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# Open Source Used In Cisco Secure Endpoint Connector (Linux) 1.18.0

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xmlsec-mscrypto library

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#### References

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\* AOL

http://www.aleksey.com/pipermail/xmlsec/2003/005488.html http://www.aleksey.com/pipermail/xmlsec/attachments/20030729/0e25648e/attachment.htm

\* Cordys R&D BV http://www.aleksey.com/pipermail/xmlsec/2003/005581.html

\* Cryptocom LTD http://www.aleksey.com/pipermail/xmlsec/2006/007410.html

## 1.5 jansson 2.11

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## 1.6 pcre 10.34

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#### THE BASIC LIBRARY FUNCTIONS

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Written by: Philip Hazel Email local part: ph10 Email domain: cam.ac.uk

University of Cambridge Computing Service, Cambridge, England.

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PCRE2 JUST-IN-TIME COMPILATION SUPPORT

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Written by: Zoltan Herczeg Email local part: hzmester Email domain: freemail.hu

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#### STACK-LESS JUST-IN-TIME COMPILER

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Written by: Zoltan Herczeg Email local part: hzmester Email domain: freemail.hu

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## **1.7 IIvm 8.0.1** 1.7.1 Available under license :

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; 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(i8*) {
; CHECK-NOT: Expected a GR32Bit register, but got a GRX32Bit register
BB:
%L34 = load i8, i8* %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, i8* %0
br label %CF248
}
```

; NOTE: Assertions have been autogenerated by utils/update\_llc\_test\_checks.py

; RUN: llc < %s -mtriple=x86\_64-unknown-unknown -mattr=avx512vl,avx512bw,avx512dq,prefer-256-bit | FileCheck %s

; 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 void @add256(<16 x i32>* %a, <16 x i32>* %b, <16 x i32>* %c) "min-legal-vector-width"="256" {
```

```
; CHECK-LABEL: add256:
            # %bb.0:
: CHECK:
; CHECK-NEXT: vmovdqa (%rdi), %ymm0
; CHECK-NEXT: vmovdqa 32(%rdi), %ymm1
; CHECK-NEXT: vpaddd (%rsi), %ymm0, %ymm0
; CHECK-NEXT: vpaddd 32(%rsi), %ymm1, %ymm1
; CHECK-NEXT: vmovdqa %ymm1, 32(%rdx)
; CHECK-NEXT: vmovdqa %ymm0, (%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
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 i 32 >, < 16 x i 32 >* %a
\%e = load < 16 \text{ x i} 32 >, < 16 \text{ x i} 32 >* \%b
\%f = add <16 x i32> %d, %e
store <16 x i32> %f, <16 x i32>* %c
ret void
}
define 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

```
%6 = add nuw nsw <64 x i32> %5, %4
```

%7 = lshr <64 x i32> %6, <i32 1, i32 1, i32

 $1,\,i32\,\,1,\,i$ 

%8 = trunc < 64 x i 32 > %7 to < 64 x i 8 >

store <64 x i8> %8, <64 x i8>\* undef, align 4

```
ret void
```

```
}
```

define void @avg\_v64i8\_512(<64 x i8>\* %a, <64 x i8>\* %b) "min-legal-vector-width"="512" {

; CHECK-LABEL: avg\_v64i8\_512:

; CHECK: # %bb.0:

; CHECK-NEXT: vmovdqa64 (%rsi), %zmm0

; CHECK-NEXT: vpavgb (%rdi), %zmm0, %zmm0

; CHECK-NEXT: vmovdqu64 %zmm0, (%rax)

- ; CHECK-NEXT: vzeroupper
- ; CHECK-NEXT: retq

 $\%1 = \text{load} <\!\!64 \ x \ i8\!\!>, <\!\!64 \ x \ i8\!\!>^* \%a$ 

%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

i 32 1, i 32 1

i 32 1, i 32 1

%6 = add nuw nsw <64 x i32> %5, %4

%7 = lshr <64 x i32> %6, <i32 1, i32 1, i32

%8 = trunc < 64 x i 32 > %7 to < 64 x i 8 >

```
store <64 x i8> %8, <64 x i8>* undef, align 4
ret void
}
```

```
define 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:
                           # %bb.0:
; CHECK:
; CHECK-NEXT: vmovdqa (%rdi), %ymm0
; CHECK-NEXT: vmovdqa 32(%rdi),
 %ymm1
; CHECK-NEXT: vpmaddwd (%rsi), %ymm0, %ymm0
; CHECK-NEXT: vpmaddwd 32(%rsi), %ymm1, %ymm1
; CHECK-NEXT: vmovdqa %ymm1, 32(%rdx)
; CHECK-NEXT: vmovdqa %ymm0, (%rdx)
; CHECK-NEXT: vzeroupper
; CHECK-NEXT: retq
  %A = load <32 \text{ x i}16>, <32 \text{ x i}16>* %APtr
  B = 10ad < 32 x i 16 > . < 32 x i 16 > * BPtr
  \%a = \text{sext} < 32 \text{ x i16} > \%A \text{ to} < 32 \text{ 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 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 \text{ x i} 16>, <32 \text{ x i} 16>* % \text{APtr}
  B = load <32 \text{ x i} 16>, <32 \text{ x i} 16>* BPtr
  \%a = \text{sext} < 32 \text{ x i16} > \%A \text{ to } < 32 \text{ x i32} >
  b = sext < 32 x i 16 > B to < 32 x i 32 > 32 > 32 v i 32 
  \%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>
```

 $\% even = shufflevector < 32 \ x \ i32 > \% \ m, < 32 \ x \ i32 > undef, < 16 \ x \ i32 > < i32 \ 1, \ i32 \ 3, \ i32 \ 5, \ i32 \ 7, \ i32 \ 9, \ i32 \ 11,$ 

```
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 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:
            # %bb.0:
: CHECK:
; CHECK-NEXT: vmovdqa (%rdi), %ymm0
; CHECK-NEXT: vmovdqa 32(%rdi), %ymm1
; CHECK-NEXT: vpsubusb (%rsi), %ymm0, %ymm0
; CHECK-NEXT: vpsubusb 32(%rsi), %ymm1, %ymm1
; CHECK-NEXT: vmovdqa %ymm1, 32(%rdx)
; CHECK-NEXT: vmovdqa %ymm0, (%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 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 i32 @\_Z9test\_charPcS\_i\_256(i8\* nocapture readonly, i8\* nocapture readonly, i32) "min-legal-vector-width"="256" {

