, 209715
; RV64I-NEXT: addi a1, a1, 819
; RV64I-NEXT:
and a2, a0, a1
; RV64I-NEXT: srliw a0, a0, 2
; RV64I-NEXT: and a0, a0, a1
; RV64I-NEXT: add a0, a2, a0
; RV64I-NEXT: srliw a1, a0, 4
; RV64I-NEXT: addw a0, a0, a1
; RV64I-NEXT: lui a1, 61681
; RV64I-NEXT: addiw a1, a1, -241
; RV64I-NEXT: and a0, a0, a1
; RV64I-NEXT: lui a1, 4112
; RV64I-NEXT: addiw a1, a1, 257
; RV64I-NEXT: call __muldi3
; RV64I-NEXT: srliw a0, a0, 24
; RV64I-NEXT: ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT: addi sp, sp, 16
; RV64I-NEXT: j .LBB1_3
; RV64I-NEXT: .LBB1_2:
; RV64I-NEXT: li a0, 32
; RV64I-NEXT: .LBB1_3: # %cond.end
; RV64I-NEXT: li a1, 31
; RV64I-NEXT: subw a0, a1, a0
; RV64I-NEXT: ret

```



```

;
; RV64XTHEADBB-LABEL: log2_i32:
; RV64XTHEADBB:    # %bb.0:
; RV64XTHEADBB-NEXT:  th.extu a0, a0, 31, 0
; RV64XTHEADBB-NEXT:  th.ff1 a0, a0
; RV64XTHEADBB-NEXT:  addi a0, a0, -32
; RV64XTHEADBB-NEXT:  li a1, 31
; RV64XTHEADBB-NEXT:  subw a0, a1, a0
; RV64XTHEADBB-NEXT:  ret
%1 = call i32 @llvmctlz.i32(i32
%a, i1 false)
%2 = sub i32 31, %1
ret i32 %2
}

```

```

define signext i32 @log2_ceil_i32(i32 signext %a) nounwind {
; RV64I-LABEL: log2_ceil_i32:
; RV64I:    # %bb.0:
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  sd s0, 0(sp) # 8-byte Folded Spill
; RV64I-NEXT:  addiw a0, a0, -1
; RV64I-NEXT:  li s0, 32
; RV64I-NEXT:  li a1, 32
; RV64I-NEXT:  beqz a0, .LBB2_2
; RV64I-NEXT:  # %bb.1: # %cond.false
; RV64I-NEXT:  srliw a1, a0, 1
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  srliw a1, a0, 2
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  srliw a1, a0, 4
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  srliw a1, a0, 8
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  srliw a1, a0, 16
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  not a0, a0
; RV64I-NEXT:  srliw a1, a0, 1
; RV64I-NEXT:  lui a2, 349525
; RV64I-NEXT:  addi a2, a2, 1365
; RV64I-NEXT:  and a1, a1, a2
; RV64I-NEXT:  subw a0, a0, a1
; RV64I-NEXT:
    lui a1, 209715
; RV64I-NEXT:  addi a1, a1, 819
; RV64I-NEXT:  and a2, a0, a1
; RV64I-NEXT:  srliw a0, a0, 2
; RV64I-NEXT:  and a0, a0, a1

```

```

; RV64I-NEXT:  add a0, a2, a0
; RV64I-NEXT:  srliw a1, a0, 4
; RV64I-NEXT:  addw a0, a0, a1
; RV64I-NEXT:  lui a1, 61681
; RV64I-NEXT:  addiw a1, a1, -241
; RV64I-NEXT:  and a0, a0, a1
; RV64I-NEXT:  lui a1, 4112
; RV64I-NEXT:  addiw a1, a1, 257
; RV64I-NEXT:  call __muldi3
; RV64I-NEXT:  srliw a1, a0, 24
; RV64I-NEXT:  .LBB2_2: # %cond.end
; RV64I-NEXT:  subw a0, s0, a1
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT:  ld s0, 0(sp) # 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
;
; RV64XTHEADBB-LABEL: log2_ceil_i32:
; RV64XTHEADBB:    # %bb.0:
; RV64XTHEADBB-NEXT:  addi a0, a0, -1
; RV64XTHEADBB-NEXT:  slli a0, a0, 32
; RV64XTHEADBB-NEXT:  srli a0, a0, 32
; RV64XTHEADBB-NEXT:  th.ff1 a0, a0
; RV64XTHEADBB-NEXT:  addi a0, a0, -32
; RV64XTHEADBB-NEXT:
    li a1, 32
; RV64XTHEADBB-NEXT:  subw a0, a1, a0
; RV64XTHEADBB-NEXT:  ret
%1 = sub i32 %a, 1
%2 = call i32 @llvmctlz.i32(i32 %1, i1 false)
%3 = sub i32 32, %2
ret i32 %3
}

define signext i32 @findLastSet_i32(i32 signext %a) nounwind {
; RV64I-LABEL: findLastSet_i32:
; RV64I:    # %bb.0:
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  sd s0, 0(sp) # 8-byte Folded Spill
; RV64I-NEXT:  mv s0, a0
; RV64I-NEXT:  srliw a0, a0, 1
; RV64I-NEXT:  or a0, s0, a0
; RV64I-NEXT:  srliw a1, a0, 2
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  srliw a1, a0, 4
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  srliw a1, a0, 8

```

```

; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT: srliw a1, a0, 16
; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT: not a0, a0
; RV64I-NEXT: srliw a1, a0, 1
; RV64I-NEXT: lui a2, 349525
; RV64I-NEXT: addi a2, a2, 1365
; RV64I-NEXT: and a1, a1, a2
; RV64I-NEXT: subw a0, a0, a1
; RV64I-NEXT:
    lui a1, 209715
; RV64I-NEXT: addi a1, a1, 819
; RV64I-NEXT: and a2, a0, a1
; RV64I-NEXT: srliw a0, a0, 2
; RV64I-NEXT: and a0, a0, a1
; RV64I-NEXT: add a0, a2, a0
; RV64I-NEXT: srliw a1, a0, 4
; RV64I-NEXT: addw a0, a0, a1
; RV64I-NEXT: lui a1, 61681
; RV64I-NEXT: addiw a1, a1, -241
; RV64I-NEXT: and a0, a0, a1
; RV64I-NEXT: lui a1, 4112
; RV64I-NEXT: addiw a1, a1, 257
; RV64I-NEXT: call __muldi3
; RV64I-NEXT: srliw a0, a0, 24
; RV64I-NEXT: xori a0, a0, 31
; RV64I-NEXT: snez a1, s0
; RV64I-NEXT: addiw a1, a1, -1
; RV64I-NEXT: or a0, a1, a0
; RV64I-NEXT: ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT: ld s0, 0(sp) # 8-byte Folded Reload
; RV64I-NEXT: addi sp, sp, 16
; RV64I-NEXT: ret
;
; RV64XTHEADBB-LABEL: findLastSet_i32:
; RV64XTHEADBB:    # %bb.0:
; RV64XTHEADBB-NEXT: th.extu a1, a0, 31, 0
; RV64XTHEADBB-NEXT: th.ff1 a1, a1
; RV64XTHEADBB-NEXT: addiw a1, a1, -32
; RV64XTHEADBB-NEXT: xori a1, a1,
31
; RV64XTHEADBB-NEXT: snez a0, a0
; RV64XTHEADBB-NEXT: addiw a0, a0, -1
; RV64XTHEADBB-NEXT: or a0, a0, a1
; RV64XTHEADBB-NEXT: ret
%1 = call i32 @llvm.ctlz.i32(i32 %a, i1 true)
%2 = xor i32 31, %1
%3 = icmp eq i32 %a, 0

```

```

%4 = select i1 %3, i32 -1, i32 %2
ret i32 %4
}

```

```

define i32 @ctlz_lshr_i32(i32 signext %a) {
; RV64I-LABEL: ctlz_lshr_i32:
; RV64I:      # %bb.0:
; RV64I-NEXT:  srliw a0, a0, 1
; RV64I-NEXT:  beqz a0, .LBB4_2
; RV64I-NEXT:  # %bb.1: # %cond.false
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  .cfi_def_cfa_offset 16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  .cfi_offset ra, -8
; RV64I-NEXT:  srliw a1, a0, 1
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  srliw a1, a0, 2
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  srliw a1, a0, 4
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  srliw a1, a0, 8
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  srliw a1, a0, 16
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  not
;               a0, a0
; RV64I-NEXT:  srliw a1, a0, 1
; RV64I-NEXT:  lui a2, 349525
; RV64I-NEXT:  addi a2, a2, 1365
; RV64I-NEXT:  and a1, a1, a2
; RV64I-NEXT:  subw a0, a0, a1
; RV64I-NEXT:  lui a1, 209715
; RV64I-NEXT:  addi a1, a1, 819
; RV64I-NEXT:  and a2, a0, a1
; RV64I-NEXT:  srliw a0, a0, 2
; RV64I-NEXT:  and a0, a0, a1
; RV64I-NEXT:  add a0, a2, a0
; RV64I-NEXT:  srliw a1, a0, 4
; RV64I-NEXT:  addw a0, a0, a1
; RV64I-NEXT:  lui a1, 61681
; RV64I-NEXT:  addiw a1, a1, -241
; RV64I-NEXT:  and a0, a0, a1
; RV64I-NEXT:  lui a1, 4112
; RV64I-NEXT:  addiw a1, a1, 257
; RV64I-NEXT:  call __muldi3
; RV64I-NEXT:  srliw a0, a0, 24
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16

```

```

; RV64I-NEXT:  ret
; RV64I-NEXT:  .LBB4_2:
; RV64I-NEXT:  li a0, 32
; RV64I-NEXT:  ret
;
; RV64XTHEADBB-LABEL: ctlz_lshr_i32:
; RV64XTHEADBB:    # %bb.0:
; RV64XTHEADBB-NEXT:  srliw a0, a0, 1
; RV64XTHEADBB-NEXT:  th.ff1 a0, a0
; RV64XTHEADBB-NEXT:
    addi a0, a0, -32
; RV64XTHEADBB-NEXT:  ret
%1 = lshr i32 %a, 1
%2 = call i32 @llvm.ctlz.i32(i32 %1, i1 false)
ret i32 %2
}

```

```

declare i64 @llvm.ctlz.i64(i64, i1)

```

```

define i64 @ctlz_i64(i64 %a) nounwind {
; RV64I-LABEL: ctlz_i64:
; RV64I:    # %bb.0:
; RV64I-NEXT:  beqz a0, .LBB5_2
; RV64I-NEXT:  # %bb.1: # %cond.false
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  srli a1, a0, 1
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  srli a1, a0, 2
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  srli a1, a0, 4
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  srli a1, a0, 8
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  srli a1, a0, 16
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  srli a1, a0, 32
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  not a0, a0
; RV64I-NEXT:  srli a1, a0, 1
; RV64I-NEXT:  lui a2, 349525
; RV64I-NEXT:  addiw a2, a2, 1365
; RV64I-NEXT:  slli a3, a2, 32
; RV64I-NEXT:  add a2, a2,
a3
; RV64I-NEXT:  and a1, a1, a2
; RV64I-NEXT:  sub a0, a0, a1
; RV64I-NEXT:  lui a1, 209715

```

```

; RV64I-NEXT: addiw a1, a1, 819
; RV64I-NEXT: slli a2, a1, 32
; RV64I-NEXT: add a1, a1, a2
; RV64I-NEXT: and a2, a0, a1
; RV64I-NEXT: srli a0, a0, 2
; RV64I-NEXT: and a0, a0, a1
; RV64I-NEXT: add a0, a2, a0
; RV64I-NEXT: srli a1, a0, 4
; RV64I-NEXT: add a0, a0, a1
; RV64I-NEXT: lui a1, 61681
; RV64I-NEXT: addiw a1, a1, -241
; RV64I-NEXT: slli a2, a1, 32
; RV64I-NEXT: add a1, a1, a2
; RV64I-NEXT: and a0, a0, a1
; RV64I-NEXT: lui a1, 4112
; RV64I-NEXT: addiw a1, a1, 257
; RV64I-NEXT: slli a2, a1, 32
; RV64I-NEXT: add a1, a1, a2
; RV64I-NEXT: call __muldi3
; RV64I-NEXT: srli a0, a0, 56
; RV64I-NEXT: ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT: addi sp, sp, 16
; RV64I-NEXT: ret
; RV64I-NEXT: .LBB5_2:
; RV64I-NEXT: li a0, 64
; RV64I-NEXT: ret
;
; RV64XTHEADBB-LABEL: ctlz_i64:
; RV64XTHEADBB:    # %bb.0:
; RV64XTHEADBB-NEXT:
    th.ff1 a0, a0
; RV64XTHEADBB-NEXT: ret
%1 = call i64 @llvm.ctlz.i64(i64 %a, i1 false)
ret i64 %1
}

```

```

declare i32 @llvm.cttz.i32(i32, i1)

```

```

define signext i32 @cttz_i32(i32 signext %a) nounwind {
; RV64I-LABEL: cttz_i32:
; RV64I:    # %bb.0:
; RV64I-NEXT: beqz a0, .LBB6_2
; RV64I-NEXT: # %bb.1: # %cond.false
; RV64I-NEXT: addi sp, sp, -16
; RV64I-NEXT: sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT: negw a1, a0
; RV64I-NEXT: and a0, a0, a1
; RV64I-NEXT: lui a1, 30667

```

```

; RV64I-NEXT: addiw a1, a1, 1329
; RV64I-NEXT: call __muldi3
; RV64I-NEXT: srliw a0, a0, 27
; RV64I-NEXT: lui a1, %hi(.LCPI6_0)
; RV64I-NEXT: addi a1, a1, %lo(.LCPI6_0)
; RV64I-NEXT: add a0, a1, a0
; RV64I-NEXT: lbu a0, 0(a0)
; RV64I-NEXT: ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT: addi sp, sp, 16
; RV64I-NEXT: ret
; RV64I-NEXT: .LBB6_2:
; RV64I-NEXT: li a0, 32
; RV64I-NEXT: ret
;
; RV64XTHEADBB-LABEL: cttz_i32:
; RV64XTHEADBB:    #
%bb.0:
; RV64XTHEADBB-NEXT: beqz a0, .LBB6_2
; RV64XTHEADBB-NEXT: # %bb.1: # %cond.false
; RV64XTHEADBB-NEXT: addi sp, sp, -16
; RV64XTHEADBB-NEXT: sd ra, 8(sp) # 8-byte Folded Spill
; RV64XTHEADBB-NEXT: negw a1, a0
; RV64XTHEADBB-NEXT: and a0, a0, a1
; RV64XTHEADBB-NEXT: lui a1, 30667
; RV64XTHEADBB-NEXT: addiw a1, a1, 1329
; RV64XTHEADBB-NEXT: call __muldi3
; RV64XTHEADBB-NEXT: srliw a0, a0, 27
; RV64XTHEADBB-NEXT: lui a1, %hi(.LCPI6_0)
; RV64XTHEADBB-NEXT: addi a1, a1, %lo(.LCPI6_0)
; RV64XTHEADBB-NEXT: add a0, a1, a0
; RV64XTHEADBB-NEXT: lbu a0, 0(a0)
; RV64XTHEADBB-NEXT: ld ra, 8(sp) # 8-byte Folded Reload
; RV64XTHEADBB-NEXT: addi sp, sp, 16
; RV64XTHEADBB-NEXT: ret
; RV64XTHEADBB-NEXT: .LBB6_2:
; RV64XTHEADBB-NEXT: li a0, 32
; RV64XTHEADBB-NEXT: ret
; RV64ZBB-LABEL: cttz_i32:
; RV64ZBB:    # %bb.0:
; RV64ZBB-NEXT: ctzw a0, a0
; RV64ZBB-NEXT: ret
%1 = call i32 @llvm.cttz.i32(i32 %a, i1 false)
ret i32 %1
}

define
  signext i32 @cttz_zero_undef_i32(i32 signext %a) nounwind {
; RV64I-LABEL: cttz_zero_undef_i32:

```

```

; RV64I:    # %bb.0:
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  negw a1, a0
; RV64I-NEXT:  and a0, a0, a1
; RV64I-NEXT:  lui a1, 30667
; RV64I-NEXT:  addiw a1, a1, 1329
; RV64I-NEXT:  call __muldi3
; RV64I-NEXT:  srliw a0, a0, 27
; RV64I-NEXT:  lui a1, %hi(.LCPI7_0)
; RV64I-NEXT:  addi a1, a1, %lo(.LCPI7_0)
; RV64I-NEXT:  add a0, a1, a0
; RV64I-NEXT:  lbu a0, 0(a0)
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
;
; RV64XTHEADBB-LABEL: cttz_zero_undef_i32:
; RV64XTHEADBB:    # %bb.0:
; RV64XTHEADBB-NEXT:  addi sp, sp, -16
; RV64XTHEADBB-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64XTHEADBB-NEXT:  negw a1, a0
; RV64XTHEADBB-NEXT:  and a0, a0, a1
; RV64XTHEADBB-NEXT:  lui a1, 30667
; RV64XTHEADBB-NEXT:  addiw a1, a1, 1329
; RV64XTHEADBB-NEXT:
;   call __muldi3
; RV64XTHEADBB-NEXT:  srliw a0, a0, 27
; RV64XTHEADBB-NEXT:  lui a1, %hi(.LCPI7_0)
; RV64XTHEADBB-NEXT:  addi a1, a1, %lo(.LCPI7_0)
; RV64XTHEADBB-NEXT:  add a0, a1, a0
; RV64XTHEADBB-NEXT:  lbu a0, 0(a0)
; RV64XTHEADBB-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload
; RV64XTHEADBB-NEXT:  addi sp, sp, 16
; RV64XTHEADBB-NEXT:  ret
%1 = call i32 @llvm.cttz.i32(i32 %a, i1 true)
ret i32 %1
}

define signext i32 @findFirstSet_i32(i32 signext %a) nounwind {
; RV64I-LABEL: findFirstSet_i32:
; RV64I:    # %bb.0:
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  sd s0, 0(sp) # 8-byte Folded Spill
; RV64I-NEXT:  mv s0, a0
; RV64I-NEXT:  negw a0, a0
; RV64I-NEXT:  and a0, s0, a0

```



```

; RV64I-NEXT: lui a1, 30667
; RV64I-NEXT: addiw a1, a1, 1329
; RV64I-NEXT: call __muldi3
; RV64I-NEXT: srlw a0, a0, 27
; RV64I-NEXT: lui a1, %hi(.LCPI8_0)
; RV64I-NEXT: addi a1, a1, %lo(.LCPI8_0)
; RV64I-NEXT:
    add a0, a1, a0
; RV64I-NEXT: lbu a0, 0(a0)
; RV64I-NEXT: snez a1, s0
; RV64I-NEXT: addi a1, a1, -1
; RV64I-NEXT: or a0, a1, a0
; RV64I-NEXT: ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT: ld s0, 0(sp) # 8-byte Folded Reload
; RV64I-NEXT: addi sp, sp, 16
; RV64I-NEXT: ret
;
; RV64XTHEADBB-LABEL: findFirstSet_i32:
; RV64XTHEADBB:    # %bb.0:
; RV64XTHEADBB-NEXT: addi sp, sp, -16
; RV64XTHEADBB-NEXT: sd ra, 8(sp) # 8-byte Folded Spill
; RV64XTHEADBB-NEXT: sd s0, 0(sp) # 8-byte Folded Spill
; RV64XTHEADBB-NEXT: mv s0, a0
; RV64XTHEADBB-NEXT: negw a0, a0
; RV64XTHEADBB-NEXT: and a0, s0, a0
; RV64XTHEADBB-NEXT: lui a1, 30667
; RV64XTHEADBB-NEXT: addiw a1, a1, 1329
; RV64XTHEADBB-NEXT: call __muldi3
; RV64XTHEADBB-NEXT: srlw a0, a0, 27
; RV64XTHEADBB-NEXT: lui a1, %hi(.LCPI8_0)
; RV64XTHEADBB-NEXT: addi a1, a1, %lo(.LCPI8_0)
; RV64XTHEADBB-NEXT: add a0, a1, a0
; RV64XTHEADBB-NEXT: lbu a0, 0(a0)
; RV64XTHEADBB-NEXT:
    snez a1, s0
; RV64XTHEADBB-NEXT: addi a1, a1, -1
; RV64XTHEADBB-NEXT: or a0, a1, a0
; RV64XTHEADBB-NEXT: ld ra, 8(sp) # 8-byte Folded Reload
; RV64XTHEADBB-NEXT: ld s0, 0(sp) # 8-byte Folded Reload
; RV64XTHEADBB-NEXT: addi sp, sp, 16
; RV64XTHEADBB-NEXT: ret
%1 = call i32 @llvm.cttz.i32(i32 %a, i1 true)
%2 = icmp eq i32 %a, 0
%3 = select i1 %2, i32 -1, i32 %1
ret i32 %3
}

```

```

define signext i32 @ffs_i32(i32 signext %a) nounwind {

```

```

; RV64I-LABEL: ffs_i32:
; RV64I:    # %bb.0:
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  sd s0, 0(sp) # 8-byte Folded Spill
; RV64I-NEXT:  mv s0, a0
; RV64I-NEXT:  negw a0, a0
; RV64I-NEXT:  and a0, s0, a0
; RV64I-NEXT:  lui a1, 30667
; RV64I-NEXT:  addiw a1, a1, 1329
; RV64I-NEXT:  call __muldi3
; RV64I-NEXT:  srliw a0, a0, 27
; RV64I-NEXT:  lui a1, %hi(.LCPI9_0)
; RV64I-NEXT:  addi a1, a1, %lo(.LCPI9_0)
; RV64I-NEXT:  add a0, a1, a0
; RV64I-NEXT:
    lbu a0, 0(a0)
; RV64I-NEXT:  addi a0, a0, 1
; RV64I-NEXT:  seqz a1, s0
; RV64I-NEXT:  addi a1, a1, -1
; RV64I-NEXT:  and a0, a1, a0
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  srli a0, a0, 32
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT:  ld s0, 0(sp) # 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
;
; RV64XTHEADBB-LABEL: ffs_i32:
; RV64XTHEADBB:    # %bb.0:
; RV64XTHEADBB-NEXT:  addi sp, sp, -16
; RV64XTHEADBB-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64XTHEADBB-NEXT:  sd s0, 0(sp) # 8-byte Folded Spill
; RV64XTHEADBB-NEXT:  mv s0, a0
; RV64XTHEADBB-NEXT:  negw a0, a0
; RV64XTHEADBB-NEXT:  and a0, s0, a0
; RV64XTHEADBB-NEXT:  lui a1, 30667
; RV64XTHEADBB-NEXT:  addiw a1, a1, 1329
; RV64XTHEADBB-NEXT:  call __muldi3
; RV64XTHEADBB-NEXT:  srliw a0, a0, 27
; RV64XTHEADBB-NEXT:  lui a1, %hi(.LCPI9_0)
; RV64XTHEADBB-NEXT:  addi a1, a1, %lo(.LCPI9_0)
; RV64XTHEADBB-NEXT:  add a0, a1, a0
;
RV64XTHEADBB-NEXT:  lbu a0, 0(a0)
; RV64XTHEADBB-NEXT:  addi a0, a0, 1
; RV64XTHEADBB-NEXT:  seqz a1, s0
; RV64XTHEADBB-NEXT:  addi a1, a1, -1

```

```

; RV64XTHEADBB-NEXT:  and a0, a1, a0
; RV64XTHEADBB-NEXT:  slli a0, a0, 32
; RV64XTHEADBB-NEXT:  srli a0, a0, 32
; RV64XTHEADBB-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload
; RV64XTHEADBB-NEXT:  ld s0, 0(sp) # 8-byte Folded Reload
; RV64XTHEADBB-NEXT:  addi sp, sp, 16
; RV64XTHEADBB-NEXT:  ret
%1 = call i32 @llvm.cttz.i32(i32 %a, i1 true)
%2 = add i32 %1, 1
%3 = icmp eq i32 %a, 0
%4 = select i1 %3, i32 0, i32 %2
ret i32 %4
}

```

```

declare i64 @llvm.cttz.i64(i64, i1)

```

```

define i64 @cttz_i64(i64 %a) nounwind {
; RV64I-LABEL: cttz_i64:
; RV64I:      # %bb.0:
; RV64I-NEXT:  beqz a0, .LBB10_2
; RV64I-NEXT:  # %bb.1: # %cond.false
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  neg a1, a0
; RV64I-NEXT:  and a0, a0, a1
; RV64I-NEXT:  lui a1, %hi(.LCPI10_0)
; RV64I-NEXT:
    ld a1, %lo(.LCPI10_0)(a1)
; RV64I-NEXT:  call __muldi3
; RV64I-NEXT:  srli a0, a0, 58
; RV64I-NEXT:  lui a1, %hi(.LCPI10_1)
; RV64I-NEXT:  addi a1, a1, %lo(.LCPI10_1)
; RV64I-NEXT:  add a0, a1, a0
; RV64I-NEXT:  lbu a0, 0(a0)
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
; RV64I-NEXT: .LBB10_2:
; RV64I-NEXT:  li a0, 64
; RV64I-NEXT:  ret
;
; RV64XTHEADBB-LABEL: cttz_i64:
; RV64XTHEADBB:  # %bb.0:
; RV64XTHEADBB-NEXT:  beqz a0, .LBB10_2
; RV64XTHEADBB-NEXT:  # %bb.1: # %cond.false
; RV64XTHEADBB-NEXT:  addi a1, a0, -1
; RV64XTHEADBB-NEXT:  not a0, a0
; RV64XTHEADBB-NEXT:  and a0, a0, a1

```

```
; RV64XTHEADBB-NEXT: th.ff1 a0, a0
; RV64XTHEADBB-NEXT: li a1, 64
; RV64XTHEADBB-NEXT: sub a0, a1, a0
; RV64XTHEADBB-NEXT: ret
; RV64XTHEADBB-NEXT: .LBB10_2:
; RV64XTHEADBB-NEXT: li a0, 64
; RV64XTHEADBB-NEXT: ret
%1 = call i64 @llvm.cttz.i64(i64 %a, i1 false)
ret i64 %1
}
```

```
define signext
i32 @sextb_i32(i32 signext %a) nounwind {
; RV64I-LABEL: sextb_i32:
; RV64I:    # %bb.0:
; RV64I-NEXT: slli a0, a0, 56
; RV64I-NEXT: srai a0, a0, 56
; RV64I-NEXT: ret
;
; RV64XTHEADBB-LABEL: sextb_i32:
; RV64XTHEADBB:    # %bb.0:
; RV64XTHEADBB-NEXT: th.ext a0, a0, 7, 0
; RV64XTHEADBB-NEXT: ret
%shl = shl i32 %a, 24
%shr = ashr exact i32 %shl, 24
ret i32 %shr
}
```

```
define i64 @sextb_i64(i64 %a) nounwind {
; RV64I-LABEL: sextb_i64:
; RV64I:    # %bb.0:
; RV64I-NEXT: slli a0, a0, 56
; RV64I-NEXT: srai a0, a0, 56
; RV64I-NEXT: ret
;
; RV64XTHEADBB-LABEL: sextb_i64:
; RV64XTHEADBB:    # %bb.0:
; RV64XTHEADBB-NEXT: th.ext a0, a0, 7, 0
; RV64XTHEADBB-NEXT: ret
%shl = shl i64 %a, 56
%shr = ashr exact i64 %shl, 56
ret i64 %shr
}
```

```
define signext i32 @sextb_i32(i32 signext %a) nounwind {
; RV64I-LABEL: sextb_i32:
; RV64I:    # %bb.0:
; RV64I-NEXT: slli a0, a0, 48
```

```

; RV64I-NEXT:  srai a0, a0, 48
; RV64I-NEXT:  ret
;
; RV64XTHEADBB-LABEL:
sexth_i32:
; RV64XTHEADBB:    # %bb.0:
; RV64XTHEADBB-NEXT:  th.ext a0, a0, 15, 0
; RV64XTHEADBB-NEXT:  ret
%shl = shl i32 %a, 16
%shr = ashr exact i32 %shl, 16
ret i32 %shr
}

define signext i32 @no_sexth_i32(i32 signext %a) nounwind {
; RV64I-LABEL: no_sexth_i32:
; RV64I:    # %bb.0:
; RV64I-NEXT:  slli a0, a0, 17
; RV64I-NEXT:  sraiw a0, a0, 16
; RV64I-NEXT:  ret
;
; RV64XTHEADBB-LABEL: no_sexth_i32:
; RV64XTHEADBB:    # %bb.0:
; RV64XTHEADBB-NEXT:  slli a0, a0, 17
; RV64XTHEADBB-NEXT:  sraiw a0, a0, 16
; RV64XTHEADBB-NEXT:  ret
%shl = shl i32 %a, 17
%shr = ashr exact i32 %shl, 16
ret i32 %shr
}

define i64 @sexth_i64(i64 %a) nounwind {
; RV64I-LABEL: sexth_i64:
; RV64I:    # %bb.0:
; RV64I-NEXT:  slli a0, a0, 48
; RV64I-NEXT:  srai a0, a0, 48
; RV64I-NEXT:  ret
;
; RV64XTHEADBB-LABEL: sexth_i64:
; RV64XTHEADBB:    # %bb.0:
; RV64XTHEADBB-NEXT:  th.ext a0, a0, 15, 0
; RV64XTHEADBB-NEXT:  ret
%shl = shl i64 %a, 48
%shr = ashr
exact i64 %shl, 48
ret i64 %shr
}

define i64 @no_sexth_i64(i64 %a) nounwind {

```

```

; RV64I-LABEL: no_s Sixth_i64:
; RV64I:    # %bb.0:
; RV64I-NEXT:  slli a0, a0, 49
; RV64I-NEXT:  srli a0, a0, 48
; RV64I-NEXT:  ret
;
; RV64XTHEADBB-LABEL: no_s Sixth_i64:
; RV64XTHEADBB:    # %bb.0:
; RV64XTHEADBB-NEXT:  slli a0, a0, 49
; RV64XTHEADBB-NEXT:  srli a0, a0, 48
; RV64XTHEADBB-NEXT:  ret
%shl = shl i64 %a, 49
%shr = ashr exact i64 %shl, 48
ret i64 %shr
}

define i32 @zexth_i32(i32 %a) nounwind {
; RV64I-LABEL: zexth_i32:
; RV64I:    # %bb.0:
; RV64I-NEXT:  slli a0, a0, 48
; RV64I-NEXT:  srli a0, a0, 48
; RV64I-NEXT:  ret
;
; RV64XTHEADBB-LABEL: zexth_i32:
; RV64XTHEADBB:    # %bb.0:
; RV64XTHEADBB-NEXT:  th.extu a0, a0, 15, 0
; RV64XTHEADBB-NEXT:  ret
%and = and i32 %a, 65535
ret i32 %and
}

define i64 @zexth_i64(i64 %a) nounwind {
; RV64I-LABEL: zexth_i64:
; RV64I:    # %bb.0:
; RV64I-NEXT:  slli a0, a0, 48
; RV64I-NEXT:  srli a0, a0, 48
; RV64I-NEXT:
ret
;
; RV64XTHEADBB-LABEL: zexth_i64:
; RV64XTHEADBB:    # %bb.0:
; RV64XTHEADBB-NEXT:  th.extu a0, a0, 15, 0
; RV64XTHEADBB-NEXT:  ret
%and = and i64 %a, 65535
ret i64 %and
}

define i64 @zext_bf_i64(i64 %a) nounwind {

```

```

; RV64I-LABEL: zext_bf_i64:
; RV64I:    # %bb.0:
; RV64I-NEXT:  slli a0, a0, 47
; RV64I-NEXT:  srli a0, a0, 48
; RV64I-NEXT:  ret
;
; RV64XTHEADBB-LABEL: zext_bf_i64:
; RV64XTHEADBB:    # %bb.0:
; RV64XTHEADBB-NEXT:  th.extu a0, a0, 16, 1
; RV64XTHEADBB-NEXT:  ret
%1 = lshr i64 %a, 1
%and = and i64 %1, 65535
ret i64 %and
}

```

```

define i64 @zext_i64_srliw(i64 %a) nounwind {
; RV64I-LABEL: zext_i64_srliw:
; RV64I:    # %bb.0:
; RV64I-NEXT:  srliw a0, a0, 16
; RV64I-NEXT:  ret
;
; RV64XTHEADBB-LABEL: zext_i64_srliw:
; RV64XTHEADBB:    # %bb.0:
; RV64XTHEADBB-NEXT:  srliw a0, a0, 16
; RV64XTHEADBB-NEXT:  ret
%1 = lshr i64 %a, 16
%and = and i64 %1, 65535
ret i64 %and
}

```

```

declare i32 @llvm.bswap.i32(i32)

```

```

define signext
i32 @bswap_i32(i32 signext %a) nounwind {
; RV64I-LABEL: bswap_i32:
; RV64I:    # %bb.0:
; RV64I-NEXT:  srliw a1, a0, 8
; RV64I-NEXT:  lui a2, 16
; RV64I-NEXT:  addiw a2, a2, -256
; RV64I-NEXT:  and a1, a1, a2
; RV64I-NEXT:  srliw a3, a0, 24
; RV64I-NEXT:  or a1, a1, a3
; RV64I-NEXT:  and a2, a0, a2
; RV64I-NEXT:  slliw a2, a2, 8
; RV64I-NEXT:  slliw a0, a0, 24
; RV64I-NEXT:  or a0, a0, a2
; RV64I-NEXT:  or a0, a0, a1
; RV64I-NEXT:  ret

```

```

;
; RV64XTHEADBB-LABEL: bswap_i32:
; RV64XTHEADBB:    # %bb.0:
; RV64XTHEADBB-NEXT:  th.revw a0, a0
; RV64XTHEADBB-NEXT:  ret
%1 = tail call i32 @llvm.bswap.i32(i32 %a)
ret i32 %1
}

; Similar to bswap_i32 but the result is not sign extended.
define void @bswap_i32_nosext(i32 signext %a, ptr %x) nounwind {
; RV64I-LABEL: bswap_i32_nosext:
; RV64I:    # %bb.0:
; RV64I-NEXT:  srliw a2, a0, 8
; RV64I-NEXT:  lui a3, 16
; RV64I-NEXT:  addi a3, a3, -256
; RV64I-NEXT:  and a2, a2, a3
; RV64I-NEXT:  srliw
a4, a0, 24
; RV64I-NEXT:  or a2, a2, a4
; RV64I-NEXT:  and a3, a0, a3
; RV64I-NEXT:  slli a3, a3, 8
; RV64I-NEXT:  slli a0, a0, 24
; RV64I-NEXT:  or a0, a0, a3
; RV64I-NEXT:  or a0, a0, a2
; RV64I-NEXT:  sw a0, 0(a1)
; RV64I-NEXT:  ret
;
; RV64XTHEADBB-LABEL: bswap_i32_nosext:
; RV64XTHEADBB:    # %bb.0:
; RV64XTHEADBB-NEXT:  th.revw a0, a0
; RV64XTHEADBB-NEXT:  sw a0, 0(a1)
; RV64XTHEADBB-NEXT:  ret
%1 = tail call i32 @llvm.bswap.i32(i32 %a)
store i32 %1, ptr %x
ret void
}

declare i64 @llvm.bswap.i64(i64)

define i64 @bswap_i64(i64 %a) {
; RV64I-LABEL: bswap_i64:
; RV64I:    # %bb.0:
; RV64I-NEXT:  srli a1, a0, 40
; RV64I-NEXT:  lui a2, 16
; RV64I-NEXT:  addiw a2, a2, -256
; RV64I-NEXT:  and a1, a1, a2
; RV64I-NEXT:  srli a3, a0, 56

```



```

; RV64I-NEXT: or a1, a1, a3
; RV64I-NEXT: srli a3, a0, 24
; RV64I-NEXT: lui a4, 4080
; RV64I-NEXT: and a3, a3, a4
; RV64I-NEXT: srli a5, a0, 8
; RV64I-NEXT: srliw a5, a5, 24
; RV64I-NEXT: slli
a5, a5, 24
; RV64I-NEXT: or a3, a5, a3
; RV64I-NEXT: or a1, a3, a1
; RV64I-NEXT: and a4, a0, a4
; RV64I-NEXT: slli a4, a4, 24
; RV64I-NEXT: srliw a3, a0, 24
; RV64I-NEXT: slli a3, a3, 32
; RV64I-NEXT: or a3, a4, a3
; RV64I-NEXT: and a2, a0, a2
; RV64I-NEXT: slli a2, a2, 40
; RV64I-NEXT: slli a0, a0, 56
; RV64I-NEXT: or a0, a0, a2
; RV64I-NEXT: or a0, a0, a3
; RV64I-NEXT: or a0, a0, a1
; RV64I-NEXT: ret
;
; RV64XTHEADBB-LABEL: bswap_i64:
; RV64XTHEADBB: # %bb.0:
; RV64XTHEADBB-NEXT: th.rev a0, a0
; RV64XTHEADBB-NEXT: ret
%1 = call i64 @llvm.bswap.i64(i64 %a)
ret i64 %1
}
; RUN: opt -passes=consthoist -S -o - %s | FileCheck %s
target datalayout = "e-m:e-p:32:32-i64:64-v128:64:128-a:0:32-n32-S64"
target triple = "thumbv6m-none--musleabi"

```

```

; Check that for i8 type, the maximum legal offset is 31.
; Also check that an constant used as value to be stored rather than
; pointer in a store instruction is hoisted.
; CHECK: foo_i8
; CHECK-DAG: %[[C1:const[0-9]?]] = bitcast i32 805874720 to i32
; CHECK-DAG: %[[C2:const[0-9]?]] = bitcast i32 805874688 to i32
; CHECK-DAG: %[[C3:const[0-9]?]] = bitcast i32 805873720 to i32
; CHECK-DAG: %[[C4:const[0-9]?]] = bitcast i32 805873688 to i32
; CHECK: %0 = inttoptr i32 %[[C2]] to ptr
; CHECK-NEXT: %1 = load volatile i8, ptr %0
; CHECK-NEXT: %[[M1:const_mat[0-9]?]] = add i32 %[[C2]], 4
; CHECK-NEXT: %2 = inttoptr i32 %[[M1]] to ptr
; CHECK-NEXT: %3 = load volatile i8, ptr %2
; CHECK-NEXT: %[[M2:const_mat[0-9]?]] = add i32 %[[C2]], 31

```

```

; CHECK-NEXT: %4 = inttoptr i32 %[[M2]] to ptr
; CHECK-NEXT: %5 = load volatile
i8, ptr %4
; CHECK-NEXT: %6 = inttoptr i32 %[[C1]] to ptr
; CHECK-NEXT: %7 = load volatile i8, ptr %6
; CHECK-NEXT: %[[M3:const_mat[0-9]?]] = add i32 %[[C1]], 7
; CHECK-NEXT: %8 = inttoptr i32 %[[M3]] to ptr
; CHECK-NEXT: %9 = load volatile i8, ptr %8
; CHECK-NEXT: %10 = inttoptr i32 %[[C4]] to ptr
; CHECK-NEXT: store i8 %9, ptr %10
; CHECK-NEXT: %[[M4:const_mat[0-9]?]] = add i32 %[[C4]], 31
; CHECK-NEXT: %11 = inttoptr i32 %[[M4]] to ptr
; CHECK-NEXT: store i8 %7, ptr %11
; CHECK-NEXT: %12 = inttoptr i32 %[[C3]] to ptr
; CHECK-NEXT: store i8 %5, ptr %12
; CHECK-NEXT: %[[M5:const_mat[0-9]?]] = add i32 %[[C3]], 7
; CHECK-NEXT: %13 = inttoptr i32 %[[M5]] to ptr
; CHECK-NEXT: store i8 %3, ptr %13
; CHECK-NEXT: %[[M6:const_mat[0-9]?]] = add i32 %[[C1]], 80
; CHECK-NEXT: %14 = inttoptr i32 %[[M6]] to ptr
; CHECK-NEXT: store ptr %14, ptr @goo

```

@goo = global ptr undef

```

define void @foo_i8() {
entry:
%0 = load volatile i8, ptr inttoptr (i32 805874688 to ptr)
%1 = load volatile
i8, ptr inttoptr (i32 805874692 to ptr)
%2 = load volatile i8, ptr inttoptr (i32 805874719 to ptr)
%3 = load volatile i8, ptr inttoptr (i32 805874720 to ptr)
%4 = load volatile i8, ptr inttoptr (i32 805874727 to ptr)
store i8 %4, ptr inttoptr(i32 805873688 to ptr)
store i8 %3, ptr inttoptr(i32 805873719 to ptr)
store i8 %2, ptr inttoptr(i32 805873720 to ptr)
store i8 %1, ptr inttoptr(i32 805873727 to ptr)
store ptr inttoptr(i32 805874800 to ptr), ptr @goo
ret void
}

```

```

; Check that for i16 type, the maximum legal offset is 62.
; CHECK: foo_i16
; CHECK-DAG: %[[C1:const[0-9]?]] = bitcast i32 805874752 to i32
; CHECK-DAG: %[[C2:const[0-9]?]] = bitcast i32 805874688 to i32
; CHECK: %0 = inttoptr i32 %[[C2]] to ptr
; CHECK-NEXT: %1 = load volatile i16, ptr %0, align 2
; CHECK-NEXT: %[[M1:const_mat[0-9]?]] = add i32 %[[C2]], 4
; CHECK-NEXT: %2 = inttoptr i32 %[[M1]] to ptr

```

```

; CHECK-NEXT: %3 = load volatile i16, ptr %2, align 2
; CHECK-NEXT: %[[M2:const_mat[0-9]?]] = add
i32 %[[C2]], 32
; CHECK-NEXT: %4 = inttoptr i32 %[[M2]] to ptr
; CHECK-NEXT: %5 = load volatile i16, ptr %4, align 2
; CHECK-NEXT: %[[M3:const_mat[0-9]?]] = add i32 %[[C2]], 62
; CHECK-NEXT: %6 = inttoptr i32 %[[M3]] to ptr
; CHECK-NEXT: %7 = load volatile i16, ptr %6, align 2
; CHECK-NEXT: %8 = inttoptr i32 %[[C1]] to ptr
; CHECK-NEXT: %9 = load volatile i16, ptr %8, align 2
; CHECK-NEXT: %[[M4:const_mat[0-9]?]] = add i32 %[[C1]], 22
; CHECK-NEXT: %10 = inttoptr i32 %[[M4]] to ptr
; CHECK-NEXT: %11 = load volatile i16, ptr %10, align 2

```

```

define void @foo_i16() {

```

```

entry:

```

```

%0 = load volatile i16, ptr inttoptr (i32 805874688 to ptr), align 2
%1 = load volatile i16, ptr inttoptr (i32 805874692 to ptr), align 2
%2 = load volatile i16, ptr inttoptr (i32 805874720 to ptr), align 2
%3 = load volatile i16, ptr inttoptr (i32 805874750 to ptr), align 2
%4 = load volatile i16, ptr inttoptr (i32 805874752 to ptr), align 2
%5 = load volatile i16, ptr inttoptr (i32 805874774 to ptr), align
2

```

```

ret void

```

```

}

```

```

; Check that for i32 type, the maximum legal offset is 124.

```

```

; CHECK: foo_i32

```

```

; CHECK-DAG: %[[C1:const[0-9]?]] = bitcast i32 805874816 to i32

```

```

; CHECK-DAG: %[[C2:const[0-9]?]] = bitcast i32 805874688 to i32

```

```

; CHECK: %0 = inttoptr i32 %[[C2]] to ptr

```

```

; CHECK-NEXT: %1 = load volatile i32, ptr %0, align 4

```

```

; CHECK-NEXT: %[[M1:const_mat[0-9]?]] = add i32 %[[C2]], 4

```

```

; CHECK-NEXT: %2 = inttoptr i32 %[[M1]] to ptr

```

```

; CHECK-NEXT: %3 = load volatile i32, ptr %2, align 4

```

```

; CHECK-NEXT: %[[M2:const_mat[0-9]?]] = add i32 %[[C2]], 124

```

```

; CHECK-NEXT: %4 = inttoptr i32 %[[M2]] to ptr

```

```

; CHECK-NEXT: %5 = load volatile i32, ptr %4, align 4

```

```

; CHECK-NEXT: %6 = inttoptr i32 %[[C1]] to ptr

```

```

; CHECK-NEXT: %7 = load volatile i32, ptr %6, align 4

```

```

; CHECK-NEXT: %[[M3:const_mat[0-9]?]] = add i32 %[[C1]], 8

```

```

; CHECK-NEXT: %8 = inttoptr i32 %[[M3]] to ptr

```

```

; CHECK-NEXT: %9 = load volatile i32, ptr %8, align 4

```

```

; CHECK-NEXT: %[[M4:const_mat[0-9]?]] = add i32 %[[C1]], 12

```

```

; CHECK-NEXT: %10 = inttoptr

```

```

i32 %[[M4]] to ptr

```

```

; CHECK-NEXT: %11 = load volatile i32, ptr %10, align 4

```

```

define void @foo_i32() {
entry:
    %0 = load volatile i32, ptr inttoptr (i32 805874688 to ptr), align 4
    %1 = load volatile i32, ptr inttoptr (i32 805874692 to ptr), align 4
    %2 = load volatile i32, ptr inttoptr (i32 805874812 to ptr), align 4
    %3 = load volatile i32, ptr inttoptr (i32 805874816 to ptr), align 4
    %4 = load volatile i32, ptr inttoptr (i32 805874824 to ptr), align 4
    %5 = load volatile i32, ptr inttoptr (i32 805874828 to ptr), align 4
    ret void
}
; RUN: llc < %s -mtriple=s390x-linux-gnu -mcpu=zEC12 -verify-machineinstrs | FileCheck %s
;
; Test that early if conversion produces LOCR with operands of the right
; register classes.

define void @autogen_SD4739(ptr) {
; CHECK-NOT: Expected a GR32Bit register, but got a GRX32Bit register
BB:
    %L34 = load i8, ptr %0
    %Cmp56 = icmp sgt i8 undef, %L34
    br label %CF246

CF246:                                ; preds = %CF246, %BB
    %S1163 = select i1 %Cmp56, i8 %L34, i8 undef
    br i1 undef, label %CF246, label %CF248

CF248:                                ; preds = %CF248, %CF246
    store i8 %S1163, ptr %0
    br label %CF248
}
; RUN: llc -march=hexagon -hexagon-hvx-widen=32 < %s | FileCheck %s

; Truncating a type-to-be-widened to a legal type (v8i8).
; Check that this compiles successfully.
; CHECK-LABEL: f0:
; CHECK: dealloc_return

target datalayout = "e-m:e-p:32:32:32-a:0-n16:32-i64:64:64-i32:32:32-i16:16:16-i1:8:8-f32:32:32-f64:64:64-v32:32:32-v64:64:64-v512:512:512-v1024:1024:1024-v2048:2048:2048"
target triple = "hexagon"

define dlllexport void @f0(ptr %a0) local_unnamed_addr #0 {
b0:
    %v0 = load i8, ptr undef, align 1
    %v1 = zext i8 %v0 to i16
    %v2 = add i16 0, %v1
    %v3 = icmp sgt i16 %v2, 1
    %v4 = select i1 %v3, i16 %v2, i16 1

```

```

%v5 = udiv i16 -32768, %v4
%v6 = zext i16 %v5 to i32
%v7 = insertelement <8 x i32> undef, i32 %v6, i32 0
%v8 = shufflevector <8 x i32> %v7, <8 x i32> undef, <8 x i32> zeroinitializer
%v9 = load <8 x i16>, ptr undef, align 2
%v10 = sext <8 x i16> %v9 to <8 x i32>
%v11 = mul nsw <8 x i32> %v8, %v10
%v12 = add nsw <8 x i32> %v11, <i32 16384, i32 16384, i32 16384,
i32 16384, i32 16384, i32 16384, i32 16384, i32 16384>
%v13 = lshr <8 x i32> %v12, <i32 15, i32 15, i32 15, i32 15, i32 15, i32 15, i32 15, i32 15>
%v14 = trunc <8 x i32> %v13 to <8 x i8>
%v15 = getelementptr inbounds i8, ptr %a0, i32 undef
store <8 x i8> %v14, ptr %v15, align 1
ret void
}

```

```

attributes #0 = { "target-features"="+hvx,+hvx-length128b" }
; RUN: llc -march=hexagon < %s
; REQUIRES: asserts

```

; The two loads based on %struct.0, loading two different data types  
; cause LSR to assume type "void" for the memory type. This would then  
; cause an assert in isLegalAddressingMode. Make sure we no longer crash.

