CSE 142
Computer Programming I

Conditionals

Overview

Concepts this lecture

- Conditional execution
- if statement
- Conditional expressions
- Relational and logical operators
- {Compound statements}

Related Reading

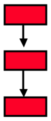
Read Sections 4.1-4.5, 4.7-4.9

- 4.1: Control structure preview
- 4.2: Relational and logical operators
- 4.3: *if* statements
- 4.4: Compound statements
- 4.5: Example
- 4.7: Nested *if* statements

Control Flow

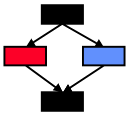
“Control flow” is the order in which statements are executed

Until now, control flow has been sequential -- the next statement executed is the next one that appears, in order, in the C program

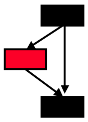


Conditional Control Flow

choosing which of two (or more) statements to execute before continuing



choosing whether or not to to skip a statement before continuing



Conditional Execution

A conditional statement allows the computer to choose an execution path depending on the value of a variable or expression

- if the withdrawal is more than the bank balance, then print an error
- if today is my birthday, then add one to my age
- if using whole milk, add two eggs, otherwise add three eggs

Conditional ("*if* ") Statement

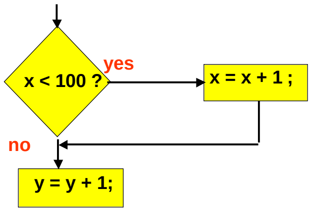
if (condition) statement;

The statement is executed if and only if the condition is true.

```
if (withdrawalAmount > balance)
        printf( “Not enough money\n”);
if (temperature > 98.6)
        printf(“You have a fever.\n”);
if (x < 100) x = x + 1;
```

Conditional Flow Chart

if (x < 100) x = x + 1 ;
y = y + 1;



Conditions

In parentheses is a condition, also called a “logical” or “Boolean” expression

Made up of variables, constants, arithmetic expressions, and the relational operators

Math symbols: < , ≤, >, ≥ , = , ≠
in C: < ,<=, > , >= , == , !=

Conditional Expressions

air_temperature > 80.0
98.6 <= body_temperature
marital_status == ‘M’
divisor != 0

Such expressions are used in “if” statements and numerous other places in C.

Value of Conditional Expressions

What is the value of a conditional expression??

Answer: we think of it as TRUE or FALSE

Value of Conditional Expressions

What is the value of a conditional expression??

Answer: we think of it as TRUE or FALSE

Under the hood in C, it’s really an integer

FALSE is 0 (and 0 is FALSE)

TRUE is any value other than 0 *(and non-zero is TRUE)*

1 is the result of a true relational operator (e.g., 4 < 7 evaluates to 1)

Complex Conditionals

if I have at least $15 or you have at least $15, then we can go to the movies

if the temperature is below 32 degrees and it’s raining, then it’s snowing

if it’s not the case that it’s Saturday or Sunday, then it’s a work day

Complex Conditionals in C

We use Boolean operators to code complex conditionals in C.

We’ll say lots more about this later! For now, here is some information for reference.

Boolean operators	&&	||	!
	and	or	not

```
#define    TRUE     1
#define    FALSE    0
```

```
if (myMoney>=15.0 || yourMoney>=15.0)
        canGoToMovies = TRUE;
```

Multiple Actions

What if there’s more than one conditional action?

“If your temperature is high, then you have a fever and should take two aspirin and go to bed and call in sick tomorrow”

Compound Statement

Groups together statements so that they are treated as a single statement:

```
{
        statement1 ;
        statement2 ;
        ...
}
```

Also called a "block."

Highly useful

Not just in conditionals, but many places in C

Using a Compound Statement

```
if ( temperature > 98.6 ) {
    printf ( “You have a fever. \n” );
    aspirin  =  aspirin – 2 ;
    printf (“Go to bed\n”);
    printf (“Sleep in tomorrow\n”);
}
```

Combining and Substituting Statements

You may use a compound statement anywhere that a single statement may be used

Anywhere that a statement is allowed in C, any kind of statement can be used

A compound statement can contain any number of statements (including 0)

Among other things, these principles imply that compound statements can be nested to any depth

Another Compound Example

Cash machine program fragment:

```
if (balance >= withdrawal){
    balance = balance – withdrawal;
    dispense_funds(withdrawal);
}
```

What if () omitted?
What if {} omitted?

