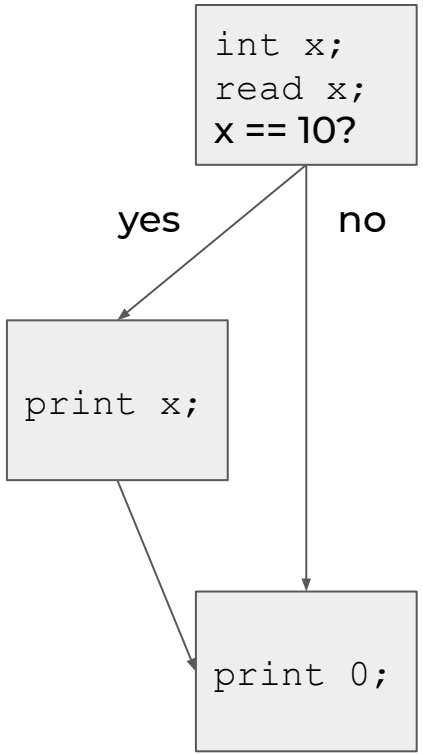
UCF | College of Engineering and Computer Science
UNIVERSITY OF CENTRAL FLORIDA

Code Generation for Control Flow

COP-3402 Systems Software
Paul Gazzillo

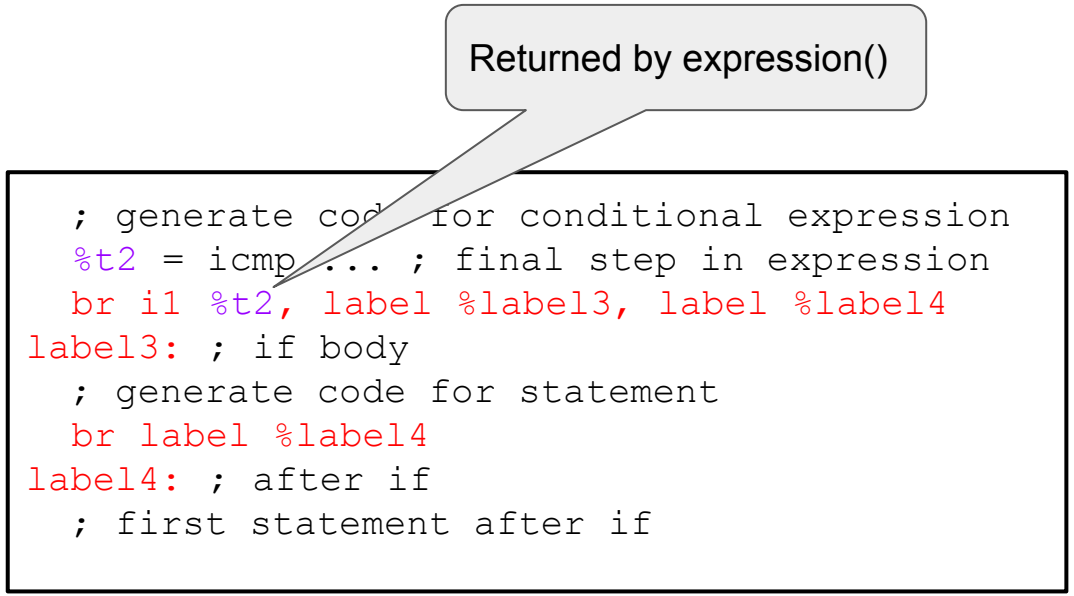
If Statements as a Flow Chart

```
int x;
read x;
if (x == 10) {
  print x;
}
print 0;
```



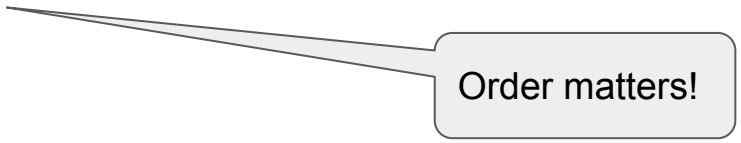
Template for If Statements

```
int x;
read x;
if (x == 10) {
  print x;
}
print 0;
```