```
target triple = "hexagon"
```

```

%struct.0 = type { ptr, i8, %union.anon.0 }
%union.anon.0 = type { ptr }

```

```

define hidden fastcc void @fred() unnamed_addr #0 {
entry:
br i1 undef, label %while.end, label %while.body.lr.ph

```

```

while.body.lr.ph:                                ; preds = %entry
br label %while.body

```

```

while.body:                                       ; preds = %exit.2, %while.body.lr.ph
%lsr.iv = phi ptr [ %cgep22, %exit.2 ], [ undef, %while.body.lr.ph ]
switch i32 undef, label %exit [
  i32 1, label %sw.bb.i
  i32 2, label %sw.bb3.i
]

```

```

sw.bb.i:                                         ; preds = %while.body
unreachable

```

```

sw.bb3.i:                                       ; preds = %while.body
unreachable

```

```

exit:
                                ; preds = %while.body
switch i32 undef, label %exit.2 [
  i32 1, label %sw.bb.i17
  i32 2, label %sw.bb3.i20
]

sw.bb.i17:                                ; preds = %exit
%0 = load i32, ptr %lsr.iv, align 4
unreachable

sw.bb3.i20:                              ; preds = %exit
%1 = load ptr, ptr %lsr.iv, align 4
unreachable

exit.2:                                ; preds = %exit
%cgcp22 = getelementptr %struct.0, ptr %lsr.iv, i32 1
br label %while.body

while.end:                              ; preds = %entry
ret void
}

attributes #0 = { nounwind optsize "target-cpu"="hexagonv55" }
; NOTE: Assertions have been autogenerated by utils/update_test_checks.py UTC_ARGS: --include-generated-funcs
; RUN: opt -S -passes=verify,iroutliner -ir-outlining-no-cost < %s | FileCheck %s
; FIXME: Disabled run-line after running into some turbulence with debuginfo-iterators
; run: opt -S -passes=verify,iroutliner -ir-outlining-no-cost < %s --try-experimental-debuginfo-iterators | FileCheck %s

; This test checks that debug info is recognized as able to be extracted along
; with the other instructions, but is not included in the consolidated function.

define void @function1() !dbg !6 {
entry:
%a = alloca i32, align 4, !dbg !17
call void @llvm.dbg.value(metadata ptr %a, metadata !9, metadata !DIExpression()), !dbg !17
%b = alloca i32, align 4, !dbg !18
call void @llvm.dbg.value(metadata ptr %b, metadata !11, metadata !DIExpression()), !dbg !18
%c = alloca i32, align 4, !dbg !19
call void @llvm.dbg.value(metadata ptr %c, metadata !12, metadata !DIExpression()), !dbg !19

store i32 2, ptr %a, align 4, !dbg !20
store i32 3, ptr %b, align 4, !dbg !21
store i32 4, ptr %c, align 4, !dbg !22
%al = load i32, ptr %a, align 4, !dbg !23

```

```

call void @llvm.dbg.value(metadata i32 %a, metadata !13, metadata !DIExpression()), !dbg !23
%bl = load i32, ptr %b, align 4, !dbg !24
call void @llvm.dbg.value(metadata i32 %bl, metadata !15, metadata !DIExpression()), !dbg !24
%cl = load i32, ptr %c, align 4, !dbg !25
call void @llvm.dbg.value(metadata i32 %cl, metadata !16, metadata !DIExpression()), !dbg !25
ret void, !dbg !26
}

```

```

define void @function2() !dbg !27 {
entry:
  %a = alloca i32, align 4, !dbg !35
  call void @llvm.dbg.value(metadata ptr %a, metadata !29, metadata !DIExpression()), !dbg !35
  %b = alloca i32, align 4, !dbg !36
  call void @llvm.dbg.value(metadata ptr %b, metadata !30, metadata !DIExpression()), !dbg !36
  %c = alloca i32, align 4, !dbg !37
  call void @llvm.dbg.value(metadata ptr %c, metadata !31, metadata !DIExpression()), !dbg
!37
  store i32 2, ptr %a, align 4, !dbg !38
  store i32 3, ptr %b, align 4, !dbg !39
  store i32 4, ptr %c, align 4, !dbg !40
  %al = load i32, ptr %a, align 4, !dbg !41
  call void @llvm.dbg.value(metadata i32 %al, metadata !32, metadata !DIExpression()), !dbg !41
  %bl = load i32, ptr %b, align 4, !dbg !42
  call void @llvm.dbg.value(metadata i32 %bl, metadata !33, metadata !DIExpression()), !dbg !42
  %cl = load i32, ptr %c, align 4, !dbg !43
  call void @llvm.dbg.value(metadata i32 %cl, metadata !34, metadata !DIExpression()), !dbg !43
  ret void, !dbg !44
}

```

```

; Function Attrs: nounwind readnone speculatable willreturn
declare void @llvm.dbg.value(metadata, metadata, metadata) #0

```

```

attributes #0 = { nounwind readnone speculatable willreturn }

```

```

!llvm.dbg.cu = !{!0}
!llvm.debugify = !{!3, !4}
!llvm.module.flags = !{!5}

```

```

!0 = distinct !DICompileUnit(language: DW_LANG_C, file: !1, producer: "debugify", isOptimized: true,
runtimeVersion: 0, emissionKind: FullDebug, enums: !2)

```

```

!1 = !DIFile(filename:
"legal-debug.ll", directory: "/")

```

```

!2 = !{}

```

```

!3 = !{i32 20}

```

```

!4 = !{i32 12}

```

```

!5 = !{i32 2, !"Debug Info Version", i32 3}

```

```

!6 = distinct !DISubprogram(name: "function1", linkageName: "function1", scope: null, file: !1, line: 1, type: !7,

```

```

scopeLine: 1, spFlags: DISPFlagDefinition | DISPFlagOptimized, unit: !0, retainedNodes: !8)
!7 = !DISubroutineType(types: !2)
!8 = !{!9, !11, !12, !13, !15, !16}
!9 = !DILocalVariable(name: "1", scope: !6, file: !1, line: 1, type: !10)
!10 = !DIBasicType(name: "ty64", size: 64, encoding: DW_ATE_unsigned)
!11 = !DILocalVariable(name: "2", scope: !6, file: !1, line: 2, type: !10)
!12 = !DILocalVariable(name: "3", scope: !6, file: !1, line: 3, type: !10)
!13 = !DILocalVariable(name: "4", scope: !6, file: !1, line: 7, type: !14)
!14 = !DIBasicType(name: "ty32", size: 32, encoding: DW_ATE_unsigned)
!15 = !DILocalVariable(name: "5", scope: !6, file: !1, line: 8, type: !14)
!16 = !DILocalVariable(name: "6", scope: !6, file: !1, line: 9, type: !14)
!17
= !DILocation(line: 1, column: 1, scope: !6)
!18 = !DILocation(line: 2, column: 1, scope: !6)
!19 = !DILocation(line: 3, column: 1, scope: !6)
!20 = !DILocation(line: 4, column: 1, scope: !6)
!21 = !DILocation(line: 5, column: 1, scope: !6)
!22 = !DILocation(line: 6, column: 1, scope: !6)
!23 = !DILocation(line: 7, column: 1, scope: !6)
!24 = !DILocation(line: 8, column: 1, scope: !6)
!25 = !DILocation(line: 9, column: 1, scope: !6)
!26 = !DILocation(line: 10, column: 1, scope: !6)
!27 = distinct !DISubprogram(name: "function2", linkageName: "function2", scope: null, file: !1, line: 11, type: !7,
scopeLine: 11, spFlags: DISPFlagDefinition | DISPFlagOptimized, unit: !0, retainedNodes: !28)
!28 = !{!29, !30, !31, !32, !33, !34}
!29 = !DILocalVariable(name: "7", scope: !27, file: !1, line: 11, type: !10)
!30 = !DILocalVariable(name: "8", scope: !27, file: !1, line: 12, type: !10)
!31 = !DILocalVariable(name: "9", scope: !27, file: !1, line: 13, type: !10)
!32 = !DILocalVariable(name: "10",
scope: !27, file: !1, line: 17, type: !14)
!33 = !DILocalVariable(name: "11", scope: !27, file: !1, line: 18, type: !14)
!34 = !DILocalVariable(name: "12", scope: !27, file: !1, line: 19, type: !14)
!35 = !DILocation(line: 11, column: 1, scope: !27)
!36 = !DILocation(line: 12, column: 1, scope: !27)
!37 = !DILocation(line: 13, column: 1, scope: !27)
!38 = !DILocation(line: 14, column: 1, scope: !27)
!39 = !DILocation(line: 15, column: 1, scope: !27)
!40 = !DILocation(line: 16, column: 1, scope: !27)
!41 = !DILocation(line: 17, column: 1, scope: !27)
!42 = !DILocation(line: 18, column: 1, scope: !27)
!43 = !DILocation(line: 19, column: 1, scope: !27)
!44 = !DILocation(line: 20, column: 1, scope: !27)
; CHECK-LABEL: @function1(
; CHECK-NEXT: entry:
; CHECK-NEXT: [[A:%.*]] = alloca i32, align 4, !dbg [[DBG17:![0-9]+]]
; CHECK-NEXT: call void @llvm.dbg.value(metadata ptr [[A]], metadata [[META9:![0-9]+]], metadata
!DIExpression()), !dbg [[DBG17]]
; CHECK-NEXT: [[B:%.*]] = alloca

```



```

i32, align 4, !dbg [[DBG18:[0-9]+]]
; CHECK-NEXT: call void @llvm.dbg.value(metadata ptr [[B]], metadata [[META11:[0-9]+]], metadata
!DIExpression()), !dbg [[DBG18]]
; CHECK-NEXT: [[C:%.*]] = alloca i32, align 4, !dbg [[DBG19:[0-9]+]]
; CHECK-NEXT: call void @llvm.dbg.value(metadata ptr [[C]], metadata [[META12:[0-9]+]], metadata
!DIExpression()), !dbg [[DBG19]]
; CHECK-NEXT: call void @outlined_ir_func_0(ptr [[A]], ptr [[B]], ptr [[C]]), !dbg [[DBG20:[0-9]+]]
; CHECK-NEXT: ret void, !dbg [[DBG21:[0-9]+]]
;
;
; CHECK-LABEL: @function2(
; CHECK-NEXT: entry:
; CHECK-NEXT: [[A:%.*]] = alloca i32, align 4, !dbg [[DBG30:[0-9]+]]
; CHECK-NEXT: call void @llvm.dbg.value(metadata ptr [[A]], metadata [[META24:[0-9]+]], metadata
!DIExpression()), !dbg [[DBG30]]
; CHECK-NEXT: [[B:%.*]] = alloca i32, align 4, !dbg [[DBG31:[0-9]+]]
; CHECK-NEXT: call void @llvm.dbg.value(metadata ptr [[B]], metadata [[META25:[0-9]+]], metadata
!DIExpression()), !dbg [[DBG31]]
;
CHECK-NEXT: [[C:%.*]] = alloca i32, align 4, !dbg [[DBG32:[0-9]+]]
; CHECK-NEXT: call void @llvm.dbg.value(metadata ptr [[C]], metadata [[META26:[0-9]+]], metadata
!DIExpression()), !dbg [[DBG32]]
; CHECK-NEXT: call void @outlined_ir_func_0(ptr [[A]], ptr [[B]], ptr [[C]]), !dbg [[DBG33:[0-9]+]]
; CHECK-NEXT: ret void, !dbg [[DBG34:[0-9]+]]
;
;
; CHECK: @outlined_ir_func_0(ptr [[TMP0:%.*]], ptr [[TMP1:%.*]], ptr [[TMP2:%.*]])
; CHECK: entry_to_outline:
; CHECK-NEXT: store i32 2, ptr [[TMP0]], align 4
; CHECK-NEXT: store i32 3, ptr [[TMP1]], align 4
; CHECK-NEXT: store i32 4, ptr [[TMP2]], align 4
; CHECK-NEXT: [[AL:%.*]] = load i32, ptr [[TMP0]], align 4
; CHECK-NEXT: [[BL:%.*]] = load i32, ptr [[TMP1]], align 4
; CHECK-NEXT: [[CL:%.*]] = load i32, ptr [[TMP2]], align 4
; CHECK-NEXT: br label [[ENTRY_AFTER_OUTLINE_EXITSTUB:%.*]]
;
; RUN: opt < %s -passes=argpromotion -S | FileCheck %s

; CHECK-LABEL: define i32 @foo() #0 {
; CHECK-NEXT:    %.val = load <32 x half>, ptr undef, align 4
; CHECK-NEXT:    call void @bar(<32 x half> %.val)
; CHECK-NEXT:    ret i32 0
; CHECK-NEXT: }

; CHECK-LABEL: define internal void @bar(<32 x half> %.0.val) #0 {
; CHECK-NEXT:    ret void
; CHECK-NEXT: }

```

```
; CHECK:  attributes #0 = { uwtable "min-legal-vector-width"="512" }
```

```
define i32 @foo() #0 {  
  call void @bar(ptr undef)  
  ret i32 0  
}
```

```
define internal void @bar(ptr) #0 {  
  %2 = load <32 x half>, ptr %0, align 4  
  ret void  
}
```

```
attributes #0 = { uwtable "min-legal-vector-width"="0" }
```

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```
; NOTE: Assertions have been autogenerated by utils/update_llc_test_checks.py
; RUN: llc -mtriple=riscv64 -mattr=+m -verify-machineinstrs < %s \
; RUN: -riscv-experimental-rv64-legal-i32 | FileCheck %s -check-prefixes=CHECK,RV64I
; RUN: llc -mtriple=riscv64 -mattr=+m,+zba -verify-machineinstrs < %s \
; RUN: -riscv-experimental-rv64-legal-i32 | FileCheck %s -check-
prefixes=CHECK,RV64ZBA,RV64ZBANOBZBB
; RUN: llc -mtriple=riscv64 -mattr=+m,+zba,+zbb -verify-machineinstrs < %s \
; RUN: -riscv-experimental-rv64-legal-i32 | FileCheck %s -check-prefixes=CHECK,RV64ZBA,RV64ZBAZBB
```

```
define i64 @slliuw(i64 %a) nounwind {
; RV64I-LABEL: slliuw:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  srli a0, a0, 31
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: slliuw:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  slli.uw a0, a0, 1
; RV64ZBA-NEXT:  ret
%conv1 = shl i64 %a, 1
%shl = and i64 %conv1, 8589934590
ret i64 %shl
}
```

```

define i128 @slliuw_2(i32 signext %0, ptr %1) {
; RV64I-LABEL:
slliuw_2:
; RV64I:    # %bb.0:
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  srli a0, a0, 28
; RV64I-NEXT:  add a1, a1, a0
; RV64I-NEXT:  ld a0, 0(a1)
; RV64I-NEXT:  ld a1, 8(a1)
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: slliuw_2:
; RV64ZBA:    # %bb.0:
; RV64ZBA-NEXT:  slli.uw a0, a0, 4
; RV64ZBA-NEXT:  add a1, a1, a0
; RV64ZBA-NEXT:  ld a0, 0(a1)
; RV64ZBA-NEXT:  ld a1, 8(a1)
; RV64ZBA-NEXT:  ret
%3 = zext i32 %0 to i64
%4 = getelementptr inbounds i128, ptr %1, i64 %3
%5 = load i128, ptr %4
ret i128 %5
}

```

```

define i128 @slliuw_3(i32 signext %0, ptr %1) {
; RV64I-LABEL: slliuw_3:
; RV64I:    # %bb.0:
; RV64I-NEXT:  addi a0, a0, 1
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  srli a0, a0, 28
; RV64I-NEXT:  add a1, a1, a0
; RV64I-NEXT:  ld a0, 0(a1)
; RV64I-NEXT:  ld a1, 8(a1)
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: slliuw_3:
; RV64ZBA:    # %bb.0:
; RV64ZBA-NEXT:  addi a0, a0, 1
; RV64ZBA-NEXT:  slli.uw a0, a0, 4
; RV64ZBA-NEXT:
add a1, a1, a0
; RV64ZBA-NEXT:  ld a0, 0(a1)
; RV64ZBA-NEXT:  ld a1, 8(a1)
; RV64ZBA-NEXT:  ret
%add = add i32 %0, 1
%3 = zext i32 %add to i64
%4 = getelementptr inbounds i128, ptr %1, i64 %3
%5 = load i128, ptr %4

```

```

ret i128 %5
}

define i64 @adduw(i64 %a, i64 %b) nounwind {
; RV64I-LABEL: adduw:
; RV64I:      # %bb.0:
; RV64I-NEXT: slli a1, a1, 32
; RV64I-NEXT: srli a1, a1, 32
; RV64I-NEXT: add a0, a1, a0
; RV64I-NEXT: ret
;
; RV64ZBA-LABEL: adduw:
; RV64ZBA:    # %bb.0:
; RV64ZBA-NEXT: add.uw a0, a1, a0
; RV64ZBA-NEXT: ret
%and = and i64 %b, 4294967295
%add = add i64 %and, %a
ret i64 %add
}

define signext i8 @adduw_2(i32 signext %0, ptr %1) {
; RV64I-LABEL: adduw_2:
; RV64I:      # %bb.0:
; RV64I-NEXT: slli a0, a0, 32
; RV64I-NEXT: srli a0, a0, 32
; RV64I-NEXT: add a0, a1, a0
; RV64I-NEXT: lb a0, 0(a0)
; RV64I-NEXT: ret
;
; RV64ZBA-LABEL: adduw_2:
; RV64ZBA:    # %bb.0:
; RV64ZBA-NEXT: add.uw a0, a0, a1
; RV64ZBA-NEXT:
    lb a0, 0(a0)
; RV64ZBA-NEXT: ret
%3 = zext i32 %0 to i64
%4 = getelementptr inbounds i8, ptr %1, i64 %3
%5 = load i8, ptr %4
ret i8 %5
}

define signext i8 @adduw_3(i32 signext %0, ptr %1) {
; RV64I-LABEL: adduw_3:
; RV64I:      # %bb.0:
; RV64I-NEXT: addi a0, a0, 1
; RV64I-NEXT: slli a0, a0, 32
; RV64I-NEXT: srli a0, a0, 32
; RV64I-NEXT: add a0, a1, a0

```

```

; RV64I-NEXT:  lb a0, 0(a0)
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: adduw_3:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  addi a0, a0, 1
; RV64ZBA-NEXT:  add.uw a0, a0, a1
; RV64ZBA-NEXT:  lb a0, 0(a0)
; RV64ZBA-NEXT:  ret
%add = add i32 %0, 1
%3 = zext i32 %add to i64
%4 = getelementptr inbounds i8, ptr %1, i64 %3
%5 = load i8, ptr %4
ret i8 %5
}

```

```

define i64 @zextw_i64(i64 %a) nounwind {
; RV64I-LABEL: zextw_i64:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  srli a0, a0, 32
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: zextw_i64:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:
    zext.w a0, a0
; RV64ZBA-NEXT:  ret
%and = and i64 %a, 4294967295
ret i64 %and
}

```

; This makes sure targetShrinkDemandedConstant changes the and immediate to  
; allow zext.w or slli+srli.

```

define i64 @zextw_demandedbits_i64(i64 %0) {
; RV64I-LABEL: zextw_demandedbits_i64:
; RV64I:      # %bb.0:
; RV64I-NEXT:  ori a0, a0, 1
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  srli a0, a0, 32
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: zextw_demandedbits_i64:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  ori a0, a0, 1
; RV64ZBA-NEXT:  zext.w a0, a0
; RV64ZBA-NEXT:  ret
%2 = and i64 %0, 4294967294

```

```

%3 = or i64 %2, 1
ret i64 %3
}

define signext i16 @sh1add(i64 %0, ptr %1) {
; RV64I-LABEL: sh1add:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a0, a0, 1
; RV64I-NEXT:  add a0, a1, a0
; RV64I-NEXT:  lh a0, 0(a0)
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: sh1add:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  sh1add a0, a0, a1
; RV64ZBA-NEXT:  lh a0, 0(a0)
; RV64ZBA-NEXT:
    ret
%3 = getelementptr inbounds i16, ptr %1, i64 %0
%4 = load i16, ptr %3
ret i16 %4
}

define signext i32 @sh2add(i64 %0, ptr %1) {
; RV64I-LABEL: sh2add:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a0, a0, 2
; RV64I-NEXT:  add a0, a1, a0
; RV64I-NEXT:  lw a0, 0(a0)
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: sh2add:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  sh2add a0, a0, a1
; RV64ZBA-NEXT:  lw a0, 0(a0)
; RV64ZBA-NEXT:  ret
%3 = getelementptr inbounds i32, ptr %1, i64 %0
%4 = load i32, ptr %3
ret i32 %4
}

define i64 @sh3add(i64 %0, ptr %1) {
; RV64I-LABEL: sh3add:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a0, a0, 3
; RV64I-NEXT:  add a0, a1, a0
; RV64I-NEXT:  ld a0, 0(a0)
; RV64I-NEXT:  ret

```

```

;
; RV64ZBA-LABEL: sh3add:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  sh3add a0, a0, a1
; RV64ZBA-NEXT:  ld a0, 0(a0)
; RV64ZBA-NEXT:  ret
%3 = getelementptr inbounds i64, ptr %1, i64 %0
%4 = load i64, ptr %3
ret i64 %4
}

```

```

define signext i16 @sh1adduw(i32
signext %0, ptr %1) {
; RV64I-LABEL: sh1adduw:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  srli a0, a0, 31
; RV64I-NEXT:  add a0, a1, a0
; RV64I-NEXT:  lh a0, 0(a0)
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: sh1adduw:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  sh1add.uw a0, a0, a1
; RV64ZBA-NEXT:  lh a0, 0(a0)
; RV64ZBA-NEXT:  ret
%3 = zext i32 %0 to i64
%4 = getelementptr inbounds i16, ptr %1, i64 %3
%5 = load i16, ptr %4
ret i16 %5
}

```

```

define i64 @sh1adduw_2(i64 %0, i64 %1) {
; RV64I-LABEL: sh1adduw_2:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  srli a0, a0, 31
; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: sh1adduw_2:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  sh1add.uw a0, a0, a1
; RV64ZBA-NEXT:  ret
%3 = shl i64 %0, 1
%4 = and i64 %3, 8589934590
%5 = add i64 %4, %1
ret i64 %5

```

```

}

define signext i32 @sh2adduw(i32 signext %0, ptr %1) {
; RV64I-LABEL: sh2adduw:
; RV64I:
    # %bb.0:
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  srli a0, a0, 30
; RV64I-NEXT:  add a0, a1, a0
; RV64I-NEXT:  lw a0, 0(a0)
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: sh2adduw:
; RV64ZBA:    # %bb.0:
; RV64ZBA-NEXT:  sh2add.uw a0, a0, a1
; RV64ZBA-NEXT:  lw a0, 0(a0)
; RV64ZBA-NEXT:  ret
%3 = zext i32 %0 to i64
%4 = getelementptr inbounds i32, ptr %1, i64 %3
%5 = load i32, ptr %4
ret i32 %5
}

```

```

define i64 @sh2adduw_2(i64 %0, i64 %1) {
; RV64I-LABEL: sh2adduw_2:
; RV64I:    # %bb.0:
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  srli a0, a0, 30
; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: sh2adduw_2:
; RV64ZBA:    # %bb.0:
; RV64ZBA-NEXT:  sh2add.uw a0, a0, a1
; RV64ZBA-NEXT:  ret
%3 = shl i64 %0, 2
%4 = and i64 %3, 17179869180
%5 = add i64 %4, %1
ret i64 %5
}

```

```

define i64 @sh3adduw(i32 signext %0, ptr %1) {
; RV64I-LABEL: sh3adduw:
; RV64I:    # %bb.0:
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:
    srli a0, a0, 29
; RV64I-NEXT:  add a0, a1, a0

```

```

; RV64I-NEXT:  ld a0, 0(a0)
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: sh3adduw:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  sh3add.uw a0, a0, a1
; RV64ZBA-NEXT:  ld a0, 0(a0)
; RV64ZBA-NEXT:  ret
%3 = zext i32 %0 to i64
%4 = getelementptr inbounds i64, ptr %1, i64 %3
%5 = load i64, ptr %4
ret i64 %5
}

```

```

define i64 @sh3adduw_2(i64 %0, i64 %1) {
; RV64I-LABEL: sh3adduw_2:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  srli a0, a0, 29
; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: sh3adduw_2:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  sh3add.uw a0, a0, a1
; RV64ZBA-NEXT:  ret
%3 = shl i64 %0, 3
%4 = and i64 %3, 34359738360
%5 = add i64 %4, %1
ret i64 %5
}

```

; Type legalization inserts a sext\_inreg after the first add. That add will be  
; selected as sh2add which does not sign extend. SimplifyDemandedBits is unable  
; to remove the sext\_inreg because it has multiple uses.

The ashr will use the

; sext\_inreg to become sraiw. This leaves the sext\_inreg only used by the shl.

; If the shl is selected as sllw, we don't need the sext\_inreg.

```
define i64 @sh2add_extra_sext(i32 %x, i32 %y, i32 %z) {
```

```

; RV64I-LABEL: sh2add_extra_sext:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a0, a0, 2
; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  sllw a1, a2, a0
; RV64I-NEXT:  sraiw a0, a0, 2
; RV64I-NEXT:  mul a0, a1, a0
; RV64I-NEXT:  ret
;

```



```

; RV64ZBA-LABEL: sh2add_extra_sext:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT: sh2add a0, a0, a1
; RV64ZBA-NEXT: sllw a1, a2, a0
; RV64ZBA-NEXT: sraiw a0, a0, 2
; RV64ZBA-NEXT: mul a0, a1, a0
; RV64ZBA-NEXT: ret
%a = shl i32 %x, 2
%b = add i32 %a, %y
%c = shl i32 %z, %b
%d = ashr i32 %b, 2
%e = sext i32 %c to i64
%f = sext i32 %d to i64
%g = mul i64 %e, %f
ret i64 %g
}

```

```

define i64 @addmul6(i64 %a, i64 %b) {
; RV64I-LABEL: addmul6:
; RV64I:      # %bb.0:
; RV64I-NEXT: li a2, 6
; RV64I-NEXT: mul
a0, a0, a2
; RV64I-NEXT: add a0, a0, a1
; RV64I-NEXT: ret
;
; RV64ZBA-LABEL: addmul6:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT: sh1add a0, a0, a0
; RV64ZBA-NEXT: sh1add a0, a0, a1
; RV64ZBA-NEXT: ret
%c = mul i64 %a, 6
%d = add i64 %c, %b
ret i64 %d
}

```

```

define i64 @addmul10(i64 %a, i64 %b) {
; RV64I-LABEL: addmul10:
; RV64I:      # %bb.0:
; RV64I-NEXT: li a2, 10
; RV64I-NEXT: mul a0, a0, a2
; RV64I-NEXT: add a0, a0, a1
; RV64I-NEXT: ret
;
; RV64ZBA-LABEL: addmul10:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT: sh2add a0, a0, a0
; RV64ZBA-NEXT: sh1add a0, a0, a1

```

```

; RV64ZBA-NEXT:  ret
%c = mul i64 %a, 10
%d = add i64 %c, %b
ret i64 %d
}

define i64 @addmul12(i64 %a, i64 %b) {
; RV64I-LABEL: addmul12:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a2, 12
; RV64I-NEXT:  mul a0, a0, a2
; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: addmul12:
; RV64ZBA:    # %bb.0:
; RV64ZBA-NEXT:  sh1add a0, a0, a0
; RV64ZBA-NEXT:  sh2add
a0, a0, a1
; RV64ZBA-NEXT:  ret
%c = mul i64 %a, 12
%d = add i64 %c, %b
ret i64 %d
}

define i64 @addmul18(i64 %a, i64 %b) {
; RV64I-LABEL: addmul18:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a2, 18
; RV64I-NEXT:  mul a0, a0, a2
; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: addmul18:
; RV64ZBA:    # %bb.0:
; RV64ZBA-NEXT:  sh3add a0, a0, a0
; RV64ZBA-NEXT:  sh1add a0, a0, a1
; RV64ZBA-NEXT:  ret
%c = mul i64 %a, 18
%d = add i64 %c, %b
ret i64 %d
}

define i64 @addmul20(i64 %a, i64 %b) {
; RV64I-LABEL: addmul20:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a2, 20
; RV64I-NEXT:  mul a0, a0, a2

```

```

; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: addmul20:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  sh2add a0, a0, a0
; RV64ZBA-NEXT:  sh2add a0, a0, a1
; RV64ZBA-NEXT:  ret
%c = mul i64 %a, 20
%d = add i64 %c, %b
ret i64 %d
}

```

```

define i64 @addmul24(i64 %a, i64 %b) {
; RV64I-LABEL: addmul24:
; RV64I:
;   # %bb.0:
; RV64I-NEXT:  li a2, 24
; RV64I-NEXT:  mul a0, a0, a2
; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: addmul24:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  sh1add a0, a0, a0
; RV64ZBA-NEXT:  sh3add a0, a0, a1
; RV64ZBA-NEXT:  ret
%c = mul i64 %a, 24
%d = add i64 %c, %b
ret i64 %d
}

```

```

define i64 @addmul36(i64 %a, i64 %b) {
; RV64I-LABEL: addmul36:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a2, 36
; RV64I-NEXT:  mul a0, a0, a2
; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: addmul36:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  sh3add a0, a0, a0
; RV64ZBA-NEXT:  sh2add a0, a0, a1
; RV64ZBA-NEXT:  ret
%c = mul i64 %a, 36
%d = add i64 %c, %b
ret i64 %d
}

```

```
}
```

```
define i64 @addmul40(i64 %a, i64 %b) {  
; RV64I-LABEL: addmul40:  
; RV64I:      # %bb.0:  
; RV64I-NEXT:  li a2, 40  
; RV64I-NEXT:  mul a0, a0, a2  
; RV64I-NEXT:  add a0, a0, a1  
; RV64I-NEXT:  ret  
;  
; RV64ZBA-LABEL: addmul40:  
; RV64ZBA:      # %bb.0:  
;  
RV64ZBA-NEXT:  sh2add a0, a0, a0  
; RV64ZBA-NEXT:  sh3add a0, a0, a1  
; RV64ZBA-NEXT:  ret  
%c = mul i64 %a, 40  
%d = add i64 %c, %b  
ret i64 %d  
}
```

```
define i64 @addmul72(i64 %a, i64 %b) {  
; RV64I-LABEL: addmul72:  
; RV64I:      # %bb.0:  
; RV64I-NEXT:  li a2, 72  
; RV64I-NEXT:  mul a0, a0, a2  
; RV64I-NEXT:  add a0, a0, a1  
; RV64I-NEXT:  ret  
;  
; RV64ZBA-LABEL: addmul72:  
; RV64ZBA:      # %bb.0:  
; RV64ZBA-NEXT:  sh3add a0, a0, a0  
; RV64ZBA-NEXT:  sh3add a0, a0, a1  
; RV64ZBA-NEXT:  ret  
%c = mul i64 %a, 72  
%d = add i64 %c, %b  
ret i64 %d  
}
```

```
define i64 @mul96(i64 %a) {  
; RV64I-LABEL: mul96:  
; RV64I:      # %bb.0:  
; RV64I-NEXT:  li a1, 96  
; RV64I-NEXT:  mul a0, a0, a1  
; RV64I-NEXT:  ret  
;  
; RV64ZBA-LABEL: mul96:  
; RV64ZBA:      # %bb.0:
```

```

; RV64ZBA-NEXT:  sh1add a0, a0, a0
; RV64ZBA-NEXT:  slli a0, a0, 5
; RV64ZBA-NEXT:  ret
%c = mul i64 %a, 96
ret i64 %c
}

```

```

define i64 @mul160(i64 %a) {
; RV64I-LABEL: mul160:
; RV64I:      # %bb.0:
; RV64I-NEXT:
    li a1, 160
; RV64I-NEXT:  mul a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: mul160:
; RV64ZBA:    # %bb.0:
; RV64ZBA-NEXT:  sh2add a0, a0, a0
; RV64ZBA-NEXT:  slli a0, a0, 5
; RV64ZBA-NEXT:  ret
%c = mul i64 %a, 160
ret i64 %c
}

```

```

define i64 @mul288(i64 %a) {
; RV64I-LABEL: mul288:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a1, 288
; RV64I-NEXT:  mul a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: mul288:
; RV64ZBA:    # %bb.0:
; RV64ZBA-NEXT:  sh3add a0, a0, a0
; RV64ZBA-NEXT:  slli a0, a0, 5
; RV64ZBA-NEXT:  ret
%c = mul i64 %a, 288
ret i64 %c
}

```

```

define i64 @zext_mul96(i32 signext %a) {
; RV64I-LABEL: zext_mul96:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a1, 3
; RV64I-NEXT:  slli a1, a1, 37
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  mulhu a0, a0, a1
; RV64I-NEXT:  ret

```

```

;
; RV64ZBA-LABEL: zext_mul96:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  slli.uw a0, a0, 5
; RV64ZBA-NEXT:  sh1add a0, a0, a0
; RV64ZBA-NEXT:  ret
%b = zext
i32 %a to i64
%c = mul i64 %b, 96
ret i64 %c
}

```

```

define i64 @zext_mul160(i32 signext %a) {
; RV64I-LABEL: zext_mul160:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a1, 5
; RV64I-NEXT:  slli a1, a1, 37
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  mulhu a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: zext_mul160:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  slli.uw a0, a0, 5
; RV64ZBA-NEXT:  sh2add a0, a0, a0
; RV64ZBA-NEXT:  ret
%b = zext i32 %a to i64
%c = mul i64 %b, 160
ret i64 %c
}

```

```

define i64 @zext_mul288(i32 signext %a) {
; RV64I-LABEL: zext_mul288:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a1, 9
; RV64I-NEXT:  slli a1, a1, 37
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  mulhu a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: zext_mul288:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  slli.uw a0, a0, 5
; RV64ZBA-NEXT:  sh3add a0, a0, a0
; RV64ZBA-NEXT:  ret
%b = zext i32 %a to i64
%c = mul i64 %b, 288
ret i64 %c

```

```

}

; We can't use slli.uw becaues
the shift amount is more than 31.
; FIXME: The zext.w is unneeded.
define i64 @zext_mul12884901888(i32 signext %a) {
; RV64I-LABEL: zext_mul12884901888:
; RV64I:    # %bb.0:
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  srli a0, a0, 32
; RV64I-NEXT:  li a1, 3
; RV64I-NEXT:  slli a1, a1, 32
; RV64I-NEXT:  mul a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: zext_mul12884901888:
; RV64ZBA:    # %bb.0:
; RV64ZBA-NEXT:  andi a0, a0, -1
; RV64ZBA-NEXT:  sh1add a0, a0, a0
; RV64ZBA-NEXT:  slli a0, a0, 32
; RV64ZBA-NEXT:  ret
%b = zext i32 %a to i64
%c = mul i64 %b, 12884901888
ret i64 %c
}

; We can't use slli.uw becaues the shift amount is more than 31.
; FIXME: The zext.w is unneeded.
define i64 @zext_mul21474836480(i32 signext %a) {
; RV64I-LABEL: zext_mul21474836480:
; RV64I:    # %bb.0:
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  srli a0, a0, 32
; RV64I-NEXT:  li a1, 5
; RV64I-NEXT:  slli a1, a1, 32
; RV64I-NEXT:  mul a0, a0, a1
; RV64I-NEXT:
ret
;
; RV64ZBA-LABEL: zext_mul21474836480:
; RV64ZBA:    # %bb.0:
; RV64ZBA-NEXT:  andi a0, a0, -1
; RV64ZBA-NEXT:  sh2add a0, a0, a0
; RV64ZBA-NEXT:  slli a0, a0, 32
; RV64ZBA-NEXT:  ret
%b = zext i32 %a to i64
%c = mul i64 %b, 21474836480
ret i64 %c

```

```

}

; We can't use slli.uw becaues the shift amount is more than 31.
; FIXME: The zext.w is unneeded.
define i64 @zext_mul38654705664(i32 signext %a) {
; RV64I-LABEL: zext_mul38654705664:
; RV64I:    # %bb.0:
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  srli a0, a0, 32
; RV64I-NEXT:  li a1, 9
; RV64I-NEXT:  slli a1, a1, 32
; RV64I-NEXT:  mul a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: zext_mul38654705664:
; RV64ZBA:    # %bb.0:
; RV64ZBA-NEXT:  andi a0, a0, -1
; RV64ZBA-NEXT:  sh3add a0, a0, a0
; RV64ZBA-NEXT:  slli a0, a0, 32
; RV64ZBA-NEXT:  ret
    %b = zext i32 %a to i64
    %c = mul i64 %b, 38654705664
    ret i64 %c
}

define i64 @sh1add_imm(i64 %0) {
; CHECK-LABEL: sh1add_imm:
;
; CHECK:    # %bb.0:
; CHECK-NEXT:  slli a0, a0, 1
; CHECK-NEXT:  addi a0, a0, 5
; CHECK-NEXT:  ret
    %a = shl i64 %0, 1
    %b = add i64 %a, 5
    ret i64 %b
}

define i64 @sh2add_imm(i64 %0) {
; CHECK-LABEL: sh2add_imm:
; CHECK:    # %bb.0:
; CHECK-NEXT:  slli a0, a0, 2
; CHECK-NEXT:  addi a0, a0, -6
; CHECK-NEXT:  ret
    %a = shl i64 %0, 2
    %b = add i64 %a, -6
    ret i64 %b
}

```



```

define i64 @sh3add_imm(i64 %0) {
; CHECK-LABEL: sh3add_imm:
; CHECK:      # %bb.0:
; CHECK-NEXT:  slli a0, a0, 3
; CHECK-NEXT:  addi a0, a0, 7
; CHECK-NEXT:  ret
    %a = shl i64 %0, 3
    %b = add i64 %a, 7
    ret i64 %b
}

```

```

define i64 @sh1adduw_imm(i32 signext %0) {
; RV64I-LABEL: sh1adduw_imm:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  srli a0, a0, 31
; RV64I-NEXT:  addi a0, a0, 11
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: sh1adduw_imm:
; RV64ZBA:    # %bb.0:
; RV64ZBA-NEXT:  slli.uw a0, a0, 1
; RV64ZBA-NEXT:  addi a0, a0, 11
; RV64ZBA-NEXT:  ret
    %a =
    zext i32 %0 to i64
    %b = shl i64 %a, 1
    %c = add i64 %b, 11
    ret i64 %c
}

```

```

define i64 @sh2adduw_imm(i32 signext %0) {
; RV64I-LABEL: sh2adduw_imm:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  srli a0, a0, 30
; RV64I-NEXT:  addi a0, a0, -12
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: sh2adduw_imm:
; RV64ZBA:    # %bb.0:
; RV64ZBA-NEXT:  slli.uw a0, a0, 2
; RV64ZBA-NEXT:  addi a0, a0, -12
; RV64ZBA-NEXT:  ret
    %a = zext i32 %0 to i64
    %b = shl i64 %a, 2
    %c = add i64 %b, -12
    ret i64 %c
}

```

```
}
```

```
define i64 @sh3adduw_imm(i32 signext %0) {  
; RV64I-LABEL: sh3adduw_imm:  
; RV64I:      # %bb.0:  
; RV64I-NEXT: slli a0, a0, 32  
; RV64I-NEXT: srli a0, a0, 29  
; RV64I-NEXT: addi a0, a0, 13  
; RV64I-NEXT: ret  
;  
; RV64ZBA-LABEL: sh3adduw_imm:  
; RV64ZBA:    # %bb.0:  
; RV64ZBA-NEXT: slli.uw a0, a0, 3  
; RV64ZBA-NEXT: addi a0, a0, 13  
; RV64ZBA-NEXT: ret  
%a = zext i32 %0 to i64  
%b = shl i64 %a, 3  
%c = add i64 %b, 13  
ret i64 %c  
}
```

```
define i64  
@adduw_imm(i32 signext %0) nounwind {  
; RV64I-LABEL: adduw_imm:  
; RV64I:      # %bb.0:  
; RV64I-NEXT: slli a0, a0, 32  
; RV64I-NEXT: srli a0, a0, 32  
; RV64I-NEXT: addi a0, a0, 5  
; RV64I-NEXT: ret  
;  
; RV64ZBA-LABEL: adduw_imm:  
; RV64ZBA:    # %bb.0:  
; RV64ZBA-NEXT: zext.w a0, a0  
; RV64ZBA-NEXT: addi a0, a0, 5  
; RV64ZBA-NEXT: ret  
%a = zext i32 %0 to i64  
%b = add i64 %a, 5  
ret i64 %b  
}
```

```
define i64 @mul258(i64 %a) {  
; CHECK-LABEL: mul258:  
; CHECK:      # %bb.0:  
; CHECK-NEXT: li a1, 258  
; CHECK-NEXT: mul a0, a0, a1  
; CHECK-NEXT: ret  
%c = mul i64 %a, 258  
ret i64 %c
```

```
}
```

```
define i64 @mul260(i64 %a) {  
; CHECK-LABEL: mul260:  
; CHECK:      # %bb.0:  
; CHECK-NEXT:  li a1, 260  
; CHECK-NEXT:  mul a0, a0, a1  
; CHECK-NEXT:  ret  
%c = mul i64 %a, 260  
ret i64 %c  
}
```

```
define i64 @mul264(i64 %a) {  
; CHECK-LABEL: mul264:  
; CHECK:      # %bb.0:  
; CHECK-NEXT:  li a1, 264  
; CHECK-NEXT:  mul a0, a0, a1  
; CHECK-NEXT:  ret  
%c = mul i64 %a, 264  
ret i64  
%c  
}
```

```
define i64 @imm_zextw() nounwind {  
; RV64I-LABEL: imm_zextw:  
; RV64I:      # %bb.0:  
; RV64I-NEXT:  li a0, 1  
; RV64I-NEXT:  slli a0, a0, 32  
; RV64I-NEXT:  addi a0, a0, -2  
; RV64I-NEXT:  ret  
;  
; RV64ZBA-LABEL: imm_zextw:  
; RV64ZBA:     # %bb.0:  
; RV64ZBA-NEXT:  li a0, -2  
; RV64ZBA-NEXT:  zext.w a0, a0  
; RV64ZBA-NEXT:  ret  
ret i64 4294967294 ; -2 in 32 bits.  
}
```

```
define i64 @mul11(i64 %a) {  
; RV64I-LABEL: mul11:  
; RV64I:      # %bb.0:  
; RV64I-NEXT:  li a1, 11  
; RV64I-NEXT:  mul a0, a0, a1  
; RV64I-NEXT:  ret  
;  
; RV64ZBA-LABEL: mul11:  
; RV64ZBA:     # %bb.0:
```

```
; RV64ZBA-NEXT:  sh2add a1, a0, a0
; RV64ZBA-NEXT:  sh1add a0, a1, a0
; RV64ZBA-NEXT:  ret
%c = mul i64 %a, 11
ret i64 %c
}
```

```
define i64 @mul19(i64 %a) {
; RV64I-LABEL: mul19:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a1, 19
; RV64I-NEXT:  mul a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: mul19:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  sh3add a1, a0, a0
; RV64ZBA-NEXT:  sh1add a0,
a1, a0
; RV64ZBA-NEXT:  ret
%c = mul i64 %a, 19
ret i64 %c
}
```

```
define i64 @mul13(i64 %a) {
; RV64I-LABEL: mul13:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a1, 13
; RV64I-NEXT:  mul a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: mul13:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  sh1add a1, a0, a0
; RV64ZBA-NEXT:  sh2add a0, a1, a0
; RV64ZBA-NEXT:  ret
%c = mul i64 %a, 13
ret i64 %c
}
```

```
define i64 @mul21(i64 %a) {
; RV64I-LABEL: mul21:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a1, 21
; RV64I-NEXT:  mul a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: mul21:
```

```
; RV64ZBA:    # %bb.0:
; RV64ZBA-NEXT:  sh2add a1, a0, a0
; RV64ZBA-NEXT:  sh2add a0, a1, a0
; RV64ZBA-NEXT:  ret
%c = mul i64 %a, 21
ret i64 %c
}
```

```
define i64 @mul37(i64 %a) {
; RV64I-LABEL: mul37:
; RV64I:    # %bb.0:
; RV64I-NEXT:  li a1, 37
; RV64I-NEXT:  mul a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: mul37:
; RV64ZBA:    # %bb.0:
; RV64ZBA-NEXT:  sh3add a1, a0, a0
; RV64ZBA-NEXT:
    sh2add a0, a1, a0
; RV64ZBA-NEXT:  ret
%c = mul i64 %a, 37
ret i64 %c
}
```

```
define i64 @mul25(i64 %a) {
; RV64I-LABEL: mul25:
; RV64I:    # %bb.0:
; RV64I-NEXT:  li a1, 25
; RV64I-NEXT:  mul a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: mul25:
; RV64ZBA:    # %bb.0:
; RV64ZBA-NEXT:  sh1add a1, a0, a0
; RV64ZBA-NEXT:  sh3add a0, a1, a0
; RV64ZBA-NEXT:  ret
%c = mul i64 %a, 25
ret i64 %c
}
```

```
define i64 @mul41(i64 %a) {
; RV64I-LABEL: mul41:
; RV64I:    # %bb.0:
; RV64I-NEXT:  li a1, 41
; RV64I-NEXT:  mul a0, a0, a1
; RV64I-NEXT:  ret
;
;
```

```

; RV64ZBA-LABEL: mul41:
; RV64ZBA:    # %bb.0:
; RV64ZBA-NEXT:  sh2add a1, a0, a0
; RV64ZBA-NEXT:  sh3add a0, a1, a0
; RV64ZBA-NEXT:  ret
%c = mul i64 %a, 41
ret i64 %c
}