Finding Absolute Value (1)

Problem: Compute the absolute value |x| of x and put the answer in variable *abs*. Here are three solutions, all correct:

```
if (x >= 0) abs = x;
if ( x < 0 ) abs =  -x;
```

Finding Absolute Value (2)

Problem: Compute the absolute value |x| of x and put the answer in variable *abs*. Here are three solutions, all correct:

```
if (x >= 0) abs = x;          abs = x;
if ( x < 0 ) abs =  -x;       if ( x < 0 ) abs  = -x;
```

Finding Absolute Value (3)

Problem: Compute the absolute value |x| of x and put the answer in variable *abs*. Here are three solutions, all correct:

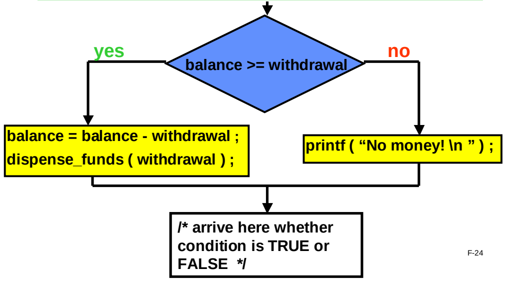
```
if (x >= 0) abs = x;          abs = x;
if ( x < 0 ) abs =  -x;       if ( x < 0 ) abs  = -x;

                  if (x >= 0) abs = x;
                  else abs = -x;
```

if - else

Print error message only if the condition is false:

```
if ( balance >= withdrawal ) {
   balance = balance - withdrawal ;
   dispense_funds ( withdrawal ) ;
}  <------------ no ; here
else {
   printf ( “Insufficient Funds! \n ” ) ;
}
```

if-else Control Flow



yes

balance >= withdrawal

no

balance = balance - withdrawal ;
dispense_funds (withdrawal) ;

printf (“No money! \n ”) ;

/* arrive here whether condition is TRUE or FALSE */

Nested *if* Statements

```
#define BILL_SIZE  20
if ( balance >= withdrawal ) {
    balance = balance - withdrawal ;
    dispense_funds ( withdrawal ) ;
} else {
    if ( balance >= BILL_SIZE )
          printf ( “Try a smaller amount. \n ” ) ;
    else printf ( “Go away! \n ” ) ;
}
```

Nested *ifs* , Part II

```
if ( x == 5 ) {
     if  ( y == 5 ) printf ( “Both are 5. \n ”) ;
     else printf ( “x is 5, but y is not. \n ”) ;
} else {
     if  ( y == 5 ) printf ( “y is 5, but x is not. \n ”) ;
     else printf ( “Neither is 5. \n ”) ;
}
```

Tax Table Example

Problem: Print the % tax based on income:

income	tax
< 15,000	0%
15,000, < 30,000	18%
30,000, < 50,000	22%
50,000, < 100,000	28%
100,000	31%

Direct Solution

```
if ( income < 15000 ) {
     printf( “No tax.” );
}
if ( income >= 15000 && income < 30000 ) {
     printf(“18%% tax.”);
}
if ( income >= 30000 && income < 50000 ) {
     printf(“22%% tax.”);
}
if ( income >= 50000 && income < 100000 ) {
     printf(“28%% tax.”);
}
if ( income >=100000) {
    printf(“31%% tax.”);
}
```

Mutually exclusive conditions - only one will be true

Cascaded ifs

```
if ( income < 15000 ) {
      printf( “No tax” );
} else {
      if ( income < 30000 ) {
         printf( “18%% tax.” );
      } else {
         if ( income < 50000 ) {
            printf( “ 22%% tax.” );
         } else {
            if ( income < 100000 ) {
               printf( “28%% tax.” );
            } else {
               printf( “31%% tax.” );
            }
         }
      }
}
```

```
if ( income < 15000 ) {
      printf( “No tax” );
} else if ( income < 30000 ) {
      printf( “18%% tax.” );
} else if ( income < 50000 ) {
      printf( “ 22%% tax.” );
} else if ( income < 100000 ) {
      printf( “28%% tax.” );
} else
      printf( “31%% tax.” );
}
```

Order is important. Conditions are evaluated in order given.