; CHECK-LABEL: Z9test charPcS i 256: ; CHECK: # %bb.0: # %entry ; CHECK-NEXT: movl %edx, %eax ; CHECK-NEXT: vpxor %xmm0, %xmm0, %xmm0 ; CHECK-NEXT: xorl %ecx, %ecx ; CHECK-NEXT: vpxor %xmm1, %xmm1, %xmm1 ; CHECK-NEXT: vpxor %xmm2, %xmm2, %xmm2 ; CHECK-NEXT: .p2align 4, 0x90 ; CHECK-NEXT: .LBB8\_1: # %vector.body ; CHECK-NEXT: # =>This Inner Loop Header: Depth=1 ; CHECK-NEXT: vpmovsxbw (%rdi,%rcx), %ymm3 ; CHECK-NEXT: vpmovsxbw 16(%rdi,%rcx), %ymm4 ; CHECK-NEXT: vpmovsxbw (%rsi,%rcx), %ymm5 ; CHECK-NEXT: vpmaddwd %ymm3, %ymm5, %ymm3 ; CHECK-NEXT: vpaddd %ymm1, %ymm3, %ymm1 ; CHECK-NEXT: vpmovsxbw 16(%rsi,%rcx), %ymm3 ; CHECK-NEXT: vpmaddwd %ymm4, %ymm3, %ymm3 ; CHECK-NEXT: vpaddd %ymm2, %ymm3, %ymm2 ; CHECK-NEXT: addq \$32, %rcx ; CHECK-NEXT: cmpq %rcx, %rax ; CHECK-NEXT: jne .LBB8\_1 ; CHECK-NEXT: # %bb.2: # %middle.block ; CHECK-NEXT: vpaddd %ymm0, %ymm1, %ymm1 ; CHECK-NEXT: vpaddd %ymm0, %ymm2, %ymm0 ; CHECK-NEXT: vpaddd %ymm0, %ymm1, %ymm0 ; CHECK-NEXT: vextracti128 \$1, %ymm0, %xmm1 ; CHECK-NEXT: vpaddd %ymm1, %ymm0, %ymm0 ; CHECK-NEXT: vpshufd  $\{\{.*\#+\}\}$  xmm1 = xmm0[2,3,0,1] ; CHECK-NEXT: vpaddd %ymm1, %ymm0, %ymm0 ; CHECK-NEXT: vpshufd  $\{\{.*\#+\}\}$  xmm1 = xmm0[1,1,2,3] ; CHECK-NEXT: vpaddd %xmm1, %xmm0, %xmm0 ; CHECK-NEXT: vmovd %xmm0, %eax ; CHECK-NEXT: vzeroupper ; CHECK-NEXT: retq entry: %3 = zext i 32 %2 to i 64br 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  $\%6 = \text{sext} < 32 \text{ x i8} > \% \text{ wide.load to } < 32 \text{ x i32} > 32 \text{ wide.load to } < 32 \text{ x i32} > 32 \text{ wide.load to } < 32 \text{ x i32} > 32 \text{ wide.load to } < 32 \text{ x i32} > 32 \text{ wide.load to } < 32 \text{ x i32} > 32 \text{ wide.load to } < 32 \text{ x i32} > 32 \text{ wide.load to } < 32 \text{ x i32} > 32 \text{ wide.load to } < 32 \text{ x i32} > 32 \text{ wide.load to } < 32 \text{ x i32} > 32 \text{ wide.load to } < 32 \text{ x i32} > 32 \text{ wide.load to } < 32 \text{ x i32} > 32 \text{ wide.load to } < 32 \text{ x i32} > 32 \text{ wide.load to } < 32 \text{ x i32} > 32 \text{ wide.load to } < 32 \text{ x i32} > 32 \text{ wide.load to } < 32 \text{ x i32} > 32 \text{ wide.load to } < 32 \text{ x i32} > 32 \text{ wide.load to } < 32 \text{ x i32} > 32 \text{ wide.load to } < 32 \text{ x i32} > 32 \text{ wide.load to } < 32 \text{ x i32} > 32 \text{ wide.load to } < 32 \text{ x i32} > 32 \text{ wide.load to } < 32 \text{ x i32} > 32 \text{ wide.load to } < 32 \text{ x i32} > 32 \text{ wide.load to } < 32 \text{ x i32} > 32 \text{ wide.load to } < 32 \text{ x i32} > 32 \text{ wide.load to } < 32 \text{ x i32} > 32 \text{ wide.load to } < 32 \text{ x i32} > 32 \text{ wide.load to } < 32 \text{ x i32} > 32 \text{ wide.load to } < 32 \text{ x i32} > 32 \text{ wide.load to } < 32 \text{ x i32} > 32 \text{ wide.load to } < 32 \text{ wide.load t$ %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 > 32

%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, i33 unde

%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, i33 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, i33 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, i33 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, i33 undef,
```

```
%bin.rdx20 = add <32 x i32> %bin.rdx18, %rdx.shuf19
```

```
\%13 = extractelement <32 x i32> % bin.rdx20,
```

i32 0

```
ret i32 %13
```

```
define i32 @_Z9test_charPcS_i_512(i8* nocapture readonly, i8* nocapture readonly, i32) "min-legal-vector-width"="512" {
```

```
; CHECK-LABEL: _Z9test_charPcS_i_512:
```

; CHECK: # %bb.0: # %entry

; CHECK-NEXT: movl %edx, %eax

; CHECK-NEXT: vpxor %xmm0, %xmm0, %xmm0

- ; CHECK-NEXT: xorl %ecx, %ecx
- ; CHECK-NEXT: vpxor %xmm1, %xmm1, %xmm1

```
; CHECK-NEXT: .p2align 4, 0x90
; CHECK-NEXT: .LBB9_1: # % vector.body
; CHECK-NEXT: # =>This Inner Loop Header: Depth=1
; CHECK-NEXT: vpmovsxbw (%rdi,%rcx), %zmm2
; CHECK-NEXT: vpmovsxbw (%rsi,%rcx), %zmm3
; CHECK-NEXT: vpmaddwd %zmm2, %zmm3, %zmm2
; CHECK-NEXT: vpaddd %zmm1, %zmm2, %zmm1
; CHECK-NEXT: addq $32, %rcx
; CHECK-NEXT: cmpq %rcx, %rax
; CHECK-NEXT: jne .LBB9 1
; CHECK-NEXT: # %bb.2: # %middle.block
; CHECK-NEXT: vpaddd %zmm0, %zmm1, %zmm0
; CHECK-NEXT: vextracti64x4 $1, % zmm0, % ymm1
; CHECK-NEXT: vpaddd %zmm1, %zmm0, %zmm0
; CHECK-NEXT: vextracti128 $1, %ymm0, %xmm1
CHECK-NEXT: vpaddd %zmm1, %zmm0, %zmm0
; CHECK-NEXT: vpshufd \{\{.*\#+\}\} xmm1 = xmm0[2,3,0,1]
; CHECK-NEXT: vpaddd %zmm1, %zmm0, %zmm0
; CHECK-NEXT: vpshufd \{\{.*\#+\}\} xmm1 = xmm0[1,1,2,3]
; CHECK-NEXT: vpaddd %xmm1, %xmm0, %xmm0
; CHECK-NEXT: vmovd %xmm0, %eax
; CHECK-NEXT: vzeroupper
; CHECK-NEXT: retq
entry:
\%3 = \text{zext i} 32 \%2 \text{ to i} 64
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, i33 undef, i33

%bin.rdx = add <32 x i 32 > %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, i33 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, i33 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, i33 undef, i33

%bin.rdx20 = add <32 x i32> %bin.rdx18, %rdx.shuf19

%13 = extractelement <32 x i32> % bin.rdx20, i32 0

```
ret i32 %13
```

```
}
```

@a = global [1024 x i8] zeroinitializer, align 16
@b = global [1024 x i8] zeroinitializer, align 16

```
define i32 @sad_16i8_256() "min-legal-vector-width"="256" {
```

; CHECK-LABEL: sad\_16i8\_256:

```
; CHECK: # %bb.0: # %entry
```

```
; CHECK-NEXT: vpxor %xmm0, %xmm0, %xmm0
```

```
; CHECK-NEXT: movq $-1024, %rax # imm = 0xFC00
```

```
; CHECK-NEXT: vpxor %xmm1, %xmm1, %xmm1
```

```
; CHECK-NEXT: .p2align 4, 0x90
```

```
; CHECK-NEXT: .LBB10_1: # %vector.body
```

; CHECK-NEXT: # =>This Inner Loop Header:

```
Depth=1
```

- ; CHECK-NEXT: vmovdqu a+1024(%rax), %xmm2
- ; CHECK-NEXT: vpsadbw b+1024(%rax), %xmm2, %xmm2
- ; CHECK-NEXT: vpaddd %ymm1, %ymm2, %ymm1

```
; CHECK-NEXT: addq $4, %rax
```

```
; CHECK-NEXT: jne .LBB10_1
```