```

```

define i64 @mul73(i64 %a) {
; RV64I-LABEL: mul73:
; RV64I:    # %bb.0:
; RV64I-NEXT:  li a1, 73
; RV64I-NEXT:  mul a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: mul73:
; RV64ZBA:    # %bb.0:
; RV64ZBA-NEXT:  sh3add
a1, a0, a0
; RV64ZBA-NEXT:  sh3add a0, a1, a0
; RV64ZBA-NEXT:  ret
%c = mul i64 %a, 73
ret i64 %c
}

```

```

define i64 @mul27(i64 %a) {
; RV64I-LABEL: mul27:
; RV64I:    # %bb.0:
; RV64I-NEXT:  li a1, 27
; RV64I-NEXT:  mul a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: mul27:
; RV64ZBA:    # %bb.0:
; RV64ZBA-NEXT:  sh3add a0, a0, a0
; RV64ZBA-NEXT:  sh1add a0, a0, a0
; RV64ZBA-NEXT:  ret
%c = mul i64 %a, 27
ret i64 %c
}

```

```

define i64 @mul45(i64 %a) {
; RV64I-LABEL: mul45:
; RV64I:    # %bb.0:
; RV64I-NEXT:  li a1, 45
; RV64I-NEXT:  mul a0, a0, a1
; RV64I-NEXT:  ret

```

```

;
; RV64ZBA-LABEL: mul45:
; RV64ZBA:    # %bb.0:
; RV64ZBA-NEXT:  sh3add a0, a0, a0
; RV64ZBA-NEXT:  sh2add a0, a0, a0
; RV64ZBA-NEXT:  ret
%c = mul i64 %a, 45
ret i64 %c
}

```

```

define i64 @mul81(i64 %a) {
; RV64I-LABEL: mul81:
; RV64I:    # %bb.0:
; RV64I-NEXT:  li a1, 81
; RV64I-NEXT:  mul a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: mul81:
; RV64ZBA:    # %bb.0:
;
RV64ZBA-NEXT:  sh3add a0, a0, a0
; RV64ZBA-NEXT:  sh3add a0, a0, a0
; RV64ZBA-NEXT:  ret
%c = mul i64 %a, 81
ret i64 %c
}

```

```

define i64 @mul4098(i64 %a) {
; RV64I-LABEL: mul4098:
; RV64I:    # %bb.0:
; RV64I-NEXT:  slli a1, a0, 1
; RV64I-NEXT:  slli a0, a0, 12
; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: mul4098:
; RV64ZBA:    # %bb.0:
; RV64ZBA-NEXT:  slli a1, a0, 12
; RV64ZBA-NEXT:  sh1add a0, a0, a1
; RV64ZBA-NEXT:  ret
%c = mul i64 %a, 4098
ret i64 %c
}

```

```

define i64 @mul4100(i64 %a) {
; RV64I-LABEL: mul4100:
; RV64I:    # %bb.0:
; RV64I-NEXT:  slli a1, a0, 2

```

```

; RV64I-NEXT:  slli a0, a0, 12
; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: mul4100:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  slli a1, a0, 12
; RV64ZBA-NEXT:  sh2add a0, a0, a1
; RV64ZBA-NEXT:  ret
%c = mul i64 %a, 4100
ret i64 %c
}

```

```

define i64 @mul4104(i64 %a) {
; RV64I-LABEL: mul4104:
; RV64I:        # %bb.0:
; RV64I-NEXT:
    slli a1, a0, 3
; RV64I-NEXT:  slli a0, a0, 12
; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: mul4104:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  slli a1, a0, 12
; RV64ZBA-NEXT:  sh3add a0, a0, a1
; RV64ZBA-NEXT:  ret
%c = mul i64 %a, 4104
ret i64 %c
}

```

```

define signext i32 @mulw192(i32 signext %a) {
; CHECK-LABEL: mulw192:
; CHECK:       # %bb.0:
; CHECK-NEXT:  li a1, 192
; CHECK-NEXT:  mulw a0, a0, a1
; CHECK-NEXT:  ret
%c = mul i32 %a, 192
ret i32 %c
}

```

```

define signext i32 @mulw320(i32 signext %a) {
; CHECK-LABEL: mulw320:
; CHECK:       # %bb.0:
; CHECK-NEXT:  li a1, 320
; CHECK-NEXT:  mulw a0, a0, a1
; CHECK-NEXT:  ret
%c = mul i32 %a, 320
}

```



```

ret i32 %c
}

define signext i32 @mulw576(i32 signext %a) {
; CHECK-LABEL: mulw576:
; CHECK:      # %bb.0:
; CHECK-NEXT:  li a1, 576
; CHECK-NEXT:  mulw a0, a0, a1
; CHECK-NEXT:  ret
%c = mul i32 %a, 576
ret i32 %c
}

define i64 @add4104(i64 %a) {
; RV64I-LABEL: add4104:
; RV64I:
;   # %bb.0:
; RV64I-NEXT:  lui a1, 1
; RV64I-NEXT:  addiw a1, a1, 8
; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: add4104:
; RV64ZBA:    # %bb.0:
; RV64ZBA-NEXT:  li a1, 1026
; RV64ZBA-NEXT:  sh2add a0, a1, a0
; RV64ZBA-NEXT:  ret
%c = add i64 %a, 4104
ret i64 %c
}

define i64 @add8208(i64 %a) {
; RV64I-LABEL: add8208:
; RV64I:    # %bb.0:
; RV64I-NEXT:  lui a1, 2
; RV64I-NEXT:  addiw a1, a1, 16
; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: add8208:
; RV64ZBA:    # %bb.0:
; RV64ZBA-NEXT:  li a1, 1026
; RV64ZBA-NEXT:  sh3add a0, a1, a0
; RV64ZBA-NEXT:  ret
%c = add i64 %a, 8208
ret i64 %c
}

```

```

; Make sure we prefer LUI for the 8192 instead of using sh3add.
define signext i32 @add8192_i32(i32 signext %a) {
; CHECK-LABEL: add8192_i32:
; CHECK:      # %bb.0:
; CHECK-NEXT: lui a1, 2
; CHECK-NEXT: addw a0, a0, a1
; CHECK-NEXT: ret
%c = add i32 %a, 8192
ret i32 %c
}

; Make sure we prefer LUI
for the 8192 instead of using sh3add.
define i64 @add8192(i64 %a) {
; CHECK-LABEL: add8192:
; CHECK:      # %bb.0:
; CHECK-NEXT: lui a1, 2
; CHECK-NEXT: add a0, a0, a1
; CHECK-NEXT: ret
%c = add i64 %a, 8192
ret i64 %c
}

define signext i32 @addshl32_5_6(i32 signext %a, i32 signext %b) {
; RV64I-LABEL: addshl32_5_6:
; RV64I:      # %bb.0:
; RV64I-NEXT: slli a0, a0, 5
; RV64I-NEXT: slli a1, a1, 6
; RV64I-NEXT: addw a0, a0, a1
; RV64I-NEXT: ret
;
; RV64ZBA-LABEL: addshl32_5_6:
; RV64ZBA:    # %bb.0:
; RV64ZBA-NEXT: sh1add a0, a1, a0
; RV64ZBA-NEXT: slliw a0, a0, 5
; RV64ZBA-NEXT: ret
%c = shl i32 %a, 5
%d = shl i32 %b, 6
%e = add i32 %c, %d
ret i32 %e
}

define i64 @addshl64_5_6(i64 %a, i64 %b) {
; RV64I-LABEL: addshl64_5_6:
; RV64I:      # %bb.0:
; RV64I-NEXT: slli a0, a0, 5
; RV64I-NEXT: slli a1, a1, 6
; RV64I-NEXT: add a0, a0, a1

```

```

; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: addshl64_5_6:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:
    sh1add a0, a1, a0
; RV64ZBA-NEXT:  slli a0, a0, 5
; RV64ZBA-NEXT:  ret
%c = shl i64 %a, 5
%d = shl i64 %b, 6
%e = add i64 %c, %d
ret i64 %e
}

define signext i32 @addshl32_5_7(i32 signext %a, i32 signext %b) {
; RV64I-LABEL: addshl32_5_7:
; RV64I:        # %bb.0:
; RV64I-NEXT:   slli a0, a0, 5
; RV64I-NEXT:   slli a1, a1, 7
; RV64I-NEXT:   addw a0, a0, a1
; RV64I-NEXT:   ret
;
; RV64ZBA-LABEL: addshl32_5_7:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  sh2add a0, a1, a0
; RV64ZBA-NEXT:  slliw a0, a0, 5
; RV64ZBA-NEXT:  ret
%c = shl i32 %a, 5
%d = shl i32 %b, 7
%e = add i32 %c, %d
ret i32 %e
}

define i64 @addshl64_5_7(i64 %a, i64 %b) {
; RV64I-LABEL: addshl64_5_7:
; RV64I:        # %bb.0:
; RV64I-NEXT:   slli a0, a0, 5
; RV64I-NEXT:   slli a1, a1, 7
; RV64I-NEXT:   add a0, a0, a1
; RV64I-NEXT:   ret
;
; RV64ZBA-LABEL: addshl64_5_7:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  sh2add a0, a1, a0
; RV64ZBA-NEXT:  slli a0, a0, 5
; RV64ZBA-NEXT:  ret
%c

```

```

= shl i64 %a, 5
%d = shl i64 %b, 7
%e = add i64 %c, %d
ret i64 %e
}

define signext i32 @addshl32_5_8(i32 signext %a, i32 signext %b) {
; RV64I-LABEL: addshl32_5_8:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a0, a0, 5
; RV64I-NEXT:  slli a1, a1, 8
; RV64I-NEXT:  addw a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: addshl32_5_8:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  sh3add a0, a1, a0
; RV64ZBA-NEXT:  slliw a0, a0, 5
; RV64ZBA-NEXT:  ret
%c = shl i32 %a, 5
%d = shl i32 %b, 8
%e = add i32 %c, %d
ret i32 %e
}

define i64 @addshl64_5_8(i64 %a, i64 %b) {
; RV64I-LABEL: addshl64_5_8:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a0, a0, 5
; RV64I-NEXT:  slli a1, a1, 8
; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: addshl64_5_8:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  sh3add a0, a1, a0
; RV64ZBA-NEXT:  slli a0, a0, 5
; RV64ZBA-NEXT:  ret
%c = shl i64 %a, 5
%d = shl i64 %b, 8
%e = add i64 %c, %d
ret i64 %e
}

; Make
sure we use sext.h+slli+srli for Zba+Zbb.
; FIXME: The RV64I and Zba only cases can be done with only 3 shifts.
define zeroext i32 @sext_ashr_zext_i8(i8 %a) nounwind {

```

```

; RV64I-LABEL: sext_ashr_zext_i8:
; RV64I:    # %bb.0:
; RV64I-NEXT:  slli a0, a0, 24
; RV64I-NEXT:  sraiw a0, a0, 31
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  srli a0, a0, 32
; RV64I-NEXT:  ret
;
; RV64ZBANOBZBB-LABEL: sext_ashr_zext_i8:
; RV64ZBANOBZBB:    # %bb.0:
; RV64ZBANOBZBB-NEXT:  slli a0, a0, 24
; RV64ZBANOBZBB-NEXT:  sraiw a0, a0, 31
; RV64ZBANOBZBB-NEXT:  zext.w a0, a0
; RV64ZBANOBZBB-NEXT:  ret
;
; RV64ZBAZBB-LABEL: sext_ashr_zext_i8:
; RV64ZBAZBB:    # %bb.0:
; RV64ZBAZBB-NEXT:  sext.b a0, a0
; RV64ZBAZBB-NEXT:  sraiw a0, a0, 9
; RV64ZBAZBB-NEXT:  zext.w a0, a0
; RV64ZBAZBB-NEXT:  ret
%ext = sext i8 %a to i32
%1 = ashr i32 %ext, 9
ret i32 %1
}

; Make sure we use sext.h+slli+srli for Zba+Zbb.
; FIXME: The RV64I and Zba only cases can be done with only 3 shifts.
define
  zeroext i32 @sext_ashr_zext_i16(i16 %a) nounwind {
; RV64I-LABEL: sext_ashr_zext_i16:
; RV64I:    # %bb.0:
; RV64I-NEXT:  slli a0, a0, 16
; RV64I-NEXT:  sraiw a0, a0, 25
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  srli a0, a0, 32
; RV64I-NEXT:  ret
;
; RV64ZBANOBZBB-LABEL: sext_ashr_zext_i16:
; RV64ZBANOBZBB:    # %bb.0:
; RV64ZBANOBZBB-NEXT:  slli a0, a0, 16
; RV64ZBANOBZBB-NEXT:  sraiw a0, a0, 25
; RV64ZBANOBZBB-NEXT:  zext.w a0, a0
; RV64ZBANOBZBB-NEXT:  ret
;
; RV64ZBAZBB-LABEL: sext_ashr_zext_i16:
; RV64ZBAZBB:    # %bb.0:
; RV64ZBAZBB-NEXT:  slli a0, a0, 48

```

```

; RV64ZBAZBB-NEXT:  srai a0, a0, 57
; RV64ZBAZBB-NEXT:  zext.w a0, a0
; RV64ZBAZBB-NEXT:  ret
%ext = sext i16 %a to i32
%1 = ashr i32 %ext, 9
ret i32 %1
}

```

; This the IR you get from InstCombine if take the difference of 2 pointers and  
; cast is to unsigned before using as an index.

```

define signext i16 @sh1adduw_ptrdiff(i64 %diff, ptr %baseptr) {

```

```

; RV64I-LABEL: sh1adduw_ptrdiff:

```

```

; RV64I:

```

```

    # %bb.0:

```

```

; RV64I-NEXT:  li a2, 1

```

```

; RV64I-NEXT:  slli a2, a2, 33

```

```

; RV64I-NEXT:  addi a2, a2, -2

```

```

; RV64I-NEXT:  and a0, a0, a2

```

```

; RV64I-NEXT:  add a0, a1, a0

```

```

; RV64I-NEXT:  lh a0, 0(a0)

```

```

; RV64I-NEXT:  ret

```

```

;

```

```

; RV64ZBA-LABEL: sh1adduw_ptrdiff:

```

```

; RV64ZBA:    # %bb.0:

```

```

; RV64ZBA-NEXT:  srli a0, a0, 1

```

```

; RV64ZBA-NEXT:  sh1add.uw a0, a0, a1

```

```

; RV64ZBA-NEXT:  lh a0, 0(a0)

```

```

; RV64ZBA-NEXT:  ret

```

```

%ptrdiff = lshr exact i64 %diff, 1

```

```

%cast = and i64 %ptrdiff, 4294967295

```

```

%ptr = getelementptr inbounds i16, ptr %baseptr, i64 %cast

```

```

%res = load i16, ptr %ptr

```

```

ret i16 %res

```

```

}

```

```

define signext i32 @sh2adduw_ptrdiff(i64 %diff, ptr %baseptr) {

```

```

; RV64I-LABEL: sh2adduw_ptrdiff:

```

```

; RV64I:    # %bb.0:

```

```

; RV64I-NEXT:  li a2, 1

```

```

; RV64I-NEXT:  slli a2, a2, 34

```

```

; RV64I-NEXT:  addi a2, a2, -4

```

```

; RV64I-NEXT:  and a0, a0, a2

```

```

; RV64I-NEXT:  add a0, a1, a0

```

```

; RV64I-NEXT:  lw a0, 0(a0)

```

```

; RV64I-NEXT:  ret

```

```

;

```

```

; RV64ZBA-LABEL: sh2adduw_ptrdiff:

```

```

; RV64ZBA:    # %bb.0:

```

```

; RV64ZBA-NEXT:
    srli a0, a0, 2
; RV64ZBA-NEXT:  sh2add.uw a0, a0, a1
; RV64ZBA-NEXT:  lw a0, 0(a0)
; RV64ZBA-NEXT:  ret
%ptrdiff = lshr exact i64 %diff, 2
%cast = and i64 %ptrdiff, 4294967295
%ptr = getelementptr inbounds i32, ptr %baseptr, i64 %cast
%res = load i32, ptr %ptr
ret i32 %res
}

```

```

define i64 @sh3adduw_ptrdiff(i64 %diff, ptr %baseptr) {
; RV64I-LABEL: sh3adduw_ptrdiff:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a2, 1
; RV64I-NEXT:  slli a2, a2, 35
; RV64I-NEXT:  addi a2, a2, -8
; RV64I-NEXT:  and a0, a0, a2
; RV64I-NEXT:  add a0, a1, a0
; RV64I-NEXT:  ld a0, 0(a0)
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: sh3adduw_ptrdiff:
; RV64ZBA:    # %bb.0:
; RV64ZBA-NEXT:  srli a0, a0, 3
; RV64ZBA-NEXT:  sh3add.uw a0, a0, a1
; RV64ZBA-NEXT:  ld a0, 0(a0)
; RV64ZBA-NEXT:  ret
%ptrdiff = lshr exact i64 %diff, 3
%cast = and i64 %ptrdiff, 4294967295
%ptr = getelementptr inbounds i64, ptr %baseptr, i64 %cast
%res = load i64, ptr %ptr
ret i64 %res
}

```

```

define signext
i16 @srliw_1_sh1add(ptr %0, i32 signext %1) {
; RV64I-LABEL: srliw_1_sh1add:
; RV64I:      # %bb.0:
; RV64I-NEXT:  srliw a1, a1, 1
; RV64I-NEXT:  slli a1, a1, 1
; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  lh a0, 0(a0)
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: srliw_1_sh1add:
; RV64ZBA:    # %bb.0:

```

```

; RV64ZBA-NEXT:  srliw a1, a1, 1
; RV64ZBA-NEXT:  sh1add a0, a1, a0
; RV64ZBA-NEXT:  lh a0, 0(a0)
; RV64ZBA-NEXT:  ret
%3 = lshr i32 %1, 1
%4 = zext i32 %3 to i64
%5 = getelementptr inbounds i16, ptr %0, i64 %4
%6 = load i16, ptr %5, align 2
ret i16 %6
}

define i128 @slliuw_ptrdiff(i64 %diff, ptr %baseptr) {
; RV64I-LABEL: slliuw_ptrdiff:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a2, 1
; RV64I-NEXT:  slli a2, a2, 36
; RV64I-NEXT:  addi a2, a2, -16
; RV64I-NEXT:  and a0, a0, a2
; RV64I-NEXT:  add a1, a1, a0
; RV64I-NEXT:  ld a0, 0(a1)
; RV64I-NEXT:  ld a1, 8(a1)
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: slliuw_ptrdiff:
; RV64ZBA:    # %bb.0:
;
RV64ZBA-NEXT:  srli a0, a0, 4
; RV64ZBA-NEXT:  slli.uw a0, a0, 4
; RV64ZBA-NEXT:  add a1, a1, a0
; RV64ZBA-NEXT:  ld a0, 0(a1)
; RV64ZBA-NEXT:  ld a1, 8(a1)
; RV64ZBA-NEXT:  ret
%ptrdiff = lshr exact i64 %diff, 4
%cast = and i64 %ptrdiff, 4294967295
%ptr = getelementptr inbounds i128, ptr %baseptr, i64 %cast
%res = load i128, ptr %ptr
ret i128 %res
}

define signext i32 @srliw_2_sh2add(ptr %0, i32 signext %1) {
; RV64I-LABEL: srliw_2_sh2add:
; RV64I:      # %bb.0:
; RV64I-NEXT:  srliw a1, a1, 2
; RV64I-NEXT:  slli a1, a1, 2
; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  lw a0, 0(a0)
; RV64I-NEXT:  ret
;

```



```

; RV64ZBA-LABEL: srlw_2_sh2add:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT: srlw a1, a1, 2
; RV64ZBA-NEXT: sh2add a0, a1, a0
; RV64ZBA-NEXT: lw a0, 0(a0)
; RV64ZBA-NEXT: ret
%3 = lshr i32 %1, 2
%4 = zext i32 %3 to i64
%5 = getelementptr inbounds i32, ptr %0, i64 %4
%6 = load i32, ptr %5, align 4
ret i32 %6
}

```

```

define i64 @srlw_3_sh3add(ptr
%0, i32 signext %1) {
; RV64I-LABEL: srlw_3_sh3add:
; RV64I:      # %bb.0:
; RV64I-NEXT: srlw a1, a1, 3
; RV64I-NEXT: slli a1, a1, 3
; RV64I-NEXT: add a0, a0, a1
; RV64I-NEXT: ld a0, 0(a0)
; RV64I-NEXT: ret
;
; RV64ZBA-LABEL: srlw_3_sh3add:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT: srlw a1, a1, 3
; RV64ZBA-NEXT: sh3add a0, a1, a0
; RV64ZBA-NEXT: ld a0, 0(a0)
; RV64ZBA-NEXT: ret
%3 = lshr i32 %1, 3
%4 = zext i32 %3 to i64
%5 = getelementptr inbounds i64, ptr %0, i64 %4
%6 = load i64, ptr %5, align 8
ret i64 %6
}

```

```

define signext i32 @srlw_1_sh2add(ptr %0, i32 signext %1) {
; RV64I-LABEL: srlw_1_sh2add:
; RV64I:      # %bb.0:
; RV64I-NEXT: srlw a1, a1, 1
; RV64I-NEXT: slli a1, a1, 32
; RV64I-NEXT: srli a1, a1, 30
; RV64I-NEXT: add a0, a0, a1
; RV64I-NEXT: lw a0, 0(a0)
; RV64I-NEXT: ret
;
; RV64ZBA-LABEL: srlw_1_sh2add:
; RV64ZBA:      # %bb.0:

```

```

; RV64ZBA-NEXT:  srlw a1, a1, 1
; RV64ZBA-NEXT:  sh2add a0, a1, a0
;
RV64ZBA-NEXT:  lw a0, 0(a0)
; RV64ZBA-NEXT:  ret
%3 = lshr i32 %1, 1
%4 = zext i32 %3 to i64
%5 = getelementptr inbounds i32, ptr %0, i64 %4
%6 = load i32, ptr %5, align 4
ret i32 %6
}

define i64 @srlw_1_sh3add(ptr %0, i32 signext %1) {
; RV64I-LABEL: srlw_1_sh3add:
; RV64I:      # %bb.0:
; RV64I-NEXT:  srlw a1, a1, 1
; RV64I-NEXT:  slli a1, a1, 32
; RV64I-NEXT:  srli a1, a1, 29
; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  ld a0, 0(a0)
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: srlw_1_sh3add:
; RV64ZBA:    # %bb.0:
; RV64ZBA-NEXT:  srlw a1, a1, 1
; RV64ZBA-NEXT:  sh3add a0, a1, a0
; RV64ZBA-NEXT:  ld a0, 0(a0)
; RV64ZBA-NEXT:  ret
%3 = lshr i32 %1, 1
%4 = zext i32 %3 to i64
%5 = getelementptr inbounds i64, ptr %0, i64 %4
%6 = load i64, ptr %5, align 8
ret i64 %6
}

define i64 @srlw_2_sh3add(ptr %0, i32 signext %1) {
; RV64I-LABEL: srlw_2_sh3add:
; RV64I:      # %bb.0:
; RV64I-NEXT:  srlw a1, a1, 2
; RV64I-NEXT:  slli a1, a1, 32
;
RV64I-NEXT:  srli a1, a1, 29
; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  ld a0, 0(a0)
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: srlw_2_sh3add:
; RV64ZBA:    # %bb.0:

```

```

; RV64ZBA-NEXT:  srlw a1, a1, 2
; RV64ZBA-NEXT:  sh3add a0, a1, a0
; RV64ZBA-NEXT:  ld a0, 0(a0)
; RV64ZBA-NEXT:  ret
%3 = lshr i32 %1, 2
%4 = zext i32 %3 to i64
%5 = getelementptr inbounds i64, ptr %0, i64 %4
%6 = load i64, ptr %5, align 8
ret i64 %6
}

```

```

define signext i16 @srlw_2_sh1add(ptr %0, i32 signext %1) {
; RV64I-LABEL: srlw_2_sh1add:
; RV64I:      # %bb.0:
; RV64I-NEXT:  srlw a1, a1, 2
; RV64I-NEXT:  slli a1, a1, 32
; RV64I-NEXT:  srli a1, a1, 31
; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  lh a0, 0(a0)
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: srlw_2_sh1add:
; RV64ZBA:    # %bb.0:
; RV64ZBA-NEXT:  srlw a1, a1, 2
; RV64ZBA-NEXT:  sh1add a0, a1, a0
; RV64ZBA-NEXT:  lh a0, 0(a0)
; RV64ZBA-NEXT:  ret
%3 = lshr i32 %1, 2
%4 = zext i32 %3 to i64
%5 = getelementptr
inbounds i16, ptr %0, i64 %4
%6 = load i16, ptr %5, align 2
ret i16 %6
}

```

```

define signext i32 @srlw_3_sh2add(ptr %0, i32 signext %1) {
; RV64I-LABEL: srlw_3_sh2add:
; RV64I:      # %bb.0:
; RV64I-NEXT:  srlw a1, a1, 3
; RV64I-NEXT:  slli a1, a1, 32
; RV64I-NEXT:  srli a1, a1, 30
; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  lw a0, 0(a0)
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: srlw_3_sh2add:
; RV64ZBA:    # %bb.0:

```

```

; RV64ZBA-NEXT:  srlw a1, a1, 3
; RV64ZBA-NEXT:  sh2add a0, a1, a0
; RV64ZBA-NEXT:  lw a0, 0(a0)
; RV64ZBA-NEXT:  ret
%3 = lshr i32 %1, 3
%4 = zext i32 %3 to i64
%5 = getelementptr inbounds i32, ptr %0, i64 %4
%6 = load i32, ptr %5, align 4
ret i32 %6
}

```

```

define i64 @srlw_4_sh3add(ptr %0, i32 signext %1) {
; RV64I-LABEL: srlw_4_sh3add:
; RV64I:      # %bb.0:
; RV64I-NEXT:  srlw a1, a1, 4
; RV64I-NEXT:  slli a1, a1, 32
; RV64I-NEXT:  srli a1, a1, 29
; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  ld a0, 0(a0)
; RV64I-NEXT:
    ret
;
; RV64ZBA-LABEL: srlw_4_sh3add:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  srlw a1, a1, 4
; RV64ZBA-NEXT:  sh3add a0, a1, a0
; RV64ZBA-NEXT:  ld a0, 0(a0)
; RV64ZBA-NEXT:  ret
%3 = lshr i32 %1, 4
%4 = zext i32 %3 to i64
%5 = getelementptr inbounds i64, ptr %0, i64 %4
%6 = load i64, ptr %5, align 8
ret i64 %6
}

```

```

define signext i32 @srli_1_sh2add(ptr %0, i64 %1) {
; RV64I-LABEL: srli_1_sh2add:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a1, a1, 1
; RV64I-NEXT:  andi a1, a1, -4
; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  lw a0, 0(a0)
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: srli_1_sh2add:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  srli a1, a1, 1
; RV64ZBA-NEXT:  sh2add a0, a1, a0

```

```
; RV64ZBA-NEXT:  lw a0, 0(a0)
; RV64ZBA-NEXT:  ret
%3 = lshr i64 %1, 1
%4 = getelementptr inbounds i32, ptr %0, i64 %3
%5 = load i32, ptr %4, align 4
ret i32 %5
}
```

```
define i64 @srli_2_sh3add(ptr %0, i64 %1) {
; RV64I-LABEL: srli_2_sh3add:
; RV64I:      # %bb.0:
;
RV64I-NEXT:  slli a1, a1, 1
; RV64I-NEXT:  andi a1, a1, -8
; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  ld a0, 0(a0)
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: srli_2_sh3add:
; RV64ZBA:    # %bb.0:
; RV64ZBA-NEXT:  srli a1, a1, 2
; RV64ZBA-NEXT:  sh3add a0, a1, a0
; RV64ZBA-NEXT:  ld a0, 0(a0)
; RV64ZBA-NEXT:  ret
%3 = lshr i64 %1, 2
%4 = getelementptr inbounds i64, ptr %0, i64 %3
%5 = load i64, ptr %4, align 8
ret i64 %5
}
```

```
define signext i16 @srli_2_sh1add(ptr %0, i64 %1) {
; RV64I-LABEL: srli_2_sh1add:
; RV64I:      # %bb.0:
; RV64I-NEXT:  srli a1, a1, 1
; RV64I-NEXT:  andi a1, a1, -2
; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  lh a0, 0(a0)
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: srli_2_sh1add:
; RV64ZBA:    # %bb.0:
; RV64ZBA-NEXT:  srli a1, a1, 2
; RV64ZBA-NEXT:  sh1add a0, a1, a0
; RV64ZBA-NEXT:  lh a0, 0(a0)
; RV64ZBA-NEXT:  ret
%3 = lshr i64 %1, 2
%4 = getelementptr inbounds i16, ptr %0, i64 %3
%5 = load i16, ptr %4, align
```

```

2
ret i16 %5
}

define signext i32 @srli_3_sh2add(ptr %0, i64 %1) {
; RV64I-LABEL: srli_3_sh2add:
; RV64I:      # %bb.0:
; RV64I-NEXT: srli a1, a1, 1
; RV64I-NEXT: andi a1, a1, -4
; RV64I-NEXT: add a0, a0, a1
; RV64I-NEXT: lw a0, 0(a0)
; RV64I-NEXT: ret
;
; RV64ZBA-LABEL: srli_3_sh2add:
; RV64ZBA:    # %bb.0:
; RV64ZBA-NEXT: srli a1, a1, 3
; RV64ZBA-NEXT: sh2add a0, a1, a0
; RV64ZBA-NEXT: lw a0, 0(a0)
; RV64ZBA-NEXT: ret
%3 = lshr i64 %1, 3
%4 = getelementptr inbounds i32, ptr %0, i64 %3
%5 = load i32, ptr %4, align 4
ret i32 %5
}

define i64 @srli_4_sh3add(ptr %0, i64 %1) {
; RV64I-LABEL: srli_4_sh3add:
; RV64I:      # %bb.0:
; RV64I-NEXT: srli a1, a1, 1
; RV64I-NEXT: andi a1, a1, -8
; RV64I-NEXT: add a0, a0, a1
; RV64I-NEXT: ld a0, 0(a0)
; RV64I-NEXT: ret
;
; RV64ZBA-LABEL: srli_4_sh3add:
; RV64ZBA:    # %bb.0:
; RV64ZBA-NEXT: srli a1, a1, 4
; RV64ZBA-NEXT: sh3add a0, a1, a0
; RV64ZBA-NEXT: ld a0, 0(a0)
; RV64ZBA-NEXT:
ret
%3 = lshr i64 %1, 4
%4 = getelementptr inbounds i64, ptr %0, i64 %3
%5 = load i64, ptr %4, align 8
ret i64 %5
}

define signext i16 @shl_2_sh1add(ptr %0, i32 signext %1) {

```

```

; RV64I-LABEL: shl_2_sh1add:
; RV64I:    # %bb.0:
; RV64I-NEXT:  slli a1, a1, 2
; RV64I-NEXT:  slli a1, a1, 32
; RV64I-NEXT:  srli a1, a1, 31
; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  lh a0, 0(a0)
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: shl_2_sh1add:
; RV64ZBA:    # %bb.0:
; RV64ZBA-NEXT:  slli a1, a1, 2
; RV64ZBA-NEXT:  zext.w a1, a1
; RV64ZBA-NEXT:  sh1add a0, a1, a0
; RV64ZBA-NEXT:  lh a0, 0(a0)
; RV64ZBA-NEXT:  ret
%3 = shl i32 %1, 2
%4 = zext i32 %3 to i64
%5 = getelementptr inbounds i16, ptr %0, i64 %4
%6 = load i16, ptr %5, align 2
ret i16 %6
}

define signext i32 @shl_16_sh2add(ptr %0, i32 signext %1) {
; RV64I-LABEL: shl_16_sh2add:
; RV64I:    # %bb.0:
; RV64I-NEXT:  slli a1, a1, 16
; RV64I-NEXT:  slli a1, a1, 32
; RV64I-NEXT:  srli a1, a1, 30
;
; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  lw a0, 0(a0)
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: shl_16_sh2add:
; RV64ZBA:    # %bb.0:
; RV64ZBA-NEXT:  slli a1, a1, 16
; RV64ZBA-NEXT:  zext.w a1, a1
; RV64ZBA-NEXT:  sh2add a0, a1, a0
; RV64ZBA-NEXT:  lw a0, 0(a0)
; RV64ZBA-NEXT:  ret
%3 = shl i32 %1, 16
%4 = zext i32 %3 to i64
%5 = getelementptr inbounds i32, ptr %0, i64 %4
%6 = load i32, ptr %5, align 4
ret i32 %6
}

```

```

define i64 @shl_31_sh3add(ptr %0, i32 signext %1) {
; RV64I-LABEL: shl_31_sh3add:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a1, a1, 31
; RV64I-NEXT:  slli a1, a1, 32
; RV64I-NEXT:  srli a1, a1, 29
; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  ld a0, 0(a0)
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: shl_31_sh3add:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  slli a1, a1, 31
; RV64ZBA-NEXT:  zext.w a1, a1
; RV64ZBA-NEXT:  sh3add a0, a1, a0
; RV64ZBA-NEXT:  ld a0, 0(a0)
; RV64ZBA-NEXT:  ret
%3 = shl i32 %1, 31
%4 = zext i32 %3
to i64
%5 = getelementptr inbounds i64, ptr %0, i64 %4
%6 = load i64, ptr %5, align 8
ret i64 %6
}

define i64 @pack_i64(i64 %a, i64 %b) nounwind {
; RV64I-LABEL: pack_i64:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  srli a0, a0, 32
; RV64I-NEXT:  slli a1, a1, 32
; RV64I-NEXT:  or a0, a1, a0
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: pack_i64:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  slli a1, a1, 32
; RV64ZBA-NEXT:  add.uw a0, a0, a1
; RV64ZBA-NEXT:  ret
%shl = and i64 %a, 4294967295
%shl1 = shl i64 %b, 32
%or = or i64 %shl1, %shl
ret i64 %or
}

define i64 @pack_i64_2(i32 signext %a, i32 signext %b) nounwind {
; RV64I-LABEL: pack_i64_2:
; RV64I:      # %bb.0:

```



```

; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  srli a0, a0, 32
; RV64I-NEXT:  slli a1, a1, 32
; RV64I-NEXT:  or a0, a1, a0
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: pack_i64_2:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  slli a1, a1, 32
; RV64ZBA-NEXT:  add.uw a0, a0,
a1
; RV64ZBA-NEXT:  ret
%zexta = zext i32 %a to i64
%zextb = zext i32 %b to i64
%shl1 = shl i64 %zextb, 32
%or = or i64 %shl1, %zexta
ret i64 %or
}

```

```

define i64 @pack_i64_3(i32 signext %a, i32 signext %b) nounwind {

```

```

; RV64I-LABEL: pack_i64_3:
; RV64I:      # %bb.0:
; RV64I-NEXT:  addi a0, a0, 1
; RV64I-NEXT:  addi a1, a1, 1
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  srli a0, a0, 32
; RV64I-NEXT:  slli a1, a1, 32
; RV64I-NEXT:  or a0, a1, a0
; RV64I-NEXT:  ret
;
; RV64ZBA-LABEL: pack_i64_3:
; RV64ZBA:      # %bb.0:
; RV64ZBA-NEXT:  addi a0, a0, 1
; RV64ZBA-NEXT:  addi a1, a1, 1
; RV64ZBA-NEXT:  slli a1, a1, 32
; RV64ZBA-NEXT:  add.uw a0, a0, a1
; RV64ZBA-NEXT:  ret
%adda = add i32 %a, 1
%addb = add i32 %b, 1
%zexta = zext i32 %adda to i64
%zextb = zext i32 %addb to i64
%shl1 = shl i64 %zextb, 32
%or = or i64 %shl1, %zexta
ret i64 %or
}

```

```

; RUN: llc -O3 -mtriple=powerpc-unknown-linux-gnu -mcpu=e500 -mattr=spe < %s | FileCheck %s

```

; PowerPC SPE is a rare in-tree target that has the FP\_TO\_SINT node marked

; as Legal.

; Verify that fptosi(42.1) isn't simplified when the rounding mode is

; unknown.

; Verify that no gross errors happen.

; CHECK-LABEL: @f20

; COMMON: cfdctsiz

define i32 @f20(double %a) strictfp {

entry:

    %result = call i32 @llvm.experimental.constrained.fptosi.i32.f64(double 42.1,  
                                    metadata !"fpexcept.strict")  
            strictfp

    ret i32 %result

}

@llvm.fp.env = thread\_local global i8 zeroinitializer, section "llvm.metadata"

declare i32 @llvm.experimental.constrained.fptosi.i32.f64(double, metadata)

; NOTE: Assertions have been autogenerated by utils/update\_analyze\_test\_checks.py

; RUN: opt < %s -passes="print<cost-model>" 2>&1 -disable-output -mtriple=x86\_64-apple-macosx10.8.0 -  
mattr=+avx2 | FileCheck %s --check-prefixes=VEC256,AVX

; RUN: opt < %s -passes="print<cost-model>" 2>&1 -disable-output -mtriple=x86\_64-apple-macosx10.8.0 -  
mattr=+avx512vl,+prefer-256-bit | FileCheck %s --check-prefixes=VEC256,AVX512VL256

; RUN: opt < %s -passes="print<cost-model>" 2>&1 -disable-output -mtriple=x86\_64-apple-macosx10.8.0 -  
mattr=+avx512vl,-prefer-256-bit | FileCheck %s --check-prefixes=AVX512VL512

; RUN: opt < %s -passes="print<cost-model>" 2>&1 -disable-output -mtriple=x86\_64-apple-macosx10.8.0 -  
mattr=+avx512vl,+avx512bw,+avx512dq,+prefer-256-bit | FileCheck %s --check-prefixes=VEC256,SKX256

; RUN: opt < %s -passes="print<cost-model>" 2>&1 -disable-output -mtriple=x86\_64-apple-macosx10.8.0 -  
mattr=+avx512vl,+avx512bw,+avx512dq,-prefer-256-bit | FileCheck %s --check-prefixes=SKX512

define

void @zext256() "min-legal-vector-width"="256" {

; AVX-LABEL: 'zext256'

; AVX-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %A = zext <8 x i16> undef to <8 x i64>

; AVX-NEXT: Cost Model: Found an estimated cost of 5 for instruction: %B = zext <8 x i32> undef to <8 x i64>

; AVX-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %C = zext <16 x i8> undef to <16 x i32>

; AVX-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %D = zext <16 x i16> undef to <16 x  
i32>

; AVX-NEXT: Cost Model: Found an estimated cost of 5 for instruction: %E = zext <32 x i8> undef to <32 x i16>

; AVX-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret void

;

; AVX512VL256-LABEL: 'zext256'

; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %A = zext <8 x i16> undef to  
<8 x i64>

; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %B = zext <8 x i32> undef to  
<8 x i64>

; AVX512VL256-NEXT: Cost

Model: Found an estimated cost of 2 for instruction: %C = zext <16 x i8> undef to <16 x i32>

; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %D = zext <16 x i16> undef to

```

<16 x i32>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %E = zext <32 x i8> undef to
<32 x i16>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret void
;
; AVX512VL512-LABEL: 'zext256'
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %A = zext <8 x i16> undef to
<8 x i64>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %B = zext <8 x i32> undef to
<8 x i64>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %C = zext <16 x i8> undef to
<16 x i32>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %D = zext <16 x i16> undef to
<16 x i32>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 3 for instruction:
%E = zext <32 x i8> undef to <32 x i16>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret void
;
; SKX256-LABEL: 'zext256'
; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %A = zext <8 x i16> undef to <8 x
i64>
; SKX256-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %B = zext <8 x i32> undef to <8 x
i64>
; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %C = zext <16 x i8> undef to <16 x
i32>
; SKX256-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %D = zext <16 x i16> undef to <16 x
i32>
; SKX256-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %E = zext <32 x i8> undef to <32 x
i16>
; SKX256-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret void
;
; SKX512-LABEL: 'zext256'
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %A = zext <8 x i16> undef to <8 x
i64>
; SKX512-NEXT: Cost Model: Found an estimated
cost of 1 for instruction: %B = zext <8 x i32> undef to <8 x i64>
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %C = zext <16 x i8> undef to <16 x
i32>
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %D = zext <16 x i16> undef to <16 x
i32>
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %E = zext <32 x i8> undef to <32 x
i16>
; SKX512-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret void
;
%A = zext <8 x i16> undef to <8 x i64>
%B = zext <8 x i32> undef to <8 x i64>
%C = zext <16 x i8> undef to <16 x i32>
%D = zext <16 x i16> undef to <16 x i32>

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%E = zext <32 x i8> undef to <32 x i16>
ret void
}

define void @zext512() "min-legal-vector-width"="512" {
; AVX-LABEL: 'zext512'
; AVX-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %A = zext <8 x i16> undef to <8 x i64>
; AVX-NEXT: Cost Model: Found an estimated cost of 5 for instruction: %B = zext <8 x i32>
undef to <8 x i64>
; AVX-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %C = zext <16 x i8> undef to <16 x i32>
; AVX-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %D = zext <16 x i16> undef to <16 x
i32>
; AVX-NEXT: Cost Model: Found an estimated cost of 5 for instruction: %E = zext <32 x i8> undef to <32 x i16>
; AVX-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret void
;
; AVX512VL256-LABEL: 'zext512'
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %A = zext <8 x i16> undef to
<8 x i64>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %B = zext <8 x i32> undef to
<8 x i64>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %C = zext <16 x i8> undef to
<16 x i32>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %D = zext <16 x i16> undef to
<16 x i32>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost
of 3 for instruction: %E = zext <32 x i8> undef to <32 x i16>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret void
;
; AVX512VL512-LABEL: 'zext512'
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %A = zext <8 x i16> undef to
<8 x i64>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %B = zext <8 x i32> undef to
<8 x i64>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %C = zext <16 x i8> undef to
<16 x i32>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %D = zext <16 x i16> undef to
<16 x i32>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %E = zext <32 x i8> undef to
<32 x i16>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret void
;
; SKX256-LABEL: 'zext512'
; SKX256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %A = zext <8 x i16> undef to <8
x i64>
; SKX256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %B = zext <8 x i32> undef to <8 x
i64>
; SKX256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %C = zext <16 x i8> undef to <16 x
i32>

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; SKX256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %D = zext <16 x i16> undef to <16 x
i32>
; SKX256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %E = zext <32 x i8> undef to <32 x
i16>
; SKX256-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret void
;
; SKX512-LABEL: 'zext512'
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %A = zext <8 x i16> undef to <8 x
i64>
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %B = zext <8 x i32> undef to <8 x
i64>
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %C = zext <16 x i8> undef to <16 x
i32>
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %D = zext <16
x i16> undef to <16 x i32>
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %E = zext <32 x i8> undef to <32 x
i16>
; SKX512-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret void
;
%A = zext <8 x i16> undef to <8 x i64>
%B = zext <8 x i32> undef to <8 x i64>
%C = zext <16 x i8> undef to <16 x i32>
%D = zext <16 x i16> undef to <16 x i32>
%E = zext <32 x i8> undef to <32 x i16>
ret void
}

define void @sext256() "min-legal-vector-width"="256" {
; AVX-LABEL: 'sext256'
; AVX-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %A = sext <8 x i8> undef to <8 x i64>
; AVX-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %B = sext <8 x i16> undef to <8 x i64>
; AVX-NEXT: Cost Model: Found an estimated cost of 5 for instruction: %C = sext <8 x i32> undef to <8 x i64>
; AVX-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %D = sext <16 x i8> undef to <16 x i32>
; AVX-NEXT: Cost Model: Found
an estimated cost of 3 for instruction: %E = sext <16 x i16> undef to <16 x i32>
; AVX-NEXT: Cost Model: Found an estimated cost of 5 for instruction: %F = sext <32 x i8> undef to <32 x i16>
; AVX-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret void
;
; AVX512VL256-LABEL: 'sext256'
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %A = sext <8 x i8> undef to <8
x i64>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %B = sext <8 x i16> undef to
<8 x i64>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %C = sext <8 x i32> undef to
<8 x i64>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %D = sext <16 x i8> undef to
<16 x i32>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %E = sext <16 x i16> undef to

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<16 x i32>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %F = sext <32 x i8> undef
to <32 x i16>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret void
;
; AVX512VL512-LABEL: 'sext256'
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %A = sext <8 x i8> undef to <8
x i64>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %B = sext <8 x i16> undef to
<8 x i64>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %C = sext <8 x i32> undef to
<8 x i64>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %D = sext <16 x i8> undef to
<16 x i32>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %E = sext <16 x i16> undef to
<16 x i32>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %F = sext <32 x i8> undef to
<32 x i16>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret void
;
; SKX256-LABEL: 'sext256'
; SKX256-NEXT: Cost Model: Found an
estimated cost of 2 for instruction: %A = sext <8 x i8> undef to <8 x i64>
; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %B = sext <8 x i16> undef to <8 x
i64>
; SKX256-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %C = sext <8 x i32> undef to <8 x
i64>
; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %D = sext <16 x i8> undef to <16 x
i32>
; SKX256-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %E = sext <16 x i16> undef to <16 x
i32>
; SKX256-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %F = sext <32 x i8> undef to <32 x
i16>
; SKX256-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret void
;
; SKX512-LABEL: 'sext256'
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %A = sext <8 x i8> undef to <8 x i64>
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %B = sext <8 x i16> undef to <8 x
i64>
; SKX512-NEXT: Cost
Model: Found an estimated cost of 1 for instruction: %C = sext <8 x i32> undef to <8 x i64>
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %D = sext <16 x i8> undef to <16 x
i32>
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %E = sext <16 x i16> undef to <16 x
i32>
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %F = sext <32 x i8> undef to <32 x
i16>
; SKX512-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret void

