CS443: Compiler Construction

Lecture 6: Flattening Expressions, Basic Control Flow

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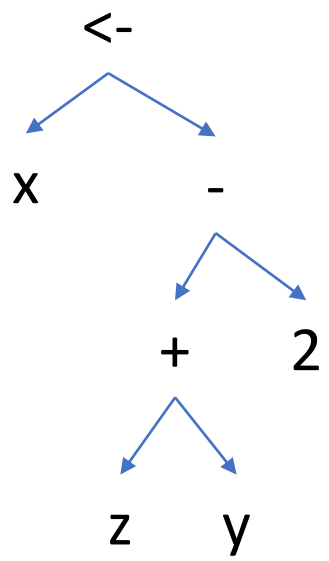
Flattening expressions

```
x <- y + z - 2  → %temp = add i32 %y %z
                  %x = sub i32 %temp 2
```



One approach: destination passing

```
let rec compile_exp (dest: var) (e: exp) : inst list =
  match e with
  | ENum n -> [dest = set n]
  | EUnop (UNeg, e1) ->
     let dest1 = new_temp () in
     (compile_exp dest1 e1) @ [dest = sub 0 dest1]
   | EAssign (EVar v, e1) ->
     (compile_exp v e1) @ (* … need to copy v to dest *)
```

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let rec compile_exp (dest: var) (e: exp) : inst list =
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```

```
x <- y + z – 2
```

```
temp1 = set y
temp2 = set z
temp3 = add temp1 temp2
temp4 = set 2
x = sub temp3 temp4
```

Another approach

```
let rec compile_exp (e: exp) : inst list * value =
  match e with
  | ENum n -> [], n
  | EBinop (BAdd, e1, e2) ->
     let (is1, v1) = compile_exp e1 in
     let (is2, v2) = compile_exp e2 in
     let d = new_temp () in
     (is1 @ is2 @ [d = add v1 v2], d)
   | EAssign (EVar v, e1) ->
     let (is, d) = compile_exp e1 in
              (is @ [v = set d], v)
```

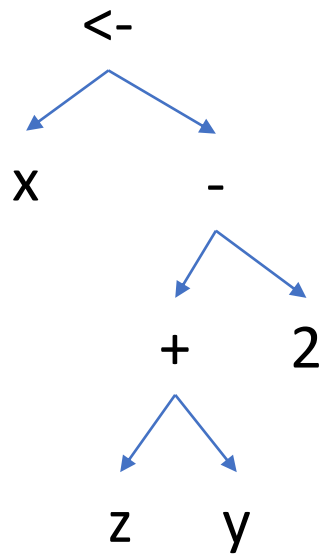
Another approach

```
let rec compile_exp (e: exp) : inst list * value =
  match e with
  | ENum n -> [], n
  | EBinop (BAdd, e1, e2) ->
     let (is1, v1) = compile_exp e1 in
     let (is2, v2) = compile_exp e2 in
     let d = new_temp () in
     (is1 @ is2 @ [d = add v1 v2], d)
   | EAssign (EVar v, e1) ->
     let (is, d) = compile_exp e1 in
            (is @ [v = set d], v)
```

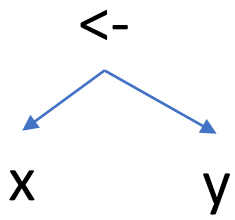
```
x <- y + z – 2
```

```
temp1 = add y z
temp2 = sub temp1 2
x = set temp2
```

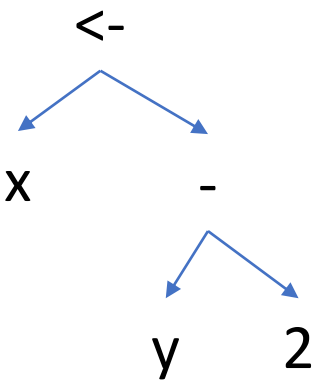
A somewhat better approach: Maximal Munch



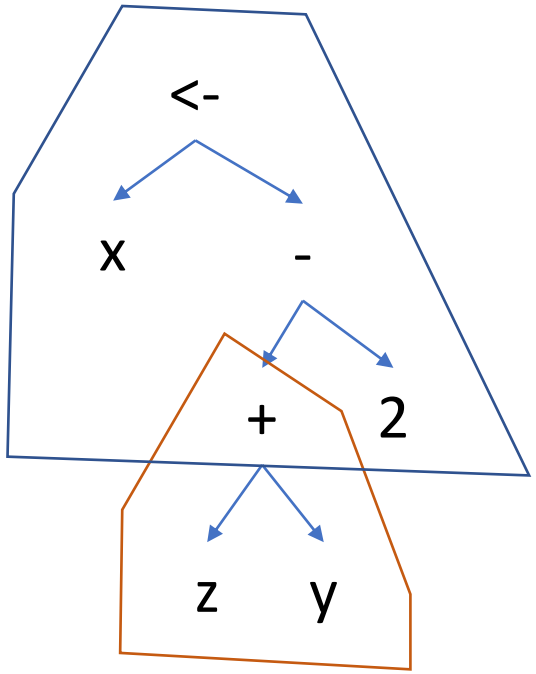

```
x = set y
```




```
x = sub y 2
```



A somewhat better approach: Maximal Munch




```
temp1 = add z y
x = sub temp1 2
```

(In practice, doesn't matter a lot)

Boolean operators should short-circuit!

```
LOGICAL RESULT
RESULT <- 1 > 0 OR 42 / 0 = 2
```

Idea: Compile Boolean expressions into code that jumps to one of two labels

```
compile_bexpr(bexpr : exp, tdest : label, fdest : label)

compile_bexpr(x < 10, tdest, fdest) =
  %temp = icmp lt i32 %x 10
  br i1 %temp, label tdest, label fdest
```

Idea: Compile Boolean expressions into code that jumps to one of two labels

```
compile_bexpr(bexpr : exp, tdest : label, fdest : label)

compile_bexpr(e1 AND e2, tdest, fdest) =
    compile_bexpr(e1, %e1true, fdest)
  e1true:
    compile_bexpr(e2, tdest, fdest)
```

Idea: Compile Boolean expressions into code that jumps to one of two labels

```
compile_bexpr(bexpr : exp, tdest : label, fdest : label)

compile_bexpr(e1 OR e2, tdest, fdest) =
    compile_bexpr(e1, tdest, %e1false)
  e1false:
    compile_bexpr(e2, tdest, fdest)
```

If/then compile to conditional jumps

```
IF x < 10 s1 ELSE s2

  %temp = icmp lt i32 %x 10
  br i1 %temp, label %label1, label %label2
label1:
  (Compilation of s1)
  br label %label3
label2:
  (Compilation of s2)
  br label %label3
label3: …
```

looks like output of compile_bexpr…

While loops have a backward jump

```
WHILE x < 10 s1

testl:
  %temp = icmp lt i32 %x 10
  br i1 %temp, label %bodyl, label %donel
bodyl:
  (compilation of s1)
  br label %testl
donel:
```

Unconditional jump back to test (NOT start of body!)

Example

```
WHILE x = 0 OR 10 / x > 2    x <- x + 1
```

```
test:
  %temp1 = icmp eq i32 %x 0
  br i1 %temp1, label %body, label %xnezero
xnezero:
  %temp2 = sdiv 10 i32 %x
  %temp3 = icmp gt i32 %temp2 2
  br i1 %temp3, label %body, label %done
```

(Probably) Not SSA!

```
body:
  %x = add i32 %x 1
  br label %test
done:
```