; CHECK-NEXT: # %bb.2: # %middle.block

; CHECK-NEXT: vpaddd %ymm0, %ymm1, %ymm0
; CHECK-NEXT: vextracti128 \$1, % ymm0, % xmm1
; CHECK-NEXT: vpaddd %ymm1, %ymm0, %ymm0
; CHECK-NEXT: vpshufd {{.*#+}} xmm1 = xmm0[2,3,0,1]
; CHECK-NEXT: vpaddd %ymm1, %ymm0, %ymm0
; CHECK-NEXT: vpshufd {{.*#+}} xmm1 = xmm0[1,1,2,3]
; CHECK-NEXT: vpaddd %xmm1, %xmm0, %xmm0
; CHECK-NEXT: vmovd %xmm0, %eax
; CHECK-NEXT: vzeroupper
; CHECK-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 $<16 \times i8>$ ,
$<16 \times i8>* \% 1$ , 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 > 0(2 - 0)(5 - 0) = 0(2 - 0)(5 - 0)(2 - 0)(5 - 0)(2 - 0)(5 - 0))(3 - 0)(3 - 0)(3 - 0)(3 - 0)(3 - 0))(3 - 0)(3 - 0)(3 - 0)(3 - 0)(3 - 0))(3 - 0)(3 - 0)(3 - 0)(3 - 0)(3 - 0))(3 - 0)(3 - 0)(3 - 0)(3 - 0)(3 - 0)(3 - 0))(3 - 0)(3
%6 = sub nsw < 16  x i 32 > %2, %5 %7 = iamp sat < 16  x i 32 > %6 < < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1, < 32, 1,
%7 = icmp sgt <16 x i32> %6, <i32 -1,="" -1,<="" i32="" td=""></i32>
8 = sub nsw < 16  x i 32 > zeroinitializer, %6
% = sub isw <10 x i32> zeroinitaizet, $%$ 0 %9 = select <16 x i1> %7, <16 x i32> %6, <16 x i32> %8
$\% = \text{add nsw} < 16 \times 132 > \% 0, < 16 \times 132 > \% 0$
% index.next = add i64 % index, 4
% 11 = icmp eq i64 % index.next, 1024
br i1 %11, label %middle.block, label %vector.body
of it /off, laber /officiel.ofock, laber /ovector.obdy

middle.block:

%.lcssa = phi <16 x i32> [ %10, %vector.body ]

%rdx.shuf = shufflevector <16 x i32> %.lcssa, <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> %.lcssa, %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, i33 undef,

%bin.rdx2 = add <16 x i32> %bin.rdx, %rdx.shuf2

 $\$  wrdx.shuf3 = shufflevector <16 x i32>  $\$  bin.rdx2, <16 x i32> undef, <16 x i32> <i32 2, i32 3, i32 undef, i33 undef, i34 undef, i35 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, 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, 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, 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, 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, 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, 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 i32 @sad_16i8_512() "min-legal-vector-width"="512" {
; CHECK-LABEL: sad_16i8_512:
; CHECK:
                        # %bb.0: # %entry
; CHECK-NEXT: vpxor %xmm0, %xmm0, %xmm0
; CHECK-NEXT: movq $-1024, %rax # imm = 0xFC00
; CHECK-NEXT: .p2align 4, 0x90
; CHECK-NEXT: .LBB11_1: # % vector.body
; CHECK-NEXT: # =>This Inner Loop Header: Depth=1
; CHECK-NEXT: vmovdqu a+1024(%rax), %xmm1
; CHECK-NEXT: vpsadbw b+1024(%rax), %xmm1, %xmm1
; CHECK-NEXT: vpaddd %zmm0, %zmm1, %zmm0
; CHECK-NEXT: addq $4, %rax
; CHECK-NEXT: jne .LBB11_1
; CHECK-NEXT: # %bb.2: # %middle.block
; CHECK-NEXT: vextracti64x4 $1, %zmm0, %ymm1
; CHECK-NEXT: vpaddd %zmm1, %zmm0, %zmm0
; CHECK-NEXT: vextracti128 $1, %ymm0, %xmm1
; CHECK-NEXT: vpaddd %zmm1, %zmm0, %zmm0
; CHECK-NEXT: vpshufd \{\{.*\#+\}\} xmm1 = xmm0[2,3,0,1]
; CHECK-NEXT: vpaddd %zmm1, %zmm0, %zmm0
; CHECK-NEXT: vpshufd \{\{.*\#+\}\} xmm1 = xmm0[1,1,2,3]
; CHECK-NEXT: vpaddd %xmm1,
%xmm0, %xmm0
; CHECK-NEXT: vmovd %xmm0, %eax
; CHECK-NEXT: vzeroupper
; CHECK-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 = \text{zext} < 16 \text{ x i8} > \% \text{ wide.load to} < 16 \text{ 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,

```
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 i 1 %11, label % middle.block, label % vector.body

middle.block:

```
%.lcssa = phi <16 x i32> [ %10, %vector.body ]
```

%rdx.shuf = shufflevector <16 x i32> %.lcssa, <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 u

%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, i33 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, i3

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, i33 undef, i33 undef, i34 undef, i35 unde

```
%bin.rdx4 = add <16 x i32> %bin.rdx3, %rdx.shuf4
```

```
\%12 = extractelement < 16 x i 32 > \% bin.rdx4, i 32 0
```

ret i32 %12

}

define 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: vcvtdq2ps %ymm0, %ymm0

; CHECK-NEXT: vpmovm2d %k0, %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 = \text{sitofp} < 16 \text{ x i1} > \% \text{ mask to} < 16 \text{ x float} >
store <16 x float> %1, <16 x float>* %res
ret void
}
define 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 = \text{sitofp} < 16 \text{ x il} > \% \text{ mask to} < 16 \text{ x float} >
store <16 \text{ x float} > \%1, <16 \text{ x float} > \% res
ret void
}
define 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 > 16 x do
```

```
store <16 x double> %1, <16 x double>* %res
```

```
ret void
```

}

define 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 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 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 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: vpmovw2m %ymm0, %k1
; CHECK-NEXT: vpmovm2d %k1, %ymm0
; CHECK-NEXT: vpsrld $31, %ymm0, %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 i 16 > %a, zeroinitializer
- %1 = uitofp < 16 x i1 > %mask to < 16 x double >
- store <16 x double> %1, <16 x double>\* %res

```
ret void
```

}

define 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 \text{ x double} > \%1, <16 \text{ 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 \text{ x i}16> % 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: 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 void @mul256(<64 x i8>* %a, <64 x i8>* %b, <64 x i8>* %c) "min-legal-vector-width"="256" { ; CHECK-LABEL: mul256:
```

```
; CHECK: # %bb.0:
```

```
; CHECK-NEXT: vmovdqa (%rdi), %ymm0
```

```
; CHECK-NEXT: vmovdqa 32(%rdi), %ymm1
```

```
; CHECK-NEXT: vmovdqa (%rsi), %ymm2
```

```
; CHECK-NEXT: vmovdqa 32(%rsi), %ymm3
```

```
; CHECK-NEXT: vpunpckhbw
```

```
{{.*#+}} ymm4 =
```

ymm2[8],ymm0[8],ymm2[9],ymm0[9],ymm2[10],ymm0[10],ymm2[11],ymm0[11],ymm2[12],ymm0[12],ymm2[13 ],ymm0[13],ymm2[14],ymm0[14],ymm0[15],ymm0[15],ymm2[24],ymm0[24],ymm0[25],ymm0[25],ymm2[26],ym m0[26],ymm2[27],ymm0[27],ymm2[28],ymm0[28],ymm2[29],ymm0[29],ymm2[30],ymm0[30],ymm2[31],ymm0[ 31]

```
; CHECK-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-NEXT: vpmullw %ymm4, %ymm5, %ymm4
```

; CHECK-NEXT: vmovdqa {{.\*#+}} ymm5 =