```

```

;
%A = sext <8 x i8> undef to <8 x i64>
%B = sext <8 x i16> undef to <8 x i64>
%C = sext <8 x i32> undef to <8 x i64>
%D = sext <16 x i8> undef to <16 x i32>
%E = sext <16 x i16> undef to <16 x i32>
%F = sext <32 x i8> undef to <32 x i16>
ret void
}

define void @sext512() "min-legal-vector-width"="512" {
; AVX-LABEL: 'sext512'
; AVX-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %A = sext <8 x i8> undef to <8 x i64>
; AVX-NEXT: Cost Model: Found
an estimated cost of 4 for instruction: %B = sext <8 x i16> undef to <8 x i64>
; AVX-NEXT: Cost Model: Found an estimated cost of 5 for instruction: %C = sext <8 x i32> undef to <8 x i64>
; AVX-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %D = sext <16 x i8> undef to <16 x i32>
; AVX-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %E = sext <16 x i16> undef to <16 x i32>
; AVX-NEXT: Cost Model: Found an estimated cost of 5 for instruction: %F = sext <32 x i8> undef to <32 x i16>
; AVX-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret void
;
; AVX512VL256-LABEL: 'sext512'
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %A = sext <8 x i8> undef to <8
x i64>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %B = sext <8 x i16> undef to
<8 x i64>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %C = sext <8 x i32> undef to
<8 x i64>
; AVX512VL256-NEXT:
Cost Model: Found an estimated cost of 1 for instruction: %D = sext <16 x i8> undef to <16 x i32>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %E = sext <16 x i16> undef to
<16 x i32>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %F = sext <32 x i8> undef to
<32 x i16>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret void
;
; AVX512VL512-LABEL: 'sext512'
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %A = sext <8 x i8> undef to <8
x i64>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %B = sext <8 x i16> undef to
<8 x i64>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %C = sext <8 x i32> undef to
<8 x i64>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %D = sext <16 x i8> undef to
<16 x i32>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost
of 1 for instruction: %E = sext <16 x i16> undef to <16 x i32>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %F = sext <32 x i8> undef to

```

```

<32 x i16>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret void
;
; SKX256-LABEL: 'sext512'
; SKX256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %A = sext <8 x i8> undef to <8 x i64>
; SKX256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %B = sext <8 x i16> undef to <8 x
i64>
; SKX256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %C = sext <8 x i32> undef to <8 x
i64>
; SKX256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %D = sext <16 x i8> undef to <16 x
i32>
; SKX256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %E = sext <16 x i16> undef to <16 x
i32>
; SKX256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %F = sext <32 x i8> undef to <32 x
i16>
; SKX256-NEXT: Cost
Model: Found an estimated cost of 0 for instruction: ret void
;
; SKX512-LABEL: 'sext512'
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %A = sext <8 x i8> undef to <8 x i64>
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %B = sext <8 x i16> undef to <8 x
i64>
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %C = sext <8 x i32> undef to <8 x
i64>
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %D = sext <16 x i8> undef to <16 x
i32>
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %E = sext <16 x i16> undef to <16 x
i32>
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %F = sext <32 x i8> undef to <32 x
i16>
; SKX512-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret void
;
%A = sext <8 x i8> undef to <8 x i64>
%B = sext <8 x i16> undef to <8 x i64>
%C = sext <8 x i32> undef to <8 x i64>
%D = sext <16 x i8>
undef to <16 x i32>
%E = sext <16 x i16> undef to <16 x i32>
%F = sext <32 x i8> undef to <32 x i16>
ret void
}

define void @trunc256() "min-legal-vector-width"="256" {
; VEC256-LABEL: 'trunc256'
; VEC256-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %A = trunc <8 x i64> undef to <8 x
i32>
; VEC256-NEXT: Cost Model: Found an estimated cost of 10 for instruction: %B = trunc <8 x i64> undef to <8 x
i16>

```



```

; VEC256-NEXT: Cost Model: Found an estimated cost of 8 for instruction: %C = trunc <8 x i64> undef to <8 x
i8>
; VEC256-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %D = trunc <16 x i32> undef to <16 x
i16>
; VEC256-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %E = trunc <16 x i32> undef to <16 x
i8>
; VEC256-NEXT: Cost Model: Found an estimated cost of 5 for instruction: %F = trunc <32 x i16> undef to <32 x
i8>
; VEC256-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret void
;
; AVX512VL512-LABEL: 'trunc256'
;
AVX512VL512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %A = trunc <8 x i64> undef to
<8 x i32>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %B = trunc <8 x i64> undef to
<8 x i16>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %C = trunc <8 x i64> undef to
<8 x i8>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %D = trunc <16 x i32> undef
to <16 x i16>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %E = trunc <16 x i32> undef to
<16 x i8>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 8 for instruction: %F = trunc <32 x i16> undef to
<32 x i8>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret void
;
; SKX512-LABEL: 'trunc256'
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %A = trunc <8 x i64> undef to <8 x
i32>
; SKX512-NEXT: Cost Model: Found an estimated
cost of 2 for instruction: %B = trunc <8 x i64> undef to <8 x i16>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %C = trunc <8 x i64> undef to <8 x
i8>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %D = trunc <16 x i32> undef to <16 x
i16>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %E = trunc <16 x i32> undef to <16 x
i8>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %F = trunc <32 x i16> undef to <32 x
i8>
; SKX512-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret void
;
%A = trunc <8 x i64> undef to <8 x i32>
%B = trunc <8 x i64> undef to <8 x i16>
%C = trunc <8 x i64> undef to <8 x i8>
%D = trunc <16 x i32> undef to <16 x i16>
%E = trunc <16 x i32> undef to <16 x i8>
%F = trunc <32 x i16> undef to <32 x i8>
ret void

```

}

```
define i32 @zext256_vXi1() "min-legal-vector-width"="256" {  
; AVX-LABEL: 'zext256_vXi1'  
; AVX-NEXT: Cost Model: Found  
an estimated cost of 1 for instruction: %V2i64 = zext <2 x i1> undef to <2 x i64>  
; AVX-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %V4i64 = zext <4 x i1> undef to <4 x  
i64>  
; AVX-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %V8i64 = zext <8 x i1> undef to <8 x  
i64>  
; AVX-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V2i32 = zext <2 x i1> undef to <2 x  
i32>  
; AVX-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V4i32 = zext <4 x i1> undef to <4 x  
i32>  
; AVX-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %V8i32 = zext <8 x i1> undef to <8 x  
i32>  
; AVX-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %V16i32 = zext <16 x i1> undef to <16 x  
i32>  
; AVX-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V2i16 = zext <2 x i1> undef to <2 x  
i16>  
; AVX-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V4i16 = zext <4 x i1> undef to <4 x  
i16>  
; AVX-NEXT:  
Cost Model: Found an estimated cost of 1 for instruction: %V8i16 = zext <8 x i1> undef to <8 x i16>  
; AVX-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V16i16 = zext <16 x i1> undef to <16 x  
i16>  
; AVX-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %V32i16 = zext <32 x i1> undef to <32 x  
i16>  
; AVX-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V2i8 = zext <2 x i1> undef to <2 x i8>  
; AVX-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V4i8 = zext <4 x i1> undef to <4 x i8>  
; AVX-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V8i8 = zext <8 x i1> undef to <8 x i8>  
; AVX-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V16i8 = zext <16 x i1> undef to <16 x  
i8>  
; AVX-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V32i8 = zext <32 x i1> undef to <32 x  
i8>  
; AVX-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V64i8 = zext <64 x i1> undef  
to <64 x i8>  
; AVX-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret i32 undef  
;  
; AVX512VL256-LABEL: 'zext256_vXi1'  
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V2i64 = zext <2 x i1> undef  
to <2 x i64>  
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V4i64 = zext <4 x i1> undef  
to <4 x i64>  
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 5 for instruction: %V8i64 = zext <8 x i1> undef  
to <8 x i64>  
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V2i32 = zext <2 x i1> undef  
to <2 x i32>
```

```

; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V4i32 = zext <4 x i1> undef
to <4 x i32>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V8i32 = zext <8 x i1> undef
to <8 x i32>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %V16i32 = zext <16 x i1>
undef to <16 x i32>
; AVX512VL256-NEXT:
  Cost Model: Found an estimated cost of 5 for instruction: %V2i16 = zext <2 x i1> undef to <2 x i16>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 5 for instruction: %V4i16 = zext <4 x i1> undef
to <4 x i16>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 5 for instruction: %V8i16 = zext <8 x i1> undef
to <8 x i16>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 12 for instruction: %V16i16 = zext <16 x i1>
undef to <16 x i16>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 24 for instruction: %V32i16 = zext <32 x i1>
undef to <32 x i16>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 6 for instruction: %V2i8 = zext <2 x i1> undef to
<2 x i8>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 6 for instruction: %V4i8 = zext <4 x i1> undef to
<4 x i8>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 6 for instruction: %V8i8 = zext <8 x i1> undef to
<8 x i8>
; AVX512VL256-NEXT: Cost Model: Found an estimated
  cost of 12 for instruction: %V16i8 = zext <16 x i1> undef to <16 x i8>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 25 for instruction: %V32i8 = zext <32 x i1>
undef to <32 x i8>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 50 for instruction: %V64i8 = zext <64 x i1>
undef to <64 x i8>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret i32 undef
;
; AVX512VL512-LABEL: 'zext256_vXi1'
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V2i64 = zext <2 x i1> undef
to <2 x i64>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V4i64 = zext <4 x i1> undef
to <4 x i64>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V8i64 = zext <8 x i1> undef
to <8 x i64>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V2i32 = zext <2 x i1> undef
to <2 x i32>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of
  2 for instruction: %V4i32 = zext <4 x i1> undef to <4 x i32>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V8i32 = zext <8 x i1> undef
to <8 x i32>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V16i32 = zext <16 x i1>
undef to <16 x i32>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %V2i16 = zext <2 x i1> undef
to <2 x i16>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %V4i16 = zext <4 x i1> undef

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to <4 x i16>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %V8i16 = zext <8 x i1> undef
to <8 x i16>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %V16i16 = zext <16 x i1>
undef to <16 x i16>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 9 for instruction: %V32i16 = zext <32 x i1>
undef to <32 x i16>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %V2i8
= zext <2 x i1> undef to <2 x i8>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %V4i8 = zext <4 x i1> undef to
<4 x i8>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %V8i8 = zext <8 x i1> undef to
<8 x i8>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %V16i8 = zext <16 x i1> undef
to <16 x i8>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 9 for instruction: %V32i8 = zext <32 x i1> undef
to <32 x i8>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 19 for instruction: %V64i8 = zext <64 x i1>
undef to <64 x i8>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret i32 undef
;
; SKX256-LABEL: 'zext256_vXi1'
; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V2i64 = zext <2 x i1> undef to <2 x
i64>
; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V4i64 = zext <4 x i1> undef to <4 x
i64>
;
SKX256-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %V8i64 = zext <8 x i1> undef to <8 x
i64>
; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V2i32 = zext <2 x i1> undef to <2 x
i32>
; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V4i32 = zext <4 x i1> undef to <4 x
i32>
; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V8i32 = zext <8 x i1> undef to <8 x
i32>
; SKX256-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %V16i32 = zext <16 x i1> undef to
<16 x i32>
; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V2i16 = zext <2 x i1> undef to <2 x
i16>
; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V4i16 = zext <4 x i1> undef to <4 x
i16>
; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V8i16 = zext <8 x i1> undef to <8 x
i16>
; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction:
%V16i16 = zext <16 x i1> undef to <16 x i16>
; SKX256-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %V32i16 = zext <32 x i1> undef to
<32 x i16>
; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V2i8 = zext <2 x i1> undef to <2 x

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i8>
; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V4i8 = zext <4 x i1> undef to <4 x
i8>
; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V8i8 = zext <8 x i1> undef to <8 x
i8>
; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V16i8 = zext <16 x i1> undef to <16
x i8>
; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V32i8 = zext <32 x i1> undef to <32
x i8>
; SKX256-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %V64i8 = zext <64 x i1> undef to <64
x i8>
; SKX256-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret i32 undef
;
; SKX512-LABEL: 'zext256_vXi1'
; SKX512-NEXT: Cost
Model: Found an estimated cost of 2 for instruction: %V2i64 = zext <2 x i1> undef to <2 x i64>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V4i64 = zext <4 x i1> undef to <4 x
i64>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V8i64 = zext <8 x i1> undef to <8 x
i64>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V2i32 = zext <2 x i1> undef to <2 x
i32>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V4i32 = zext <4 x i1> undef to <4 x
i32>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V8i32 = zext <8 x i1> undef to <8 x
i32>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V16i32 = zext <16 x i1> undef to
<16 x i32>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V2i16 = zext <2 x i1> undef to <2 x
i16>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V4i16 = zext
<4 x i1> undef to <4 x i16>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V8i16 = zext <8 x i1> undef to <8 x
i16>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V16i16 = zext <16 x i1> undef to
<16 x i16>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V32i16 = zext <32 x i1> undef to
<32 x i16>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V2i8 = zext <2 x i1> undef to <2 x
i8>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V4i8 = zext <4 x i1> undef to <4 x
i8>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V8i8 = zext <8 x i1> undef to <8 x
i8>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V16i8 = zext <16 x i1> undef to <16
x i8>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V32i8 = zext <32 x i1> undef to <32
x i8>

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; SKX512-NEXT: Cost Model: Found an estimated
cost of 2 for instruction: %V64i8 = zext <64 x i1> undef to <64 x i8>
; SKX512-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret i32 undef
;
%V2i64 = zext <2 x i1> undef to <2 x i64>
%V4i64 = zext <4 x i1> undef to <4 x i64>
%V8i64 = zext <8 x i1> undef to <8 x i64>

%V2i32 = zext <2 x i1> undef to <2 x i32>
%V4i32 = zext <4 x i1> undef to <4 x i32>
%V8i32 = zext <8 x i1> undef to <8 x i32>
%V16i32 = zext <16 x i1> undef to <16 x i32>

%V2i16 = zext <2 x i1> undef to <2 x i16>
%V4i16 = zext <4 x i1> undef to <4 x i16>
%V8i16 = zext <8 x i1> undef to <8 x i16>
%V16i16 = zext <16 x i1> undef to <16 x i16>
%V32i16 = zext <32 x i1> undef to <32 x i16>

%V2i8 = zext <2 x i1> undef to <2 x i8>
%V4i8 = zext <4 x i1> undef to <4 x i8>
%V8i8 = zext <8 x i1> undef to <8 x i8>
%V16i8 = zext <16 x i1> undef to <16 x i8>
%V32i8 = zext <32 x i1> undef to <32 x i8>
%V64i8 = zext <64 x i1> undef to <64 x i8>

ret i32 undef
}

define i32 @sext256_vXi1()
"min-legal-vector-width"="256" {
; AVX-LABEL: 'sext256_vXi1'
; AVX-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %I64 = sext i1 undef to i64
; AVX-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V2i64 = sext <2 x i1> undef to <2 x
i64>
; AVX-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %V4i64 = sext <4 x i1> undef to <4 x
i64>
; AVX-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %V8i64 = sext <8 x i1> undef to <8 x
i64>
; AVX-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %I32 = sext i1 undef to i32
; AVX-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V2i32 = sext <2 x i1> undef to <2 x
i32>
; AVX-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V4i32 = sext <4 x i1> undef to <4 x
i32>
; AVX-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %V8i32 = sext <8 x i1> undef to <8 x
i32>
; AVX-NEXT: Cost Model: Found an estimated cost

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of 4 for instruction: %V16i32 = sext <16 x i1> undef to <16 x i32>

; AVX-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %I16 = sext i1 undef to i16

; AVX-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V2i16 = sext <2 x i1> undef to <2 x i16>

; AVX-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V4i16 = sext <4 x i1> undef to <4 x i16>

; AVX-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V8i16 = sext <8 x i1> undef to <8 x i16>

; AVX-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V16i16 = sext <16 x i1> undef to <16 x i16>

; AVX-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %V32i16 = sext <32 x i1> undef to <32 x i16>

; AVX-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %I8 = sext i1 undef to i8

; AVX-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V2i8 = sext <2 x i1> undef to <2 x i8>

; AVX-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V4i8 = sext <4 x i1> undef to <4 x i8>

; AVX-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V8i8 = sext <8 x i1> undef to <8 x i8>

; AVX-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V16i8 = sext <16 x i1> undef to <16 x i8>

; AVX-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V32i8 = sext <32 x i1> undef to <32 x i8>

; AVX-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %V64i8 = sext <64 x i1> undef to <64 x i8>

; AVX-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret i32 undef

;

; AVX512VL256-LABEL: 'sext256\_vXi1'

; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %I64 = sext i1 undef to i64

; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V2i64 = sext <2 x i1> undef to <2 x i64>

; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V4i64 = sext <4 x i1> undef to <4 x i64>

; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %V8i64 = sext <8 x i1> undef to <8 x i64>

; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %I32 = sext i1 undef to i32

; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V2i32 = sext <2 x i1> undef to <2 x i32>

; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V4i32 = sext <4 x i1> undef to <4 x i32>

; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V8i32 = sext <8 x i1> undef to <8 x i32>

; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V16i32 = sext <16 x i1> undef to <16 x i32>

; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %I16 = sext i1 undef to i16

; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %V2i16 = sext <2 x i1> undef to <2 x i16>

; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %V4i16 = sext <4 x i1> undef to <4 x i16>

; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %V8i16 = sext <8 x i1> undef

to <8 x i16>

; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 10 for instruction: %V16i16 = sext <16 x i1> undef to <16 x i16>

; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 20 for instruction: %V32i16 = sext <32 x i1> undef to <32 x i16>

; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %I8 = sext i1 undef to i8

; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 5 for instruction: %V2i8 = sext <2 x i1> undef to <2 x i8>

; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 5 for instruction: %V4i8 = sext <4 x i1> undef to <4 x i8>

; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 5 for instruction: %V8i8 = sext <8 x i1> undef to <8 x i8>

; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 10 for instruction: %V16i8 = sext <16 x i1> undef to <16 x i8>

;

AVX512VL256-NEXT: Cost Model: Found an estimated cost of 21 for instruction: %V32i8 = sext <32 x i1> undef to <32 x i8>

; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 42 for instruction: %V64i8 = sext <64 x i1> undef to <64 x i8>

; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret i32 undef

;

; AVX512VL512-LABEL: 'sext256\_vXi1'

; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %I64 = sext i1 undef to i64

; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V2i64 = sext <2 x i1> undef to <2 x i64>

; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V4i64 = sext <4 x i1> undef to <4 x i64>

; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V8i64 = sext <8 x i1> undef to <8 x i64>

; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %I32 = sext i1 undef to i32

; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V2i32 = sext <2 x i1> undef to <2 x i32>

; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V4i32 = sext <4 x i1> undef to <4 x i32>

; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V8i32 = sext <8 x i1> undef to <8 x i32>

; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V16i32 = sext <16 x i1> undef to <16 x i32>

; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %I16 = sext i1 undef to i16

; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %V2i16 = sext <2 x i1> undef to <2 x i16>

; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %V4i16 = sext <4 x i1> undef to <4 x i16>

; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %V8i16 = sext <8 x i1> undef to <8 x i16>

; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %V16i16 = sext <16 x i1> undef to <16 x i16>

; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 7 for instruction: %V32i16 = sext <32 x i1>



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undef to <32 x i16>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %I8 = sext i1 undef to i8
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %V2i8 = sext <2 x i1> undef to
<2 x i8>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %V4i8 = sext <4 x i1> undef to
<4 x i8>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %V8i8 = sext <8 x i1> undef to
<8 x i8>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %V16i8 = sext <16 x i1> undef
to <16 x i8>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 7 for instruction: %V32i8 = sext <32 x i1> undef
to <32 x i8>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 15 for instruction: %V64i8 = sext <64 x i1>
undef to <64 x i8>
; AVX512VL512-NEXT:
  Cost Model: Found an estimated cost of 0 for instruction: ret i32 undef
;
; SKX256-LABEL: 'sext256_vXi1'
; SKX256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %I64 = sext i1 undef to i64
; SKX256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V2i64 = sext <2 x i1> undef to <2 x
i64>
; SKX256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V4i64 = sext <4 x i1> undef to <4 x
i64>
; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V8i64 = sext <8 x i1> undef to <8 x
i64>
; SKX256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %I32 = sext i1 undef to i32
; SKX256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V2i32 = sext <2 x i1> undef to <2 x
i32>
; SKX256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V4i32 = sext <4 x i1> undef to <4 x
i32>
; SKX256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V8i32 = sext <8 x i1> undef
to <8 x i32>
; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V16i32 = sext <16 x i1> undef to
<16 x i32>
; SKX256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %I16 = sext i1 undef to i16
; SKX256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V2i16 = sext <2 x i1> undef to <2 x
i16>
; SKX256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V4i16 = sext <4 x i1> undef to <4 x
i16>
; SKX256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V8i16 = sext <8 x i1> undef to <8 x
i16>
; SKX256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V16i16 = sext <16 x i1> undef to
<16 x i16>
; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V32i16 = sext <32 x i1> undef to
<32 x i16>
; SKX256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %I8 = sext i1 undef to i8
; SKX256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V2i8

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= sext <2 x i1> undef to <2 x i8>
; SKX256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V4i8 = sext <4 x i1> undef to <4 x
i8>
; SKX256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V8i8 = sext <8 x i1> undef to <8 x
i8>
; SKX256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V16i8 = sext <16 x i1> undef to <16
x i8>
; SKX256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V32i8 = sext <32 x i1> undef to <32
x i8>
; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V64i8 = sext <64 x i1> undef to <64
x i8>
; SKX256-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret i32 undef
;
; SKX512-LABEL: 'sext256_vXi1'
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %I64 = sext i1 undef to i64
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V2i64 = sext <2 x i1> undef to <2 x
i64>
; SKX512-NEXT: Cost Model: Found an estimated
cost of 1 for instruction: %V4i64 = sext <4 x i1> undef to <4 x i64>
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V8i64 = sext <8 x i1> undef to <8 x
i64>
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %I32 = sext i1 undef to i32
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V2i32 = sext <2 x i1> undef to <2 x
i32>
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V4i32 = sext <4 x i1> undef to <4 x
i32>
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V8i32 = sext <8 x i1> undef to <8 x
i32>
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V16i32 = sext <16 x i1> undef to
<16 x i32>
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %I16 = sext i1 undef to i16
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V2i16 = sext <2 x i1> undef to <2 x
i16>
; SKX512-NEXT: Cost Model:
Found an estimated cost of 1 for instruction: %V4i16 = sext <4 x i1> undef to <4 x i16>
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V8i16 = sext <8 x i1> undef to <8 x
i16>
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V16i16 = sext <16 x i1> undef to
<16 x i16>
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V32i16 = sext <32 x i1> undef to
<32 x i16>
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %I8 = sext i1 undef to i8
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V2i8 = sext <2 x i1> undef to <2 x
i8>
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V4i8 = sext <4 x i1> undef to <4 x
i8>
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V8i8 = sext <8 x i1> undef to <8 x
i8>

```

```

; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V16i8 = sext <16 x i1> undef to <16
x i8>
;
SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V32i8 = sext <32 x i1> undef to <32
x i8>
; SKX512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V64i8 = sext <64 x i1> undef to <64
x i8>
; SKX512-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret i32 undef
;
%I64 = sext i1 undef to i64
%V2i64 = sext <2 x i1> undef to <2 x i64>
%V4i64 = sext <4 x i1> undef to <4 x i64>
%V8i64 = sext <8 x i1> undef to <8 x i64>

%I32 = sext i1 undef to i32
%V2i32 = sext <2 x i1> undef to <2 x i32>
%V4i32 = sext <4 x i1> undef to <4 x i32>
%V8i32 = sext <8 x i1> undef to <8 x i32>
%V16i32 = sext <16 x i1> undef to <16 x i32>

%I16 = sext i1 undef to i16
%V2i16 = sext <2 x i1> undef to <2 x i16>
%V4i16 = sext <4 x i1> undef to <4 x i16>
%V8i16 = sext <8 x i1> undef to <8 x i16>
%V16i16 = sext <16 x i1> undef to <16 x i16>
%V32i16 = sext <32 x i1> undef to <32 x i16>

%I8 = sext i1 undef to i8
%V2i8 = sext <2
x i1> undef to <2 x i8>
%V4i8 = sext <4 x i1> undef to <4 x i8>
%V8i8 = sext <8 x i1> undef to <8 x i8>
%V16i8 = sext <16 x i1> undef to <16 x i8>
%V32i8 = sext <32 x i1> undef to <32 x i8>
%V64i8 = sext <64 x i1> undef to <64 x i8>

ret i32 undef
}

define i32 @trunc_vXi1() "min-legal-vector-width"="256" {
; AVX-LABEL: 'trunc_vXi1'
; AVX-NEXT: Cost Model: Found an estimated cost of 0 for instruction: %V2i64 = trunc <2 x i64> undef to <2 x
i1>
; AVX-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %V4i64 = trunc <4 x i64> undef to <4 x
i1>
; AVX-NEXT: Cost Model: Found an estimated cost of 9 for instruction: %V8i64 = trunc <8 x i64> undef to <8 x
i1>
; AVX-NEXT: Cost Model: Found an estimated cost of 11 for instruction: %V16i64 = trunc <16 x i64> undef to

```

```

<16 x i1>
; AVX-NEXT: Cost Model: Found an estimated cost of 0 for instruction: %V32i64 = trunc <32 x i64> undef to <32
x i1>
; AVX-NEXT: Cost Model: Found an estimated cost of 0 for instruction: %V64i64
= trunc <64 x i64> undef to <64 x i1>
; AVX-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V2i32 = trunc <2 x i32> undef to <2 x
i1>
; AVX-NEXT: Cost Model: Found an estimated cost of 0 for instruction: %V4i32 = trunc <4 x i32> undef to <4 x
i1>
; AVX-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V8i32 = trunc <8 x i32> undef to <8 x
i1>
; AVX-NEXT: Cost Model: Found an estimated cost of 8 for instruction: %V16i32 = trunc <16 x i32> undef to <16
x i1>
; AVX-NEXT: Cost Model: Found an estimated cost of 0 for instruction: %V32i32 = trunc <32 x i32> undef to <32
x i1>
; AVX-NEXT: Cost Model: Found an estimated cost of 0 for instruction: %V64i32 = trunc <64 x i32> undef to <64
x i1>
; AVX-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V2i16 = trunc <2 x i16> undef to <2 x
i1>
; AVX-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V4i16 = trunc <4 x i16> undef to <4 x
i1>
; AVX-NEXT: Cost Model: Found an estimated
cost of 0 for instruction: %V8i16 = trunc <8 x i16> undef to <8 x i1>
; AVX-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %V16i16 = trunc <16 x i16> undef to <16
x i1>
; AVX-NEXT: Cost Model: Found an estimated cost of 0 for instruction: %V32i16 = trunc <32 x i16> undef to <32
x i1>
; AVX-NEXT: Cost Model: Found an estimated cost of 0 for instruction: %V64i16 = trunc <64 x i16> undef to <64
x i1>
; AVX-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V2i8 = trunc <2 x i8> undef to <2 x i1>
; AVX-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V4i8 = trunc <4 x i8> undef to <4 x i1>
; AVX-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %V8i8 = trunc <8 x i8> undef to <8 x i1>
; AVX-NEXT: Cost Model: Found an estimated cost of 0 for instruction: %V16i8 = trunc <16 x i8> undef to <16 x
i1>
; AVX-NEXT: Cost Model: Found an estimated cost of 0 for instruction: %V32i8 = trunc <32 x i8> undef to <32 x
i1>
; AVX-NEXT:
Cost Model: Found an estimated cost of 0 for instruction: %V64i8 = trunc <64 x i8> undef to <64 x i1>
; AVX-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret i32 undef
;
; AVX512VL256-LABEL: 'trunc_vXi1'
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V2i64 = trunc <2 x i64>
undef to <2 x i1>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V4i64 = trunc <4 x i64>
undef to <4 x i1>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 9 for instruction: %V8i64 = trunc <8 x i64>
undef to <8 x i1>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 11 for instruction: %V16i64 = trunc <16 x i64>

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```

undef to <16 x i1>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 0 for instruction: %V32i64 = trunc <32 x i64>
undef to <32 x i1>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 0 for instruction: %V64i64 = trunc <64 x i64>
undef to <64 x i1>
; AVX512VL256-NEXT: Cost Model:
  Found an estimated cost of 2 for instruction: %V2i32 = trunc <2 x i32> undef to <2 x i1>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V4i32 = trunc <4 x i32>
undef to <4 x i1>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V8i32 = trunc <8 x i32>
undef to <8 x i1>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %V16i32 = trunc <16 x i32>
undef to <16 x i1>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 8 for instruction: %V32i32 = trunc <32 x i32>
undef to <32 x i1>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 16 for instruction: %V64i32 = trunc <64 x i32>
undef to <64 x i1>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %V2i16 = trunc <2 x i16>
undef to <2 x i1>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %V4i16 = trunc <4 x i16>
undef to <4 x i1>
; AVX512VL256-NEXT: Cost Model: Found an
  estimated cost of 3 for instruction: %V8i16 = trunc <8 x i16> undef to <8 x i1>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 8 for instruction: %V16i16 = trunc <16 x i16>
undef to <16 x i1>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 16 for instruction: %V32i16 = trunc <32 x i16>
undef to <32 x i1>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 32 for instruction: %V64i16 = trunc <64 x i16>
undef to <64 x i1>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %V2i8 = trunc <2 x i8> undef
to <2 x i1>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %V4i8 = trunc <4 x i8> undef
to <4 x i1>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %V8i8 = trunc <8 x i8> undef
to <8 x i1>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 8 for instruction: %V16i8 = trunc <16 x i8>
undef to <16 x i1>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of
  0 for instruction: %V32i8 = trunc <32 x i8> undef to <32 x i1>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 0 for instruction: %V64i8 = trunc <64 x i8>
undef to <64 x i1>
; AVX512VL256-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret i32 undef
;
; AVX512VL512-LABEL: 'trunc_vXi1'
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V2i64 = trunc <2 x i64>
undef to <2 x i1>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V4i64 = trunc <4 x i64>
undef to <4 x i1>

```

```

; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V8i64 = trunc <8 x i64>
undef to <8 x i1>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 11 for instruction: %V16i64 = trunc <16 x i64>
undef to <16 x i1>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 0 for instruction: %V32i64 = trunc <32 x i64>
undef to <32 x i1>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 0 for instruction:
%V64i64 = trunc <64 x i64> undef to <64 x i1>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V2i32 = trunc <2 x i32>
undef to <2 x i1>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V4i32 = trunc <4 x i32>
undef to <4 x i1>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V8i32 = trunc <8 x i32>
undef to <8 x i1>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V16i32 = trunc <16 x i32>
undef to <16 x i1>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %V32i32 = trunc <32 x i32>
undef to <32 x i1>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 8 for instruction: %V64i32 = trunc <64 x i32>
undef to <64 x i1>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %V2i16 = trunc <2 x i16>
undef to <2 x i1>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 3 for instruction:
%V4i16 = trunc <4 x i16> undef to <4 x i1>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %V8i16 = trunc <8 x i16>
undef to <8 x i1>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %V16i16 = trunc <16 x i16>
undef to <16 x i1>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 0 for instruction: %V32i16 = trunc <32 x i16>
undef to <32 x i1>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 0 for instruction: %V64i16 = trunc <64 x i16>
undef to <64 x i1>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %V2i8 = trunc <2 x i8> undef
to <2 x i1>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %V4i8 = trunc <4 x i8> undef
to <4 x i1>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %V8i8 = trunc <8 x i8> undef
to <8 x i1>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %V16i8 = trunc <16 x
i8> undef to <16 x i1>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 0 for instruction: %V32i8 = trunc <32 x i8>
undef to <32 x i1>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 0 for instruction: %V64i8 = trunc <64 x i8>
undef to <64 x i1>
; AVX512VL512-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret i32 undef
;
; SKX256-LABEL: 'trunc_vXi1'
; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V2i64 = trunc <2 x i64> undef to <2

```

```

x i1>
; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V4i64 = trunc <4 x i64> undef to <4
x i1>
; SKX256-NEXT: Cost Model: Found an estimated cost of 9 for instruction: %V8i64 = trunc <8 x i64> undef to <8
x i1>
; SKX256-NEXT: Cost Model: Found an estimated cost of 11 for instruction: %V16i64 = trunc <16 x i64> undef to
<16 x i1>
; SKX256-NEXT: Cost Model: Found an estimated cost of 0 for instruction: %V32i64 = trunc <32 x i64> undef to
<32 x i1>
; SKX256-NEXT:
Cost Model: Found an estimated cost of 0 for instruction: %V64i64 = trunc <64 x i64> undef to <64 x i1>
; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V2i32 = trunc <2 x i32> undef to <2
x i1>
; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V4i32 = trunc <4 x i32> undef to <4
x i1>
; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V8i32 = trunc <8 x i32> undef to <8
x i1>
; SKX256-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %V16i32 = trunc <16 x i32> undef to
<16 x i1>
; SKX256-NEXT: Cost Model: Found an estimated cost of 0 for instruction: %V32i32 = trunc <32 x i32> undef to
<32 x i1>
; SKX256-NEXT: Cost Model: Found an estimated cost of 0 for instruction: %V64i32 = trunc <64 x i32> undef to
<64 x i1>
; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V2i16 = trunc <2 x i16> undef to <2
x i1>
; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction:
%V4i16 = trunc <4 x i16> undef to <4 x i1>
; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V8i16 = trunc <8 x i16> undef to <8
x i1>
; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V16i16 = trunc <16 x i16> undef to
<16 x i1>
; SKX256-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %V32i16 = trunc <32 x i16> undef to
<32 x i1>
; SKX256-NEXT: Cost Model: Found an estimated cost of 8 for instruction: %V64i16 = trunc <64 x i16> undef to
<64 x i1>
; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V2i8 = trunc <2 x i8> undef to <2 x
i1>
; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V4i8 = trunc <4 x i8> undef to <4 x
i1>
; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V8i8 = trunc <8 x i8> undef to <8 x
i1>
; SKX256-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V16i8 = trunc <16 x i8> undef to
<16 x i1>
; SKX256-NEXT:
Cost Model: Found an estimated cost of 2 for instruction: %V32i8 = trunc <32 x i8> undef to <32 x i1>
; SKX256-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %V64i8 = trunc <64 x i8> undef to
<64 x i1>
; SKX256-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret i32 undef

```

```

;
; SKX512-LABEL: 'trunc_vXi1'
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V2i64 = trunc <2 x i64> undef to <2
x i1>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V4i64 = trunc <4 x i64> undef to <4
x i1>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V8i64 = trunc <8 x i64> undef to <8
x i1>
; SKX512-NEXT: Cost Model: Found an estimated cost of 11 for instruction: %V16i64 = trunc <16 x i64> undef to
<16 x i1>
; SKX512-NEXT: Cost Model: Found an estimated cost of 0 for instruction: %V32i64 = trunc <32 x i64> undef to
<32 x i1>
; SKX512-NEXT: Cost Model: Found an estimated cost of 0 for instruction:
%V64i64 = trunc <64 x i64> undef to <64 x i1>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V2i32 = trunc <2 x i32> undef to <2
x i1>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V4i32 = trunc <4 x i32> undef to <4
x i1>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V8i32 = trunc <8 x i32> undef to <8
x i1>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V16i32 = trunc <16 x i32> undef to
<16 x i1>
; SKX512-NEXT: Cost Model: Found an estimated cost of 0 for instruction: %V32i32 = trunc <32 x i32> undef to
<32 x i1>
; SKX512-NEXT: Cost Model: Found an estimated cost of 0 for instruction: %V64i32 = trunc <64 x i32> undef to
<64 x i1>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V2i16 = trunc <2 x i16> undef to <2
x i1>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V4i16 = trunc <4 x i16> undef to <4
x i1>
;
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V8i16 = trunc <8 x i16> undef to <8
x i1>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V16i16 = trunc <16 x i16> undef to
<16 x i1>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V32i16 = trunc <32 x i16> undef to
<32 x i1>
; SKX512-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %V64i16 = trunc <64 x i16> undef to
<64 x i1>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V2i8 = trunc <2 x i8> undef to <2 x
i1>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V4i8 = trunc <4 x i8> undef to <4 x
i1>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V8i8 = trunc <8 x i8> undef to <8 x
i1>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V16i8 = trunc <16 x i8> undef to
<16 x i1>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for

```



```

instruction: %V32i8 = trunc <32 x i8> undef to <32 x i1>
; SKX512-NEXT: Cost Model: Found an estimated cost of 2 for instruction: %V64i8 = trunc <64 x i8> undef to
<64 x i1>
; SKX512-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret i32 undef
;
%V2i64 = trunc <2 x i64> undef to <2 x i1>
%V4i64 = trunc <4 x i64> undef to <4 x i1>
%V8i64 = trunc <8 x i64> undef to <8 x i1>
%V16i64 = trunc <16 x i64> undef to <16 x i1>
%V32i64 = trunc <32 x i64> undef to <32 x i1>
%V64i64 = trunc <64 x i64> undef to <64 x i1>

%V2i32 = trunc <2 x i32> undef to <2 x i1>
%V4i32 = trunc <4 x i32> undef to <4 x i1>
%V8i32 = trunc <8 x i32> undef to <8 x i1>
%V16i32 = trunc <16 x i32> undef to <16 x i1>
%V32i32 = trunc <32 x i32> undef to <32 x i1>
%V64i32 = trunc <64 x i32> undef to <64 x i1>

%V2i16 = trunc <2 x i16> undef to <2 x i1>
%V4i16 = trunc <4 x i16> undef to <4 x i1>
%V8i16 = trunc <8 x i16> undef to <8 x i1>
%V16i16 = trunc <16 x i16> undef to
<16 x i1>
%V32i16 = trunc <32 x i16> undef to <32 x i1>
%V64i16 = trunc <64 x i16> undef to <64 x i1>

%V2i8 = trunc <2 x i8> undef to <2 x i1>
%V4i8 = trunc <4 x i8> undef to <4 x i1>
%V8i8 = trunc <8 x i8> undef to <8 x i1>
%V16i8 = trunc <16 x i8> undef to <16 x i1>
%V32i8 = trunc <32 x i8> undef to <32 x i1>
%V64i8 = trunc <64 x i8> undef to <64 x i1>

ret i32 undef
}
; NOTE: Assertions have been autogenerated by utils/update_llc_test_checks.py
; RUN: llc -mtriple=riscv64 -mattr=+zbb -verify-machineinstrs < %s \
; RUN: -riscv-experimental-rv64-legal-i32 | FileCheck %s -check-prefix=RV64ZBB

declare i32 @llvm.riscv.orc.b.i32(i32)

define signext i32 @orc32(i32 signext %a) nounwind {
; RV64ZBB-LABEL: orc32:
; RV64ZBB:      # %bb.0:
; RV64ZBB-NEXT:  orc.b a0, a0
; RV64ZBB-NEXT:  sext.w a0, a0
; RV64ZBB-NEXT:  ret

```

```

%tmp = call i32 @llvm.riscv.orc.b.i32(i32 %a)
ret i32 %tmp
}

define zeroext i32 @orc32_zext(i32 zeroext %a) nounwind {
; RV64ZBB-LABEL: orc32_zext:
; RV64ZBB:      # %bb.0:
; RV64ZBB-NEXT:  orc.b a0, a0
; RV64ZBB-NEXT:  ret
%tmp = call i32 @llvm.riscv.orc.b.i32(i32 %a)
ret i32 %tmp
}

; Second and+or is redundant with the first, make sure we remove them.
define signext i32 @orc32_knownbits(i32 signext %a) nounwind {
; RV64ZBB-LABEL: orc32_knownbits:
; RV64ZBB:      # %bb.0:
; RV64ZBB-NEXT:  lui a1, 1044480
; RV64ZBB-NEXT:
    and a0, a0, a1
; RV64ZBB-NEXT:  lui a1, 2048
; RV64ZBB-NEXT:  addi a1, a1, 1
; RV64ZBB-NEXT:  or a0, a0, a1
; RV64ZBB-NEXT:  orc.b a0, a0
; RV64ZBB-NEXT:  sext.w a0, a0
; RV64ZBB-NEXT:  ret
%tmp = and i32 %a, 4278190080 ; 0xFF000000
%tmp2 = or i32 %tmp, 8388609 ; 0x800001
%tmp3 = call i32 @llvm.riscv.orc.b.i32(i32 %tmp2)
%tmp4 = and i32 %tmp3, 4278190080 ; 0xFF000000
%tmp5 = or i32 %tmp4, 16711935 ; 0xFF00FF
ret i32 %tmp5
}

declare i64 @llvm.riscv.orc.b.i64(i64)

define i64 @orc64(i64 %a) nounwind {
; RV64ZBB-LABEL: orc64:
; RV64ZBB:      # %bb.0:
; RV64ZBB-NEXT:  orc.b a0, a0
; RV64ZBB-NEXT:  ret
%tmp = call i64 @llvm.riscv.orc.b.i64(i64 %a)
ret i64 %tmp
}

; Second and+or is redundant with the first, make sure we remove them.
define i64 @orc64_knownbits(i64 %a) nounwind {
; RV64ZBB-LABEL: orc64_knownbits:

```

```

; RV64ZBB:    # %bb.0:
; RV64ZBB-NEXT:  lui a1, 65535
; RV64ZBB-NEXT:  slli a1, a1, 12
; RV64ZBB-NEXT:  and a0, a0, a1
;
RV64ZBB-NEXT:  lui a1, 256
; RV64ZBB-NEXT:  addiw a1, a1, 8
; RV64ZBB-NEXT:  slli a2, a1, 42
; RV64ZBB-NEXT:  add a1, a1, a2
; RV64ZBB-NEXT:  or a0, a0, a1
; RV64ZBB-NEXT:  orc.b a0, a0
; RV64ZBB-NEXT:  ret
%tmp = and i64 %a, 1099494850560 ; 0x000000ffff000000
%tmp2 = or i64 %tmp, 4611721202800525320 ; 0x4000200000100008
%tmp3 = call i64 @llvm.riscv.orc.b.i64(i64 %tmp2)
%tmp4 = and i64 %tmp3, 1099494850560 ; 0x000000ffff000000
%tmp5 = or i64 %tmp4, 18374966855153418495 ; 0xff00ff0000ff00ff
ret i64 %tmp5
}
; NOTE: Assertions have been autogenerated by utils/update_llc_test_checks.py
; RUN: llc -mtriple=riscv64 -mattr=+m -verify-machineinstrs < %s \
; RUN: -riscv-experimental-rv64-legal-i32 | FileCheck %s -check-prefix=RV64

;
; Get the actual value of the overflow bit.
;
define zeroext i1 @saddo1.i32(i32 signext %v1, i32 signext %v2, ptr %res) {
; RV64-LABEL: saddo1.i32:
; RV64:    # %bb.0: # %entry
; RV64-NEXT:  addw a3, a0, a1
; RV64-NEXT:  slt a0, a3, a0
; RV64-NEXT:  slti a1, a1, 0
; RV64-NEXT:  xor a0, a1, a0
; RV64-NEXT:  sw a3, 0(a2)
; RV64-NEXT:  ret
entry:
%t = call {i32, i1} @llvm.sadd.with.overflow.i32(i32 %v1, i32 %v2)
%val = extractvalue {i32, i1} %t, 0
%obit = extractvalue {i32, i1} %t, 1
store i32 %val, ptr %res
ret i1 %obit
}

; Test the immediate version.
define zeroext i1 @saddo2.i32(i32 signext %v1, ptr %res) {
; RV64-LABEL: saddo2.i32:
; RV64:    # %bb.0: # %entry
; RV64-NEXT:  addiw a2, a0, 4