Pseudo-Code for If Statements

```
ifstatement():
  consume(IF)
  consume(LPAREN)
  cond = expression()
  consume(RPAREN)
  body = newlabel()
  end = newlabel()
  emit "br i1" cond ", label" body ", label" end
  emit body ":"
  statement()
  emit end ":"
```



Generating Labels

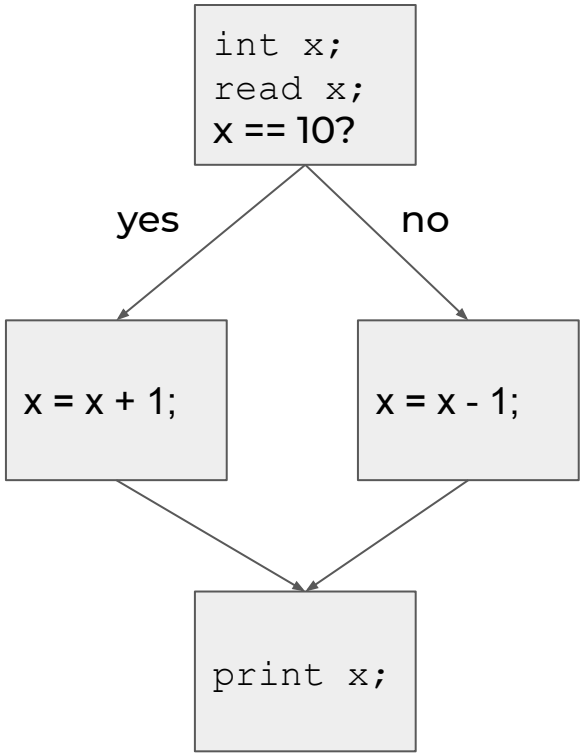
- Like variables, labels can only be defined once
- Generate just like temporary registers, e.g.,
  - label1, label2, label3
  - ifbranch1, elsebranch1, etc

Curly Braces

- Compound statement is just another statement
  - example: use it by itself without an if
- Defines nesting level, scope
- Tip: always use curly braces
  - https://nakedsecurity.sophos.com/2014/02/24/anatomy-of-a-goto-fail-apples-ssl-bug-explained-plus-an-unofficial-patch/

If-Then-Else Statements as a Flow Chart

```
int x;
read x;
if (x == 10) {
   x = x + 1;
} else {
   x = x - 1;
}
print x;
```



Template for If-Then-Else Statements

```
int x;
read x;
if (x == 10) {
  x = x + 1;
} else {
  x = x - 1;
}
print x;
```

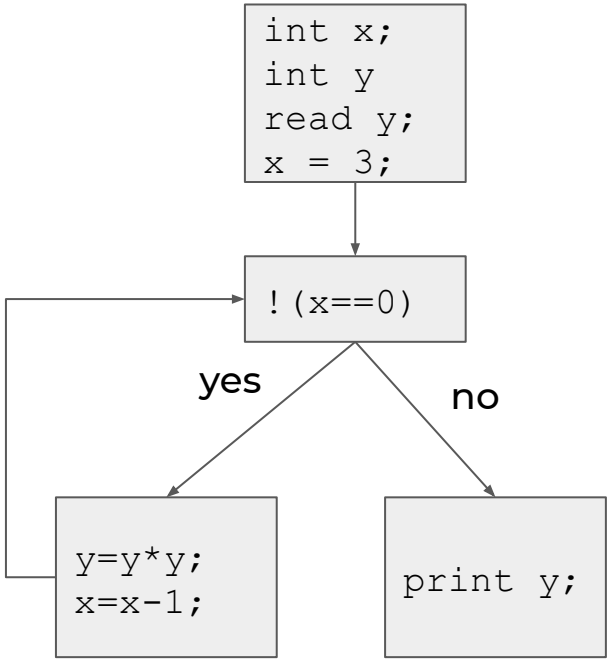
```
  ; generate code for conditional expression
  %t2 = icmp ... ; final step in expression
  br i1 %t2, label %label3, label %label4
label3: ; if body
  ; generate code for statement
  br label %label5
label4: ; else body
  ; generate code for statement
  br label %label5
label5: ; after if-then-else
  ; first statement after if-then-else
```