```
; CHECK-NEXT: vpand %ymm5, %ymm4, %ymm4
```

```
; CHECK-NEXT: vpunpcklbw {{.*#+}} ymm2 =
```

ymm2[0],ymm0[0],ymm2[1],ymm0[1],ymm2[2],ymm0[2],ymm2[3],ymm0[3],ymm2[4],ymm0[4],ymm2[5],ymm0[ 5],ymm2[6],ymm0[6],ymm0[7],ymm0[16],ymm0[16],ymm0[17],ymm0[17],ymm0[18],ymm0[ 19],ymm0[19],ymm2[20],ymm0[20],ymm2[21],ymm0[21],ymm2[22],ymm0[22],ymm0[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: vpmullw %ymm2, %ymm0, %ymm0

; CHECK-NEXT: vpand %ymm5, %ymm0, %ymm0

; CHECK-NEXT: vpackuswb %ymm4, %ymm0, %ymm0

; CHECK-NEXT: vpunpckhbw {{.\*#+}} ymm2 =

ymm3[8],ymm0[8],ymm3[9],ymm0[9],ymm3[10],ymm0[10],ymm3[11],ymm0[11],ymm3[12],ymm0[12],ymm3[13 ],ymm0[13],ymm3[14],ymm0[14],ymm3[15],ymm0[15],ymm3[24],ymm0[24],ymm3[25],ymm0[25],ymm3[26],ym m0[26],ymm3[27],ymm0[27],ymm3[28],ymm0[28],ymm3[29],ymm0[29],ymm3[30],ymm0[30],ymm3[31],ymm0[ 31]

; CHECK-NEXT: vpunpckhbw {{.\*#+}} ymm4 =

ymm1[8],ymm0[8],ymm1[9],ymm0[9],ymm1[10],ymm0[10],ymm1[11],ymm0[11],ymm1[12],ymm0[12],ymm1[13 ],ymm0[13],ymm1[14],ymm0[14],ymm1[15],ymm0[15],ymm1[24],ymm0[24],ymm0[25],ymm1[26],ym m0[26],ymm1[27],ymm0[27],ymm1[28],ymm0[28],ymm1[29],ymm0[29],ymm1[30],ymm0[30],ymm1[31],ymm0[ 31]

; CHECK-NEXT: vpmullw %ymm2, %ymm4, %ymm2

; CHECK-NEXT: vpand %ymm5, %ymm2, %ymm2

; CHECK-NEXT: vpunpcklbw {{.\*#+}}

ymm3 =

ymm3[0],ymm0[0],ymm3[1],ymm0[1],ymm3[2],ymm0[2],ymm3[3],ymm0[3],ymm3[4],ymm0[4],ymm3[5],ymm0[ 5],ymm3[6],ymm0[6],ymm3[7],ymm0[7],ymm3[16],ymm0[16],ymm3[17],ymm0[17],ymm3[18],ymm0[18],ymm3[ 19],ymm0[19],ymm3[20],ymm0[20],ymm3[21],ymm0[21],ymm3[22],ymm0[22],ymm3[23],ymm0[23]

```
; CHECK-NEXT: vpunpcklbw {{.*#+}} ymm1 =
```

```
ymm1[0],ymm0[0],ymm1[1],ymm0[1],ymm1[2],ymm0[2],ymm1[3],ymm0[3],ymm0[4],ymm0[4],ymm0[5],ymm0[5],ymm1[6],ymm0[6],ymm0[7],ymm0[7],ymm1[16],ymm0[16],ymm0[17],ymm0[17],ymm0[18],ymm1[19],ymm0[19],ymm0[20],ymm1[21],ymm0[21],ymm0[22],ymm0[22],ymm0[22],ymm0[23]
```

; CHECK-NEXT: vpmullw %ymm3, %ymm1, %ymm1

```
; CHECK-NEXT: vpand %ymm5, %ymm1, %ymm1
```

; CHECK-NEXT: vpackuswb %ymm2, %ymm1, %ymm1

; CHECK-NEXT: vmovdqa %ymm1, 32(%rdx)

; CHECK-NEXT: vmovdqa %ymm0, (%rdx)

; CHECK-NEXT: vzeroupper

; CHECK-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 void @mul512(<64 x i8>\* %a, <64 x i8>\* %b, <64 x i8>\* %c) "min-legal-vector-width"="512" { ; CHECK-LABEL: mul512:

; CHECK: # %bb.0:

; CHECK-NEXT: vmovdqa64 (%rdi), %zmm0

; CHECK-NEXT: vmovdqa64 (%rsi), %zmm1

; CHECK-NEXT: vpunpckhbw {{.\*#+}} zmm2 =

zmm1[8],zmm0[8],zmm1[9],zmm0[9],zmm1[10],zmm0[10],zmm1[11],zmm0[11],zmm1[12],zmm0[12],zmm1[13], zmm0[13],zmm1[14],zmm0[14],zmm1[15],zmm0[15],zmm1[24],zmm0[24],zmm1[25],zmm0[25],zmm1[26],zmm0 [26],zmm1[27],zmm0[27],zmm1[28],zmm0[28],zmm1[29],zmm0[29],zmm1[30],zmm0[30],zmm1[31],zmm0[31],z mm1[40],zmm0[40],zmm1[41],zmm0[41],zmm1[42],zmm0[42],zmm1[43],zmm0[43],zmm1[44],zmm0[44],zmm1[ 45],zmm0[45],zmm1[46],zmm1[47],zmm0[47],zmm1[56],zmm0[56],zmm1[57],zmm0[57],zmm1[58],z mm0[58],zmm1[59],zmm1[60],zmm1[60],zmm1[61],zmm0[61],zmm1[62],zmm0[62],zmm1[63],zmm0[ 63]

; CHECK-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-NEXT: vpmullw %zmm2, %zmm3, %zmm2

; CHECK-NEXT: vmovdqa64 {{.\*#+}} zmm3 =

; CHECK-NEXT: vpandq %zmm3, %zmm2, %zmm2

; CHECK-NEXT: vpunpcklbw {{.\*#+}} zmm1 =

zmm1[0],zmm0[0],zmm1[1],zmm0[1],zmm1[2],zmm0[2],zmm1[3],zmm0[3],zmm1[4],zmm0[4],zmm1[5],zmm0[5] ,zmm1[6],zmm0[6],zmm1[7],zmm0[7],zmm1[16],zmm0[16],zmm1[17],zmm0[17],zmm1[18],zmm0[18],zmm1[19] ,zmm0[19],zmm1[20],zmm0[20],zmm1[21],zmm0[21],zmm1[22],zmm0[22],zmm1[23],zmm0[23],zmm1[32],zmm 0[32],zmm1[33],zmm0[33],zmm1[34],zmm0[34],zmm1[35],zmm0[35],zmm1[36],zmm0[36],zmm1[37],zmm0[37], zmm1[38],zmm0[38],zmm1[39],zmm0[39],zmm1[48],zmm0[48],zmm1[49],zmm0[49],zmm1[50],zmm0[50],zmm1 [51],zmm0[51],zmm1[52],zmm0[52],zmm1[53],zmm0[53],zmm1[54],zmm0[54],zmm0[55],zmm0[55]

; CHECK-NEXT: vpunpcklbw {{.\*#+}}

zmm0 =

zmm0[0,0,1,1,2,2,3,3,4,4,5,5,6,6,7,7,16,16,17,17,18,18,19,19,20,20,21,21,22,22,23,23,32,32,32,33,33,34,34,35,35,36,3 6,37,37,38,38,39,39,48,48,49,49,50,50,51,51,52,52,53,53,54,54,55,55]

; CHECK-NEXT: vpmullw %zmm1, %zmm0, %zmm0

; CHECK-NEXT: vpandq %zmm3, %zmm0, %zmm0

; CHECK-NEXT: vpackuswb %zmm2, %zmm0, %zmm0

; CHECK-NEXT: vmovdqa64 %zmm0, (%rdx)

; CHECK-NEXT: vzeroupper

; CHECK-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
```

```
}
```

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#### Developed by:

#### LLVM Team

University of Illinois at Urbana-Champaign

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Program Directory

<none yet>

; NOTE: Assertions have been autogenerated by utils/update\_analyze\_test\_checks.py

; RUN: opt < \$s -cost-model -analyze -mtriple=x86\_64-apple-macosx10.8.0 -mattr=+avx2 | FileCheck \$s --check-

prefixes=CHECK,VEC256,AVX

; RUN: opt < %s -cost-model -analyze -mtriple=x86\_64-apple-macosx10.8.0 -

mattr=+avx512vl,+avx512bw,+avx512dq,+prefer-256-bit | FileCheck %s --check-

prefixes=CHECK,VEC256,SKX256

; RUN: opt < %s -cost-model -analyze -mtriple=x86\_64-apple-macosx10.8.0 -

mattr=+avx512vl,+avx512bw,+avx512dq,-prefer-256-bit | FileCheck %s --check-prefixes=CHECK,VEC512

define void @zext256() "min-legal-vector-width"="256" {

; VEC256-LABEL: 'zext256'

; VEC256-NEXT: Cost Model: Found an estimated cost of 7 for instruction: %A = zext < 8 x i 16> undef to < 8 x i 64>

; VEC256-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %B = zext <8 x i32> undef to <8 x i64>

; VEC256-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %C = zext <16 x i8> undef to <16 x i32>