```

```

; RV64-NEXT:  slt a0, a2, a0
; RV64-NEXT:
    sw a2, 0(a1)
; RV64-NEXT:  ret
entry:
    %t = call @llvm.sadd.with.overflow.i32(i32 %v1, i32 4)
    %val = extractvalue {i32, i1} %t, 0
    %obit = extractvalue {i32, i1} %t, 1
    store i32 %val, ptr %res
    ret i1 %obit
}

; Test negative immediates.
define zeroext i1 @saddo3.i32(i32 signext %v1, ptr %res) {
; RV64-LABEL: saddo3.i32:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  addiw a2, a0, -4
; RV64-NEXT:  slt a0, a2, a0
; RV64-NEXT:  xori a0, a0, 1
; RV64-NEXT:  sw a2, 0(a1)
; RV64-NEXT:  ret
entry:
    %t = call @llvm.sadd.with.overflow.i32(i32 %v1, i32 -4)
    %val = extractvalue {i32, i1} %t, 0
    %obit = extractvalue {i32, i1} %t, 1
    store i32 %val, ptr %res
    ret i1 %obit
}

; Test immediates that are too large to be encoded.
define zeroext i1 @saddo4.i32(i32 signext %v1, ptr %res) {
; RV64-LABEL: saddo4.i32:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  lui a2, 4096
; RV64-NEXT:  addi a2, a2, -1
; RV64-NEXT:  addw a2, a0, a2
; RV64-NEXT:  slt
a0, a2, a0
; RV64-NEXT:  sw a2, 0(a1)
; RV64-NEXT:  ret
entry:
    %t = call @llvm.sadd.with.overflow.i32(i32 %v1, i32 16777215)
    %val = extractvalue {i32, i1} %t, 0
    %obit = extractvalue {i32, i1} %t, 1
    store i32 %val, ptr %res
    ret i1 %obit
}

```

```

define zeroext i1 @saddo1.i64(i64 %v1, i64 %v2, ptr %res) {
; RV64-LABEL: saddo1.i64:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  add a3, a0, a1
; RV64-NEXT:  slt a0, a3, a0
; RV64-NEXT:  slti a1, a1, 0
; RV64-NEXT:  xor a0, a1, a0
; RV64-NEXT:  sd a3, 0(a2)
; RV64-NEXT:  ret
entry:
%t = call {i64, i1} @llvm.sadd.with.overflow.i64(i64 %v1, i64 %v2)
%val = extractvalue {i64, i1} %t, 0
%obit = extractvalue {i64, i1} %t, 1
store i64 %val, ptr %res
ret i1 %obit
}

```

```

define zeroext i1 @saddo2.i64(i64 %v1, ptr %res) {
; RV64-LABEL: saddo2.i64:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  addi a2, a0, 4
; RV64-NEXT:  slt a0, a2, a0
; RV64-NEXT:  sd a2, 0(a1)
; RV64-NEXT:  ret
entry:
%t = call {i64, i1}
@llvm.sadd.with.overflow.i64(i64 %v1, i64 4)
%val = extractvalue {i64, i1} %t, 0
%obit = extractvalue {i64, i1} %t, 1
store i64 %val, ptr %res
ret i1 %obit
}

```

```

define zeroext i1 @saddo3.i64(i64 %v1, ptr %res) {
; RV64-LABEL: saddo3.i64:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  addi a2, a0, -4
; RV64-NEXT:  slt a0, a2, a0
; RV64-NEXT:  xori a0, a0, 1
; RV64-NEXT:  sd a2, 0(a1)
; RV64-NEXT:  ret
entry:
%t = call {i64, i1} @llvm.sadd.with.overflow.i64(i64 %v1, i64 -4)
%val = extractvalue {i64, i1} %t, 0
%obit = extractvalue {i64, i1} %t, 1
store i64 %val, ptr %res
ret i1 %obit
}

```

```

define zeroext i1 @uaddo.i32(i32 signext %v1, i32 signext %v2, ptr %res) {
; RV64-LABEL: uaddo.i32:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  addw a1, a0, a1
; RV64-NEXT:  sltu a0, a1, a0
; RV64-NEXT:  sw a1, 0(a2)
; RV64-NEXT:  ret
entry:
%t = call {i32, i1} @llvm.uadd.with.overflow.i32(i32 %v1, i32 %v2)
%val = extractvalue {i32, i1} %t, 0
%obit = extractvalue {i32,
i1} %t, 1
store i32 %val, ptr %res
ret i1 %obit
}

```

```

define zeroext i1 @uaddo.i32.constant(i32 signext %v1, ptr %res) {
; RV64-LABEL: uaddo.i32.constant:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  addiw a2, a0, -2
; RV64-NEXT:  sltu a0, a2, a0
; RV64-NEXT:  sw a2, 0(a1)
; RV64-NEXT:  ret
entry:
%t = call {i32, i1} @llvm.uadd.with.overflow.i32(i32 %v1, i32 -2)
%val = extractvalue {i32, i1} %t, 0
%obit = extractvalue {i32, i1} %t, 1
store i32 %val, ptr %res
ret i1 %obit
}

```

```

define zeroext i1 @uaddo.i32.constant_one(i32 signext %v1, ptr %res) {
; RV64-LABEL: uaddo.i32.constant_one:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  addiw a2, a0, 1
; RV64-NEXT:  seqz a0, a2
; RV64-NEXT:  sw a2, 0(a1)
; RV64-NEXT:  ret
entry:
%t = call {i32, i1} @llvm.uadd.with.overflow.i32(i32 %v1, i32 1)
%val = extractvalue {i32, i1} %t, 0
%obit = extractvalue {i32, i1} %t, 1
store i32 %val, ptr %res
ret i1 %obit
}

```

```

define zeroext i1 @uaddo.i64(i64 %v1, i64 %v2, ptr

```

```

%res) {
; RV64-LABEL: uaddo.i64:
; RV64:    # %bb.0: # %entry
; RV64-NEXT:  add a1, a0, a1
; RV64-NEXT:  sltu a0, a1, a0
; RV64-NEXT:  sd a1, 0(a2)
; RV64-NEXT:  ret
entry:
%t = call {i64, i1} @llvm.uadd.with.overflow.i64(i64 %v1, i64 %v2)
%val = extractvalue {i64, i1} %t, 0
%obit = extractvalue {i64, i1} %t, 1
store i64 %val, ptr %res
ret i1 %obit
}

```

```

define zeroext i1 @uaddo.i64.constant_one(i64 %v1, ptr %res) {
; RV64-LABEL: uaddo.i64.constant_one:
; RV64:    # %bb.0: # %entry
; RV64-NEXT:  addi a2, a0, 1
; RV64-NEXT:  seqz a0, a2
; RV64-NEXT:  sd a2, 0(a1)
; RV64-NEXT:  ret
entry:
%t = call {i64, i1} @llvm.uadd.with.overflow.i64(i64 %v1, i64 1)
%val = extractvalue {i64, i1} %t, 0
%obit = extractvalue {i64, i1} %t, 1
store i64 %val, ptr %res
ret i1 %obit
}

```

```

define zeroext i1 @ssub1.i32(i32 signext %v1, i32 signext %v2, ptr %res) {
; RV64-LABEL: ssub1.i32:
; RV64:    # %bb.0: # %entry
; RV64-NEXT:  sgtz a3, a1
; RV64-NEXT:  subw a1,
a0, a1
; RV64-NEXT:  slt a0, a1, a0
; RV64-NEXT:  xor a0, a3, a0
; RV64-NEXT:  sw a1, 0(a2)
; RV64-NEXT:  ret
entry:
%t = call {i32, i1} @llvm.ssub.with.overflow.i32(i32 %v1, i32 %v2)
%val = extractvalue {i32, i1} %t, 0
%obit = extractvalue {i32, i1} %t, 1
store i32 %val, ptr %res
ret i1 %obit
}

```

```

define zeroext i1 @ssubo2.i32(i32 signext %v1, ptr %res) {
; RV64-LABEL: ssubo2.i32:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  addiw a2, a0, 4
; RV64-NEXT:  slt a0, a2, a0
; RV64-NEXT:  sw a2, 0(a1)
; RV64-NEXT:  ret
entry:
%t = call {i32, i1} @llvm.ssub.with.overflow.i32(i32 %v1, i32 -4)
%val = extractvalue {i32, i1} %t, 0
%obit = extractvalue {i32, i1} %t, 1
store i32 %val, ptr %res
ret i1 %obit
}

define zeroext i1 @ssubo.i64(i64 %v1, i64 %v2, ptr %res) {
; RV64-LABEL: ssubo.i64:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  sgtz a3, a1
; RV64-NEXT:  sub a1, a0, a1
; RV64-NEXT:  slt a0, a1, a0
; RV64-NEXT:  xor a0, a3, a0
; RV64-NEXT:  sd a1,
0(a2)
; RV64-NEXT:  ret
entry:
%t = call {i64, i1} @llvm.ssub.with.overflow.i64(i64 %v1, i64 %v2)
%val = extractvalue {i64, i1} %t, 0
%obit = extractvalue {i64, i1} %t, 1
store i64 %val, ptr %res
ret i1 %obit
}

define zeroext i1 @usubo.i32(i32 signext %v1, i32 signext %v2, ptr %res) {
; RV64-LABEL: usubo.i32:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  subw a1, a0, a1
; RV64-NEXT:  sltu a0, a0, a1
; RV64-NEXT:  sw a1, 0(a2)
; RV64-NEXT:  ret
entry:
%t = call {i32, i1} @llvm.usub.with.overflow.i32(i32 %v1, i32 %v2)
%val = extractvalue {i32, i1} %t, 0
%obit = extractvalue {i32, i1} %t, 1
store i32 %val, ptr %res
ret i1 %obit
}

```



```

define zeroext i1 @usubo.i32.constant.rhs(i32 signext %v1, ptr %res) {
; RV64-LABEL: usubo.i32.constant.rhs:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  addiw a2, a0, 2
; RV64-NEXT:  sltu a0, a0, a2
; RV64-NEXT:  sw a2, 0(a1)
; RV64-NEXT:  ret
entry:
%t = call {i32, i1} @llvm.usub.with.overflow.i32(i32 %v1, i32 -2)

%val = extractvalue {i32, i1} %t, 0
%obit = extractvalue {i32, i1} %t, 1
store i32 %val, ptr %res
ret i1 %obit
}

```

```

define zeroext i1 @usubo.i32.constant.lhs(i32 signext %v1, ptr %res) {
; RV64-LABEL: usubo.i32.constant.lhs:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  li a2, -2
; RV64-NEXT:  subw a2, a2, a0
; RV64-NEXT:  addi a0, a2, 1
; RV64-NEXT:  seqz a0, a0
; RV64-NEXT:  sw a2, 0(a1)
; RV64-NEXT:  ret
entry:
%t = call {i32, i1} @llvm.usub.with.overflow.i32(i32 -2, i32 %v1)
%val = extractvalue {i32, i1} %t, 0
%obit = extractvalue {i32, i1} %t, 1
store i32 %val, ptr %res
ret i1 %obit
}

```

```

define zeroext i1 @usubo.i64(i64 %v1, i64 %v2, ptr %res) {
; RV64-LABEL: usubo.i64:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  sub a1, a0, a1
; RV64-NEXT:  sltu a0, a0, a1
; RV64-NEXT:  sd a1, 0(a2)
; RV64-NEXT:  ret
entry:
%t = call {i64, i1} @llvm.usub.with.overflow.i64(i64 %v1, i64 %v2)
%val = extractvalue {i64, i1} %t, 0
%obit = extractvalue {i64, i1} %t,
1
store i64 %val, ptr %res
ret i1 %obit
}

```

```

define zeroext i1 @smulo.i32(i32 signext %v1, i32 signext %v2, ptr %res) {
; RV64-LABEL: smulo.i32:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  mul a1, a0, a1
; RV64-NEXT:  srai a0, a1, 32
; RV64-NEXT:  sraiw a3, a1, 31
; RV64-NEXT:  xor a0, a0, a3
; RV64-NEXT:  snez a0, a0
; RV64-NEXT:  sw a1, 0(a2)
; RV64-NEXT:  ret
entry:
%t = call {i32, i1} @llvm.smul.with.overflow.i32(i32 %v1, i32 %v2)
%val = extractvalue {i32, i1} %t, 0
%obit = extractvalue {i32, i1} %t, 1
store i32 %val, ptr %res
ret i1 %obit
}

```

```

define zeroext i1 @smulo2.i32(i32 signext %v1, ptr %res) {
; RV64-LABEL: smulo2.i32:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  li a2, 13
; RV64-NEXT:  mul a2, a0, a2
; RV64-NEXT:  srai a0, a2, 32
; RV64-NEXT:  sraiw a3, a2, 31
; RV64-NEXT:  xor a0, a0, a3
; RV64-NEXT:  snez a0, a0
; RV64-NEXT:  sw a2, 0(a1)
; RV64-NEXT:  ret
entry:
%t = call {i32, i1} @llvm.smul.with.overflow.i32(i32 %v1, i32
13)
%val = extractvalue {i32, i1} %t, 0
%obit = extractvalue {i32, i1} %t, 1
store i32 %val, ptr %res
ret i1 %obit
}

```

```

define zeroext i1 @smulo.i64(i64 %v1, i64 %v2, ptr %res) {
; RV64-LABEL: smulo.i64:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  mulh a3, a0, a1
; RV64-NEXT:  mul a1, a0, a1
; RV64-NEXT:  srai a0, a1, 63
; RV64-NEXT:  xor a0, a3, a0
; RV64-NEXT:  snez a0, a0
; RV64-NEXT:  sd a1, 0(a2)

```

```

; RV64-NEXT:  ret
entry:
%t = call {i64, i1} @llvm.smul.with.overflow.i64(i64 %v1, i64 %v2)
%val = extractvalue {i64, i1} %t, 0
%obit = extractvalue {i64, i1} %t, 1
store i64 %val, ptr %res
ret i1 %obit
}

```

```

define zeroext i1 @smulo2.i64(i64 %v1, ptr %res) {
; RV64-LABEL: smulo2.i64:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  li a2, 13
; RV64-NEXT:  mulh a3, a0, a2
; RV64-NEXT:  mul a2, a0, a2
; RV64-NEXT:  srai a0, a2, 63
; RV64-NEXT:  xor a0, a3, a0
; RV64-NEXT:  snez a0, a0
; RV64-NEXT:  sd a2, 0(a1)
; RV64-NEXT:  ret
entry:
%t = call
{i64, i1} @llvm.smul.with.overflow.i64(i64 %v1, i64 13)
%val = extractvalue {i64, i1} %t, 0
%obit = extractvalue {i64, i1} %t, 1
store i64 %val, ptr %res
ret i1 %obit
}

```

```

define zeroext i1 @umulo.i32(i32 signext %v1, i32 signext %v2, ptr %res) {
; RV64-LABEL: umulo.i32:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  slli a1, a1, 32
; RV64-NEXT:  slli a0, a0, 32
; RV64-NEXT:  mulhu a1, a0, a1
; RV64-NEXT:  srai a0, a1, 32
; RV64-NEXT:  snez a0, a0
; RV64-NEXT:  sw a1, 0(a2)
; RV64-NEXT:  ret
entry:
%t = call {i32, i1} @llvm.umul.with.overflow.i32(i32 %v1, i32 %v2)
%val = extractvalue {i32, i1} %t, 0
%obit = extractvalue {i32, i1} %t, 1
store i32 %val, ptr %res
ret i1 %obit
}

```

```

define zeroext i1 @umulo2.i32(i32 signext %v1, ptr %res) {

```

```

; RV64-LABEL: umulo2.i32:
; RV64:      # %bb.0: # %entry
; RV64-NEXT: li a2, 13
; RV64-NEXT: slli a2, a2, 32
; RV64-NEXT: slli a0, a0, 32
; RV64-NEXT: mulhu a2, a0, a2
; RV64-NEXT: srli a0, a2, 32
; RV64-NEXT:
    snez a0, a0
; RV64-NEXT: sw a2, 0(a1)
; RV64-NEXT: ret
entry:
%t = call {i32, i1} @llvm.umul.with.overflow.i32(i32 %v1, i32 13)
%val = extractvalue {i32, i1} %t, 0
%obit = extractvalue {i32, i1} %t, 1
store i32 %val, ptr %res
ret i1 %obit
}

; Similar to umulo.i32, but storing the overflow and returning the result.
define signext i32 @umulo3.i32(i32 signext %0, i32 signext %1, ptr %2) {
; RV64-LABEL: umulo3.i32:
; RV64:      # %bb.0:
; RV64-NEXT: slli a1, a1, 32
; RV64-NEXT: slli a0, a0, 32
; RV64-NEXT: mulhu a0, a0, a1
; RV64-NEXT: srai a1, a0, 32
; RV64-NEXT: snez a1, a1
; RV64-NEXT: sext.w a0, a0
; RV64-NEXT: sw a1, 0(a2)
; RV64-NEXT: ret
%4 = tail call { i32, i1 } @llvm.umul.with.overflow.i32(i32 %0, i32 %1)
%5 = extractvalue { i32, i1 } %4, 1
%6 = extractvalue { i32, i1 } %4, 0
%7 = zext i1 %5 to i32
store i32 %7, ptr %2, align 4
ret i32 %6
}

define zeroext i1 @umulo.i64(i64 %v1, i64 %v2, ptr %res) {
; RV64-LABEL: umulo.i64:
;
RV64:      # %bb.0: # %entry
; RV64-NEXT: mulhu a3, a0, a1
; RV64-NEXT: snez a3, a3
; RV64-NEXT: mul a0, a0, a1
; RV64-NEXT: sd a0, 0(a2)
; RV64-NEXT: mv a0, a3

```

```

; RV64-NEXT:  ret
entry:
%t = call {i64, i1} @llvm.umul.with.overflow.i64(i64 %v1, i64 %v2)
%val = extractvalue {i64, i1} %t, 0
%obit = extractvalue {i64, i1} %t, 1
store i64 %val, ptr %res
ret i1 %obit
}

define zeroext i1 @umulo2.i64(i64 %v1, ptr %res) {
; RV64-LABEL: umulo2.i64:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  li a3, 13
; RV64-NEXT:  mulhu a2, a0, a3
; RV64-NEXT:  snez a2, a2
; RV64-NEXT:  mul a0, a0, a3
; RV64-NEXT:  sd a0, 0(a1)
; RV64-NEXT:  mv a0, a2
; RV64-NEXT:  ret
entry:
%t = call {i64, i1} @llvm.umul.with.overflow.i64(i64 %v1, i64 13)
%val = extractvalue {i64, i1} %t, 0
%obit = extractvalue {i64, i1} %t, 1
store i64 %val, ptr %res
ret i1 %obit
}

;
; Check the use of the overflow bit in combination with a select instruction.
;
define i32 @saddo.select.i32(i32
signext %v1, i32 signext %v2) {
; RV64-LABEL: saddo.select.i32:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  addw a2, a0, a1
; RV64-NEXT:  slt a2, a2, a0
; RV64-NEXT:  slti a3, a1, 0
; RV64-NEXT:  bne a3, a2, .LBB28_2
; RV64-NEXT: # %bb.1: # %entry
; RV64-NEXT:  mv a0, a1
; RV64-NEXT: .LBB28_2: # %entry
; RV64-NEXT:  ret
entry:
%t = call {i32, i1} @llvm.sadd.with.overflow.i32(i32 %v1, i32 %v2)
%obit = extractvalue {i32, i1} %t, 1
%ret = select i1 %obit, i32 %v1, i32 %v2
ret i32 %ret

```

```

}

define i1 @saddo.not.i32(i32 signext %v1, i32 signext %v2) {
; RV64-LABEL: saddo.not.i32:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  addw a2, a0, a1
; RV64-NEXT:  slt a0, a2, a0
; RV64-NEXT:  slti a1, a1, 0
; RV64-NEXT:  xor a0, a1, a0
; RV64-NEXT:  xori a0, a0, 1
; RV64-NEXT:  ret
entry:
%t = call {i32, i1} @llvm.sadd.with.overflow.i32(i32 %v1, i32 %v2)
%obit = extractvalue {i32, i1} %t, 1
%ret = xor i1 %obit, true
ret i1 %ret
}

```

```

define i64 @saddo.select.i64(i64
%v1, i64 %v2) {
; RV64-LABEL: saddo.select.i64:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  add a2, a0, a1
; RV64-NEXT:  slt a2, a2, a0
; RV64-NEXT:  slti a3, a1, 0
; RV64-NEXT:  bne a3, a2, .LBB30_2
; RV64-NEXT:  # %bb.1: # %entry
; RV64-NEXT:  mv a0, a1
; RV64-NEXT:  .LBB30_2: # %entry
; RV64-NEXT:  ret
entry:
%t = call {i64, i1} @llvm.sadd.with.overflow.i64(i64 %v1, i64 %v2)
%obit = extractvalue {i64, i1} %t, 1
%ret = select i1 %obit, i64 %v1, i64 %v2
ret i64 %ret
}

```

```

define i1 @saddo.not.i64(i64 %v1, i64 %v2) {
; RV64-LABEL: saddo.not.i64:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  add a2, a0, a1
; RV64-NEXT:  slt a0, a2, a0
; RV64-NEXT:  slti a1, a1, 0
; RV64-NEXT:  xor a0, a1, a0
; RV64-NEXT:  xori a0, a0, 1
; RV64-NEXT:  ret
entry:
%t = call {i64, i1} @llvm.sadd.with.overflow.i64(i64 %v1, i64 %v2)

```

```

%obit = extractvalue {i64, i1} %t, 1
%ret = xor i1 %obit, true
ret i1 %ret
}

define i32 @uaddo.select.i32(i32 signext %v1,
i32 signext %v2) {
; RV64-LABEL: uaddo.select.i32:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  addw a2, a0, a1
; RV64-NEXT:  bltu a2, a0, .LBB32_2
; RV64-NEXT: # %bb.1: # %entry
; RV64-NEXT:  mv a0, a1
; RV64-NEXT: .LBB32_2: # %entry
; RV64-NEXT:  ret
entry:
%t = call {i32, i1} @llvm.uadd.with.overflow.i32(i32 %v1, i32 %v2)
%obit = extractvalue {i32, i1} %t, 1
%ret = select i1 %obit, i32 %v1, i32 %v2
ret i32 %ret
}

define i1 @uaddo.not.i32(i32 signext %v1, i32 signext %v2) {
; RV64-LABEL: uaddo.not.i32:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  addw a1, a0, a1
; RV64-NEXT:  sltu a0, a1, a0
; RV64-NEXT:  xori a0, a0, 1
; RV64-NEXT:  ret
entry:
%t = call {i32, i1} @llvm.uadd.with.overflow.i32(i32 %v1, i32 %v2)
%obit = extractvalue {i32, i1} %t, 1
%ret = xor i1 %obit, true
ret i1 %ret
}

define i64 @uaddo.select.i64(i64 %v1, i64 %v2) {
; RV64-LABEL: uaddo.select.i64:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  add a2, a0, a1
; RV64-NEXT:
; RV64-NEXT:  bltu a2, a0, .LBB34_2
; RV64-NEXT: # %bb.1: # %entry
; RV64-NEXT:  mv a0, a1
; RV64-NEXT: .LBB34_2: # %entry
; RV64-NEXT:  ret
entry:
%t = call {i64, i1} @llvm.uadd.with.overflow.i64(i64 %v1, i64 %v2)

```

```

%obit = extractvalue {i64, i1} %t, 1
%ret = select i1 %obit, i64 %v1, i64 %v2
ret i64 %ret
}

define i1 @uaddo.not.i64(i64 %v1, i64 %v2) {
; RV64-LABEL: uaddo.not.i64:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  add a1, a0, a1
; RV64-NEXT:  sltu a0, a1, a0
; RV64-NEXT:  xori a0, a0, 1
; RV64-NEXT:  ret
entry:
%t = call {i64, i1} @llvm.uadd.with.overflow.i64(i64 %v1, i64 %v2)
%obit = extractvalue {i64, i1} %t, 1
%ret = xor i1 %obit, true
ret i1 %ret
}

define i32 @ssubo.select.i32(i32 signext %v1, i32 signext %v2) {
; RV64-LABEL: ssubo.select.i32:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  sgtz a2, a1
; RV64-NEXT:  subw a3, a0, a1
; RV64-NEXT:  slt a3, a3, a0
; RV64-NEXT:  bne a2, a3, .LBB36_2
; RV64-NEXT:  # %bb.1: # %entry
; RV64-NEXT:  mv a0,
a1
; RV64-NEXT:  .LBB36_2: # %entry
; RV64-NEXT:  ret
entry:
%t = call {i32, i1} @llvm.ssub.with.overflow.i32(i32 %v1, i32 %v2)
%obit = extractvalue {i32, i1} %t, 1
%ret = select i1 %obit, i32 %v1, i32 %v2
ret i32 %ret
}

define i1 @ssubo.not.i32(i32 signext %v1, i32 signext %v2) {
; RV64-LABEL: ssubo.not.i32:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  sgtz a2, a1
; RV64-NEXT:  subw a1, a0, a1
; RV64-NEXT:  slt a0, a1, a0
; RV64-NEXT:  xor a0, a2, a0
; RV64-NEXT:  xori a0, a0, 1
; RV64-NEXT:  ret
entry:

```



```

%t = call {i32, i1} @llvm.ssub.with.overflow.i32(i32 %v1, i32 %v2)
%obit = extractvalue {i32, i1} %t, 1
%ret = xor i1 %obit, true
ret i1 %ret
}

```

```

define i64 @ssubo.select.i64(i64 %v1, i64 %v2) {
; RV64-LABEL: ssubo.select.i64:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  sgtz a2, a1
; RV64-NEXT:  sub a3, a0, a1
; RV64-NEXT:  slt a3, a3, a0
; RV64-NEXT:  bne a2, a3, .LBB38_2
; RV64-NEXT:  # %bb.1: # %entry
; RV64-NEXT:  mv a0, a1
; RV64-NEXT:
.LBB38_2: # %entry
; RV64-NEXT:  ret
entry:
%t = call {i64, i1} @llvm.ssub.with.overflow.i64(i64 %v1, i64 %v2)
%obit = extractvalue {i64, i1} %t, 1
%ret = select i1 %obit, i64 %v1, i64 %v2
ret i64 %ret
}

```

```

define i1 @ssub.not.i64(i64 %v1, i64 %v2) {
; RV64-LABEL: ssub.not.i64:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  sgtz a2, a1
; RV64-NEXT:  sub a1, a0, a1
; RV64-NEXT:  slt a0, a1, a0
; RV64-NEXT:  xor a0, a2, a0
; RV64-NEXT:  xori a0, a0, 1
; RV64-NEXT:  ret
entry:
%t = call {i64, i1} @llvm.ssub.with.overflow.i64(i64 %v1, i64 %v2)
%obit = extractvalue {i64, i1} %t, 1
%ret = xor i1 %obit, true
ret i1 %ret
}

```

```

define i32 @usubo.select.i32(i32 signext %v1, i32 signext %v2) {
; RV64-LABEL: usubo.select.i32:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  subw a2, a0, a1
; RV64-NEXT:  bltu a0, a2, .LBB40_2
; RV64-NEXT:  # %bb.1: # %entry
; RV64-NEXT:  mv a0, a1

```

```

; RV64-NEXT: .LBB40_2: # %entry
; RV64-NEXT:  ret
entry:
%t = call {i32, i1} @llvm.usub.with.overflow.i32(i32
%v1, i32 %v2)
%obit = extractvalue {i32, i1} %t, 1
%ret = select i1 %obit, i32 %v1, i32 %v2
ret i32 %ret
}

define i1 @usubo.not.i32(i32 signext %v1, i32 signext %v2) {
; RV64-LABEL: usubo.not.i32:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  subw a1, a0, a1
; RV64-NEXT:  sltu a0, a0, a1
; RV64-NEXT:  xori a0, a0, 1
; RV64-NEXT:  ret
entry:
%t = call {i32, i1} @llvm.usub.with.overflow.i32(i32 %v1, i32 %v2)
%obit = extractvalue {i32, i1} %t, 1
%ret = xor i1 %obit, true
ret i1 %ret
}

define i64 @usubo.select.i64(i64 %v1, i64 %v2) {
; RV64-LABEL: usubo.select.i64:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  sub a2, a0, a1
; RV64-NEXT:  bltu a0, a2, .LBB42_2
; RV64-NEXT:  # %bb.1: # %entry
; RV64-NEXT:  mv a0, a1
; RV64-NEXT:  .LBB42_2: # %entry
; RV64-NEXT:  ret
entry:
%t = call {i64, i1} @llvm.usub.with.overflow.i64(i64 %v1, i64 %v2)
%obit = extractvalue {i64, i1} %t, 1
%ret = select i1 %obit, i64 %v1, i64 %v2
ret i64 %ret
}

define
i1 @usubo.not.i64(i64 %v1, i64 %v2) {
; RV64-LABEL: usubo.not.i64:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  sub a1, a0, a1
; RV64-NEXT:  sltu a0, a0, a1
; RV64-NEXT:  xori a0, a0, 1
; RV64-NEXT:  ret

```

```

entry:
  %t = call {i64, i1} @llvm.usub.with.overflow.i64(i64 %v1, i64 %v2)
  %obit = extractvalue {i64, i1} %t, 1
  %ret = xor i1 %obit, true
  ret i1 %ret
}

```

```

define i32 @smulo.select.i32(i32 signext %v1, i32 signext %v2) {
; RV64-LABEL: smulo.select.i32:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  mul a2, a0, a1
; RV64-NEXT:  srai a3, a2, 32
; RV64-NEXT:  sraiw a2, a2, 31
; RV64-NEXT:  bne a3, a2, .LBB44_2
; RV64-NEXT: # %bb.1: # %entry
; RV64-NEXT:  mv a0, a1
; RV64-NEXT: .LBB44_2: # %entry
; RV64-NEXT:  ret
entry:
  %t = call {i32, i1} @llvm.smul.with.overflow.i32(i32 %v1, i32 %v2)
  %obit = extractvalue {i32, i1} %t, 1
  %ret = select i1 %obit, i32 %v1, i32 %v2
  ret i32 %ret
}

```

```

define i1 @smulo.not.i32(i32 signext %v1, i32 signext %v2) {
; RV64-LABEL:
smulo.not.i32:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  mul a0, a0, a1
; RV64-NEXT:  srai a1, a0, 32
; RV64-NEXT:  sraiw a0, a0, 31
; RV64-NEXT:  xor a0, a1, a0
; RV64-NEXT:  snez a0, a0
; RV64-NEXT:  xori a0, a0, 1
; RV64-NEXT:  ret
entry:
  %t = call {i32, i1} @llvm.smul.with.overflow.i32(i32 %v1, i32 %v2)
  %obit = extractvalue {i32, i1} %t, 1
  %ret = xor i1 %obit, true
  ret i1 %ret
}

```

```

define i64 @smulo.select.i64(i64 %v1, i64 %v2) {
; RV64-LABEL: smulo.select.i64:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  mulh a2, a0, a1
; RV64-NEXT:  mul a3, a0, a1

```

```

; RV64-NEXT:  srai a3, a3, 63
; RV64-NEXT:  bne a2, a3, .LBB46_2
; RV64-NEXT:  # %bb.1: # %entry
; RV64-NEXT:  mv a0, a1
; RV64-NEXT:  .LBB46_2: # %entry
; RV64-NEXT:  ret
entry:
%t = call {i64, i1} @llvm.smul.with.overflow.i64(i64 %v1, i64 %v2)
%obit = extractvalue {i64, i1} %t, 1
%ret = select i1 %obit, i64 %v1, i64 %v2
ret i64 %ret
}

```

```

define i1 @smulo.not.i64(i64 %v1, i64 %v2) {
; RV64-LABEL:
smulo.not.i64:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  mulh a2, a0, a1
; RV64-NEXT:  mul a0, a0, a1
; RV64-NEXT:  srai a0, a0, 63
; RV64-NEXT:  xor a0, a2, a0
; RV64-NEXT:  snez a0, a0
; RV64-NEXT:  xori a0, a0, 1
; RV64-NEXT:  ret
entry:
%t = call {i64, i1} @llvm.smul.with.overflow.i64(i64 %v1, i64 %v2)
%obit = extractvalue {i64, i1} %t, 1
%ret = xor i1 %obit, true
ret i1 %ret
}

```

```

define i32 @umulo.select.i32(i32 signext %v1, i32 signext %v2) {
; RV64-LABEL: umulo.select.i32:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  slli a2, a1, 32
; RV64-NEXT:  slli a3, a0, 32
; RV64-NEXT:  mulhu a2, a3, a2
; RV64-NEXT:  srai a2, a2, 32
; RV64-NEXT:  bnez a2, .LBB48_2
; RV64-NEXT:  # %bb.1: # %entry
; RV64-NEXT:  mv a0, a1
; RV64-NEXT:  .LBB48_2: # %entry
; RV64-NEXT:  ret
entry:
%t = call {i32, i1} @llvm.umul.with.overflow.i32(i32 %v1, i32 %v2)
%obit = extractvalue {i32, i1} %t, 1
%ret = select i1 %obit, i32 %v1, i32 %v2
ret i32 %ret

```

```

}

define
  i1 @umulo.not.i32(i32 signext %v1, i32 signext %v2) {
; RV64-LABEL: umulo.not.i32:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  slli a1, a1, 32
; RV64-NEXT:  slli a0, a0, 32
; RV64-NEXT:  mulhu a0, a0, a1
; RV64-NEXT:  srai a0, a0, 32
; RV64-NEXT:  snez a0, a0
; RV64-NEXT:  xori a0, a0, 1
; RV64-NEXT:  ret
entry:
  %t = call {i32, i1} @llvm.umul.with.overflow.i32(i32 %v1, i32 %v2)
  %obit = extractvalue {i32, i1} %t, 1
  %ret = xor i1 %obit, true
  ret i1 %ret
}

```

```

define i64 @umulo.select.i64(i64 %v1, i64 %v2) {
; RV64-LABEL: umulo.select.i64:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  mulhu a2, a0, a1
; RV64-NEXT:  bnez a2, .LBB50_2
; RV64-NEXT:  # %bb.1: # %entry
; RV64-NEXT:  mv a0, a1
; RV64-NEXT:  .LBB50_2: # %entry
; RV64-NEXT:  ret
entry:
  %t = call {i64, i1} @llvm.umul.with.overflow.i64(i64 %v1, i64 %v2)
  %obit = extractvalue {i64, i1} %t, 1
  %ret = select i1 %obit, i64 %v1, i64 %v2
  ret i64 %ret
}

```

```

define i1 @umulo.not.i64(i64 %v1, i64 %v2)
{
; RV64-LABEL: umulo.not.i64:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  mulhu a0, a0, a1
; RV64-NEXT:  snez a0, a0
; RV64-NEXT:  xori a0, a0, 1
; RV64-NEXT:  ret
entry:
  %t = call {i64, i1} @llvm.umul.with.overflow.i64(i64 %v1, i64 %v2)
  %obit = extractvalue {i64, i1} %t, 1
  %ret = xor i1 %obit, true
}

```

```

ret i1 %ret
}

;
; Check the use of the overflow bit in combination with a branch instruction.
;
define zeroext i1 @saddo.br.i32(i32 signext %v1, i32 signext %v2) {
; RV64-LABEL: saddo.br.i32:
; RV64:    # %bb.0: # %entry
; RV64-NEXT:  addw a2, a0, a1
; RV64-NEXT:  slt a0, a2, a0
; RV64-NEXT:  slti a1, a1, 0
; RV64-NEXT:  beq a1, a0, .LBB52_2
; RV64-NEXT:  # %bb.1: # %overflow
; RV64-NEXT:  li a0, 0
; RV64-NEXT:  ret
; RV64-NEXT: .LBB52_2: # %continue
; RV64-NEXT:  li a0, 1
; RV64-NEXT:  ret
entry:
%t = call {i32, i1} @llvm.sadd.with.overflow.i32(i32 %v1, i32 %v2)
%val = extractvalue {i32, i1} %t, 0
%obit = extractvalue {i32, i1} %t, 1
br i1
%obit, label %overflow, label %continue

overflow:
ret i1 false

continue:
ret i1 true
}

define zeroext i1 @saddo.br.i64(i64 %v1, i64 %v2) {
; RV64-LABEL: saddo.br.i64:
; RV64:    # %bb.0: # %entry
; RV64-NEXT:  add a2, a0, a1
; RV64-NEXT:  slt a0, a2, a0
; RV64-NEXT:  slti a1, a1, 0
; RV64-NEXT:  beq a1, a0, .LBB53_2
; RV64-NEXT:  # %bb.1: # %overflow
; RV64-NEXT:  li a0, 0
; RV64-NEXT:  ret
; RV64-NEXT: .LBB53_2: # %continue
; RV64-NEXT:  li a0, 1
; RV64-NEXT:  ret
entry:

```

```

%t = call {i64, i1} @llvm.sadd.with.overflow.i64(i64 %v1, i64 %v2)
%val = extractvalue {i64, i1} %t, 0
%obit = extractvalue {i64, i1} %t, 1
br i1 %obit, label %overflow, label %continue

```

```

overflow:
ret i1 false

```

```

continue:
ret i1 true
}

```

```

define zeroext i1 @uaddo.br.i32(i32 %v1, i32 %v2) {
; RV64-LABEL: uaddo.br.i32:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  addw a1, a0, a1
; RV64-NEXT:  sext.w a0, a0
; RV64-NEXT:  bgeu a1, a0, .LBB54_2
; RV64-NEXT:  # %bb.1: # %overflow
;
; RV64-NEXT:  li a0, 0
; RV64-NEXT:  ret
; RV64-NEXT:  .LBB54_2: # %continue
; RV64-NEXT:  li a0, 1
; RV64-NEXT:  ret
entry:
%t = call {i32, i1} @llvm.uadd.with.overflow.i32(i32 %v1, i32 %v2)
%val = extractvalue {i32, i1} %t, 0
%obit = extractvalue {i32, i1} %t, 1
br i1 %obit, label %overflow, label %continue

```

```

overflow:
ret i1 false

```

```

continue:
ret i1 true
}

```

```

define zeroext i1 @uaddo.br.i64(i64 %v1, i64 %v2) {
; RV64-LABEL: uaddo.br.i64:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  add a1, a0, a1
; RV64-NEXT:  bgeu a1, a0, .LBB55_2
; RV64-NEXT:  # %bb.1: # %overflow
; RV64-NEXT:  li a0, 0
; RV64-NEXT:  ret
; RV64-NEXT:  .LBB55_2: # %continue
; RV64-NEXT:  li a0, 1

```

```

; RV64-NEXT:  ret
entry:
%t = call {i64, i1} @llvm.uadd.with.overflow.i64(i64 %v1, i64 %v2)
%val = extractvalue {i64, i1} %t, 0
%obit = extractvalue {i64, i1} %t, 1
br i1 %obit, label %overflow, label %continue

overflow:
ret i1 false

continue:
ret i1 true
}

```

```

define zeroext i1 @ssubo.br.i32(i32
  signext %v1, i32 signext %v2) {
; RV64-LABEL: ssubo.br.i32:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  sgtz a2, a1
; RV64-NEXT:  subw a1, a0, a1
; RV64-NEXT:  slt a0, a1, a0
; RV64-NEXT:  beq a2, a0, .LBB56_2
; RV64-NEXT:  # %bb.1: # %overflow
; RV64-NEXT:  li a0, 0
; RV64-NEXT:  ret
; RV64-NEXT: .LBB56_2: # %continue
; RV64-NEXT:  li a0, 1
; RV64-NEXT:  ret
entry:
%t = call {i32, i1} @llvm.ssub.with.overflow.i32(i32 %v1, i32 %v2)
%val = extractvalue {i32, i1} %t, 0
%obit = extractvalue {i32, i1} %t, 1
br i1 %obit, label %overflow, label %continue

overflow:
ret i1 false

continue:
ret i1 true
}

```

```

define zeroext i1 @ssubo.br.i64(i64 %v1, i64 %v2) {
; RV64-LABEL: ssubo.br.i64:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  sgtz a2, a1
; RV64-NEXT:  sub a1, a0, a1
; RV64-NEXT:  slt a0, a1, a0
; RV64-NEXT:  beq a2, a0, .LBB57_2

```



```

; RV64-NEXT: # %bb.1: # %overflow
; RV64-NEXT: li a0, 0
; RV64-NEXT: ret
; RV64-NEXT: .LBB57_2: # %continue
;
RV64-NEXT: li a0, 1
; RV64-NEXT: ret
entry:
%t = call {i64, i1} @llvm.ssub.with.overflow.i64(i64 %v1, i64 %v2)
%val = extractvalue {i64, i1} %t, 0
%obit = extractvalue {i64, i1} %t, 1
br i1 %obit, label %overflow, label %continue

overflow:
ret i1 false

continue:
ret i1 true
}

define zeroext i1 @usubo.br.i32(i32 signext %v1, i32 signext %v2) {
; RV64-LABEL: usubo.br.i32:
; RV64:    # %bb.0: # %entry
; RV64-NEXT: subw a1, a0, a1
; RV64-NEXT: bgeu a0, a1, .LBB58_2
; RV64-NEXT: # %bb.1: # %overflow
; RV64-NEXT: li a0, 0
; RV64-NEXT: ret
; RV64-NEXT: .LBB58_2: # %continue
; RV64-NEXT: li a0, 1
; RV64-NEXT: ret
entry:
%t = call {i32, i1} @llvm.usub.with.overflow.i32(i32 %v1, i32 %v2)
%val = extractvalue {i32, i1} %t, 0
%obit = extractvalue {i32, i1} %t, 1
br i1 %obit, label %overflow, label %continue

overflow:
ret i1 false

continue:
ret i1 true
}

define zeroext i1 @usubo.br.i64(i64 %v1, i64 %v2) {
; RV64-LABEL: usubo.br.i64:
;

```

```

RV64:    # %bb.0: # %entry
; RV64-NEXT:  sub a1, a0, a1
; RV64-NEXT:  bgeu a0, a1, .LBB59_2
; RV64-NEXT:  # %bb.1: # %overflow
; RV64-NEXT:  li a0, 0
; RV64-NEXT:  ret
; RV64-NEXT:  .LBB59_2: # %continue
; RV64-NEXT:  li a0, 1
; RV64-NEXT:  ret
entry:
%t = call {i64, i1} @llvm.usub.with.overflow.i64(i64 %v1, i64 %v2)
%val = extractvalue {i64, i1} %t, 0
%obit = extractvalue {i64, i1} %t, 1
br i1 %obit, label %overflow, label %continue

overflow:
ret i1 false

continue:
ret i1 true
}

define zeroext i1 @smulo.br.i32(i32 signext %v1, i32 signext %v2) {
; RV64-LABEL: smulo.br.i32:
; RV64:    # %bb.0: # %entry
; RV64-NEXT:  mul a0, a0, a1
; RV64-NEXT:  srai a1, a0, 32
; RV64-NEXT:  sraiw a0, a0, 31
; RV64-NEXT:  beq a1, a0, .LBB60_2
; RV64-NEXT:  # %bb.1: # %overflow
; RV64-NEXT:  li a0, 0
; RV64-NEXT:  ret
; RV64-NEXT:  .LBB60_2: # %continue
; RV64-NEXT:  li a0, 1
; RV64-NEXT:  ret
entry:
%t = call {i32, i1} @llvm.smul.with.overflow.i32(i32
%v1, i32 %v2)
%val = extractvalue {i32, i1} %t, 0
%obit = extractvalue {i32, i1} %t, 1
br i1 %obit, label %overflow, label %continue

overflow:
ret i1 false

continue:
ret i1 true
}

```

```

define zeroext i1 @smulo.br.i64(i64 %v1, i64 %v2) {
; RV64-LABEL: smulo.br.i64:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  mulh a2, a0, a1
; RV64-NEXT:  mul a0, a0, a1
; RV64-NEXT:  srai a0, a0, 63
; RV64-NEXT:  beq a2, a0, .LBB61_2
; RV64-NEXT:  # %bb.1: # %overflow
; RV64-NEXT:  li a0, 0
; RV64-NEXT:  ret
; RV64-NEXT: .LBB61_2: # %continue
; RV64-NEXT:  li a0, 1
; RV64-NEXT:  ret
entry:
    %t = call {i64, i1} @llvm.smul.with.overflow.i64(i64 %v1, i64 %v2)
    %val = extractvalue {i64, i1} %t, 0
    %obit = extractvalue {i64, i1} %t, 1
    br i1 %obit, label %overflow, label %continue

overflow:
    ret i1 false

continue:
    ret i1 true
}

```

```

define zeroext i1 @smulo2.br.i64(i64 %v1) {
; RV64-LABEL: smulo2.br.i64:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  li a1, -13
; RV64-NEXT:
    mulh a2, a0, a1
; RV64-NEXT:  mul a0, a0, a1
; RV64-NEXT:  srai a0, a0, 63
; RV64-NEXT:  beq a2, a0, .LBB62_2
; RV64-NEXT:  # %bb.1: # %overflow
; RV64-NEXT:  li a0, 0
; RV64-NEXT:  ret
; RV64-NEXT: .LBB62_2: # %continue
; RV64-NEXT:  li a0, 1
; RV64-NEXT:  ret
entry:
    %t = call {i64, i1} @llvm.smul.with.overflow.i64(i64 %v1, i64 -13)
    %val = extractvalue {i64, i1} %t, 0
    %obit = extractvalue {i64, i1} %t, 1
    br i1 %obit, label %overflow, label %continue