Pseudo-Code for If-Then-Else Statements

```
ifthenelsestatement():
  consume(IF)
  consume(LPAREN)
  cond = expression()
  consume(RPAREN)
  ifbody = newlabel()
  elsebody = newlabel()
  end = newlabel()
  emit "br i1" cond ", label" ifbody ", label" elsebody
  emit ifbody ":"
  statement()
  consume(ELSE)
  emit elsebody ":"
  statement()
  emit end ":"
```

While Statements as a Flow Chart

```
int x;
int y;
read y;
x = 3;
while (!(x == 0)) {
   y = y * y;
   x = x - 1;
}
print y;
```



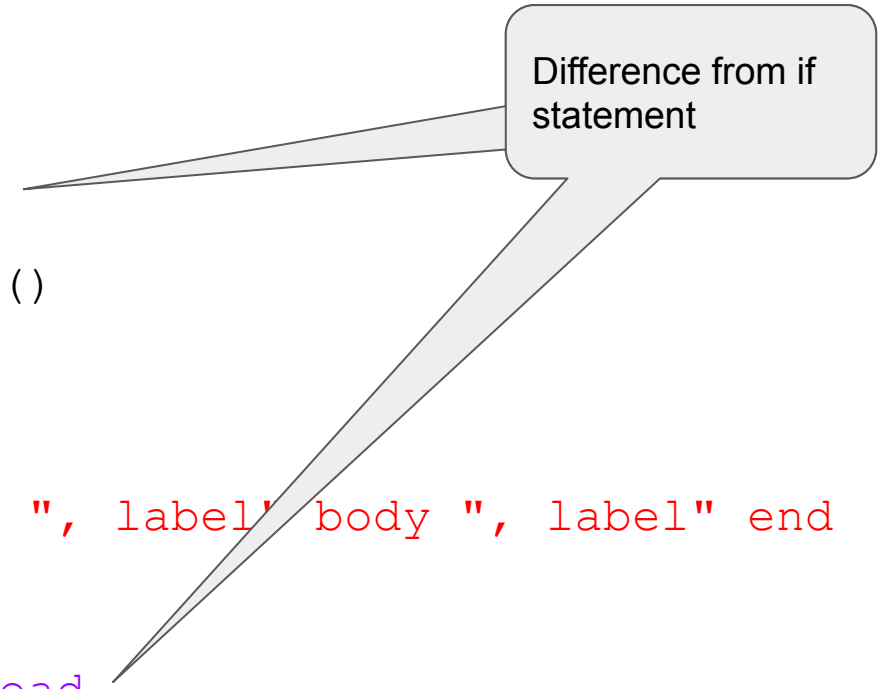
Template for While Statements

```
int x;
int y;
read y;
x = 3;
while (!(x == 0)) {
  y = y * y;
  x = x - 1;
}
print y;
```

```
  ; statements before while loop
label2: ; head of while loop
  ; generate code for conditional expression
  %t3 = icmp ... ; final step in expression
  br i1 %t3, label %label4, label %label5
label4: ; while body
  ; generate code for statement
  br label %label2
label5: ; after while
  ; first statement after while
```

Pseudo-Code for While Statements

```
whilestatement():
   consume(WHILE)
   consume(LPAREN)
   head = newlabel()
   emit head ":"
   cond = expression()
   consume(RPAREN)
   body = newlabel()
   end = newlabel()
   emit "br i1" cond ", label" body ", label" end
   emit body ":"
   statement()
   emit "br label" head
   emit end ":"
```



Demo: Code Generation

```
int x;
int y;
x = 3;
read y;
while (x != 0) {
  if (y % 2 = 0)
    print y;
  else
    print y * 2;
  x = x - 1;
  y = y + 1;
}
```