; VEC256-NEXT:

Cost Model: Found an estimated cost of 4 for instruction: %D = zext <16 x i16> undef to <16 x i32>

; VEC256-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %E = zext <32 x i8> undef to <32 x i16>

; VEC256-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret void

;

; VEC512-LABEL: 'zext256'

; VEC512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %A = zext < 8 x i 16> undef to < 8 x i 64>

; VEC512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: B = zext < 8 x i 32> undef to < 8 x i 64>

; VEC512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %C = zext < 16 x i8> undef to <16 x i32>

; VEC512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %D = zext < 16 x i 16 > undef to < 16 x i 32 > 16 v i 16 v i

; VEC512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %E = zext <32 x i8> undef to <32 x i16>

; VEC512-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 i 32> undef to < 8 x i 64>

%C = zext < 16 x i8 > undef to < 16 x i32 >

D = zext < 16 x i 16> undef to <16 x i 32>

```
\&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 7 for instruction: %A = zext <8 x i16> undef to <8 x i64> ; AVX-NEXT: Cost Model: Found an estimated cost of 3 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 4 for instruction: %D = zext <16 x i16> undef to <16 x i32>

; AVX-NEXT: Cost Model: Found an estimated cost of 3 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

;

; SKX256-LABEL: 'zext512'

; SKX256-NEXT: Cost Model: Found an estimated cost of

1 for instruction: %A = zext < 8 x i 16> undef to < 8 x i 64>

; SKX256-NEXT: Cost Model: Found an estimated cost of 1 for instruction: B = zext < 8 x i 32> undef to < 8 x i 64>

; 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 i 16 > undef to < 16 x i 32 > 16 model

; 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

;

; VEC512-LABEL: 'zext512'

; VEC512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %A = zext <8 x i16> undef to <8 x i64>

; VEC512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %B = zext <8 x i32> undef to <8 x i64>

; VEC512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %C = zext <16 x i8> undef to <16 x i32>

; VEC512-NEXT: Cost Model: Found

an estimated cost of 1 for instruction: %D = zext <16 x i16> undef to <16 x i32>

; VEC512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %E = zext <32 x i8> undef to <32 x i16>

; VEC512-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 i 32 > undef to < 8 x i 64 >

%C = zext < 16 x i8> undef to <16 x i32>

D = zext < 16 x i 16 undef to < 16 x i 32

%E = zext <32 x i8> undef to <32 x i16>

```
ret void
```

```
100 1
```

}

define void @sext256() "min-legal-vector-width"="256" {

; VEC256-LABEL: 'sext256'

; VEC256-NEXT: Cost Model: Found an estimated cost of 7 for instruction: %A = sext <8 x i8> undef to <8 x i64> ; VEC256-NEXT: Cost Model: Found an estimated cost of 7 for instruction: %B = sext <8 x i16> undef to <8 x

i64>

; VEC256-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %C = sext < 8 x i 32 > undef to < 8 x i 64 >

; VEC256-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %D

= sext <16 x i8> undef to <16 x i32>

; VEC256-NEXT: Cost Model: Found an estimated cost of 4 for instruction: %E = sext <16 x i16> undef to <16 x i32>

; VEC256-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %F = sext <32 x i8> undef to <32 x i16>

; VEC256-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret void

;

; VEC512-LABEL: 'sext256'

; VEC512-NEXT: Cost Model: Found an estimated cost of 24 for instruction: %A = sext < 8 x i8 > undef to < 8 x i64 > i6

; VEC512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: B = sext < 8 x i 16 > undef to < 8 x i 16 > i 64 > i 64

; VEC512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %C = sext < 8 x i 32 > undef to < 8 x i 64 >

; VEC512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %D = sext < 16 x i8> undef to <16 x i32>

; VEC512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %E = sext <16 x i16> undef to <16 x i32>

; VEC512-NEXT: Cost Model: Found an estimated cost of

1 for instruction: %F = sext <32 x i8> undef to <32 x i16>

; VEC512-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret void

 $%A = sext < 8 \times i8 > undef to < 8 \times i64 >$ 

 $B = \text{sext} < 8 \times \text{i16} \text{-} \text{undef to} < 8 \times \text{i64} \text{-}$ 

%C = sext <8 x i32> undef to <8 x i64>

D = sext < 16 x i8 > undef to < 16 x i32 >

&E = sext < 16 x i 16 > undef to < 16 x i 32 >

%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 7 for instruction: %A = sext < 8 x i8 > undef to < 8 x i64 > i64 >

```
; AVX-NEXT: Cost Model: Found an estimated cost of 7 for instruction: B = \text{sext} < 8 \times 16 undef to < 8 \times 64
```

```
; AVX-NEXT: Cost Model: Found an estimated cost of 3 for instruction: %C = sext < 8 \times i32> undef to < 8 \times i64>
```

```
; AVX-NEXT: Cost Model: Found an estimated cost of 4 for instruction: D = sext < 16 x i8 > undef to < 16 x i32 > 16 x i
```

; AVX-NEXT: Cost Model: Found an estimated cost of 4 for instruction: % E

```
= sext <16 x i16> undef to <16 x i32>
```

; AVX-NEXT: Cost Model: Found an estimated cost of 3 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

```
;
```

; SKX256-LABEL: 'sext512'

; SKX256-NEXT: Cost Model: Found an estimated cost of 24 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 i 16 > undef to < 8 x i 16 > i 64 > i 64

; 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 ; VEC512-LABEL: 'sext512' ; VEC512-NEXT: Cost Model: Found an estimated cost of 24 for instruction: %A = sext <8 x i8> undef to <8 x i64> ; VEC512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %B = sext <8 x i16> undef to <8 x i64> ; VEC512-NEXT: Cost Model: Found an estimated cost of 1 for instruction:  $%C = sext < 8 \times i32 > undef to < 8 \times i32 \times i32 > undef to < 8 \times i32 \times i32 > undef$ i64> ; VEC512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %D = sext <16 x i8> undef to <16 x i32> ; VEC512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %E = sext <16 x i16> undef to <16 x i32> ; VEC512-NEXT: Cost Model: Found an estimated cost of 1 for instruction: %F = sext <32 x i8> undef to <32 x i16> ; VEC512-NEXT: Cost Model: Found an estimated cost of 0 for instruction: ret void %A = sext < 8 x i8 > undef to < 8 x i64 > $B = \text{sext} < 8 \times \text{i16} \text{-} \text{undef to} < 8 \times \text{i64}$ %C = sext < 8 x i 32 > undef to < 8 x i 64 >%D = sext < 16 x i8 > undef to < 16 x i32 >&E = sext < 16 x i 16 >undef to <16 x i 32>%F = sext <32 x i8> undef to <32 x i16> ret void } Copyright (c) 2006 Kirill Simonov

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*
* @(#)COPYRIGHT 8.1 (Berkeley) 3/16/94
*/
; 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 { i8*, i8, % union.anon.0 }
%union.anon.0 = type { i8* }
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 %struct.0* [%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
1
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
1
sw.bb.i17:
                                   ; preds = %.exit
\%0 = bitcast \% struct.0* \% lsr.iv to i32*
%1 = load i32, i32* %0, align 4
unreachable
sw.bb3.i20:
                                   ; preds = % exit
\%2 = bitcast \% struct.0* \% lsr.iv to i8**
%3 = load i8*, i8** %2, align 4
unreachable
exit.2:
                                ; preds = %exit
%cgep22 = getelementptr %struct.0, %struct.0* %lsr.iv, i32 1
br label % while.body
while.end:
                                   ; preds = % entry
ret void
}
attributes #0 = { nounwind optsize "target-cpu"="hexagonv55" }
; RUN: opt %s -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" }

; 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:

; First, extend each i32 to i64

; CHECK-DAG: sshll2.2d [[BLOCK0\_HI:v[0-9]+]], v0, #0 ; CHECK-DAG: sshll2.2d [[BLOCK1\_HI:v[0-9]+]], v1, #0 ; CHECK-DAG: sshll2.2d [[BLOCK2\_HI:v[0-9]+]], v2, #0 ; CHECK-DAG: sshll2.2d [[BLOCK3\_HI:v[0-9]+]], v3, #0 ; CHECK-DAG: sshll.2d [[BLOCK0\_LO:v[0-9]+]], v0, #0 ; CHECK-DAG: sshll.2d [[BLOCK1\_LO:v[0-9]+]], v1, #0 ; CHECK-DAG: sshll.2d [[BLOCK2\_LO:v[0-9]+]], v2, #0 ; CHECK-DAG: sshll.2d [[BLOCK3\_LO:v[0-9]+]], v3, #0

; Next, convert each to double.