```

```

overflow:
ret i1 false

continue:
ret i1 true
}

define zeroext i1 @umulo.br.i32(i32 signext %v1, i32 signext %v2) {
; RV64-LABEL: umulo.br.i32:
; RV64:      # %bb.0: # %entry
; RV64-NEXT: slli a1, a1, 32
; RV64-NEXT: slli a0, a0, 32
; RV64-NEXT: mulhu a0, a0, a1
; RV64-NEXT: srai a0, a0, 32
; RV64-NEXT: beqz a0, .LBB63_2
; RV64-NEXT: # %bb.1: # %overflow
; RV64-NEXT: li a0, 0
; RV64-NEXT: ret
; RV64-NEXT: .LBB63_2: # %continue
; RV64-NEXT: li a0, 1
; RV64-NEXT: ret
entry:
%t = call
{i32, i1} @llvm.umul.with.overflow.i32(i32 %v1, i32 %v2)
%val = extractvalue {i32, i1} %t, 0
%obit = extractvalue {i32, i1} %t, 1
br i1 %obit, label %overflow, label %continue

overflow:
ret i1 false

continue:
ret i1 true
}

define zeroext i1 @umulo.br.i64(i64 %v1, i64 %v2) {
; RV64-LABEL: umulo.br.i64:
; RV64:      # %bb.0: # %entry
; RV64-NEXT: mulhu a0, a0, a1
; RV64-NEXT: beqz a0, .LBB64_2
; RV64-NEXT: # %bb.1: # %overflow
; RV64-NEXT: li a0, 0
; RV64-NEXT: ret
; RV64-NEXT: .LBB64_2: # %continue
; RV64-NEXT: li a0, 1
; RV64-NEXT: ret
entry:
%t = call {i64, i1} @llvm.umul.with.overflow.i64(i64 %v1, i64 %v2)

```

```

%val = extractvalue {i64, i1} %t, 0
%obit = extractvalue {i64, i1} %t, 1
br i1 %obit, label %overflow, label %continue

overflow:
ret i1 false

continue:
ret i1 true
}

define zeroext i1 @umulo2.br.i64(i64 %v1) {
; RV64-LABEL: umulo2.br.i64:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  add a1, a0, a0
; RV64-NEXT:  bgeu a1, a0,
.LBB65_2
; RV64-NEXT: # %bb.1: # %overflow
; RV64-NEXT: li a0, 0
; RV64-NEXT: ret
; RV64-NEXT: .LBB65_2: # %continue
; RV64-NEXT: li a0, 1
; RV64-NEXT: ret
entry:
%t = call {i64, i1} @llvm.umul.with.overflow.i64(i64 %v1, i64 2)
%val = extractvalue {i64, i1} %t, 0
%obit = extractvalue {i64, i1} %t, 1
br i1 %obit, label %overflow, label %continue

overflow:
ret i1 false

continue:
ret i1 true
}

define zeroext i1 @uaddo.i64.constant(i64 %v1, ptr %res) {
; RV64-LABEL: uaddo.i64.constant:
; RV64:      # %bb.0: # %entry
; RV64-NEXT: addi a2, a0, 2
; RV64-NEXT: sltu a0, a2, a0
; RV64-NEXT: sd a2, 0(a1)
; RV64-NEXT: ret
entry:
%t = call {i64, i1} @llvm.uadd.with.overflow.i64(i64 %v1, i64 2)
%val = extractvalue {i64, i1} %t, 0
%obit = extractvalue {i64, i1} %t, 1
store i64 %val, ptr %res

```

```

ret i1 %obit
}

define zeroext i1 @uaddo.i64.constant_2048(i64 %v1, ptr %res) {
; RV64-LABEL: uaddo.i64.constant_2048:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:
    addi a2, a0, 2047
; RV64-NEXT:  addi a2, a2, 1
; RV64-NEXT:  sltu a0, a2, a0
; RV64-NEXT:  sd a2, 0(a1)
; RV64-NEXT:  ret
entry:
    %t = call {i64, i1} @llvm.uadd.with.overflow.i64(i64 %v1, i64 2048)
    %val = extractvalue {i64, i1} %t, 0
    %obit = extractvalue {i64, i1} %t, 1
    store i64 %val, ptr %res
    ret i1 %obit
}

```

```

define zeroext i1 @uaddo.i64.constant_2049(i64 %v1, ptr %res) {
; RV64-LABEL: uaddo.i64.constant_2049:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  addi a2, a0, 2047
; RV64-NEXT:  addi a2, a2, 2
; RV64-NEXT:  sltu a0, a2, a0
; RV64-NEXT:  sd a2, 0(a1)
; RV64-NEXT:  ret
entry:
    %t = call {i64, i1} @llvm.uadd.with.overflow.i64(i64 %v1, i64 2049)
    %val = extractvalue {i64, i1} %t, 0
    %obit = extractvalue {i64, i1} %t, 1
    store i64 %val, ptr %res
    ret i1 %obit
}

```

```

define i64 @uaddo.i64.constant_setcc_on_overflow_flag(ptr %p) {
; RV64-LABEL: uaddo.i64.constant_setcc_on_overflow_flag:
; RV64:      # %bb.0: # %entry
; RV64-NEXT:  ld a1, 0(a0)
;
    RV64-NEXT:  addi a0, a1, 2
; RV64-NEXT:  bltu a0, a1, .LBB69_2
; RV64-NEXT:  # %bb.1: # %IfOverflow
; RV64-NEXT:  li a0, 0
; RV64-NEXT:  .LBB69_2: # %IfNoOverflow
; RV64-NEXT:  ret
entry:

```

```

%v1 = load i64, ptr %p
%t = call {i64, i1} @llvm.uadd.with.overflow.i64(i64 %v1, i64 2)
%val = extractvalue {i64, i1} %t, 0
%obit = extractvalue {i64, i1} %t, 1
br i1 %obit, label %IfNoOverflow, label %IfOverflow
IfOverflow:
ret i64 0
IfNoOverflow:
ret i64 %val
}

declare {i32, i1} @llvm.sadd.with.overflow.i32(i32, i32) nounwind readnone
declare {i64, i1} @llvm.sadd.with.overflow.i64(i64, i64) nounwind readnone
declare {i32, i1} @llvm.uadd.with.overflow.i32(i32, i32) nounwind readnone
declare {i64, i1} @llvm.uadd.with.overflow.i64(i64, i64) nounwind readnone
declare {i32, i1} @llvm.ssub.with.overflow.i32(i32, i32) nounwind readnone
declare {i64, i1} @llvm.ssub.with.overflow.i64(i64, i64) nounwind readnone
declare {i32, i1} @llvm.usub.with.overflow.i32(i32, i32) nounwind readnone
declare
  {i64, i1} @llvm.usub.with.overflow.i64(i64, i64) nounwind readnone
declare {i32, i1} @llvm.smul.with.overflow.i32(i32, i32) nounwind readnone
declare {i64, i1} @llvm.smul.with.overflow.i64(i64, i64) nounwind readnone
declare {i32, i1} @llvm.umul.with.overflow.i32(i32, i32) nounwind readnone
declare {i64, i1} @llvm.umul.with.overflow.i64(i64, i64) nounwind readnone
; NOTE: Assertions have been autogenerated by utils/update_llc_test_checks.py
; RUN: llc -mtriple=riscv64 -mattr=+zbc -verify-machineinstrs < %s \
; RUN: -riscv-experimental-rv64-legal-i32 | FileCheck %s -check-prefix=RV64ZBC

```

```

declare i64 @llvm.riscv.clmulr.i64(i64 %a, i64 %b)

```

```

define i64 @clmul64r(i64 %a, i64 %b) nounwind {
; RV64ZBC-LABEL: clmul64r:
; RV64ZBC:      # %bb.0:
; RV64ZBC-NEXT:  clmulr a0, a0, a1
; RV64ZBC-NEXT:  ret
  %tmp = call i64 @llvm.riscv.clmulr.i64(i64 %a, i64 %b)
  ret i64 %tmp
}

```

```

declare i32 @llvm.riscv.clmulr.i32(i32 %a, i32 %b)

```

```

define signext i32 @clmul32r(i32 signext %a, i32 signext %b) nounwind {
; RV64ZBC-LABEL: clmul32r:
; RV64ZBC:      # %bb.0:
; RV64ZBC-NEXT:  slli a1, a1, 32
; RV64ZBC-NEXT:  slli a0, a0, 32
; RV64ZBC-NEXT:  clmulr a0, a0, a1
; RV64ZBC-NEXT:  srai a0, a0, 32

```

```

; RV64ZBC-NEXT:  ret
%tmp = call i32 @llvm.riscv.clmulr.i32(i32 %a, i32 %b)
ret i32 %tmp
}

; FIXME: We could avoid the slli instructions by using clmul+srli+sext.w
since
; the inputs are zero extended.
define signext i32 @clmul32r_zext(i32 zeroext %a, i32 zeroext %b) nounwind {
; RV64ZBC-LABEL: clmul32r_zext:
; RV64ZBC:      # %bb.0:
; RV64ZBC-NEXT:  slli a1, a1, 32
; RV64ZBC-NEXT:  slli a0, a0, 32
; RV64ZBC-NEXT:  clmulr a0, a0, a1
; RV64ZBC-NEXT:  srai a0, a0, 32
; RV64ZBC-NEXT:  ret
%tmp = call i32 @llvm.riscv.clmulr.i32(i32 %a, i32 %b)
ret i32 %tmp
}

; NOTE: Assertions have been autogenerated by utils/update_llc_test_checks.py
; RUN: llc -mtriple=riscv64 -verify-machineinstrs < %s \
; RUN: -riscv-experimental-rv64-legal-i32 | FileCheck -check-prefix=RV64I %s
; RUN: llc -mtriple=riscv64 -mattr=+m -verify-machineinstrs < %s \
; RUN: -riscv-experimental-rv64-legal-i32 | FileCheck -check-prefix=RV64IM %s

define i32 @udiv(i32 %a, i32 %b) nounwind {
; RV64I-LABEL: udiv:
; RV64I:      # %bb.0:
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  srli a0, a0, 32
; RV64I-NEXT:  slli a1, a1, 32
; RV64I-NEXT:  srli a1, a1, 32
; RV64I-NEXT:  call __udivdi3
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
;
; RV64IM-LABEL: udiv:
; RV64IM:      # %bb.0:
; RV64IM-NEXT:  divuw a0, a0, a1
; RV64IM-NEXT:  ret
%1 = udiv i32 %a, %b
ret i32 %1
}

define i32 @udiv_constant(i32 %a) nounwind {

```



```

; RV64I-LABEL:
    udiv_constant:
; RV64I:    # %bb.0:
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  srli a0, a0, 32
; RV64I-NEXT:  li a1, 5
; RV64I-NEXT:  call __udivdi3
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
;
; RV64IM-LABEL: udiv_constant:
; RV64IM:    # %bb.0:
; RV64IM-NEXT:  slli a0, a0, 32
; RV64IM-NEXT:  lui a1, 838861
; RV64IM-NEXT:  addi a1, a1, -819
; RV64IM-NEXT:  slli a1, a1, 32
; RV64IM-NEXT:  mulhu a0, a0, a1
; RV64IM-NEXT:  srli a0, a0, 34
; RV64IM-NEXT:  ret
%1 = udiv i32 %a, 5
ret i32 %1
}

```

```

define i32 @udiv_pow2(i32 %a) nounwind {
; RV64I-LABEL: udiv_pow2:
; RV64I:    # %bb.0:
; RV64I-NEXT:  srliw a0, a0, 3
; RV64I-NEXT:  ret
;
; RV64IM-LABEL: udiv_pow2:
; RV64IM:    # %bb.0:
; RV64IM-NEXT:  srliw a0, a0, 3
; RV64IM-NEXT:  ret
%1 = udiv i32 %a, 8
ret i32 %1
}

```

```

define i32 @udiv_constant_lhs(i32
%a) nounwind {
; RV64I-LABEL: udiv_constant_lhs:
; RV64I:    # %bb.0:
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  slli a0, a0, 32
; RV64I-NEXT:  srli a1, a0, 32

```

```

; RV64I-NEXT:  li a0, 10
; RV64I-NEXT:  call __udivdi3
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
;
; RV64IM-LABEL: udiv_constant_lhs:
; RV64IM:      # %bb.0:
; RV64IM-NEXT:  li a1, 10
; RV64IM-NEXT:  divuw a0, a1, a0
; RV64IM-NEXT:  ret
%1 = udiv i32 10, %a
ret i32 %1
}

```

```

define i64 @udiv64(i64 %a, i64 %b) nounwind {
; RV64I-LABEL: udiv64:
; RV64I:      # %bb.0:
; RV64I-NEXT:  tail __udivdi3
;
; RV64IM-LABEL: udiv64:
; RV64IM:      # %bb.0:
; RV64IM-NEXT:  divu a0, a0, a1
; RV64IM-NEXT:  ret
%1 = udiv i64 %a, %b
ret i64 %1
}

```

```

define i64 @udiv64_constant(i64 %a) nounwind {
; RV64I-LABEL: udiv64_constant:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a1, 5
; RV64I-NEXT:
;               tail __udivdi3
;
; RV64IM-LABEL: udiv64_constant:
; RV64IM:      # %bb.0:
; RV64IM-NEXT:  lui a1, 838861
; RV64IM-NEXT:  addiw a1, a1, -819
; RV64IM-NEXT:  slli a2, a1, 32
; RV64IM-NEXT:  add a1, a1, a2
; RV64IM-NEXT:  mulhu a0, a0, a1
; RV64IM-NEXT:  srli a0, a0, 2
; RV64IM-NEXT:  ret
%1 = udiv i64 %a, 5
ret i64 %1
}

```

```

define i64 @udiv64_constant_lhs(i64 %a) nounwind {
; RV64I-LABEL: udiv64_constant_lhs:
; RV64I:      # %bb.0:
; RV64I-NEXT:  mv a1, a0
; RV64I-NEXT:  li a0, 10
; RV64I-NEXT:  tail __udivdi3
;
; RV64IM-LABEL: udiv64_constant_lhs:
; RV64IM:      # %bb.0:
; RV64IM-NEXT:  li a1, 10
; RV64IM-NEXT:  divu a0, a1, a0
; RV64IM-NEXT:  ret
    %1 = udiv i64 10, %a
    ret i64 %1
}

```

```

define i8 @udiv8(i8 %a, i8 %b) nounwind {
; RV64I-LABEL: udiv8:
; RV64I:      # %bb.0:
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  andi a0, a0, 255
; RV64I-NEXT:  andi a1, a1, 255
; RV64I-NEXT:  call
    __udivdi3
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
;
; RV64IM-LABEL: udiv8:
; RV64IM:      # %bb.0:
; RV64IM-NEXT:  andi a1, a1, 255
; RV64IM-NEXT:  andi a0, a0, 255
; RV64IM-NEXT:  divuw a0, a0, a1
; RV64IM-NEXT:  ret
    %1 = udiv i8 %a, %b
    ret i8 %1
}

```

```

define i8 @udiv8_constant(i8 %a) nounwind {
; RV64I-LABEL: udiv8_constant:
; RV64I:      # %bb.0:
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  andi a0, a0, 255
; RV64I-NEXT:  li a1, 5
; RV64I-NEXT:  call __udivdi3
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload

```

```

; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
;
; RV64IM-LABEL: udiv8_constant:
; RV64IM:      # %bb.0:
; RV64IM-NEXT:  andi a0, a0, 255
; RV64IM-NEXT:  li a1, 205
; RV64IM-NEXT:  mul a0, a0, a1
; RV64IM-NEXT:  srliw a0, a0, 10
; RV64IM-NEXT:  ret
%1 = udiv i8 %a, 5
ret i8 %1
}

```

```

define i8 @udiv8_pow2(i8 %a) nounwind
{
; RV64I-LABEL: udiv8_pow2:
; RV64I:      # %bb.0:
; RV64I-NEXT:  slli a0, a0, 56
; RV64I-NEXT:  srli a0, a0, 59
; RV64I-NEXT:  ret
;
; RV64IM-LABEL: udiv8_pow2:
; RV64IM:      # %bb.0:
; RV64IM-NEXT:  slli a0, a0, 56
; RV64IM-NEXT:  srli a0, a0, 59
; RV64IM-NEXT:  ret
%1 = udiv i8 %a, 8
ret i8 %1
}

```

```

define i8 @udiv8_constant_lhs(i8 %a) nounwind {
; RV64I-LABEL: udiv8_constant_lhs:
; RV64I:      # %bb.0:
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  andi a1, a0, 255
; RV64I-NEXT:  li a0, 10
; RV64I-NEXT:  call __udivdi3
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
;
; RV64IM-LABEL: udiv8_constant_lhs:
; RV64IM:      # %bb.0:
; RV64IM-NEXT:  andi a0, a0, 255
; RV64IM-NEXT:  li a1, 10
; RV64IM-NEXT:  divuw a0, a1, a0

```

```

; RV64IM-NEXT:  ret
%1 = udiv i8 10, %a
ret i8 %1
}

define i16 @udiv16(i16 %a, i16 %b) nounwind {
; RV64I-LABEL: udiv16:
;
RV64I:    # %bb.0:
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  lui a2, 16
; RV64I-NEXT:  addiw a2, a2, -1
; RV64I-NEXT:  and a0, a0, a2
; RV64I-NEXT:  and a1, a1, a2
; RV64I-NEXT:  call __udivdi3
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
;
; RV64IM-LABEL: udiv16:
; RV64IM:    # %bb.0:
; RV64IM-NEXT:  lui a2, 16
; RV64IM-NEXT:  addi a2, a2, -1
; RV64IM-NEXT:  and a1, a1, a2
; RV64IM-NEXT:  and a0, a0, a2
; RV64IM-NEXT:  divuw a0, a0, a1
; RV64IM-NEXT:  ret
%1 = udiv i16 %a, %b
ret i16 %1
}

define i16 @udiv16_constant(i16 %a) nounwind {
; RV64I-LABEL: udiv16_constant:
; RV64I:    # %bb.0:
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  slli a0, a0, 48
; RV64I-NEXT:  srli a0, a0, 48
; RV64I-NEXT:  li a1, 5
; RV64I-NEXT:  call __udivdi3
; RV64I-NEXT:  ld ra, 8(sp)
# 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
;
; RV64IM-LABEL: udiv16_constant:
; RV64IM:    # %bb.0:

```

```

; RV64IM-NEXT: lui a1, 52429
; RV64IM-NEXT: slli a1, a1, 4
; RV64IM-NEXT: slli a0, a0, 48
; RV64IM-NEXT: mulhu a0, a0, a1
; RV64IM-NEXT: srliw a0, a0, 18
; RV64IM-NEXT: ret
%1 = udiv i16 %a, 5
ret i16 %1
}

```

```

define i16 @udiv16_pow2(i16 %a) nounwind {
; RV64I-LABEL: udiv16_pow2:
; RV64I:    # %bb.0:
; RV64I-NEXT: slli a0, a0, 48
; RV64I-NEXT: srli a0, a0, 51
; RV64I-NEXT: ret
;
; RV64IM-LABEL: udiv16_pow2:
; RV64IM:    # %bb.0:
; RV64IM-NEXT: slli a0, a0, 48
; RV64IM-NEXT: srli a0, a0, 51
; RV64IM-NEXT: ret
%1 = udiv i16 %a, 8
ret i16 %1
}

```

```

define i16 @udiv16_constant_lhs(i16 %a) nounwind {
; RV64I-LABEL: udiv16_constant_lhs:
; RV64I:    # %bb.0:
; RV64I-NEXT: addi sp, sp, -16
; RV64I-NEXT: sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT: slli a0, a0, 48
; RV64I-NEXT: srli a1, a0, 48
; RV64I-NEXT:
    li a0, 10
; RV64I-NEXT: call __udivdi3
; RV64I-NEXT: ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT: addi sp, sp, 16
; RV64I-NEXT: ret
;
; RV64IM-LABEL: udiv16_constant_lhs:
; RV64IM:    # %bb.0:
; RV64IM-NEXT: slli a0, a0, 48
; RV64IM-NEXT: srli a0, a0, 48
; RV64IM-NEXT: li a1, 10
; RV64IM-NEXT: divuw a0, a1, a0
; RV64IM-NEXT: ret
%1 = udiv i16 10, %a

```

```

ret i16 %1
}

define i32 @sdiv(i32 %a, i32 %b) nounwind {
; RV64I-LABEL: sdiv:
; RV64I:      # %bb.0:
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  sext.w a0, a0
; RV64I-NEXT:  sext.w a1, a1
; RV64I-NEXT:  call __divdi3
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
;
; RV64IM-LABEL: sdiv:
; RV64IM:      # %bb.0:
; RV64IM-NEXT:  divw a0, a0, a1
; RV64IM-NEXT:  ret
%1 = sdiv i32 %a, %b
ret i32 %1
}

define i32 @sdiv_constant(i32 %a) nounwind {
; RV64I-LABEL: sdiv_constant:
;
; RV64I:      # %bb.0:
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  sext.w a0, a0
; RV64I-NEXT:  li a1, 5
; RV64I-NEXT:  call __divdi3
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
;
; RV64IM-LABEL: sdiv_constant:
; RV64IM:      # %bb.0:
; RV64IM-NEXT:  sext.w a0, a0
; RV64IM-NEXT:  lui a1, 419430
; RV64IM-NEXT:  addiw a1, a1, 1639
; RV64IM-NEXT:  mul a0, a0, a1
; RV64IM-NEXT:  srli a1, a0, 63
; RV64IM-NEXT:  srai a0, a0, 33
; RV64IM-NEXT:  addw a0, a0, a1
; RV64IM-NEXT:  ret
%1 = sdiv i32 %a, 5
ret i32 %1
}

```

```
}
```

```
define i32 @sdiv_pow2(i32 %a) nounwind {  
; RV64I-LABEL: sdiv_pow2:  
; RV64I:      # %bb.0:  
; RV64I-NEXT: sraiw a1, a0, 31  
; RV64I-NEXT: srlw a1, a1, 29  
; RV64I-NEXT: add a0, a0, a1  
; RV64I-NEXT: sraiw a0, a0, 3  
; RV64I-NEXT: ret  
;  
; RV64IM-LABEL: sdiv_pow2:  
; RV64IM:      # %bb.0:  
; RV64IM-NEXT: sraiw a1, a0,  
31  
; RV64IM-NEXT: srlw a1, a1, 29  
; RV64IM-NEXT: add a0, a0, a1  
; RV64IM-NEXT: sraiw a0, a0, 3  
; RV64IM-NEXT: ret  
%1 = sdiv i32 %a, 8  
ret i32 %1  
}
```

```
define i32 @sdiv_pow2_2(i32 %a) nounwind {  
; RV64I-LABEL: sdiv_pow2_2:  
; RV64I:      # %bb.0:  
; RV64I-NEXT: sraiw a1, a0, 31  
; RV64I-NEXT: srlw a1, a1, 16  
; RV64I-NEXT: add a0, a0, a1  
; RV64I-NEXT: sraiw a0, a0, 16  
; RV64I-NEXT: ret  
;  
; RV64IM-LABEL: sdiv_pow2_2:  
; RV64IM:      # %bb.0:  
; RV64IM-NEXT: sraiw a1, a0, 31  
; RV64IM-NEXT: srlw a1, a1, 16  
; RV64IM-NEXT: add a0, a0, a1  
; RV64IM-NEXT: sraiw a0, a0, 16  
; RV64IM-NEXT: ret  
%1 = sdiv i32 %a, 65536  
ret i32 %1  
}
```

```
define i32 @sdiv_constant_lhs(i32 %a) nounwind {  
; RV64I-LABEL: sdiv_constant_lhs:  
; RV64I:      # %bb.0:  
; RV64I-NEXT: addi sp, sp, -16  
; RV64I-NEXT: sd ra, 8(sp) # 8-byte Folded Spill
```



```

; RV64I-NEXT:  sext.w a1, a0
; RV64I-NEXT:  li a0, -10
; RV64I-NEXT:  call __divdi3
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded
Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
;
; RV64IM-LABEL: sdiv_constant_lhs:
; RV64IM:      # %bb.0:
; RV64IM-NEXT:  li a1, -10
; RV64IM-NEXT:  divw a0, a1, a0
; RV64IM-NEXT:  ret
%1 = sdiv i32 -10, %a
ret i32 %1
}

define i64 @sdiv64(i64 %a, i64 %b) nounwind {
; RV64I-LABEL: sdiv64:
; RV64I:      # %bb.0:
; RV64I-NEXT:  tail __divdi3
;
; RV64IM-LABEL: sdiv64:
; RV64IM:      # %bb.0:
; RV64IM-NEXT:  div a0, a0, a1
; RV64IM-NEXT:  ret
%1 = sdiv i64 %a, %b
ret i64 %1
}

define i64 @sdiv64_constant(i64 %a) nounwind {
; RV64I-LABEL: sdiv64_constant:
; RV64I:      # %bb.0:
; RV64I-NEXT:  li a1, 5
; RV64I-NEXT:  tail __divdi3
;
; RV64IM-LABEL: sdiv64_constant:
; RV64IM:      # %bb.0:
; RV64IM-NEXT:  lui a1, %hi(.LCPI21_0)
; RV64IM-NEXT:  ld a1, %lo(.LCPI21_0)(a1)
; RV64IM-NEXT:  mulh a0, a0, a1
; RV64IM-NEXT:  srli a1, a0, 63
; RV64IM-NEXT:  srai a0, a0, 1
; RV64IM-NEXT:  add a0, a0, a1
; RV64IM-NEXT:  ret
%1 = sdiv i64 %a,
5
ret i64 %1

```

```
}
```

```
define i64 @sdiv64_constant_lhs(i64 %a) nounwind {  
; RV64I-LABEL: sdiv64_constant_lhs:  
; RV64I:      # %bb.0:  
; RV64I-NEXT:  mv a1, a0  
; RV64I-NEXT:  li a0, 10  
; RV64I-NEXT:  tail __divdi3  
;  
; RV64IM-LABEL: sdiv64_constant_lhs:  
; RV64IM:      # %bb.0:  
; RV64IM-NEXT:  li a1, 10  
; RV64IM-NEXT:  div a0, a1, a0  
; RV64IM-NEXT:  ret  
%1 = sdiv i64 10, %a  
ret i64 %1  
}
```

; Although this sdiv has two sexti32 operands, it shouldn't compile to divw on  
; RV64M as that wouldn't produce the correct result for e.g. INT\_MIN/-1.

```
define i64 @sdiv64_sext_operands(i32 %a, i32 %b) nounwind {  
; RV64I-LABEL: sdiv64_sext_operands:  
; RV64I:      # %bb.0:  
; RV64I-NEXT:  sext.w a0, a0  
; RV64I-NEXT:  sext.w a1, a1  
; RV64I-NEXT:  tail __divdi3  
;  
; RV64IM-LABEL: sdiv64_sext_operands:  
; RV64IM:      # %bb.0:  
; RV64IM-NEXT:  sext.w a0, a0  
; RV64IM-NEXT:  sext.w a1, a1  
; RV64IM-NEXT:  div a0, a0, a1  
; RV64IM-NEXT:  ret  
%1 = sext i32 %a to i64  
%2 = sext i32 %b to  
i64  
%3 = sdiv i64 %1, %2  
ret i64 %3  
}
```

```
define i8 @sdiv8(i8 %a, i8 %b) nounwind {  
; RV64I-LABEL: sdiv8:  
; RV64I:      # %bb.0:  
; RV64I-NEXT:  addi sp, sp, -16  
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill  
; RV64I-NEXT:  slli a1, a1, 24  
; RV64I-NEXT:  sraiw a1, a1, 24
```

```

; RV64I-NEXT:  slli a0, a0, 24
; RV64I-NEXT:  sraiw a0, a0, 24
; RV64I-NEXT:  call __divdi3
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
;
; RV64IM-LABEL: sdiv8:
; RV64IM:      # %bb.0:
; RV64IM-NEXT:  slli a1, a1, 24
; RV64IM-NEXT:  sraiw a1, a1, 24
; RV64IM-NEXT:  slli a0, a0, 24
; RV64IM-NEXT:  sraiw a0, a0, 24
; RV64IM-NEXT:  divw a0, a0, a1
; RV64IM-NEXT:  ret
%1 = sdiv i8 %a, %b
ret i8 %1
}

```

```

define i8 @sdiv8_constant(i8 %a) nounwind {
; RV64I-LABEL: sdiv8_constant:
; RV64I:      # %bb.0:
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  slli a0, a0, 24
; RV64I-NEXT:
    sraiw a0, a0, 24
; RV64I-NEXT:  li a1, 5
; RV64I-NEXT:  call __divdi3
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
;
; RV64IM-LABEL: sdiv8_constant:
; RV64IM:      # %bb.0:
; RV64IM-NEXT:  slli a0, a0, 24
; RV64IM-NEXT:  sraiw a0, a0, 24
; RV64IM-NEXT:  li a1, 103
; RV64IM-NEXT:  mul a0, a0, a1
; RV64IM-NEXT:  sraiw a1, a0, 9
; RV64IM-NEXT:  slli a0, a0, 48
; RV64IM-NEXT:  srli a0, a0, 63
; RV64IM-NEXT:  addw a0, a1, a0
; RV64IM-NEXT:  ret
%1 = sdiv i8 %a, 5
ret i8 %1
}

```

```

define i8 @sdiv8_pow2(i8 %a) nounwind {
; RV64I-LABEL: sdiv8_pow2:
; RV64I:      # %bb.0:
; RV64I-NEXT: slli a1, a0, 24
; RV64I-NEXT: sraiw a1, a1, 24
; RV64I-NEXT: slli a1, a1, 49
; RV64I-NEXT: srli a1, a1, 61
; RV64I-NEXT: add a0, a0, a1
; RV64I-NEXT: slli a0, a0, 24
; RV64I-NEXT: sraiw a0, a0, 27
; RV64I-NEXT: ret
;
; RV64IM-LABEL: sdiv8_pow2:
; RV64IM:      # %bb.0:
; RV64IM-NEXT: slli a1, a0,
24
; RV64IM-NEXT: sraiw a1, a1, 24
; RV64IM-NEXT: slli a1, a1, 49
; RV64IM-NEXT: srli a1, a1, 61
; RV64IM-NEXT: add a0, a0, a1
; RV64IM-NEXT: slli a0, a0, 24
; RV64IM-NEXT: sraiw a0, a0, 27
; RV64IM-NEXT: ret
%1 = sdiv i8 %a, 8
ret i8 %1
}

define i8 @sdiv8_constant_lhs(i8 %a) nounwind {
; RV64I-LABEL: sdiv8_constant_lhs:
; RV64I:      # %bb.0:
; RV64I-NEXT: addi sp, sp, -16
; RV64I-NEXT: sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT: slli a0, a0, 24
; RV64I-NEXT: sraiw a1, a0, 24
; RV64I-NEXT: li a0, -10
; RV64I-NEXT: call __divdi3
; RV64I-NEXT: ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT: addi sp, sp, 16
; RV64I-NEXT: ret
;
; RV64IM-LABEL: sdiv8_constant_lhs:
; RV64IM:      # %bb.0:
; RV64IM-NEXT: slli a0, a0, 24
; RV64IM-NEXT: sraiw a0, a0, 24
; RV64IM-NEXT: li a1, -10
; RV64IM-NEXT: divw a0, a1, a0
; RV64IM-NEXT: ret
%1 = sdiv i8 -10, %a

```

```

ret i8 %1
}

define i16 @sdiv16(i16 %a, i16 %b) nounwind {
; RV64I-LABEL:
sdiv16:
; RV64I:    # %bb.0:
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  slli a1, a1, 16
; RV64I-NEXT:  sraiw a1, a1, 16
; RV64I-NEXT:  slli a0, a0, 16
; RV64I-NEXT:  sraiw a0, a0, 16
; RV64I-NEXT:  call __divdi3
; RV64I-NEXT:  ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
;
; RV64IM-LABEL: sdiv16:
; RV64IM:    # %bb.0:
; RV64IM-NEXT:  slli a1, a1, 16
; RV64IM-NEXT:  sraiw a1, a1, 16
; RV64IM-NEXT:  slli a0, a0, 16
; RV64IM-NEXT:  sraiw a0, a0, 16
; RV64IM-NEXT:  divw a0, a0, a1
; RV64IM-NEXT:  ret
%1 = sdiv i16 %a, %b
ret i16 %1
}

```

```

define i16 @sdiv16_constant(i16 %a) nounwind {
; RV64I-LABEL: sdiv16_constant:
; RV64I:    # %bb.0:
; RV64I-NEXT:  addi sp, sp, -16
; RV64I-NEXT:  sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT:  slli a0, a0, 16
; RV64I-NEXT:  sraiw a0, a0, 16
; RV64I-NEXT:  li a1, 5
; RV64I-NEXT:  call __divdi3
; RV64I-NEXT:
    ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
;
; RV64IM-LABEL: sdiv16_constant:
; RV64IM:    # %bb.0:
; RV64IM-NEXT:  slli a0, a0, 16
; RV64IM-NEXT:  sraiw a0, a0, 16

```

```

; RV64IM-NEXT: lui a1, 6
; RV64IM-NEXT: addi a1, a1, 1639
; RV64IM-NEXT: mul a0, a0, a1
; RV64IM-NEXT: srliw a1, a0, 31
; RV64IM-NEXT: sraiw a0, a0, 17
; RV64IM-NEXT: addw a0, a0, a1
; RV64IM-NEXT: ret
%1 = sdiv i16 %a, 5
ret i16 %1
}

```

```

define i16 @sdiv16_pow2(i16 %a) nounwind {
; RV64I-LABEL: sdiv16_pow2:
; RV64I:    # %bb.0:
; RV64I-NEXT: slli a1, a0, 16
; RV64I-NEXT: sraiw a1, a1, 16
; RV64I-NEXT: slli a1, a1, 33
; RV64I-NEXT: srli a1, a1, 61
; RV64I-NEXT: add a0, a0, a1
; RV64I-NEXT: slli a0, a0, 16
; RV64I-NEXT: sraiw a0, a0, 19
; RV64I-NEXT: ret
;
; RV64IM-LABEL: sdiv16_pow2:
; RV64IM:    # %bb.0:
; RV64IM-NEXT: slli a1, a0, 16
; RV64IM-NEXT: sraiw a1, a1, 16
; RV64IM-NEXT: slli a1, a1, 33
;
; RV64IM-NEXT: srli a1, a1, 61
; RV64IM-NEXT: add a0, a0, a1
; RV64IM-NEXT: slli a0, a0, 16
; RV64IM-NEXT: sraiw a0, a0, 19
; RV64IM-NEXT: ret
%1 = sdiv i16 %a, 8
ret i16 %1
}

```

```

define i16 @sdiv16_constant_lhs(i16 %a) nounwind {
; RV64I-LABEL: sdiv16_constant_lhs:
; RV64I:    # %bb.0:
; RV64I-NEXT: addi sp, sp, -16
; RV64I-NEXT: sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT: slli a0, a0, 16
; RV64I-NEXT: sraiw a1, a0, 16
; RV64I-NEXT: li a0, -10
; RV64I-NEXT: call __divdi3
; RV64I-NEXT: ld ra, 8(sp) # 8-byte Folded Reload

```

```

; RV64I-NEXT:  addi sp, sp, 16
; RV64I-NEXT:  ret
;
; RV64IM-LABEL: sdiv16_constant_lhs:
; RV64IM:      # %bb.0:
; RV64IM-NEXT:  slli a0, a0, 16
; RV64IM-NEXT:  sraiw a0, a0, 16
; RV64IM-NEXT:  li a1, -10
; RV64IM-NEXT:  divw a0, a1, a0
; RV64IM-NEXT:  ret
%1 = sdiv i16 -10, %a
ret i16 %1
}
; RUN: opt %s -passes=inline -S | FileCheck %s

define internal void @innerSmall() "min-legal-vector-width"="128" {
  ret void
}

define internal void @innerLarge() "min-legal-vector-width"="512" {
  ret void
}

define internal void @innerNoAttribute() {
  ret void
}

; We should not add an attribute during inlining. No attribute means unknown.
; Inlining doesn't change the fact that we don't know anything about this
; function.
define void @outerNoAttribute() {
  call void @innerLarge()
  ret void
}

define void @outerConflictingAttributeSmall() "min-legal-vector-width"="128" {
  call void @innerLarge()
  ret void
}

define void @outerConflictingAttributeLarge() "min-legal-vector-width"="512" {
  call void @innerSmall()
  ret void
}

; We should remove the attribute after inlining since the callee's
; vector width requirements are unknown.
define void @outerAttribute() "min-legal-vector-width"="128" {

```

```

call void @innerNoAttribute()
ret void
}

```

```

; CHECK: define void @outerNoAttribute()
{
; CHECK: define void @outerConflictingAttributeSmall() #0
; CHECK: define void @outerConflictingAttributeLarge() #0
; CHECK: define void @outerAttribute() {
; CHECK: attributes #0 = { "min-legal-vector-width"="512" }
LLVM System Interface Library
-----

```

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SPDX-License-Identifier: Apache-2.0 WITH LLVM-exception

```

; RUN: opt -mtriple=aarch64-linux-gnu -mattr=+sve -passes=sanitize-masked-mem-intrin -S < %s | FileCheck %s

```

```

; Testing that masked scatters operating on scalable vectors that are
; packed in SVE registers are not scalarized.

```

```

; CHECK-LABEL: @masked_scatter_nxv4i32(
; CHECK: call void @llvm.masked.scatter.nxv4i32
define void @masked_scatter_nxv4i32(<vscale x 4 x i32> %data, <vscale x 4 x ptr> %ptrs, <vscale x 4 x i1>
%mask) {
  call void @llvm.masked.scatter.nxv4i32(<vscale x 4 x i32> %data, <vscale x 4 x ptr> %ptrs, i32 0, <vscale x 4 x
i1> %mask)
  ret void
}

```

```

; Testing that masked scatters operating on scalable vectors of FP
; data that is packed in SVE registers are not scalarized.

```

```

; CHECK-LABEL: @masked_scatter_nxv2f64(
; CHECK: call void @llvm.masked.scatter.nxv2f64
define void @masked_scatter_nxv2f64(<vscale x 2 x double> %data, <vscale x 2 x ptr> %ptrs, <vscale x 2 x i1>
%mask) {
  call void @llvm.masked.scatter.nxv2f64(<vscale x 2 x double> %data, <vscale x 2 x ptr> %ptrs,
i32 0, <vscale x 2 x i1> %mask)
  ret void
}

```

```

; Testing that masked scatters operating on scalable vectors of FP
; data that is unpacked in SVE registers are not scalarized.

```

```

; CHECK-LABEL: @masked_scatter_nxv2f16(
; CHECK: call void @llvm.masked.scatter.nxv2f16
define void @masked_scatter_nxv2f16(<vscale x 2 x half> %data, <vscale x 2 x ptr> %ptrs, <vscale x 2 x i1>

```



```
%masks) {
  call void @llvm.masked.scatter.nxv2f16(<vscale x 2 x half> %data, <vscale x 2 x ptr> %ptrs, i32 0, <vscale x 2 x
i1> %masks)
  ret void
}
```

```
; Testing that masked scatters operating on 64-bit fixed vectors are
; scalarized because NEON doesn't have support for masked scatter
; instructions.
```

```
; CHECK-LABEL: @masked_scatter_v2f32(
; CHECK-NOT: @llvm.masked.scatter.v2f32(
define void @masked_scatter_v2f32(<2 x float> %data, <2 x ptr> %ptrs, <2 x i1> %masks) {
  call void @llvm.masked.scatter.v2f32(<2 x float> %data, <2 x ptr> %ptrs, i32 0, <2 x i1> %masks)
  ret void
}
```

```
; Testing that masked scatters operating on 128-bit
fixed vectors are
; scalarized because NEON doesn't have support for masked scatter
; instructions and because we are not targeting fixed width SVE.
```

```
; CHECK-LABEL: @masked_scatter_v4i32(
; CHECK-NOT: @llvm.masked.scatter.v4i32(
define void @masked_scatter_v4i32(<4 x i32> %data, <4 x ptr> %ptrs, <4 x i1> %masks) {
  call void @llvm.masked.scatter.v4i32(<4 x i32> %data, <4 x ptr> %ptrs, i32 0, <4 x i1> %masks)
  ret void
}
```

```
declare void @llvm.masked.scatter.nxv4i32(<vscale x 4 x i32> %data, <vscale x 4 x ptr> %ptrs, i32 %align,
<vscale x 4 x i1> %masks)
declare void @llvm.masked.scatter.nxv2f64(<vscale x 2 x double> %data, <vscale x 2 x ptr> %ptrs, i32 %align,
<vscale x 2 x i1> %masks)
declare void @llvm.masked.scatter.nxv2f16(<vscale x 2 x half> %data, <vscale x 2 x ptr> %ptrs, i32 %align,
<vscale x 2 x i1> %masks)
declare void @llvm.masked.scatter.v2f32(<2 x float> %data, <2 x ptr> %ptrs, i32 %align, <2 x i1> %masks)
declare void @llvm.masked.scatter.v4i32(<4 x i32> %data, <4 x
ptr> %ptrs, i32 %align, <4 x i1> %masks)
; NOTE: Assertions have been autogenerated by utils/update_llc_test_checks.py
; RUN: llc -mtriple=riscv64 -verify-machineinstrs < %s \
; RUN: -riscv-experimental-rv64-legal-i32 | FileCheck -check-prefix=RV64I %s
```

```
; Check indexed and unindexed, sext, zext and anyext loads
```

```
define dso_local i64 @lb(ptr %a) nounwind {
; RV64I-LABEL: lb:
; RV64I:      # %bb.0:
; RV64I-NEXT: lb a1, 1(a0)
```

```

; RV64I-NEXT:  lbu zero, 0(a0)
; RV64I-NEXT:  mv a0, a1
; RV64I-NEXT:  ret
%1 = getelementptr i8, ptr %a, i32 1
%2 = load i8, ptr %1
%3 = sext i8 %2 to i64
; the unused load will produce an anyext for selection
%4 = load volatile i8, ptr %a
ret i64 %3
}

```

```

define dso_local i64 @lh(ptr %a) nounwind {
; RV64I-LABEL: lh:
; RV64I:      # %bb.0:
; RV64I-NEXT:  lh a1, 4(a0)
; RV64I-NEXT:  lh zero, 0(a0)
; RV64I-NEXT:  mv a0, a1
; RV64I-NEXT:  ret
%1 = getelementptr i16, ptr %a, i32 2
%2 = load i16, ptr %1
%3 = sext i16 %2 to i64
; the unused load will produce an anyext for selection
%4 = load volatile i16, ptr %a
ret i64 %3
}

```

```

define dso_local i64 @lw(ptr %a) nounwind {
; RV64I-LABEL: lw:
; RV64I:      # %bb.0:
; RV64I-NEXT:  lw a1, 12(a0)
; RV64I-NEXT:  lw zero, 0(a0)
; RV64I-NEXT:  mv a0, a1
; RV64I-NEXT:  ret
%1 = getelementptr i32, ptr %a, i32 3
%2 = load i32, ptr %1
%3 = sext i32 %2 to i64
; the unused load will produce an anyext for selection
%4 = load volatile i32, ptr %a
ret i64 %3
}

```

```

define dso_local i64 @lbu(ptr %a) nounwind {
; RV64I-LABEL: lbu:
; RV64I:      # %bb.0:
; RV64I-NEXT:  lbu a1, 4(a0)
; RV64I-NEXT:  lbu a0, 0(a0)
; RV64I-NEXT:  add a0, a1, a0
; RV64I-NEXT:  ret

```

```

%1 = getelementptr i8, ptr %a, i32 4
%2 = load i8, ptr %1
%3 = zext i8 %2 to i64
%4 = load volatile i8, ptr %a
%5 = zext i8 %4 to i64
%6 = add i64 %3, %5
ret i64 %6
}

```

```

define dso_local i64 @lhu(ptr %a) nounwind {
; RV64I-LABEL: lhu:
; RV64I:      # %bb.0:
; RV64I-NEXT:  lhu a1, 10(a0)
; RV64I-NEXT:  lhu a0, 0(a0)
; RV64I-NEXT:
    add a0, a1, a0
; RV64I-NEXT:  ret
%1 = getelementptr i16, ptr %a, i32 5
%2 = load i16, ptr %1
%3 = zext i16 %2 to i64
%4 = load volatile i16, ptr %a
%5 = zext i16 %4 to i64
%6 = add i64 %3, %5
ret i64 %6
}

```

```

define dso_local i64 @lwu(ptr %a) nounwind {
; RV64I-LABEL: lwu:
; RV64I:      # %bb.0:
; RV64I-NEXT:  lwu a1, 24(a0)
; RV64I-NEXT:  lwu a0, 0(a0)
; RV64I-NEXT:  add a0, a1, a0
; RV64I-NEXT:  ret
%1 = getelementptr i32, ptr %a, i32 6
%2 = load i32, ptr %1
%3 = zext i32 %2 to i64
%4 = load volatile i32, ptr %a
%5 = zext i32 %4 to i64
%6 = add i64 %3, %5
ret i64 %6
}

```

; 64-bit loads and stores

```

define dso_local i64 @ld(ptr %a) nounwind {
; RV64I-LABEL: ld:
; RV64I:      # %bb.0:
; RV64I-NEXT:  ld a1, 80(a0)