```
; CHECK-DAG: scvtf.2d v0, [[BLOCK0_LO]]
; CHECK-DAG: scvtf.2d v1, [[BLOCK0_HI]]
```

; CHECK-DAG: scvtf.2d v2, [[BLOCK1\_LO]]

; CHECK-DAG: scvtf.2d v3, [[BLOCK1\_HI]]

; CHECK-DAG: scvtf.2d v4, [[BLOCK2\_LO]]

; CHECK-DAG: scvtf.2d v5, [[BLOCK2\_HI]]

; CHECK-DAG: scvtf.2d v6, [[BLOCK3\_LO]]

; CHECK-DAG: scvtf.2d v7, [[BLOCK3\_HI]]

; CHECK: ret

```
%flt = sitofp <16 x i32>
%in to <16 x double>
%res = fdiv <16 x double> %flt, <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-DAG: scvtf.2d v0, v0
; CHECK-DAG: scvtf.2d v1, v1
```

```
; CHECK: 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 } # People who have agreed to one of the CLAs and can contribute patches. # The AUTHORS file lists the copyright holders; this file # lists people. For example, Google employees are listed here # but not in AUTHORS, because Google holds the copyright. # # Names should be added to this file only after verifying that # the individual or the individual's organization has agreed to # the appropriate Contributor License Agreement, found here: # # https://developers.google.com/open-source/cla/individual # https://developers.google.com/open-source/cla/corporate # # The agreement for individuals can be filled out on the web. # # When adding J Random Contributor's name to this file, # either J's name or J's organization's name should be # added to the AUTHORS file, depending on whether the # individual or corporate CLA was used. # # Names should be added to this file as: # Name <email address> # # Please keep the list sorted. Albert Pretorius <pretoalb@gmail.com> Arne Beer <arne@twobeer.de> Billy

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; 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 i8*
; CHECK-NEXT: %1 = load volatile i8, i8* %0
; CHECK-NEXT: %[[M1:const mat[0-9]?]] = add i32 %[[C2]], 4
; CHECK-NEXT: %2 = inttoptr i32 %[[M1]] to i8*
; CHECK-NEXT: %3 = load volatile i8, i8* %2
; CHECK-NEXT: %[[M2:const mat[0-9]?]] = add i32 %[[C2]], 31
; CHECK-NEXT: %4 = inttoptr i32 %[[M2]] to i8*
; CHECK-NEXT: %5 = load volatile i8, i8*
%4
; CHECK-NEXT: %6 = inttoptr i32 %[[C1]] to i8*
; CHECK-NEXT: %7 = load volatile i8, i8* %6
; CHECK-NEXT: %[[M3:const_mat[0-9]?]] = add i32 %[[C1]], 7
; CHECK-NEXT: %8 = inttoptr i32 %[[M3]] to i8*
; CHECK-NEXT: %9 = load volatile i8, i8* %8
; CHECK-NEXT: %10 = inttoptr i32 %[[C4]] to i8*
; CHECK-NEXT: store i8 %9, i8* %10
; CHECK-NEXT: %[[M4:const mat[0-9]?]] = add i32 %[[C4]], 31
; CHECK-NEXT: %11 = inttoptr i32 %[[M4]] to i8*
; CHECK-NEXT: store i8 %7, i8* %11
; CHECK-NEXT: %12 = inttoptr i32 %[[C3]] to i8*
; CHECK-NEXT: store i8 %5, i8* %12
; CHECK-NEXT: %[[M5:const mat[0-9]?]] = add i32 %[[C3]], 7
; CHECK-NEXT: %13 = inttoptr i32 %[[M5]] to i8*
; CHECK-NEXT: store i8 %3, i8* %13
; CHECK-NEXT: %[[M6:const mat[0-9]?]] = add i32 %[[C1]], 80
; CHECK-NEXT: %14 = inttoptr i32 %[[M6]] to i8*
; CHECK-NEXT: store i8* %14, i8** @goo
@goo = global i8* undef
define void @foo_i8() {
entry:
\%0 = 10ad \text{ volatile i8}, i8^* \text{ inttoptr } (i32\ 805874688 \text{ to } i8^*)
\%1 = load volatile
i8, i8* inttoptr (i32 805874692 to i8*)
\%2 = 10ad \text{ volatile i8}, i8* \text{ inttoptr (i32 805874719 to i8*)}
\%3 = 10ad \text{ volatile i8}, i8* \text{ inttoptr } (i32\ 805874720 \text{ to } i8*)
\%4 = 10ad \text{ volatile i8}, i8* \text{ inttoptr (i32 805874727 to i8*)}
store i8 %4, i8* inttoptr(i32 805873688 to i8*)
store i8 %3, i8* inttoptr(i32 805873719 to i8*)
store i8 %2, i8* inttoptr(i32 805873720 to i8*)
store i8 %1, i8* inttoptr(i32 805873727 to i8*)
store i8* inttoptr(i32 805874800 to i8*), i8** @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 i16*
; CHECK-NEXT: %1 = load volatile i16, i16* %0, align 2
; CHECK-NEXT: %[[M1:const_mat[0-9]?]] = add i32 %[[C2]], 4
; CHECK-NEXT: %2 = inttoptr i32 %[[M1]] to i16*
; CHECK-NEXT: %3 = load volatile i16, i16* %2, align 2
; CHECK-NEXT: %[[M2:const_mat[0-9]?]] = add i32
%[[C2]], 32
; CHECK-NEXT: %4 = inttoptr i32 %[[M2]] to i16*
; CHECK-NEXT: %5 = load volatile i16, i16* %4, align 2
; CHECK-NEXT: %[[M3:const_mat[0-9]?]] = add i32 %[[C2]], 62
; CHECK-NEXT: %6 = inttoptr i32 %[[M3]] to i16*
; CHECK-NEXT: %7 = load volatile i16, i16* %6, align 2
; CHECK-NEXT: %8 = inttoptr i32 %[[C1]] to i16*
; CHECK-NEXT: %9 = load volatile i16, i16* %8, align 2
; CHECK-NEXT: %[[M4:const mat[0-9]?]] = add i32 %[[C1]], 22
; CHECK-NEXT: %10 = inttoptr i32 %[[M4]] to i16*
; CHECK-NEXT: %11 = load volatile i16, i16* %10, align 2
define void @foo_i16() {
entry:
\%0 = 10 volatile i16, i16* inttoptr (i32 805874688 to i16*), align 2
%1 = load volatile i16, i16* inttoptr (i32 805874692 to i16*), align 2
%2 = load volatile i16, i16* inttoptr (i32 805874720 to i16*), align 2
%3 = load volatile i16, i16* inttoptr (i32 805874750 to i16*), align 2
%4 = load volatile i16, i16* inttoptr (i32 805874752 to i16*), align 2
%5 = load volatile i16, i16* inttoptr (i32 805874774
to i16*), 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 i32*
; CHECK-NEXT: \%1 = \text{load volatile i} 32, i32*\%0, align 4
; CHECK-NEXT: %[[M1:const_mat[0-9]?]] = add i32 %[[C2]], 4
; CHECK-NEXT: %2 = inttoptr i32 %[[M1]] to i32*
; CHECK-NEXT: \%3 = 10ad volatile i32, i32* %2, align 4
; CHECK-NEXT: %[[M2:const_mat[0-9]?]] = add i32 %[[C2]], 124
; CHECK-NEXT: %4 = inttoptr i32 %[[M2]] to i32*
; CHECK-NEXT: %5 = load volatile i32, i32* %4, align 4
```