```

```

; RV64I-NEXT:  ld zero, 0(a0)
; RV64I-NEXT:  mv a0, a1
; RV64I-NEXT:  ret
%1 = getelementptr i64, ptr %a, i32 10
%2 = load i64, ptr %1
%3 = load volatile i64, ptr %a
ret i64 %2
}

define dso_local void @sd(ptr %a, i64 %b)
nounwind {
; RV64I-LABEL: sd:
; RV64I:      # %bb.0:
; RV64I-NEXT:  sd a1, 0(a0)
; RV64I-NEXT:  sd a1, 88(a0)
; RV64I-NEXT:  ret
store i64 %b, ptr %a
%1 = getelementptr i64, ptr %a, i32 11
store i64 %b, ptr %1
ret void
}

; Check load and store to an i1 location
define dso_local i64 @load_sext_zext_anyext_i1(ptr %a) nounwind {
; RV64I-LABEL: load_sext_zext_anyext_i1:
; RV64I:      # %bb.0:
; RV64I-NEXT:  lbu a1, 1(a0)
; RV64I-NEXT:  lbu a2, 2(a0)
; RV64I-NEXT:  lbu zero, 0(a0)
; RV64I-NEXT:  sub a0, a2, a1
; RV64I-NEXT:  ret
; sextload i1
%1 = getelementptr i1, ptr %a, i32 1
%2 = load i1, ptr %1
%3 = sext i1 %2 to i64
; zextload i1
%4 = getelementptr i1, ptr %a, i32 2
%5 = load i1, ptr %4
%6 = zext i1 %5 to i64
%7 = add i64 %3, %6
; extload i1 (anyext). Produced as the load is unused.
%8 = load volatile i1, ptr %a
ret i64 %7
}

define dso_local i16 @load_sext_zext_anyext_i1_i16(ptr %a) nounwind {
; RV64I-LABEL: load_sext_zext_anyext_i1_i16:
;

```

```

RV64I:    # %bb.0:
; RV64I-NEXT:  lbu a1, 1(a0)
; RV64I-NEXT:  lbu a2, 2(a0)
; RV64I-NEXT:  lbu zero, 0(a0)
; RV64I-NEXT:  subw a0, a2, a1
; RV64I-NEXT:  ret
; sextload i1
%1 = getelementptr i1, ptr %a, i32 1
%2 = load i1, ptr %1
%3 = sext i1 %2 to i16
; zextload i1
%4 = getelementptr i1, ptr %a, i32 2
%5 = load i1, ptr %4
%6 = zext i1 %5 to i16
%7 = add i16 %3, %6
; extload i1 (anyext). Produced as the load is unused.
%8 = load volatile i1, ptr %a
ret i16 %7
}

; Check load and store to a global
@G = dso_local global i64 0

define dso_local i64 @ld_sd_global(i64 %a) nounwind {
; RV64I-LABEL: ld_sd_global:
; RV64I:    # %bb.0:
; RV64I-NEXT:  lui a2, %hi(G)
; RV64I-NEXT:  ld a1, %lo(G)(a2)
; RV64I-NEXT:  addi a3, a2, %lo(G)
; RV64I-NEXT:  sd a0, %lo(G)(a2)
; RV64I-NEXT:  ld zero, 72(a3)
; RV64I-NEXT:  sd a0, 72(a3)
; RV64I-NEXT:  mv a0, a1
; RV64I-NEXT:  ret
%1 = load volatile i64, ptr @G
store i64 %a, ptr @G
%2 = getelementptr
i64, ptr @G, i64 9
%3 = load volatile i64, ptr %2
store i64 %a, ptr %2
ret i64 %1
}

define i64 @lw_near_local(ptr %a) {
; RV64I-LABEL: lw_near_local:
; RV64I:    # %bb.0:
; RV64I-NEXT:  addi a0, a0, 2047
; RV64I-NEXT:  ld a0, 9(a0)

```

```
; RV64I-NEXT:  ret
%1 = getelementptr inbounds i64, ptr %a, i64 257
%2 = load volatile i64, ptr %1
ret i64 %2
}
```

```
define void @st_near_local(ptr %a, i64 %b) {
; RV64I-LABEL: st_near_local:
; RV64I:      # %bb.0:
; RV64I-NEXT:  addi a0, a0, 2047
; RV64I-NEXT:  sd a1, 9(a0)
; RV64I-NEXT:  ret
%1 = getelementptr inbounds i64, ptr %a, i64 257
store i64 %b, ptr %1
ret void
}
```

```
define i64 @lw_sw_near_local(ptr %a, i64 %b) {
; RV64I-LABEL: lw_sw_near_local:
; RV64I:      # %bb.0:
; RV64I-NEXT:  addi a2, a0, 2047
; RV64I-NEXT:  ld a0, 9(a2)
; RV64I-NEXT:  sd a1, 9(a2)
; RV64I-NEXT:  ret
%1 = getelementptr inbounds i64, ptr %a, i64 257
%2 = load volatile i64, ptr %1
store i64 %b, ptr %1
ret i64 %2
}
```

```
define
i64 @lw_far_local(ptr %a) {
; RV64I-LABEL: lw_far_local:
; RV64I:      # %bb.0:
; RV64I-NEXT:  lui a1, 8
; RV64I-NEXT:  add a0, a0, a1
; RV64I-NEXT:  ld a0, -8(a0)
; RV64I-NEXT:  ret
%1 = getelementptr inbounds i64, ptr %a, i64 4095
%2 = load volatile i64, ptr %1
ret i64 %2
}
```

```
define void @st_far_local(ptr %a, i64 %b) {
; RV64I-LABEL: st_far_local:
; RV64I:      # %bb.0:
; RV64I-NEXT:  lui a2, 8
; RV64I-NEXT:  add a0, a0, a2
}
```

```
; RV64I-NEXT: sd a1, -8(a0)
; RV64I-NEXT: ret
%1 = getelementptr inbounds i64, ptr %a, i64 4095
store i64 %b, ptr %1
ret void
}
```

```
define i64 @lw_sw_far_local(ptr %a, i64 %b) {
; RV64I-LABEL: lw_sw_far_local:
; RV64I:    # %bb.0:
; RV64I-NEXT: lui a2, 8
; RV64I-NEXT: add a2, a0, a2
; RV64I-NEXT: ld a0, -8(a2)
; RV64I-NEXT: sd a1, -8(a2)
; RV64I-NEXT: ret
%1 = getelementptr inbounds i64, ptr %a, i64 4095
%2 = load volatile i64, ptr %1
store i64 %b, ptr %1
ret i64 %2
}
```

; Make sure we don't fold the addiw into the load offset. The sign extend of the addiw is required.

```
define i64 @lw_really_far_local(ptr %a) {
; RV64I-LABEL: lw_really_far_local:
; RV64I:    # %bb.0:
; RV64I-NEXT: lui a1, 524288
; RV64I-NEXT: addiw a1, a1, -2048
; RV64I-NEXT: add a0, a0, a1
; RV64I-NEXT: ld a0, 0(a0)
; RV64I-NEXT: ret
%1 = getelementptr inbounds i64, ptr %a, i64 268435200
%2 = load volatile i64, ptr %1
ret i64 %2
}
```

; Make sure we don't fold the addiw into the store offset. The sign extend of the addiw is required.

```
define void @st_really_far_local(ptr %a, i64 %b) {
; RV64I-LABEL: st_really_far_local:
; RV64I:    # %bb.0:
; RV64I-NEXT: lui a2, 524288
; RV64I-NEXT: addiw a2, a2, -2048
; RV64I-NEXT: add a0, a0, a2
; RV64I-NEXT: sd a1, 0(a0)
; RV64I-NEXT: ret
%1 = getelementptr inbounds i64, ptr %a, i64 268435200
```

```

store i64 %b, ptr %1
ret void
}

```

; Make sure we don't fold the addiw into the load/store offset. The sign extend  
; of the addiw is required.

```

define
i64 @lw_sw_really_far_local(ptr %a, i64 %b) {
; RV64I-LABEL: lw_sw_really_far_local:
; RV64I:      # %bb.0:
; RV64I-NEXT: lui a2, 524288
; RV64I-NEXT: addiw a2, a2, -2048
; RV64I-NEXT: add a2, a0, a2
; RV64I-NEXT: ld a0, 0(a2)
; RV64I-NEXT: sd a1, 0(a2)
; RV64I-NEXT: ret
%1 = getelementptr inbounds i64, ptr %a, i64 268435200
%2 = load volatile i64, ptr %1
store i64 %b, ptr %1
ret i64 %2
}

```

```

%struct.quux = type { i32, [0 x i8] }

```

; Make sure we don't remove the addi and fold the C from  
; (add (addi FrameIndex, C), X) into the store address.  
; FrameIndex cannot be the operand of an ADD. We must keep the ADDI.

```

define void @addi_fold_crash(i64 %arg) nounwind {
; RV64I-LABEL: addi_fold_crash:
; RV64I:      # %bb.0: # %bb
; RV64I-NEXT: addi sp, sp, -16
; RV64I-NEXT: sd ra, 8(sp) # 8-byte Folded Spill
; RV64I-NEXT: addi a1, sp, 4
; RV64I-NEXT: add a0, a1, a0
; RV64I-NEXT: sb zero, 0(a0)
; RV64I-NEXT: mv a0, a1
; RV64I-NEXT: call snork
; RV64I-NEXT:
    ld ra, 8(sp) # 8-byte Folded Reload
; RV64I-NEXT: addi sp, sp, 16
; RV64I-NEXT: ret
bb:
%tmp = alloca %struct.quux, align 8
%tmp1 = getelementptr inbounds %struct.quux, ptr %tmp, i64 0, i32 1
%tmp2 = getelementptr inbounds %struct.quux, ptr %tmp, i64 0, i32 1, i64 %arg
store i8 0, ptr %tmp2, align 1
call void @snork(ptr %tmp1)
ret void

```



```
}
```

```
declare void @snork(ptr)
```

```
; NOTE: Assertions have been autogenerated by utils/update_test_checks.py UTC_ARGS: --function-signature --scrub-attributes
```

```
; RUN: opt -S -passes=argpromotion < %s | FileCheck %s
```

```
; Test that we only promote arguments when the caller/callee have compatible
```

```
; function attributes.
```

```
target triple = "x86_64-unknown-linux-gnu"
```

```
; This should promote
```

```
define internal fastcc void @callee_avx512_legal512_prefer512_call_avx512_legal512_prefer512(ptr %arg, ptr readonly %arg1) #0 {
```

```
; CHECK-LABEL: define {{^(^@)+}}@callee_avx512_legal512_prefer512_call_avx512_legal512_prefer512
```

```
; CHECK-SAME: (ptr [[ARG:%.*]], <8 x i64> [[ARG1_VAL:%.*]])
```

```
; CHECK-NEXT: bb:
```

```
; CHECK-NEXT: store <8 x i64> [[ARG1_VAL]], ptr [[ARG]]
```

```
; CHECK-NEXT: ret void
```

```
;
```

```
bb:
```

```
%tmp = load <8 x i64>, ptr %arg1
```

```
store <8 x i64> %tmp, ptr %arg
```

```
ret void
```

```
}
```

```
define void @avx512_legal512_prefer512_call_avx512_legal512_prefer512(ptr %arg) #0 {
```

```
; CHECK-LABEL: define {{^(^@)+}}@avx512_legal512_prefer512_call_avx512_legal512_prefer512
```

```
; CHECK-SAME:
```

```
(ptr [[ARG:%.*]])
```

```
; CHECK-NEXT: bb:
```

```
; CHECK-NEXT: [[TMP:%.*]] = alloca <8 x i64>, align 32
```

```
; CHECK-NEXT: [[TMP2:%.*]] = alloca <8 x i64>, align 32
```

```
; CHECK-NEXT: call void @llvm.memset.p0.i64(ptr align 32 [[TMP]], i8 0, i64 32, i1 false)
```

```
; CHECK-NEXT: [[TMP_VAL:%.*]] = load <8 x i64>, ptr [[TMP]]
```

```
; CHECK-NEXT: call fastcc void @callee_avx512_legal512_prefer512_call_avx512_legal512_prefer512(ptr [[TMP2]], <8 x i64> [[TMP_VAL]])
```

```
; CHECK-NEXT: [[TMP4:%.*]] = load <8 x i64>, ptr [[TMP2]], align 32
```

```
; CHECK-NEXT: store <8 x i64> [[TMP4]], ptr [[ARG]], align 2
```

```
; CHECK-NEXT: ret void
```

```
;
```

```
bb:
```

```
%tmp = alloca <8 x i64>, align 32
```

```
%tmp2 = alloca <8 x i64>, align 32
```

```
call void @llvm.memset.p0.i64(ptr align 32 %tmp, i8 0, i64 32, i1 false)
```

```
call fastcc void @callee_avx512_legal512_prefer512_call_avx512_legal512_prefer512(ptr %tmp2, ptr %tmp)
```

```
%tmp4 = load <8 x i64>, ptr %tmp2, align 32
```

```
store <8 x i64> %tmp4, ptr %arg, align 2
```

```

ret void
}

; This should promote
define
  internal fastcc void @callee_avx512_legal512_prefer256_call_avx512_legal512_prefer256(ptr %arg, ptr readonly %arg1) #1 {
; CHECK-LABEL: define {{[^\@]+}}@callee_avx512_legal512_prefer256_call_avx512_legal512_prefer256
; CHECK-SAME: (ptr [[ARG:%.*]], <8 x i64> [[ARG1_VAL:%.*]])
; CHECK-NEXT: bb:
; CHECK-NEXT:   store <8 x i64> [[ARG1_VAL]], ptr [[ARG]]
; CHECK-NEXT:   ret void
;
bb:
  %tmp = load <8 x i64>, ptr %arg1
  store <8 x i64> %tmp, ptr %arg
  ret void
}

```

```

define void @avx512_legal512_prefer256_call_avx512_legal512_prefer256(ptr %arg) #1 {
; CHECK-LABEL: define {{[^\@]+}}@avx512_legal512_prefer256_call_avx512_legal512_prefer256
; CHECK-SAME: (ptr [[ARG:%.*]])
; CHECK-NEXT: bb:
; CHECK-NEXT:   [[TMP:%.*]] = alloca <8 x i64>, align 32
; CHECK-NEXT:   [[TMP2:%.*]] = alloca <8 x i64>, align 32
; CHECK-NEXT:   call void @llvm.memset.p0.i64(ptr align 32 [[TMP]], i8 0, i64 32, i1 false)
; CHECK-NEXT:   [[TMP_VAL:%.*]] = load <8 x i64>, ptr [[TMP]]
; CHECK-NEXT:   call fastcc
    void @callee_avx512_legal512_prefer256_call_avx512_legal512_prefer256(ptr [[TMP2]], <8 x i64> [[TMP_VAL]])
; CHECK-NEXT:   [[TMP4:%.*]] = load <8 x i64>, ptr [[TMP2]], align 32
; CHECK-NEXT:   store <8 x i64> [[TMP4]], ptr [[ARG]], align 2
; CHECK-NEXT:   ret void
;
bb:
  %tmp = alloca <8 x i64>, align 32
  %tmp2 = alloca <8 x i64>, align 32
  call void @llvm.memset.p0.i64(ptr align 32 %tmp, i8 0, i64 32, i1 false)
  call fastcc void @callee_avx512_legal512_prefer256_call_avx512_legal512_prefer256(ptr %tmp2, ptr %tmp)
  %tmp4 = load <8 x i64>, ptr %tmp2, align 32
  store <8 x i64> %tmp4, ptr %arg, align 2
  ret void
}

```

```

; This should promote
define internal fastcc void @callee_avx512_legal512_prefer512_call_avx512_legal512_prefer256(ptr %arg, ptr
readonly %arg1) #1 {
; CHECK-LABEL: define {{[^\@]+}}@callee_avx512_legal512_prefer512_call_avx512_legal512_prefer256

```

```

; CHECK-SAME: (ptr [[ARG:%.*]], <8 x i64> [[ARG1_VAL:%.*]])
; CHECK-NEXT: bb:
; CHECK-NEXT: store <8 x i64> [[ARG1_VAL]],
    ptr [[ARG]]
; CHECK-NEXT: ret void
;
bb:
    %tmp = load <8 x i64>, ptr %arg1
    store <8 x i64> %tmp, ptr %arg
    ret void
}

define void @avx512_legal512_prefer512_call_avx512_legal512_prefer256(ptr %arg) #0 {
; CHECK-LABEL: define {{{^@}+}}@avx512_legal512_prefer512_call_avx512_legal512_prefer256
; CHECK-SAME: (ptr [[ARG:%.*]])
; CHECK-NEXT: bb:
; CHECK-NEXT: [[TMP:%.*]] = alloca <8 x i64>, align 32
; CHECK-NEXT: [[TMP2:%.*]] = alloca <8 x i64>, align 32
; CHECK-NEXT: call void @llvm.memset.p0.i64(ptr align 32 [[TMP]], i8 0, i64 32, i1 false)
; CHECK-NEXT: [[TMP_VAL:%.*]] = load <8 x i64>, ptr [[TMP]]
; CHECK-NEXT: call fastcc void @callee_avx512_legal512_prefer512_call_avx512_legal512_prefer256(ptr
[[TMP2]], <8 x i64> [[TMP_VAL]])
; CHECK-NEXT: [[TMP4:%.*]] = load <8 x i64>, ptr [[TMP2]], align 32
; CHECK-NEXT: store <8 x i64> [[TMP4]], ptr [[ARG]], align 2
; CHECK-NEXT: ret void
;
bb:
    %tmp = alloca <8 x i64>, align 32
    %tmp2 = alloca <8 x i64>, align
    32
    call void @llvm.memset.p0.i64(ptr align 32 %tmp, i8 0, i64 32, i1 false)
    call fastcc void @callee_avx512_legal512_prefer512_call_avx512_legal512_prefer256(ptr %tmp2, ptr %tmp)
    %tmp4 = load <8 x i64>, ptr %tmp2, align 32
    store <8 x i64> %tmp4, ptr %arg, align 2
    ret void
}

; This should promote
define internal fastcc void @callee_avx512_legal512_prefer256_call_avx512_legal512_prefer512(ptr %arg, ptr
readonly %arg1) #0 {
; CHECK-LABEL: define {{{^@}+}}@callee_avx512_legal512_prefer256_call_avx512_legal512_prefer512
; CHECK-SAME: (ptr [[ARG:%.*]], <8 x i64> [[ARG1_VAL:%.*]])
; CHECK-NEXT: bb:
; CHECK-NEXT: store <8 x i64> [[ARG1_VAL]], ptr [[ARG]]
; CHECK-NEXT: ret void
;
bb:
    %tmp = load <8 x i64>, ptr %arg1

```

```

store <8 x i64> %tmp, ptr %arg
ret void
}

define void @avx512_legal512_prefer256_call_avx512_legal512_prefer512(ptr %arg) #1 {
; CHECK-LABEL: define {{^@}+}}@avx512_legal512_prefer256_call_avx512_legal512_prefer512
; CHECK-SAME: (ptr [[ARG:%.*]])
; CHECK-NEXT:
bb:
; CHECK-NEXT: [[TMP:%.*]] = alloca <8 x i64>, align 32
; CHECK-NEXT: [[TMP2:%.*]] = alloca <8 x i64>, align 32
; CHECK-NEXT: call void @llvm.memset.p0.i64(ptr align 32 [[TMP]], i8 0, i64 32, i1 false)
; CHECK-NEXT: [[TMP_VAL:%.*]] = load <8 x i64>, ptr [[TMP]]
; CHECK-NEXT: call fastcc void @callee_avx512_legal512_prefer256_call_avx512_legal512_prefer512(ptr
[[TMP2]], <8 x i64> [[TMP_VAL]])
; CHECK-NEXT: [[TMP4:%.*]] = load <8 x i64>, ptr [[TMP2]], align 32
; CHECK-NEXT: store <8 x i64> [[TMP4]], ptr [[ARG]], align 2
; CHECK-NEXT: ret void
;
bb:
%tmp = alloca <8 x i64>, align 32
%tmp2 = alloca <8 x i64>, align 32
call void @llvm.memset.p0.i64(ptr align 32 %tmp, i8 0, i64 32, i1 false)
call fastcc void @callee_avx512_legal512_prefer256_call_avx512_legal512_prefer512(ptr %tmp2, ptr %tmp)
%tmp4 = load <8 x i64>, ptr %tmp2, align 32
store <8 x i64> %tmp4, ptr %arg, align 2
ret void
}

; This should not promote
define internal fastcc void @callee_avx512_legal256_prefer256_call_avx512_legal512_prefer256(ptr
%arg, ptr readonly %arg1) #1 {
; CHECK-LABEL: define {{^@}+}}@callee_avx512_legal256_prefer256_call_avx512_legal512_prefer256
; CHECK-SAME: (ptr [[ARG:%.*]], ptr readonly [[ARG1:%.*]])
; CHECK-NEXT: bb:
; CHECK-NEXT: [[TMP:%.*]] = load <8 x i64>, ptr [[ARG1]]
; CHECK-NEXT: store <8 x i64> [[TMP]], ptr [[ARG]]
; CHECK-NEXT: ret void
;
bb:
%tmp = load <8 x i64>, ptr %arg1
store <8 x i64> %tmp, ptr %arg
ret void
}

define void @avx512_legal256_prefer256_call_avx512_legal512_prefer256(ptr %arg) #2 {
; CHECK-LABEL: define {{^@}+}}@avx512_legal256_prefer256_call_avx512_legal512_prefer256
; CHECK-SAME: (ptr [[ARG:%.*]])

```

```

; CHECK-NEXT: bb:
; CHECK-NEXT: [[TMP:%.*]] = alloca <8 x i64>, align 32
; CHECK-NEXT: [[TMP2:%.*]] = alloca <8 x i64>, align 32
; CHECK-NEXT: call void @llvm.memset.p0.i64(ptr align 32 [[TMP]], i8 0, i64 32, i1 false)
; CHECK-NEXT: call fastcc void @callee_avx512_legal256_prefer256_call_avx512_legal512_prefer256(ptr
[[TMP2]], ptr [[TMP]])
; CHECK-NEXT: [[TMP4:%.*]] = load <8 x i64>, ptr [[TMP2]], align 32
; CHECK-NEXT: store <8 x i64> [[TMP4]], ptr [[ARG]], align 2
; CHECK-NEXT: ret void
;
bb:
%tmp = alloca <8 x i64>, align 32
%tmp2 = alloca <8 x i64>, align 32
call void @llvm.memset.p0.i64(ptr align 32 %tmp, i8 0, i64 32, i1 false)
call fastcc void @callee_avx512_legal256_prefer256_call_avx512_legal512_prefer256(ptr %tmp2, ptr %tmp)
%tmp4 = load <8 x i64>, ptr %tmp2, align 32
store <8 x i64> %tmp4, ptr %arg, align 2
ret void
}

; This should not promote
define internal fastcc void @callee_avx512_legal512_prefer256_call_avx512_legal256_prefer256(ptr %arg, ptr
readonly %arg1) #2 {
; CHECK-LABEL: define {{^[^@]+}}@callee_avx512_legal512_prefer256_call_avx512_legal256_prefer256
; CHECK-SAME: (ptr [[ARG:%.*]], ptr readonly [[ARG1:%.*]])
; CHECK-NEXT: bb:
; CHECK-NEXT: [[TMP:%.*]] = load <8 x i64>, ptr [[ARG1]]
; CHECK-NEXT: store <8 x i64>
[[TMP]], ptr [[ARG]]
; CHECK-NEXT: ret void
;
bb:
%tmp = load <8 x i64>, ptr %arg1
store <8 x i64> %tmp, ptr %arg
ret void
}

define void @avx512_legal512_prefer256_call_avx512_legal256_prefer256(ptr %arg) #1 {
; CHECK-LABEL: define {{^[^@]+}}@avx512_legal512_prefer256_call_avx512_legal256_prefer256
; CHECK-SAME: (ptr [[ARG:%.*]])
; CHECK-NEXT: bb:
; CHECK-NEXT: [[TMP:%.*]] = alloca <8 x i64>, align 32
; CHECK-NEXT: [[TMP2:%.*]] = alloca <8 x i64>, align 32
; CHECK-NEXT: call void @llvm.memset.p0.i64(ptr align 32 [[TMP]], i8 0, i64 32, i1 false)
; CHECK-NEXT: call fastcc void @callee_avx512_legal512_prefer256_call_avx512_legal256_prefer256(ptr
[[TMP2]], ptr [[TMP]])
; CHECK-NEXT: [[TMP4:%.*]] = load <8 x i64>, ptr [[TMP2]], align 32
; CHECK-NEXT: store <8 x i64> [[TMP4]], ptr [[ARG]], align 2

```

```

; CHECK-NEXT:  ret void
;
bb:
%tmp = alloca <8 x i64>, align 32
%tmp2 = alloca <8 x i64>, align 32
call void @llvm.memset.p0.i64(ptr align 32 %tmp, i8 0, i64
32, i1 false)
call fastcc void @callee_avx512_legal512_prefer256_call_avx512_legal256_prefer256(ptr %tmp2, ptr %tmp)
%tmp4 = load <8 x i64>, ptr %tmp2, align 32
store <8 x i64> %tmp4, ptr %arg, align 2
ret void
}

; This should promote
define internal fastcc void @callee_avx2_legal256_prefer256_call_avx2_legal512_prefer256(ptr %arg, ptr readonly
%arg1) #3 {
; CHECK-LABEL: define {{^@+}}@callee_avx2_legal256_prefer256_call_avx2_legal512_prefer256
; CHECK-SAME: (ptr [[ARG:%.*]], <8 x i64> [[ARG1_VAL:%.*]])
; CHECK-NEXT: bb:
; CHECK-NEXT:  store <8 x i64> [[ARG1_VAL]], ptr [[ARG]]
; CHECK-NEXT:  ret void
;
bb:
%tmp = load <8 x i64>, ptr %arg1
store <8 x i64> %tmp, ptr %arg
ret void
}

define void @avx2_legal256_prefer256_call_avx2_legal512_prefer256(ptr %arg) #4 {
; CHECK-LABEL: define {{^@+}}@avx2_legal256_prefer256_call_avx2_legal512_prefer256
; CHECK-SAME: (ptr [[ARG:%.*]])
; CHECK-NEXT: bb:
; CHECK-NEXT:  [[TMP:%.*]] = alloca <8 x i64>, align 32
; CHECK-NEXT:
[[TMP2:%.*]] = alloca <8 x i64>, align 32
; CHECK-NEXT:  call void @llvm.memset.p0.i64(ptr align 32 [[TMP]], i8 0, i64 32, i1 false)
; CHECK-NEXT:  [[TMP_VAL:%.*]] = load <8 x i64>, ptr [[TMP]]
; CHECK-NEXT:  call fastcc void @callee_avx2_legal256_prefer256_call_avx2_legal512_prefer256(ptr
[[TMP2]], <8 x i64> [[TMP_VAL]])
; CHECK-NEXT:  [[TMP4:%.*]] = load <8 x i64>, ptr [[TMP2]], align 32
; CHECK-NEXT:  store <8 x i64> [[TMP4]], ptr [[ARG]], align 2
; CHECK-NEXT:  ret void
;
bb:
%tmp = alloca <8 x i64>, align 32
%tmp2 = alloca <8 x i64>, align 32
call void @llvm.memset.p0.i64(ptr align 32 %tmp, i8 0, i64 32, i1 false)
call fastcc void @callee_avx2_legal256_prefer256_call_avx2_legal512_prefer256(ptr %tmp2, ptr %tmp)

```

```

%tmp4 = load <8 x i64>, ptr %tmp2, align 32
store <8 x i64> %tmp4, ptr %arg, align 2
ret void
}

; This should promote
define internal fastcc void @callee_avx2_legal512_prefer256_call_avx2_legal256_prefer256(ptr %arg, ptr readonly
%arg1) #4 {
;
CHECK-LABEL: define {{[^@]++}}@callee_avx2_legal512_prefer256_call_avx2_legal256_prefer256
; CHECK-SAME: (ptr [[ARG:%.*]], <8 x i64> [[ARG1_VAL:%.*]])
; CHECK-NEXT: bb:
; CHECK-NEXT: store <8 x i64> [[ARG1_VAL]], ptr [[ARG]]
; CHECK-NEXT: ret void
;
bb:
%tmp = load <8 x i64>, ptr %arg1
store <8 x i64> %tmp, ptr %arg
ret void
}

define void @avx2_legal512_prefer256_call_avx2_legal256_prefer256(ptr %arg) #3 {
; CHECK-LABEL: define {{[^@]++}}@avx2_legal512_prefer256_call_avx2_legal256_prefer256
; CHECK-SAME: (ptr [[ARG:%.*]])
; CHECK-NEXT: bb:
; CHECK-NEXT: [[TMP:%.*]] = alloca <8 x i64>, align 32
; CHECK-NEXT: [[TMP2:%.*]] = alloca <8 x i64>, align 32
; CHECK-NEXT: call void @llvm.memset.p0.i64(ptr align 32 [[TMP]], i8 0, i64 32, i1 false)
; CHECK-NEXT: [[TMP_VAL:%.*]] = load <8 x i64>, ptr [[TMP]]
; CHECK-NEXT: call fastcc void @callee_avx2_legal512_prefer256_call_avx2_legal256_prefer256(ptr
[[TMP2]], <8 x i64> [[TMP_VAL]])
; CHECK-NEXT: [[TMP4:%.*]] = load
<8 x i64>, ptr [[TMP2]], align 32
; CHECK-NEXT: store <8 x i64> [[TMP4]], ptr [[ARG]], align 2
; CHECK-NEXT: ret void
;
bb:
%tmp = alloca <8 x i64>, align 32
%tmp2 = alloca <8 x i64>, align 32
call void @llvm.memset.p0.i64(ptr align 32 %tmp, i8 0, i64 32, i1 false)
call fastcc void @callee_avx2_legal512_prefer256_call_avx2_legal256_prefer256(ptr %tmp2, ptr %tmp)
%tmp4 = load <8 x i64>, ptr %tmp2, align 32
store <8 x i64> %tmp4, ptr %arg, align 2
ret void
}

; If the arguments are scalar, its ok to promote.
define internal i32 @scalar_callee_avx512_legal256_prefer256_call_avx512_legal512_prefer256(ptr %X, ptr %Y)

```

```

#2 {
; CHECK-LABEL: define
{[^[^@]+]}@scalar_callee_avx512_legal256_prefer256_call_avx512_legal512_prefer256
; CHECK-SAME: (i32 [[X_VAL:%.*]], i32 [[Y_VAL:%.*]])
; CHECK-NEXT:  [[C:%.*]] = add i32 [[X_VAL]], [[Y_VAL]]
; CHECK-NEXT:  ret i32 [[C]]
;
%A = load i32, ptr %X
%B = load i32, ptr %Y
%C = add i32 %A, %B
ret i32 %C
}

define i32 @scalar_avx512_legal256_prefer256_call_avx512_legal512_prefer256(ptr
%B) #2 {
; CHECK-LABEL: define {[^[^@]+]}@scalar_avx512_legal256_prefer256_call_avx512_legal512_prefer256
; CHECK-SAME: (ptr [[B:%.*]])
; CHECK-NEXT:  [[A:%.*]] = alloca i32
; CHECK-NEXT:  store i32 1, ptr [[A]]
; CHECK-NEXT:  [[A_VAL:%.*]] = load i32, ptr [[A]]
; CHECK-NEXT:  [[B_VAL:%.*]] = load i32, ptr [[B]]
; CHECK-NEXT:  [[C:%.*]] = call i32
@scalar_callee_avx512_legal256_prefer256_call_avx512_legal512_prefer256(i32 [[A_VAL]], i32 [[B_VAL]])
; CHECK-NEXT:  ret i32 [[C]]
;
%A = alloca i32
store i32 1, ptr %A
%C = call i32 @scalar_callee_avx512_legal256_prefer256_call_avx512_legal512_prefer256(ptr %A, ptr %B)
ret i32 %C
}

; If the arguments are scalar, its ok to promote.
define internal i32 @scalar_callee_avx512_legal512_prefer256_call_avx512_legal256_prefer256(ptr %X, ptr %Y)
#2 {
; CHECK-LABEL: define
{[^[^@]+]}@scalar_callee_avx512_legal512_prefer256_call_avx512_legal256_prefer256
; CHECK-SAME: (i32 [[X_VAL:%.*]],
i32 [[Y_VAL:%.*]])
; CHECK-NEXT:  [[C:%.*]] = add i32 [[X_VAL]], [[Y_VAL]]
; CHECK-NEXT:  ret i32 [[C]]
;
%A = load i32, ptr %X
%B = load i32, ptr %Y
%C = add i32 %A, %B
ret i32 %C
}

define i32 @scalar_avx512_legal512_prefer256_call_avx512_legal256_prefer256(ptr %B) #2 {

```



```

; CHECK-LABEL: define {{[^@]+}}@scalar_avx512_legal512_prefer256_call_avx512_legal256_prefer256
; CHECK-SAME: (ptr [[B:%.*]])
; CHECK-NEXT:  [[A:%.*]] = alloca i32
; CHECK-NEXT:  store i32 1, ptr [[A]]
; CHECK-NEXT:  [[A_VAL:%.*]] = load i32, ptr [[A]]
; CHECK-NEXT:  [[B_VAL:%.*]] = load i32, ptr [[B]]
; CHECK-NEXT:  [[C:%.*]] = call i32
@scalar_callee_avx512_legal512_prefer256_call_avx512_legal256_prefer256(i32 [[A_VAL]], i32 [[B_VAL]])
; CHECK-NEXT:  ret i32 [[C]]
;
%A = alloca i32
store i32 1, ptr %A
%C = call i32 @scalar_callee_avx512_legal512_prefer256_call_avx512_legal256_prefer256(ptr %A, ptr %B)
ret i32 %C
}

; Function Attrs: argmemonly nounwind
declare void @llvm.memset.p0.i64(ptr
nocapture writeonly, i8, i64, i1) #5

attributes #0 = { inlinehint norecurse nounwind uwtable "target-features"="+avx512vl" "min-legal-vector-
width"="512" "prefer-vector-width"="512" }
attributes #1 = { inlinehint norecurse nounwind uwtable "target-features"="+avx512vl" "min-legal-vector-
width"="512" "prefer-vector-width"="256" }
attributes #2 = { inlinehint norecurse nounwind uwtable "target-features"="+avx512vl" "min-legal-vector-
width"="256" "prefer-vector-width"="256" }
attributes #3 = { inlinehint norecurse nounwind uwtable "target-features"="+avx2" "min-legal-vector-width"="512"
"prefer-vector-width"="256" }
attributes #4 = { inlinehint norecurse nounwind uwtable "target-features"="+avx2" "min-legal-vector-width"="256"
"prefer-vector-width"="256" }
attributes #5 = { argmemonly nounwind }
; NOTE: Assertions have been autogenerated by utils/update_llc_test_checks.py
; RUN: llc -mtriple=riscv64 -mattr=+zbc -verify-machineinstrs < %s \
; RUN: -riscv-experimental-rv64-legal-i32 | FileCheck %s -check-prefix=RV64ZBC-ZBKC
; RUN: llc -mtriple=riscv64 -mattr=+zbkc -verify-machineinstrs < %s \
; RUN: -riscv-experimental-rv64-legal-i32 | FileCheck %s -check-prefix=RV64ZBC-ZBKC

declare i64 @llvm.riscv.clmul.i64(i64 %a, i64 %b)

define i64 @clmul64(i64 %a, i64 %b) nounwind {
; RV64ZBC-ZBKC-LABEL: clmul64:
; RV64ZBC-ZBKC:      # %bb.0:
; RV64ZBC-ZBKC-NEXT:  clmul a0, a0, a1
; RV64ZBC-ZBKC-NEXT:  ret
%tmp = call i64 @llvm.riscv.clmul.i64(i64 %a, i64 %b)
ret i64 %tmp
}

```

```
declare i64 @llvm.riscv.clmulh.i64(i64 %a, i64 %b)
```

```
define i64 @clmul64h(i64 %a, i64 %b) nounwind {  
; RV64ZBC-ZBKC-LABEL: clmul64h:  
; RV64ZBC-ZBKC:      # %bb.0:  
; RV64ZBC-ZBKC-NEXT:  clmulh a0, a0, a1  
; RV64ZBC-ZBKC-NEXT:  ret  
  %tmp = call i64 @llvm.riscv.clmulh.i64(i64 %a, i64 %b)  
  ret i64 %tmp  
}
```

```
declare
```

```
i32 @llvm.riscv.clmul.i32(i32 %a, i32 %b)
```

```
define signext i32 @clmul32(i32 signext %a, i32 signext %b) nounwind {  
; RV64ZBC-ZBKC-LABEL: clmul32:  
; RV64ZBC-ZBKC:      # %bb.0:  
; RV64ZBC-ZBKC-NEXT:  clmul a0, a0, a1  
; RV64ZBC-ZBKC-NEXT:  sext.w a0, a0  
; RV64ZBC-ZBKC-NEXT:  ret  
  %tmp = call i32 @llvm.riscv.clmul.i32(i32 %a, i32 %b)  
  ret i32 %tmp  
}
```

```
declare i32 @llvm.riscv.clmulh.i32(i32 %a, i32 %b)
```

```
define signext i32 @clmul32h(i32 signext %a, i32 signext %b) nounwind {  
; RV64ZBC-ZBKC-LABEL: clmul32h:  
; RV64ZBC-ZBKC:      # %bb.0:  
; RV64ZBC-ZBKC-NEXT:  slli a1, a1, 32  
; RV64ZBC-ZBKC-NEXT:  slli a0, a0, 32  
; RV64ZBC-ZBKC-NEXT:  clmulh a0, a0, a1  
; RV64ZBC-ZBKC-NEXT:  srai a0, a0, 32  
; RV64ZBC-ZBKC-NEXT:  ret  
  %tmp = call i32 @llvm.riscv.clmulh.i32(i32 %a, i32 %b)  
  ret i32 %tmp  
}
```

```
; FIXME: We could avoid the slli instructions by using clmul+srai since the  
; inputs are zero extended.
```

```
define signext i32 @clmul32h_zext(i32 zeroext %a, i32 zeroext %b) nounwind {  
;  
  RV64ZBC-ZBKC-LABEL: clmul32h_zext:  
; RV64ZBC-ZBKC:      # %bb.0:  
; RV64ZBC-ZBKC-NEXT:  slli a1, a1, 32  
; RV64ZBC-ZBKC-NEXT:  slli a0, a0, 32  
; RV64ZBC-ZBKC-NEXT:  clmulh a0, a0, a1  
; RV64ZBC-ZBKC-NEXT:  srai a0, a0, 32  
}
```

```

; RV64ZBC-ZBKC-NEXT:  ret
%tmp = call i32 @llvm.riscv.clmulh.i32(i32 %a, i32 %b)
ret i32 %tmp
}
static_library("BSD-Archive") {
  output_name = "lldbPluginObjectContainerBSDArchive"
  configs += [ "//llvm/utils/gn/build:lldb_code" ]
  deps = [
    "//lldb/source/Core",
    "//lldb/source/Host",
    "//lldb/source/Symbol",
    "//llvm/lib/Support",
  ]
  sources = [ "ObjectContainerBSDArchive.cpp" ]
}
; RUN: opt -mtriple=aarch64-linux-gnu -mattr=+sve -passes=sanitize-masked-mem-intrin -S < %s | FileCheck %s

; Testing that masked gathers operating on scalable vectors that are
; packed in SVE registers are not scalarized.

; CHECK-LABEL: @masked_gather_nxv4i32(
; CHECK: call <vscale x 4 x i32> @llvm.masked.gather.nxv4i32
define <vscale x 4 x i32> @masked_gather_nxv4i32(<vscale x 4 x ptr> %ld, <vscale x 4 x i1> %masks, <vscale x 4
x i32> %passthru) {
  %res = call <vscale x 4 x i32> @llvm.masked.gather.nxv4i32(<vscale x 4 x ptr> %ld, i32 0, <vscale x 4 x i1>
  %masks, <vscale x 4 x i32> %passthru)
  ret <vscale x 4 x i32> %res
}

; Testing that masked gathers operating on scalable vectors of FP data
; that is packed in SVE registers are not scalarized.

; CHECK-LABEL: @masked_gather_nxv2f64(
; CHECK: call <vscale x 2 x double> @llvm.masked.gather.nxv2f64
define <vscale x 2 x double> @masked_gather_nxv2f64(<vscale x 2 x ptr> %ld, <vscale x 2 x i1> %masks, <vscale
x 2 x double> %passthru)
{
  %res = call <vscale x 2 x double> @llvm.masked.gather.nxv2f64(<vscale x 2 x ptr> %ld, i32 0, <vscale x 2 x i1>
  %masks, <vscale x 2 x double> %passthru)
  ret <vscale x 2 x double> %res
}

; Testing that masked gathers operating on scalable vectors of FP data
; that is unpacked in SVE registers are not scalarized.

; CHECK-LABEL: @masked_gather_nxv2f16(
; CHECK: call <vscale x 2 x half> @llvm.masked.gather.nxv2f16
define <vscale x 2 x half> @masked_gather_nxv2f16(<vscale x 2 x ptr> %ld, <vscale x 2 x i1> %masks, <vscale x

```

```

2 x half> %passthru) {
    %res = call <vscale x 2 x half> @llvm.masked.gather.nxv2f16(<vscale x 2 x ptr> %ld, i32 0, <vscale x 2 x i1>
    %masks, <vscale x 2 x half> %passthru)
    ret <vscale x 2 x half> %res
}

; Testing that masked gathers operating on 64-bit fixed vectors are
; scalarized because NEON doesn't have support for masked gather
; instructions.

; CHECK-LABEL: @masked_gather_v2f32(
; CHECK-NOT: @llvm.masked.gather.v2f32(
define <2 x float> @masked_gather_v2f32(<2
x ptr> %ld, <2 x i1> %masks, <2 x float> %passthru) {
    %res = call <2 x float> @llvm.masked.gather.v2f32(<2 x ptr> %ld, i32 0, <2 x i1> %masks, <2 x float> %passthru)
    ret <2 x float> %res
}

; Testing that masked gathers operating on 128-bit fixed vectors are
; scalarized because NEON doesn't have support for masked gather
; instructions and because we are not targeting fixed width SVE.

; CHECK-LABEL: @masked_gather_v4i32(
; CHECK-NOT: @llvm.masked.gather.v4i32(
define <4 x i32> @masked_gather_v4i32(<4 x ptr> %ld, <4 x i1> %masks, <4 x i32> %passthru) {
    %res = call <4 x i32> @llvm.masked.gather.v4i32(<4 x ptr> %ld, i32 0, <4 x i1> %masks, <4 x i32> %passthru)
    ret <4 x i32> %res
}

declare <vscale x 4 x i32> @llvm.masked.gather.nxv4i32(<vscale x 4 x ptr> %ptrs, i32 %align, <vscale x 4 x i1>
    %masks, <vscale x 4 x i32> %passthru)
declare <vscale x 2 x double> @llvm.masked.gather.nxv2f64(<vscale x 2 x ptr> %ptrs, i32 %align, <vscale x 2 x
    i1> %masks, <vscale x 2 x double>
    %passthru)
declare <vscale x 2 x half> @llvm.masked.gather.nxv2f16(<vscale x 2 x ptr> %ptrs, i32 %align, <vscale x 2 x i1>
    %masks, <vscale x 2 x half> %passthru)
declare <2 x float> @llvm.masked.gather.v2f32(<2 x ptr> %ptrs, i32 %align, <2 x i1> %masks, <2 x float>
    %passthru)
declare <4 x i32> @llvm.masked.gather.v4i32(<4 x ptr> %ptrs, i32 %align, <4 x i1> %masks, <4 x i32> %passthru)

```

## 1.226 keyutils 1.6.3-r4

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Version 2, June 1991

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```
{
"testfiles": [
"test/*.uts",
"test/scapy/layers/*.uts",
"test/contrib/automotive/*.uts",
"test/contrib/automotive/obd/*.uts",
"test/contrib/automotive/scanner/*.uts",
"test/contrib/automotive/gm/*.uts",
"test/contrib/automotive/bmw/*.uts",
```

```

    "test/contrib/automotive/xcp/*.uts",
    "test/contrib/automotive/autosar/*.uts",
    "test/contrib/*.uts"
  ],
  "remove_testfiles": [
    "test/linux.uts",
    "test/windows.uts",
    "test/contrib/automotive/ecu_am.uts",
    "test/contrib/automotive/gm/gmlanutils.uts",
    "test/contrib/isotp_packet.uts",
    "test/contrib/isotpscan.uts",
    "test/contrib/isotp_soft_socket.uts"
  ],
  "onlyfailed": true,
  "preexec": {
    "test/contrib/*.uts": "load_contrib(\"%name%\")",
    "test/cert.uts": "load_layer(\"tls\")",
    "test/ssl2.uts": "load_layer(\"tls\")",
    "test/tls*.uts": "load_layer(\"tls\")"
  },
  "kw_ko": [
    "linux",
    "windows",
    "ipv6",
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    "tun",
    "tap"
  ]
}

```

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## 1.239 alpine-baselayout 3.6.8-r1

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These requirements apply to the modified work as a whole. If identifiable sections of that work are not derived from the Library, and can be reasonably considered independent and separate works in themselves,

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If distribution of object code is made by offering access to copy from a designated place, then offering equivalent access to copy the source code from the same place satisfies the requirement to distribute the source code, even though third parties are not compelled to copy the source along with the object code.

5. A program that contains no derivative of any portion of the Library, but is designed to work with the Library by being compiled or linked with it, is called a "work that uses the Library". Such a work, in isolation, is not a derivative work of the Library, and therefore falls outside the scope of this License.

However, linking a "work that uses the Library" with the Library creates an executable that is a derivative of the Library (because it contains portions of the Library), rather than a "work that uses the library". The executable is therefore covered by this License.

Section 6 states terms for distribution of such executables.

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If such an object file uses only numerical parameters, data structure layouts and accessors, and small macros and small inline functions (ten lines or less in length), then the use of the object file is unrestricted, regardless of whether it is legally a derivative work. (Executables containing this object code plus portions of the Library will still fall under Section 6.)

Otherwise, if the work is a derivative of the Library, you may distribute the object code for the work under the terms of Section 6.

Any

executables containing that work also fall under Section 6, whether or not they are linked directly with the Library itself.

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changes were used in the work (which must be distributed under Sections 1 and 2 above); and, if the work is an executable linked with the Library, with the complete machine-readable "work that uses the Library", as object code and/or source code, so that the user can modify the Library and then relink to produce a modified executable containing the modified Library. (It is understood that the user who changes the contents of definitions files in the Library will not necessarily be able to recompile the application to use the modified definitions.)

b) Use a suitable shared library mechanism for linking with the Library. A suitable mechanism is one that (1) uses at run time a copy of the library already present on the user's computer system, rather than copying library functions into the executable, and (2) will operate properly with a modified version of the library, if the

user installs one, as long as the modified version is interface-compatible with the version that the work was made with.

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d) If distribution of the work is made by offering access to copy from a designated place, offer equivalent access to copy the above specified materials from the same place.

e) Verify that the user has already received a copy of these materials or that you have already sent this user a copy.

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The reason we have a separate public license for some libraries is that they blur the distinction we usually make between modifying or adding to a program and simply using it. Linking a program with a library, without changing the library, is in some sense simply using the library, and is analogous to running a utility program or application program. However, in a textual and legal sense, the linked executable is a combined work, a derivative of the original library, and the ordinary General Public License

treats it as such.

Because

of this blurred distinction, using the ordinary General Public License for libraries did not effectively promote software sharing, because most developers did not use the libraries. We concluded that weaker conditions might promote sharing better.

However, unrestricted linking of non-free programs would deprive the users of those programs of all benefit from the free status of the libraries themselves. This Library General Public License is intended to permit developers of non-free programs to use free libraries, while preserving your freedom as a user of such programs to change the free libraries that are incorporated in them. (We have not seen how to achieve this as regards changes in header files, but we have achieved it as regards changes in the actual functions of the Library.) The hope is that this will lead to faster development of free libraries.

The precise terms and conditions for copying, distribution and modification follow. Pay close attention to the difference between a "work based on the library" and a "work that uses the library". The former contains code derived from the library, while the latter only works together with the library.

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table, the facility still operates, and performs whatever part of its purpose remains meaningful.

(For example, a function in a library to compute square roots has a purpose that is entirely well-defined independent of the application. Therefore, Subsection 2d requires that any application-supplied function or table used by this function must be optional: if the application does not supply it, the square root function must still compute square roots.)

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Version 3, 29 June 2007

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@c man begin SEEALSO

gfdl(7), fsf-funding(7).

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```
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```

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---

tools/shhopt.c, tools/shhopt.h:

Title: shhopt - library for parsing command line options.

Version: 1.1.2

Entered-date: 23MAR97

Description: C-functions for parsing command line options, both  
              traditional one-character options, and GNU'ish  
              --long-options.

Keywords: programming, library, lib, commandline, options

Author: s.h.huseby@usit.uio.no (Sverre H. Huseby)  
Primary-site: <http://www.ifi.uio.no/~sverrehu/pub-unix/>  
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---

## 1.244 wireshark 4.4.2-r0

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Installing Wireshark on FreeBSD/OpenBSD/NetBSD/DragonFly BSD

---

1. Berkeley Packet Filter (BPF) requirement
2. Running Wireshark as a non-root user

For general installation instructions, see the INSTALL file, along with the Developer's Guide located at <https://www.wireshark.org/docs/> and in the doc/ directory. Additional BSD specific notes and requirements follow.

1. Berkeley Packet Filter (BPF) requirement
- 

In order to capture packets (with Wireshark/TShark, tcpdump, or any other packet capture program) on a BSD system, your kernel must have the Berkeley Packet Filter mechanism enabled. The default kernel configurations in recent versions of BSD systems have this enabled already. To verify the bpf device is present, look in the /dev directory:

```
ls -l /dev/bpf*
```

You should see one or more bpf devices listed similar to this:

```
crw----- 1 root wheel  
0, 90 Aug 10 21:05 /dev/bpf0  
crw----- 1 root wheel 0, 91 Aug 10 21:05 /dev/bpf1
```

Packet-capturing programs will pick the first bpf device that's not in use. Recent versions of most BSDs will create bpf devices as needed, so you don't have to configure the number of devices that will be

available.

## 2. Running wireshark as a non-root user

-----

Since the bpf devices are read-only by the owner (root), you normally have to run packet capturing programs such as Wireshark as root. It is safer to run programs as a non-root user if possible. To run Wireshark as a non-root user, you must change the permissions on the bpf device(s). If you are the only user that needs to use Wireshark, the easiest way is to change the owner of each bpf device to your username. You can also add the read/write ability to the group (typically wheel) and add users that need to use Wireshark to the wheel group. Check your operating system's documentation on how to make permanent these changes as they are often reset upon reboot; if /dev is implemented with devfs, it might be possible to configure devfs to create all bpf devices owned by a particular user and/or group and with particular permissions. In FreeBSD 6.0 and later this can be done by creating an /etc/devfs.rules file with content such as

```
[localrules=10]
add path 'bpf*' {mode and permissions}
```

where "mode and permissions" can include clauses such as

```
mode {octal permissions}
```

to set the permissions on the device (e.g., "mode 0660" to set the permissions to rw-rw-r--),

```
user {user}
```

to set the user who owns the device, or

```
group {group}
```

to set the group that owns the device and adding a line such as

```
devfs_system_ruleset=localrules
```

to /etc/rc.conf. For example, an /etc/devfs.rules file with

```
[localrules=10]
add path 'bpf*' mode 0660 group wheel
```

will grant read and write permissions on all BPF devices to all users in the "wheel" group.

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# 1.246 zsh 5.9-r4

## 1.246.1 Available under license :

```
#autoload

# Options:
#
# -0      include jid 0 as a match for the host system
# -o param jail parameter to complete instead of jid -
#         e.g. name, path, ip4.addr, host.hostname

local addhost host param desc=1
local -a jails args expl
zparseopts -D -K -E 0=addhost o:=param
param=${param[2]:-name}

jails=( ${$(f) "$(_call_program jails jls $param name)"/ /:} )
case $param in
  jid) host=0 ;;
  name)
    host=0
    desc=0
    ;;
  path)
    host=/
    args=( -M 'r:|/=* r:|=*' )
    ;;
  ip4.addr) args=( -M 'r:|.=* r:|=*' ) ;;
esac
[[ -n $addhost && -n $host ]] && jails+=( "$host:$HOST" )

if (( desc )); then
  _describe -t jails jail jails "$@" "$args[@]"
else
  _wanted jails expl jail compadd "$@" "$args[@]" - ${jails%:*}
fi
#autoload
#
# device types on FreeBSD/DragonFly
# (for commands using devstat_buildmatch(), such as iostat and vmstat)
#
local -a d i types
```

```

d=( da sa printer proc worm cd scanner optical changer
  comm array enclosure floppy)
i=( IDE SCSI other )
types=(
  "($d)da[direct access devices]"
  "($d)sa[sequential access devices]"
  "($d)printer[printers]"
  "($d)proc[processor devices]"
  "($d)worm[write once read multiple devices]"
  "($d)cd[CD devices]"
  "($d)scanner[scanner devices]"
  "($d)optical[optical memory devices]"
  "($d)changer[medium changer devices]"
  "($d)comm[communication devices]"
  "($d)array[storage array devices]"
  "($d)enclosure[enclosure services devices]"
  "($d)floppy[floppy devices]"
  "($i)IDE[Integrated Drive Electronics devices]"
  "($i)SCSI[Small Computer System Interface devices]"
  "($i)other[any other device interface]"
  'pass[passthrough devices]'
)

_values -s , 'device type' $types
#autoload

local points=(
  'c[trace system calls]'
  'i[trace I/O]'
  'n[trace namei translations]'
  's[trace signal processing]'
  'u[trace user data]'
  '+[trace the default points]'
)

case $OSTYPE in
dragonfly*|freebsd*|netbsd*)
  points+=(
    'w[context switches]'
  )
  ;|
freebsd*|openbsd*)
  points+=(
    't[trace various structures]'
  )
  ;|
freebsd*)
  points+=(

```

```

'f[trace page faults]'
'p[trace capability check failures]'
'y[trace sysctl(3) requests]'
)
;;
netbsd*)
points+=(
'A[trace all tracepoints]'
'a[trace exec arguments]'
'e[trace emulation changes]'
'f[trace open file descriptors after exec]'
'S[trace MIB access (sysctl)]'
'v[trace exec environment]'
'-[do not trace following trace points]'
)
;;
openbsd*)
points+=(
'p[trace violation of pledge(2) restrictions]'
'x[trace argument vector in execve(2)]'
'X[trace environment in execve(2)]'
)
;;
esac

_values -s " 'ktrace point' $points
#autoload

local expl

_description architectures expl 'architecture'
compadd "$@" "$expl[@]" amd64 arm arm64 i386 mips powerpc riscv sparc64
#autoload

local expl

_description routing-domains expl 'routing domain'
compadd "$@" "$expl[@]" - ${$(M)$((f))$_call_program routing-domains netstat -R)}:#Rdomain *}#Rdomain
}
#autoload

# Provides completion for file flags (formerly part of _chflags)

local curcontext=$curcontext su=$(( ! EUID || $_comp_priv_prefix ))
local -a context line state state_descr copts=( "${@}" ) flags flag_descs
local -A val_args

flag_descs+=(

```



```

nodump nodump
uappnd 'user append-only'
uchg 'user immutable'
)

if (( su )); then
flag_descs+=(
    arch archived
    sappnd 'system append-only'
    schg 'system immutable'
)
fi

if [[ $OSTYPE = (darwin|dragonfly|freebsd|netbsd)* ]]; then
flag_descs+=(opaque opaque)

if [[ $OSTYPE = darwin* ]]; then
    flag_descs+=(hidden hidden)
fi

if [[ $OSTYPE = (dragonfly|freebsd)* ]]; then
    flag_descs+=(uunlnk 'user undeletable')

    (( su )) &&
    flag_descs+=(sunlnk 'system undeletable')
fi

if [[ $OSTYPE = dragonfly* ]]; then
    flag_descs+=(
        cache cache
        nouhistory 'user nohistory'
    )

    (( su )) && flag_descs+=(
        noscache noscache
        noshistory 'system nohistory'
    )
fi

[[ $OSTYPE =
freebsd* ]] && flag_descs+=(
    uarch archive
    uhidden hidden
    uoffline offline
    urdonly 'DOS, Windows and CIFS readonly'
    ureparse 'Windows reparse point'
    usparse 'sparse file'
    usystem 'DOS, Windows and CIFS system'

```

```

)
fi

for 1 2 in $flag_descs; do
if [[ $1 = no* ]]; then
    flags+="$({1#no})$1[set the $2 flag]"
    "$1$({1#no})[unset the $2 flag]"
else
    flags+="(no$1)$1[set the $2 flag]"
    "$1no$1[unset the $2 flag]"
fi
done

_values -O copts -s , 'file flags' $flags
#autoload
# disk device names on BSDs
local -a disks

case $OSTYPE in
freebsd*)
    disks=( ${$(M){(f)"$(geom disk list)"\:#Geom name\:.*}#\*: } )
    ;;
dragonfly*)
    disks=( $(sysctl -n kern.disks) )
    ;;
openbsd*)
    disks=( ${$(s,.)"$(sysctl -n hw.disknames)"%\:.*} )
    ;;
netbsd*)
    disks=( $(sysctl -n hw.disknames) )
    ;;
esac

if (( $#disks )); then
local expl
    _wanted disk-devices expl 'disk device' compadd "$@" $disks
return
fi

```

return 1

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#### ZSH CONTRIBUTORS

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This file credits only the major contributors to the current release. See the ChangeLog files for a complete list of people who have submitted patches. Note that email addresses below and in the ChangeLog file are included for disambiguation purposes only, and are not guaranteed to be currently accurate. If you feel that you or someone else have been unfairly omitted from this list please mail the list <zsh-workers@zsh.org>.

Version 4.3

-----

Contributors to the main shell include Clint Adams, Rocky Bernstein, Andrey Borzenkov, Dan Bullok, Marc Chantreux, Thorsten Dahlheimer, Wayne Davison, Lionel Flandrin, Michael Hwang, Oliver Kiddle, Greg Klanderman, Matthias Kopferman, Mikael Magnusson, Dan Nelson, Phil Pennock, Toby Peterson, R. Ramkumar, Franois Revol, Bart Schaefer, Tom Smetana, Joerg Sonnenberger, Peter Stephenson, Jon Strait, Takimoto Jun, River Tarnell, Frank Terbeck, Philippe Troin, Geoff Wing, Matt Wozniski.

The VCS\_Info function system was written by Frank Terbeck with contributions from Julien Langer.

Contributors to documentation and to completion and other shell functions include those above plus Nuno Alexandre, Ralph Amissah, Micah Anderson, arno, Frank Benkstein, Jay Berkenbilt, Frank Blendinger, Zack Cerza, Brendan Cully, Baptiste Daroussin, Danek Duvall, Ryan F, Sean Finney, Daniel Friesel, Alexey I. Froloff, Tobias Gruetzmacher, Pierre Habouzit, Richard Hartmann, Benjamin R. Haskell, Ag. D. Hatzimanikas, Pete Hollobon, Erik Johansson, Kohsuke Kawaguchi, Dough Kearns, Hannu Koivisto, Henryk Konsek, Chris Lamb, Vincent Lefevre, Roger Leigh, Eric Mangold, Max Mikhanosha, Arkadiusz Miskiewicz, Matthieu Moy, Scott Murray, Alexander Myodov, tpm Nmec, Kalle Olavi Niemitalo, Kazuhiro NISHIYAMA, Omari Norman, Mustafa Oezkan, Tomasz Pala, Peter Palfrader, Carlos Phillips, Daniel Qarras, Jean-Baptiste Quenot, David Riebenbauer, Haakon Riiser, Ingo Rohlfs, Felix Rosencrantz, Simon Ruderich, Stephen Rger, William Scott, Kris Shannon, Jrg Sommer, Travis Spencer, Vincent Steman, Mrten Svantesson, Evgenii Terechkov, Magnus Therning, Bernhard Tittelbach, Ingmar Vanhassel, Markus Waldeck, Motoi Washida, Nikolai Weibull, Jesse Weinstein.

Version 4.2

-----

The contributor list is similar to that for 4.1.1.

Version 4.1.1

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Chmouel Boudjnah <chmouel@mandrakesoft.com>: Linux completion support

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Tanaka Akira <akr@zsh.org>: completion functions

Philippe Troin <phil@fifi.org>: signals, process groups.

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Sven Wischnowsky <wischnow@zsh.org>: internal completion mechanism and low-level functions, line editor internals, syntax, wordcode mechanism,

Version 4.0.1

-----

Clint Adams <schizo@debian.org>: Completion functions, general configuration and module issues.

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Wayne Davison <wayned@users.sourceforge.net>: History code.

Alexandre Duret-Lutz: completion functions and substitution code.

Oliver Kiddle <opk@zsh.org>: Modules and completion functions, AIX support.

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Bart Schaefer <schaefer@zsh.org>: bits of everything in all parts of code;  
general sanity control.

Adam Spiers <adam@spiers.net>: Completion and other functions, completion  
caching.

Peter Stephenson <pws@zsh.org>: configuration and installation, parameters,  
completion functions and configuration.

Tanaka Akira <akr@zsh.org>: Completion and test functions.

Geoff Wing <gcw@zsh.org>: FTP and mailing list archive

Sven Wischnowsky <wischnow@zsh.org>:

Most of the completion code, zpty,  
signal queueing, parameters, builtins, builtouts, built-here-and-theres;  
mend garden shed, rewire electricity, reinstall shutters, fix TV aerial in  
howling gale...

Other patches from E. Jay Birkenbilt, Jan Fedak, Ulrik Haugen, Paul  
Johnson, Fr. Br. George (George V Kouryachy).

Versions 3.1.7 to 3.1.9

-----

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\* Chmouel Boudjnah <chmouel@mandrakesoft.com>: design, testing and patches  
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\* Wayne Davison <wayne@clari.net>: History code

\* Alexandre Duret-Lutz <duret\_g@epita.fr>: design, testing and patches for

completion system, documentation, various other fixes

\* Oliver Kiddle <opk@zsh.org>: AIX dynamic library support, various completion functions, web page maintenance, documentation fixes

\* Andrew Main <zefram@zsh.org>: configuration and module/DLL code, IPv6 support, various other bits

\* Felix Rosencrantz <f\_rosencrantz@yahoo.com>: design, testing and patches for completion system, documentation, various other fixes

\* Bart Schaefer <schaefer@zsh.org>: documentation and many other bits, archive maintenance

\* Adam Spiers <adam@spiers.net>: various completion functions, source code archive maintenance, documentation fixes, prompt themes

\* Peter Stephenson <pws@zsh.org>: pattern matching code rewrite and enhancements, typeset and local variables, zftp maintenance, general configuration, floating point support

\* Tanaka Akira <akr@zsh.org>: CVS archive, numerous completion functions for common commands, regex shell function state machine

\* Geoff Wing <gcw@zsh.org>: mailing list and FTP archive, various other bits

\* Sven Wischnowsky <wischnow@zsh.org>: almost all completion code including all comp\* libraries, all core functions in completion function system; styles; job control code; rewrite of internal shell code structures and parsing and execution code to use word code; parameter code; repair roof, fix guttering, put up shelves in study, recarpet hall, ...

Other patches were submitted by Will Day, Irving Wolfe, John Williams, Vin Shelton, Akim Demaille, Helmut Jarausch, Gene Cohler, Johan Sundstrm.

Version 3.1.6

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\* Sven Wischnowsky <wischnow@informatik.hu-berlin.de>: completion code, major rewrite and enhancements, including matching control, completion widgets and function system, complist module; zle code additions; job control code changes; parameters code changes; parameter module; additional autoloading code; general code changes for extra efficiency; subscripting and ordering of globbing lists.

\* Peter Stephenson <pws@zsh.org>: zftp and mapfile modules and zf\* functions; local parameters and typeset changes; changes in autoconf system; case-independent and approximate pattern matching; various options; a few completion modules; some zle changes; FAQ.

\* Bart Schaefer <schaefer@zsh.org>: associative array implementation; other parameter changes; keeping track of missing patches; function autoloading changes.

\* Wayne Davison <wayne@clari.net>: History code novelties and improvements with new options.

\* Geoff Wing <gcw@zsh.org>: Zle display code fixes, mailing list and patch archive.

\* Zoltn Hidvgy <hzoli@cs.elte.hu>: AIX dynamic loading code.

\* Matt Armstrong: cygwin configuration changes.

Other improvements, bug fixes and design suggestions from all the above plus Andrej Borsenkow, Oliver Kiddle, Tanaka Akira, Naoki Wakamatsu, Tatuso Furukawa, Ville Herva, Will Day, Lehti Rahmi, Larry P. Schrof, Helmut Jarausch, Phil Pennock, Wilfredo Sanchez, Bruce Stephens, Gene Cohler, Ollivier Robert, Felix Rosencrantz.

Previous versions of zsh 3 were maintained by Zoltn Hidvgy and Andrew Main (Zefram).

Version 3.0

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\*

Richard Coleman <coleman@math.gatech.edu> maintained the code till the release of zsh-2.6-beta16. Converted zsh to use autoconf thus greatly improving the portability. Rewrote signal handling code. Reorganized internal hash tables and rewrote the related builtins (enable, disable, hash, unhash). Made some cleanups in exec.c.

\* Zoltn Hidvgy <hzoli@cs.elte.hu> maintained zsh from version 2.6-beta16. Rewrote most of the lexer and substitution and the related completion code. Improved sh/ksh/POSIX compatibility. Fixed lots of bugs in completion, parameter and history code. Made zsh fully 8-bit clean. Made some reorganizations in exec.c. Fixed signal handling bugs. Fixed lots of bugs in various places.

\* Peter W. Stephenson <pws@zsh.org> the maintainer of the zsh FAQ. Reorganizations in exec.c. Rewrote and reorganized the history code.



Rewrote the zshcompctl manual page. Fixed several bugs related to programmable completion. Fixed several signal handling bugs. Rewrote test and read builtins. Lots of other bugfixes.

\* Andrew Main (Zefram) <zefram@zsh.org> reorganized builtin.c. Rewrote large parts of the zle vi mode. Redirection fixes. Reorganized parts of the completion code, added some enhancements and fixed lots of bugs. Made zle fully 8-bit clean. Fixed several zle bugs. Reorganized zsh option handling. Lots of other bugfixes.

\* Sven Wischnowsky <wischnow@informatik.hu-berlin.de> wrote most of the programmable completion code in zsh-2.5.0. Several bugfixes in exec.c and jobs.c. Lots of completion bugfixes and enhancements.

\* Geoff Wing <gcw@zsh.org> rewrote most of zle\_refresh.c. Some other bugfixes.

\* Clive Messer <clive@epos.demon.co.uk> brought the texinfo documentation up-to-date.

\* Mark Borges <mdb@cdc.noaa.gov> contributed several documentation fixes including further texinfo documentation updates and maintained the zsh web pages during their tenure at www.mal.com.

\* Wayne Davison <wayne@clari.net> improved the zle search functions and made them 8-bit clean. Some other little bugfixes.

\* Bart Schaefer <schaefer@zsh.org> submitted several bugfixes, reported lots of bugs and gave many very useful suggestions.

Version 2.5

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Bas de Bakker maintained zsh till the release of zsh-2.5.0. People who have contributed to zsh-2.5.0 are (in lexical order):

Chris.Moore@src.bae.co.uk (Chris Moore)  
Harald.Eikrem@delab.sintef.no  
Irving\_Wolfe@happy-man.com (Irving Wolfe)  
Jarkko.Hietaniemi@hut.fi (Jarkko Hietaniemi)  
P.Stephenson@swansea.ac.uk (Peter Stephenson)  
Richard.Sharman@software.mitel.com (Richard Sharman)  
Tero\_Kivinen@hut.FI (Tero Kivinen)  
arf@maths.nott.ac.uk (Anthony Iano-Fletcher)  
bas@phys.uva.nl (Bas de Bakker)  
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carlos@snfep1.if.usp.br (Carlos Carvalho)  
cedman@capitalist.princeton.edu (Carl Edman)  
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(Hannu Strang)  
coleman@math.gatech.edu (Richard Coleman)  
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dm@cs.brown.edu (Dimitris Michailidis)  
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(Paul Maisano)  
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schaefer@z-code.com (Bart Schaefer)  
schlangm@informatik.uni-muenchen.de (Harald Schlangmann)  
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tsm@cs.brown.edu (Timothy Miller)  
vogelke@c17mis.wpafb.af.mil (Karl E. Vogel)  
wacker@physik.uni-dortmund.de (Klaus Wacker)  
wacren@cis10.ens-cachan.fr (Laurent Wacrenier)

```
#autoload
```

```
local expl
```

```
_description architectures expl 'architecture'
```

```
compadd "$@" "$expl[@]" alpha amd64 arm64 armv7 hppa i386 landisk loongson luna88k macppc octeon sparc64
```

```
#autoload
```

```
local expl
```

```
_description architectures expl 'architecture'
```

```
compadd "$@" "$expl[@]" amd64 evbarm evbmips evbppc hpcarm i386 sparc64 xen \  
acorn32 algor alpha amiga amigappc arc atari bebox cats cesfic cobalt dreamcast \  
emips epoc32 evbsh3 ews4800mips hp300 hppa hpcmips hpcsh ia64 ibmnws iyonix \  
landisk luna68k mac68k macppc mipsco mmeye mvme68k mvmeppc netwinder news68k \  
newsmips next68k ofppc pmax prep rs6000 sandpoint sbmips sgimips shark sparc \  
sun2 sun3 vax x68k zaurus
```

```
#autoload
```

```
local expl
```

```
_description routing-tables expl 'routing table'
```

```
compadd "$@" "$expl[@]" - "${(s: )$${(M)$${(f)"$_call_program routing-tables netstat -R")}:# Routing tables#:  
*}#*: } }
```

```
#autoload
```

```
local expl login_classes
```

```
login_classes=("${(M)$${(f)"$(</etc/login.conf)"}:#[^#:blank:]]*}%%[:]*}")  
if [[ $OSTYPE = openbsd* ]]; then  
    login_classes+=("/etc/login.conf.d/*(N:t))  
fi
```

```
_description login-classes expl 'login class'
```

```
compadd "$@" "$expl[@]" - $login_classes
```

## 1.247 busybox 1.37.0-r12

### 1.247.1 Available under license :

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jseward@bzip.org

bzip2/libbzip2 version 1.0.4 of 20 December 2006

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Julian Seward, Cambridge, UK.

[jseward@bzip.org](mailto:jseward@bzip.org)

bzip2/libbzip2 version 1.0.4 of 20 December 2006

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### A. HISTORY OF THE SOFTWARE

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Python was created in the early 1990s by Guido van Rossum at Stichting Mathematisch Centrum (CWI, see <http://www.cwi.nl>) in the Netherlands as a successor of a language called ABC. Guido remains Python's principal author, although it includes many contributions from others.

In 1995, Guido continued his work on Python at the Corporation for National Research Initiatives (CNRI, see <http://www.cnri.reston.va.us>) in Reston, Virginia where he released several versions of the software.

In May 2000, Guido and the Python core development team moved to BeOpen.com to form the BeOpen PythonLabs team. In October of the same year, the PythonLabs team moved to Digital Creations (now Zope Corporation, see <http://www.zope.com>). In 2001, the Python Software Foundation (PSF, see <http://www.python.org/psf/>) was formed, a non-profit organization created specifically to own Python-related Intellectual Property. Zope Corporation is a sponsoring member of the PSF.

All Python releases are Open Source (see <http://www.opensource.org> for the Open Source Definition). Historically, most, but not all, Python releases have also been GPL-compatible; the table below summarizes the various releases.

| Release        | Derived from | Year      | Owner      | GPL-compatible? (1) |
|----------------|--------------|-----------|------------|---------------------|
| 0.9.0 thru 1.2 |              | 1991-1995 | CWI        | yes                 |
| 1.3 thru 1.5.2 | 1.2          | 1995-1999 | CNRI       | yes                 |
| 1.6            | 1.5.2        | 2000      | CNRI       | no                  |
| 2.0            | 1.6          | 2000      | BeOpen.com | no                  |
| 1.6.1          | 1.6          | 2001      | CNRI       | yes (2)             |
| 2.1            | 2.0+1.6.1    | 2001      | PSF        | no                  |
| 2.0.1          | 2.0+1.6.1    | 2001      | PSF        | yes                 |
| 2.1.1          | 2.1+2.0.1    | 2001      | PSF        | yes                 |
| 2.2            | 2.1.1        | 2001      | PSF        | yes                 |
| 2.1.2          | 2.1.1        | 2002      | PSF        | yes                 |
| 2.1.3          |              |           |            |                     |

|       |       |           |     |     |
|-------|-------|-----------|-----|-----|
| 2.1.2 | 2002  | PSF       | yes |     |
| 2.2.1 | 2.2   | 2002      | PSF | yes |
| 2.2.2 | 2.2.1 | 2002      | PSF | yes |
| 2.2.3 | 2.2.2 | 2003      | PSF | yes |
| 2.3   | 2.2.2 | 2002-2003 | PSF | yes |
| 2.3.1 | 2.3   | 2002-2003 | PSF | yes |
| 2.3.2 | 2.3.1 | 2002-2003 | PSF | yes |
| 2.3.3 | 2.3.2 | 2002-2003 | PSF | yes |
| 2.3.4 | 2.3.3 | 2004      | PSF | yes |
| 2.3.5 | 2.3.4 | 2005      | PSF | yes |
| 2.4   | 2.3   | 2004      | PSF | yes |
| 2.4.1 | 2.4   | 2005      | PSF | yes |
| 2.4.2 | 2.4.1 | 2005      | PSF | yes |
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| 2.4.4 | 2.4.3 | 2006      | PSF | yes |
| 2.5   | 2.4   | 2006      | PSF | yes |
| 2.5.1 | 2.5   | 2007      | PSF | yes |
| 2.5.2 | 2.5.1 | 2008      | PSF | yes |
| 2.5.3 | 2.5.2 | 2008      | PSF | yes |
| 2.6   | 2.5   | 2008      | PSF | yes |
| 2.6.1 | 2.6   | 2008      | PSF | yes |
| 2.6.2 | 2.6.1 | 2009      | PSF | yes |
| 2.6.3 | 2.6.2 | 2009      | PSF | yes |
| 2.6.4 | 2.6.3 | 2009      | PSF | yes |
| 2.6.5 | 2.6.4 | 2010      | PSF | yes |
| 3.0   | 2.6   | 2008      | PSF | yes |
| 3.0.1 | 3.0   | 2009      | PSF | yes |
| 3.1   | 3.0.1 | 2009      | PSF | yes |
| 3.1.1 | 3.1   | 2009      | PSF | yes |
| 3.1.2 | 3.1   | 2010      | PSF | yes |
| 3.2   | 3.1   | 2010      | PSF | yes |

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Distutils2 Contributors

=====

The Distutils2 project was started by Tarek Ziad and is currently maintained by ric Araujo. Many people have contributed to the project.

distlib has started off using some of the code from distutil2.

If you're making a patch, please add your name below in alphabetical order, and welcome into the Fellowship of the Packaging!

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cause the whole of the work to be licensed at no charge to all third parties under the terms of this License.

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If a facility in the modified Library refers to a function or a table of data to be supplied by an application program that uses the facility, other than as an argument passed when the facility is invoked, then you must make a good faith effort to ensure that, in the event an application does not supply such function or table, the facility still operates, and performs whatever part of its purpose remains meaningful.

(For example, a function in a library to compute square roots has a purpose that is entirely well-defined independent of the application. Therefore, Subsection 2d requires that any application-supplied function or table used by this function must be optional: if the application does not supply it, the square root function must still compute square roots.)

@end enumerate

These requirements apply to the modified work as a whole. If identifiable sections of that work are not derived from the Library, and can be reasonably considered independent and separate works in themselves, then this License, and its terms, do not apply to those sections when you distribute them as separate works. But when you distribute the same sections as part of a whole which is a work based on the Library, the distribution of the whole must be on the terms of this License, whose permissions for other licensees extend to the entire whole, and thus to each and every part regardless of who wrote it.

Thus, it is not the intent of this section to claim rights or contest your rights to work written entirely by you; rather, the intent is to exercise the right to control the distribution of derivative or collective works based on the Library.

In addition, mere aggregation of another work not based on the Library with the Library (or with a work based on the Library) on a volume of a storage or distribution medium does not bring the other work under the scope of this License.

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This option is useful when you wish to copy part of the code of the Library into a program that is not a library.

@item

You may copy and distribute the Library (or a portion or derivative of it, under Section 2) in object code or executable form under the terms of Sections 1 and 2 above provided that you accompany it with the complete corresponding machine-readable source code, which must be distributed under the terms of Sections 1 and 2 above on a medium customarily used for software interchange.

If distribution of object code is made by offering access to copy from a designated place, then offering equivalent access to copy the source code from the same place satisfies the requirement to distribute the source code, even though third parties are not compelled to copy the source along with the object code.

@item

A program that contains no derivative of any portion of the Library, but is designed to work with the Library by being compiled or linked with it, is called a ``work that uses the Library''. Such a work, in isolation, is not a derivative work of the Library, and therefore falls outside the scope of this License.

However, linking a ``work that uses the Library'' with the Library creates an executable that is a derivative of the Library (because it contains portions of the Library), rather than a ``work that uses the library''. The executable is therefore covered by this License. Section 6 states terms for distribution of such executables.

When a ``work that uses the Library'' uses material from a header file that is part of the Library, the object code for the work may be a derivative work of the Library even though the source code is not.



Whether this is true is especially significant if the work can be linked without the Library, or if the work is itself a library. The threshold for this to be true is not precisely defined by law.

If such an object file uses only numerical parameters, data structure layouts and accessors, and small macros and small inline functions (ten lines or less in length), then the use of the object file is unrestricted, regardless of whether it is legally a derivative work. (Executables containing this object code plus portions of the Library will still fall under Section 6.)

Otherwise,  
if the work is a derivative of the Library, you may distribute the object code for the work under the terms of Section 6. Any executables containing that work also fall under Section 6, whether or not they are linked directly with the Library itself.

#### @item

As an exception to the Sections above, you may also combine or link a ``work that uses the Library" with the Library to produce a work containing portions of the Library, and distribute that work under terms of your choice, provided that the terms permit modification of the work for the customer's own use and reverse engineering for debugging such modifications.

You must give prominent notice with each copy of the work that the Library is used in it and that the Library and its use are covered by this License. You must supply a copy of this License. If the work during execution displays copyright notices, you must include the copyright notice for the Library among them, as well as a reference directing the user to the copy of this License. Also, you must do one of these things:

#### @enumerate a

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Accompany the work with the complete corresponding machine-readable source code for the Library including whatever changes were used in the work (which must be distributed under Sections 1 and 2 above); and, if the work is an executable linked with the Library, with the complete machine-readable ``work that uses the Library", as object code and/or source code, so that the user can modify the Library and then relink to produce a modified executable containing the modified Library. (It is understood that the user who changes the contents of definitions files in the Library will not necessarily be able to recompile the application to use the modified definitions.)

@item

Use a suitable shared library mechanism for linking with the Library. A suitable mechanism is one that (1) uses at run time a copy of the library already present on the user's computer system, rather than copying library functions into the executable, and (2) will operate properly with a modified version of the library, if the user installs one, as long as the modified version is interface-compatible with the version that the work was made with.

@item

Accompany the work with a written offer, valid for at least three years, to give the same user the materials specified in Subsection 6a, above, for a charge no more than the cost of performing this distribution.

@item

If distribution of the work is made by offering access to copy from a designated place, offer equivalent access to copy the above specified materials from the same place.

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Verify that the user has already received a copy of these materials or that you have already sent this user a copy.

@end enumerate

For an executable, the required form of the ``work that uses the Library'' must include any data and utility programs needed for reproducing the executable from it. However, as a special exception, the materials to be distributed need not include anything that is normally distributed (in either source or binary form) with the major components (compiler, kernel, and so on) of the operating system on which the executable runs, unless that component itself accompanies the executable.

It may happen that this requirement contradicts the license restrictions of other proprietary libraries that do not normally accompany the operating system. Such a contradiction means you cannot use both them and the Library together in an executable that you distribute.

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Accompany the combined library with a copy of the same work based on the Library,  
uncombined with any other library facilities. This must be distributed under the terms of the Sections above.

@item

Give prominent notice with the combined library of the fact that part of it is a work based on the Library, and explaining where to find the accompanying uncombined form of the same work.

@end enumerate

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@end enumerate

@subheading END OF TERMS AND CONDITIONS

@page

## @subheading How to Apply These Terms to Your New Libraries

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@smallexample

@var{one line to give the library's name and an idea of what it does.}

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smallexample

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`Frob' (a library for tweaking knobs) written by James Random Hacker.

@var{signature of Ty Coon}, 1 April 1990

Ty Coon, President of Vice

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Version 2.1, February 1999

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A "library" means a collection of software functions and/or data prepared so as to be conveniently linked with application programs (which use some of those functions and data) to form executables.

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"Source code" for a work means the preferred form of the work for making modifications to it. For a library, complete source code means all the source code for all modules it contains, plus any associated interface definition files, plus the scripts used to control compilation and installation of the library.

Activities other than copying, distribution and modification are not covered by this License; they are outside its scope. The act of running a program using the Library is not restricted, and output from such a program is covered only if its contents constitute a work based on the Library (independent of the use of the Library in a tool for writing it). Whether that is true depends on what the Library does and what the program that uses the Library does.

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- b) You must cause the files modified to carry prominent notices stating that you changed the files and the date of any change.
- c) You must cause the whole of the work to be licensed at no charge to all third parties under the terms of this License.
- d) If a facility in the modified Library refers to a function or a table of data to be supplied by an application program that uses the facility, other than as an argument passed when the facility is invoked, then you must make a good faith effort to ensure that, in the event an application does not supply such function or table, the facility still operates, and performs whatever part of its purpose remains meaningful.

(For example, a function in a library to compute square roots has a purpose that is entirely well-defined independent of the application. Therefore, Subsection 2d requires that any application-supplied function or table used by this function must be optional: if the application does not supply it, the square root function must still compute square roots.)

These requirements apply to the modified work as a whole. If identifiable sections of that work are not derived from the Library, and can be reasonably considered independent and separate works in themselves, then this License, and its terms, do not apply to those sections when you distribute them as separate works. But when you distribute the same sections as part of a whole which is a work based on the Library, the distribution of the whole must be on the terms of this License, whose permissions for other licensees extend to the entire whole, and thus to each and every part regardless of who wrote it.

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In addition, mere aggregation of another work not based on the Library with the Library (or with a work based on the Library) on a volume of a storage or distribution medium does not bring the other work under

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3. You may opt to apply the terms of the ordinary  
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This option is useful when you wish to copy part of the code of the Library into a program that is not a library.

4. You may copy and distribute the Library (or a portion or derivative of it, under Section 2) in object code or executable form under the terms of Sections 1 and 2 above provided that you accompany it with the complete corresponding machine-readable source code, which must be distributed under the terms of Sections 1 and 2 above on a medium customarily used for software interchange.

If distribution of object code is made by offering access to copy from a designated place, then offering equivalent access to copy the source code from the same place satisfies the requirement to distribute the source code, even though third parties are not compelled to copy the source along with the object code.

5. A program that contains no derivative of any portion of the Library, but is designed to work with the Library by being compiled or linked with it, is called a "work that uses the Library". Such a work, in isolation, is not a derivative work of the Library, and therefore falls outside the scope of this License.

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a) Accompany

the work with the complete corresponding

machine-readable source code for the Library including whatever changes were used in the work (which must be distributed under Sections 1 and 2 above); and, if the work is an executable linked with the Library, with the complete machine-readable "work that uses the Library", as object code and/or source code, so that the user can modify the Library and then relink to produce a modified executable containing the modified Library. (It is understood that the user who changes the contents of definitions files in the Library will not necessarily be able to recompile the application to use the modified definitions.)

b) Use a suitable shared library mechanism for linking with the Library. A suitable mechanism is one that (1) uses at run time a

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# 1.266 libuuid 2.40.4-r1

## 1.266.1 Available under license :

| NR | START | END   | SECTORS | SIZE | NAME        | UUID |
|----|-------|-------|---------|------|-------------|------|
| 1  | 32    | 7679  | 7648    | 3.7M | 8f8378c0-01 |      |
| 2  | 7680  | 16383 | 8704    | 4.3M | 8f8378c0-02 |      |
| 5  | 7936  | 12799 | 4864    | 2.4M |             |      |
| 6  | 12544 | 16127 | 3584    | 1.8M |             |      |

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```

```
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#ifndef UTIL\_LINUX\_PT\_BSD\_H  
#define UTIL\_LINUX\_PT\_BSD\_H

#define BSD\_MAXPARTITIONS 16  
#define BSD\_FS\_UNUSED 0

```

#ifndef BSD_DISKMAGIC
#define BSD_DISKMAGIC    ((uint32_t) 0x82564557)
#endif

#define BSD_LINUX_BOOTDIR "/usr/ucb/mdec"

#if defined (__alpha__) || defined (__powerpc__) || \
    defined (__ia64__) || defined (__hppa__)
#define BSD_LABELSECTOR  0
#define BSD_LABELOFFSET  64
#else
#define BSD_LABELSECTOR  1
#define BSD_LABELOFFSET  0
#endif

#define BSD_BBSIZE      8192 /* size of boot area, with label */
#define BSD_SBSIZE      8192 /* max size of fs superblock */

struct bsd_disklabel {
    uint32_t d_magic; /* the magic number */
    int16_t d_type; /* drive type */
    int16_t d_subtype; /* controller/d_type specific */
    char d_typename[16]; /* type name, e.g. "eagle" */
    char d_packname[16]; /* pack identifier */

    /* disk geometry: */
    uint32_t d_sectsize; /*
    # of bytes per sector */
    uint32_t d_nsectors; /* # of data sectors per track */
    uint32_t d_ntracks; /* # of tracks per cylinder */
    uint32_t d_ncylinders; /* # of data cylinders per unit */
    uint32_t d_secperscyl; /* # of data sectors per cylinder */
    uint32_t d_secperunit; /* # of data sectors per unit */

    /*
    * Spares (bad sector replacements) below
    * are not counted in d_nsectors or d_secperscyl.
    * Spare sectors are assumed to be physical sectors
    * which occupy space at the end of each track and/or cylinder.
    */
    uint16_t d_sparepertrack; /* # of spare sectors per track */
    uint16_t d_spareperscyl; /* # of spare sectors per cylinder */

    /*
    * Alternate cylinders include maintenance, replacement,
    * configuration description areas, etc.
    */
    uint32_t d_acylinders; /* # of alt. cylinders per unit */

```

```

/* hardware characteristics: */
/*
* d_interleave, d_trackskew and d_cylskew describe perturbations
* in the media format used to compensate for a slow
controller.
* Interleave is physical sector interleave, set up by the formatter
* or controller when formatting. When interleaving is in use,
* logically adjacent sectors are not physically contiguous,
* but instead are separated by some number of sectors.
* It is specified as the ratio of physical sectors traversed
* per logical sector. Thus an interleave of 1:1 implies contiguous
* layout, while 2:1 implies that logical sector 0 is separated
* by one sector from logical sector 1.
* d_trackskew is the offset of sector 0 on track N
* relative to sector 0 on track N-1 on the same cylinder.
* Finally, d_cylskew is the offset of sector 0 on cylinder N
* relative to sector 0 on cylinder N-1.
*/
uint16_t d_rpm; /* rotational speed */
uint16_t d_interleave; /* hardware sector interleave */
uint16_t d_trackskew; /* sector 0 skew, per track */
uint16_t d_cylskew; /* sector 0 skew, per cylinder */
uint32_t d_headswitch; /* head switch time, usec */
uint32_t d_trkseek; /*
track-to-track seek, usec */
uint32_t d_flags; /* generic flags */
uint32_t d_drivedata[5]; /* drive-type specific information */
uint32_t d_spare[5]; /* reserved for future use */
uint32_t d_magic2; /* the magic number (again) */
uint16_t d_checksum; /* xor of data incl. partitions */

/* filesystem and partition information: */
uint16_t d_npartitions; /* number of partitions in following */
uint32_t d_bbsize; /* size of boot area at sn0, bytes */
uint32_t d_sbsize; /* max size of fs superblock, bytes */

struct bsd_partition { /* the partition table */
uint32_t p_size; /* number of sectors in partition */
uint32_t p_offset; /* starting sector */
uint32_t p_fsize; /* filesystem basic fragment size */
uint8_t p_fstype; /* filesystem type, see below */
uint8_t p_frag; /* filesystem fragments per block */
uint16_t p_cpg; /* filesystem cylinders per group */
} __attribute__((packed))
d_partitions[BSD_MAXPARTITIONS]; /* actually may be more */
} __attribute__((packed));

```

```

/* d_type values: */
#define BSD_DTYPE_SMD 1 /* SMD, XSMD; VAX hp/up */
#define BSD_DTYPE_MSCP 2 /* MSCP */
#define BSD_DTYPE_DEC 3 /* other DEC (rk, rl) */
#define BSD_DTYPE_SCSI 4 /* SCSI */
#define BSD_DTYPE_ESDI 5 /* ESDI interface */
#define BSD_DTYPE_ST506 6 /* ST506 etc. */
#define BSD_DTYPE_HPIB 7 /* CS/80 on HP-IB */
#define BSD_DTYPE_HPFL 8 /* HP Fiber-link */
#define BSD_DTYPE_FLOPPY 10 /* floppy */

/* d_subtype values: */
#define BSD_DSTYPE_INDOSPART 0x8 /* is inside dos partition */
#define BSD_DSTYPE_DOSPART(s) ((s) & 3) /* dos partition number */
#define BSD_DSTYPE_GEOMETRY 0x10 /* drive params in label */

/*
 * Filesystem type and version.
 * Used to interpret other filesystem-specific
 * per-partition information.
 */
#define BSD_FS_UNUSED 0 /* unused */
#define BSD_FS_SWAP 1 /* swap */
#define BSD_FS_V6 2 /* Sixth Edition */
#define BSD_FS_V7
    3 /* Seventh Edition */
#define BSD_FS_SYSV 4 /* System V */
#define BSD_FS_V71K 5 /* V7 with 1K blocks (4.1, 2.9) */
#define BSD_FS_V8 6 /* Eighth Edition, 4K blocks */
#define BSD_FS_BSDFFS 7 /* 4.2BSD fast file system */
#define BSD_FS_BSDLFS 9 /* 4.4BSD log-structured file system */
#define BSD_FS_OTHER 10 /* in use, but unknown/unsupported */
#define BSD_FS_HPFS 11 /* OS/2 high-performance file system */
#define BSD_FS_ISO9660 12 /* ISO-9660 filesystem (cdrom) */
#define BSD_FS_ISOFS BSD_FS_ISO9660
#define BSD_FS_BOOT 13 /* partition contains bootstrap */
#define BSD_FS_ADOS 14 /* AmigaDOS fast file system */
#define BSD_FS_HFS 15 /* Macintosh HFS */
#define BSD_FS_ADVFS 16 /* Digital Unix AdvFS */

/* this is annoying, but it's also the way it is :-/ */
#ifdef __alpha__
#define BSD_FS_EXT2 8 /* ext2 file system */
#else
#define BSD_FS_MSDOS 8 /* MS-DOS file system */
#endif

```

```

/*
 * flags shared by various drives:
 */
#define BSD_D_REMOVABLE 0x01 /*
removable media */
#define BSD_D_ECC    0x02 /* supports ECC */
#define BSD_D_BADSECT 0x04 /* supports bad sector forw. */
#define BSD_D_RAMDISK 0x08 /* disk emulator */
#define BSD_D_CHAIN    0x10 /* can do back-back transfers */
#define BSD_D_DOSPART 0x20 /* within MSDOS partition */

#endif /* UTIL_LINUX_PT_BSD_H */

```

# 1.267 libelf 0.191-r0

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