```
; CHECK-NEXT: %6 = inttoptr i32 %[[C1]] to i32*
; CHECK-NEXT: \%7 = 10 volatile i32, i32* %6, align 4
; CHECK-NEXT: %[[M3:const_mat[0-9]?]] = add i32 %[[C1]], 8
; CHECK-NEXT: %8 = inttoptr i32 %[[M3]] to i32*
; CHECK-NEXT: %9 = load volatile i32, i32* %8, align 4
; CHECK-NEXT: %[[M4:const_mat[0-9]?]] = add i32 %[[C1]],
12
; CHECK-NEXT: %10 = inttoptr i32 %[[M4]] to i32*
; CHECK-NEXT: \%11 = \text{load volatile i} 32, \text{i} 32*\%10, \text{align } 4
define void @foo_i32() {
entry:
\%0 = \text{load volatile i32, i32* inttoptr (i32 805874688 to i32*), align 4}
%1 = load volatile i32, i32* inttoptr (i32 805874692 to i32*), align 4
%2 = load volatile i32, i32* inttoptr (i32 805874812 to i32*), align 4
\%3 = 10 volatile i32, i32* inttoptr (i32 805874816 to i32*), align 4
%4 = load volatile i32, i32* inttoptr (i32 805874824 to i32*), align 4
%5 = load volatile i32, i32* inttoptr (i32 805874828 to i32*), align 4
ret void
}
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```

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; 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) {
%cmp = fcmp ogt fp128 %a, %b
%sub = fsub fp128 %a, %b
ret fp128 %res
; CHECK-LABEL: TestSelect:
; CHECK
          movaps 16(%rsp), %xmm1
; CHECK-NEXT callq __subtf3
; CHECK-NEXT testl %ebx, %ebx
; CHECK-NEXT jg .LBB0_2
; CHECK-NEXT # %bb.1:
; CHECK-NEXT movaps .LCPI0 0(%rip), %xmm0
; CHECK-NEXT .LBB0_2:
; CHECK-NEXT addq $32, %rsp
; CHECK-NEXT popq %rbx
; CHECK-NEXT retq
}
define fp128 @TestFabs(fp128 %a) {
%res = call fp128 @llvm.fabs.f128(fp128 %a)
ret fp128 %res
; CHECK-LABEL: TestFabs:
CHECK
         andps .LCPI1_0(%rip), %xmm0
; CHECK-NEXT retq
}
define fp128 @TestCopysign(fp128 %a, fp128 %b) {
%res = call fp128 @llvm.copysign.f128(fp128 %a, fp128 %b)
ret fp128 %res
; CHECK-LABEL: TestCopysign:
; CHECK andps .LCPI2_1(%rip), %xmm0
; CHECK-NEXT orps %xmm1, %xmm0
; CHECK-NEXT retq
}
define fp128 @TestFneg(fp128 %a) {
%mul = fmul fp128 %a, %a
```

ret fp128 %res

; CHECK-LABEL: TestFneg:

; CHECK movaps %xmm0, %xmm1

```
; CHECK-NEXT callq __multf3
```

; CHECK-NEXT xorps .LCPI3\_0(%rip), %xmm0

- ; CHECK-NEXT popq %rax
- ; CHECK-NEXT retq
- }

## 1.8 cre2 0.3.1

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# Klib: a Generic Library in C

## <a name="overview"></a>Overview

Klib is a standalone and lightweight C library distributed under [MIT/X11 license][1]. Most components are independent of external libraries, except the standard C library, and independent of each other. To use a component of this library, you only need to copy a couple of files to your source code tree without worrying about library dependencies.

Klib strives for efficiency and a small memory footprint. Some components, such as khash.h, kbtree.h, ksort.h and kvec.h, are among the most efficient

implementations of similar algorithms or data structures in all programming languages, in terms of both speed and memory use.

A new documentation is available [here](http://attractivechaos.github.io/klib/) which includes most information in this README file.

#### Common components

\* [khash.h][khash]: generic [hash table][2] with open addressing.

\* [kbtree.h][kbtree]:

generic search tree based on [B-tree][3].

\* [kavl.h][kavl]: generic intrusive [AVL tree][wiki-avl].

\* [ksort.h][ksort]: generic sort, including [introsort][4], [merge sort][5], [heap sort][6], [comb sort][7], [Knuth shuffle][8] and the [k-small][9] algorithm.

\* [kseq.h][kseq]: generic stream buffer and a [FASTA][10]/[FASTQ][11] format parser.

\* kvec.h: generic dynamic array.

\* klist.h: generic single-linked list and [memory pool][12].

\* kstring.{h,c}: basic string library.

\* kmath.{h,c}: numerical routines including [MT19937-64][13] [pseudorandom generator][14], basic [nonlinear programming][15] and a few special math functions.

\* [ketopt.h][ketopt]: portable command-line argument parser with getopt\\_long-like API.

#### Components for more specific use cases

\* ksa.c: constructing [suffix arrays][16] for strings with multiple sentinels, based on a revised [SAIS algorithm][17].

\* knetfile.{h,c}: random access to remote files on HTTP or FTP.

\* kopen.c: smart stream opening.

\*

khmm.{h,c}: basic [HMM][18] library.

\* ksw.(h,c}: Striped [Smith-Waterman algorithm][19].

\* knhx.{h,c}: [Newick tree format][20] parser.

## <a name="methodology"></a>Methodology

For the implementation of generic [containers][21], klib extensively uses C macros. To use these data structures, we usually need to instantiate methods by expanding a long macro. This makes the source code look unusual or even ugly and adds difficulty to debugging. Unfortunately, for efficient generic programming in C that lacks [template][22], using macros is the only solution. Only with macros, we can write a generic container which, once instantiated, compete with a type-specific container in efficiency. Some generic libraries in C, such as [Glib][23], use the `void\*` type to implement containers. These implementations are usually slower and use more memory than klib (see [this benchmark][31]).

To effectively use klib, it is important to understand how it achieves generic programming. We will use the

```
#include "khash.h"
KHASH_MAP_INIT_INT(m32, char)
                                           // instantiate structs and methods
int main() {
  int ret, is_missing;
  khint tk;
  khash_t(m32) *h = kh_init(m32); // allocate a hash table
  k = kh_put(m32, h, 5, \&ret); // insert a key to the hash table
  if (!ret) kh del(m32, h, k);
  kh_value(h, k) = 10;
                              // set the value
  k = kh_get(m32, h, 10);
                                // query the hash table
  is_missing = (k == kh_end(h)); // test if the key is present
  k = kh_get(m32, h, 5);
  kh_del(m32, h, k);
                              // remove a key-value pair
  for (k = kh_begin(h); k != kh_end(h); ++k) // traverse
     if (kh_exist(h, k))
                           // test if a bucket contains data
 kh value(h, k) = 1;
                               // deallocate the hash table
  kh_destroy(m32, h);
  return 0;
}
```

In this example, the second line instantiates a hash table with `unsigned` as

the key type and `char` as the value type. `m32` names such a type of hash table. All types and functions associated with this name are macros, which will be explained later. Macro `kh\_init()` initiates a hash table and `kh\_destroy()` frees it. `kh\_put()` inserts a key and returns the iterator (or the position) in the hash table. `kh\_get()` and `kh\_del()` get a key and delete an element, respectively. Macro `kh\_exist()` tests if an iterator (or a position) is filled with data.

An immediate question is this piece of code does not look like a valid C program (e.g. lacking semicolon, assignment to an \_apparent\_ function call and \_apparent\_ undefined `m32` 'variable'). To understand why the code is correct, let's go a bit further into the source code of `khash.h`, whose skeleton looks like:

```
#define KHASH_INIT(name, SCOPE, key_t, val_t, is_map, _hashf, _hasheq) \
typedef struct { \
    int n_buckets, size, n_occupied, upper_bound; \
    unsigned *flags; \
    key_t *keys; \
    val_t *vals; \
    kh_##name##_t; \
SCOPE inline kh_##name##_t *init_##name() { \
    return (kh_##name##_t*)calloc(1, sizeof(kh_##name##_t)); \
```

```
} \
SCOPE inline int get_##name(kh_##name##_t *h, key_t k) \
.... \
SCOPE inline void destroy_##name(kh_##name##_t *h) { \
if (h) { \
free(h->keys); free(h->flags); free(h->vals); free(h); \
} \
```

```
#define _int_hf(key) (unsigned)(key)
#define _int_heq(a, b) (a == b)
#define khash_t(name) kh_##name##_t
#define kh_value(h, k) ((h)->vals[k])
#define kh_begin(h, k) 0
#define kh_end(h) ((h)->n_buckets)
#define kh_init(name) init_##name()
#define kh_get(name, h, k) get_##name(h, k)
#define kh_destroy(name, h) destroy_##name(h)
...
#define KHASH_MAP_INIT_INT(name, val_t) \
KHASH_INIT(name, static, unsigned, val_t, is_map, _int_hf, _int_heq)
```

`KHASH\_INIT()` is a huge macro defining all the structs and methods.

When this

macro is called, all the code inside it will be inserted by the [C preprocess][37] to the place where it is called. If the macro is called multiple times, multiple copies of the code will be inserted. To avoid naming conflict of hash tables with different key-value types, the library uses [token concatenation][36], which is a preprocessor feature whereby we can substitute part of a symbol based on the parameter of the macro. In the end, the C preprocessor will generate the following code and feed it to the compiler (macro `kh\_exist(h,k)` is a little complex and not expanded for simplicity):

```
typedef struct {
    int n_buckets, size, n_occupied, upper_bound;
    unsigned *flags;
    unsigned *keys;
    char *vals;
} kh_m32_t;
static inline kh_m32_t *init_m32() {
    return (kh_m32_t*)calloc(1, sizeof(kh_m32_t));
}
static inline int get_m32(kh_m32_t *h, unsigned k)
...
static inline void destroy_m32(kh_m32_t *h) {
    if (h) {
```

```
free(h->keys); free(h->flags); free(h->vals); free(h);
}
```

```
int main() {
int ret, is_missing;
khint tk;
kh_m32_t *h = init_m32();
k = put_m32(h, 5, \&ret);
if (!ret) del m32(h, k);
h - vals[k] = 10;
k = get_m 32(h, 10);
is missing = (k == h -> n \text{ buckets});
k = get_m 32(h, 5);
del_m32(h, k);
for (k = 0; k != h > n \text{ buckets}; ++k)
 if (kh_exist(h, k)) h->vals[k] = 1;
destroy m32(h);
return 0;
}
```

This is the C program we know.

From this example, we can see that macros and the C preprocessor plays a key role in klib. Klib is fast partly because the compiler knows the key-value type at the compile time and is able to optimize the code to the same level as type-specific code. A generic library written with `void\*` will not get such performance boost.

Massively inserting code upon instantiation may remind us of C++'s slow compiling speed and huge binary size when STL/boost is in use. Klib is much better in this respect due to its small code size and component independency.

Inserting several hundreds lines of code won't make compiling obviously slower.

## <a name="resources"></a>Resources

\* Library documentation, if present, is available in the header files. Examples can be found in the [test/][24] directory.

\* \*\*Obsolete\*\* documentation of the hash table library can be found at

[SourceForge][25]. This README is partly adapted from the old documentation.

\* [Blog post][26] describing the hash table library.

\* [Blog post][27] on why using `void\*` for generic programming may be inefficient.

\* [Blog post][28] on the generic stream buffer.

\* [Blog post][29] evaluating the performance of `kvec.h`.

\* [Blog post][30] arguing B-tree may be a better data structure than a binary search tree.

\* [Blog post][31] evaluating the performance of `khash.h` and `kbtree.h` among many other implementations. [An older version][33] of the benchmark is also available. \* [Blog post][34] benchmarking internal sorting algorithms and implementations.

\* [Blog post][32]

on the k-small algorithm.

\* [Blog post][35] on the Hooke-Jeeve's algorithm for nonlinear programming.

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[3]: http://en.wikipedia.org/wiki/B-tree

[4]: http://en.wikipedia.org/wiki/Introsort

[5]: http://en.wikipedia.org/wiki/Merge\_sort

[6]: http://en.wikipedia.org/wiki/Heapsort

[7]: http://en.wikipedia.org/wiki/Comb\_sort

[8]: http://en.wikipedia.org/wiki/Fisher-Yates\_shuffle

[9]: http://en.wikipedia.org/wiki/Selection\_algorithm

[10]: http://en.wikipedia.org/wiki/FASTA\_format

[11]: http://en.wikipedia.org/wiki/FASTQ\_format

[12]: http://en.wikipedia.org/wiki/Memory\_pool

[13]: http://en.wikipedia.org/wiki/Mersenne\_twister

[14]: http://en.wikipedia.org/wiki/Pseudorandom\_generator

[15]: http://en.wikipedia.org/wiki/Nonlinear\_programming

[16]: http://en.wikipedia.org/wiki/Suffix\_array

[17]: https://sites.google.com/site/yuta256/sais

[18]: http://en.wikipedia.org/wiki/Hidden\_Markov\_model

[19]: http://en.wikipedia.org/wiki/Smith-Waterman\_algorithm

[20]:

http://en.wikipedia.org/wiki/Newick\_format

[21]: http://en.wikipedia.org/wiki/Container\_(abstract\_data\_type)

[22]: http://en.wikipedia.org/wiki/Template\_(C%2B%2B)

[23]: http://en.wikipedia.org/wiki/GLib

[24]: https://github.com/attractivechaos/klib/tree/master/test

[25]: http://klib.sourceforge.net/

[26]: http://attractivechaos.wordpress.com/2008/09/02/implementing-generic-hash-library-in-c/

[27]: http://attractivechaos.wordpress.com/2008/10/02/using-void-in-generic-c-programming-may-be-inefficient/

[28]: http://attractivechaos.wordpress.com/2008/10/11/a-generic-buffered-stream-wrapper/

[29]: http://attractivechaos.wordpress.com/2008/09/19/c-array-vs-c-vector/

[30]: http://attractivechaos.wordpress.com/2008/09/24/b-tree-vs-binary-search-tree/

[31]: http://attractivechaos.wordpress.com/2008/10/07/another-look-at-my-old-benchmark/

[32]: http://attractivechaos.wordpress.com/2008/09/13/calculating-median/

[33]: http://attractivechaos.wordpress.com/2008/08/28/comparison-of-hash-table-libraries/

[34]:

http://attractivechaos.wordpress.com/2008/08/28/comparison-of-internal-sorting-algorithms/

[35]: http://attractivechaos.wordpress.com/2008/08/24/derivative-free-optimization-dfo/

[36]: http://en.wikipedia.org/wiki/C\_preprocessor#Token\_concatenation

[37]: http://en.wikipedia.org/wiki/C\_preprocessor

[wiki-avl]: https://en.wikipedia.org/wiki/AVL\_tree

[kbtree]:

http://attractivechaos.github.io/klib/#KBtree%3A%20generic%20ordered%20map:%5B%5BKBtree%3A%20generi c%20ordered%20map%5D%5D

#### [khash]:

http://attractivechaos.github.io/klib/#Khash%3A%20generic%20hash%20table:%5B%5BKhash%3A%20generic%20hash%20table%5D%5D

#### [kseq]:

http://attractivechaos.github.io/klib/#Kseq%3A%20stream%20buffer%20and%20FASTA%2FQ%20parser:%5B%5 BKseq%3A%20stream%20buffer%20and%20FASTA%2FQ%20parser%5D%5D

[ksort]: http://attractivechaos.github.io/klib/#Ksort%3A%20sorting%2C%20shuffling%2C%20heap%20and%20k-small:%5B%5BKsort%3A%20sorting%2C%20shuffling%2C%20heap%20and%20k-small%5D%5D [kavl]:

http://attractivechaos.github.io/klib/#KAVL%3A%20generic%20intrusive%20AVL%20tree [ketopt]: http://attractivechaos.github.io/klib/#Ketopt%3A%20parsing%20command-line%20arguments

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tomb - support for clean goroutine termination in Go.

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## 1.13 x-net 747e238

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## 1.15 sqlite 3.35.3

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## 1.17 libxml2 2.9.12

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# 1.18 avflt 1.5

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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.

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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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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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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

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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.

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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

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llvm/autoconf

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Google Test llvm/utils/unittest/googletest

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Written by:Philip HazelEmail local part:ph10Email domain:cam.ac.uk

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