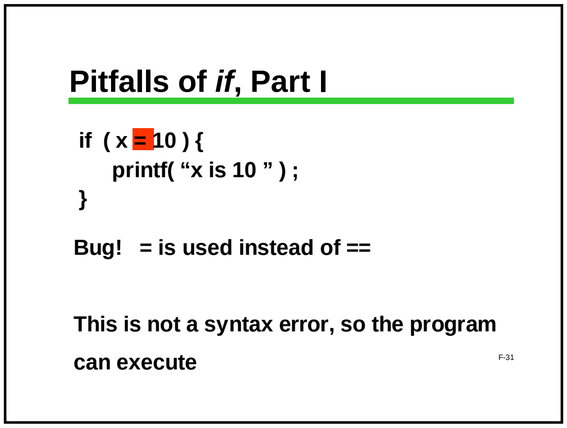
Warning: Danger Ahead

The idea of conditional execution is natural , intuitive, and highly useful

However...

Programs can get convoluted and hard to understand

There are syntactic pitfalls to avoid



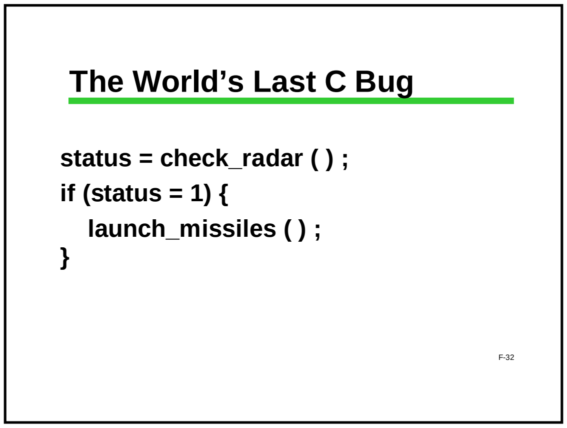
Pitfalls of *if*, Part I

```
if  ( x = 10 ) {
     printf( “x is 10 ” ) ;
}
```

Bug!   = is used instead of ==

This is not a syntax error, so the program can execute

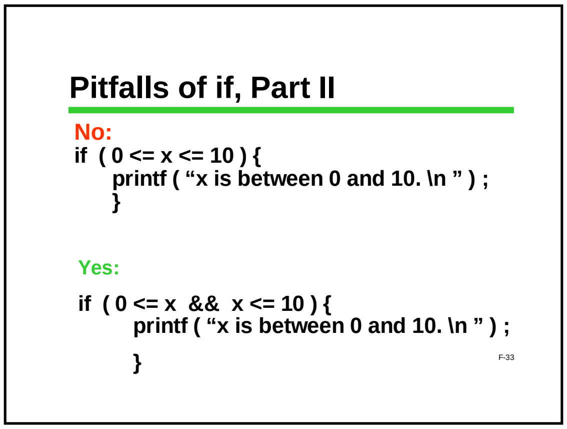
F-31



The World’s Last C Bug

```
status = check_radar ( ) ;
if (status = 1) {
    launch_missiles ( ) ;
}
```

F-32



Pitfalls of if, Part II

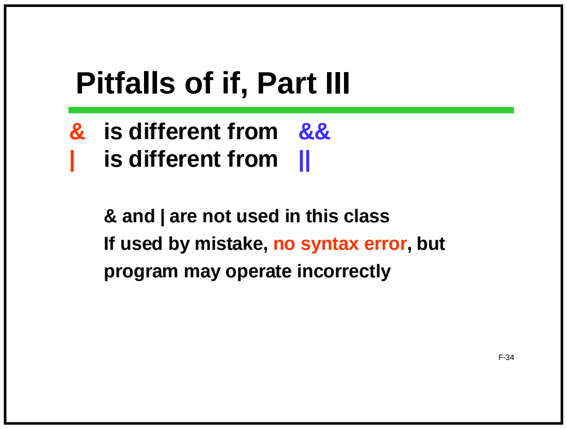
No:

```
if  ( 0 <= x <= 10 ) {
     printf ( “x is between 0 and 10. \n ” ) ;
     }
```

Yes:

```
if  ( 0 <= x  &&  x <= 10 ) {
        printf ( “x is between 0 and 10. \n ” ) ;
        }
```

F-33

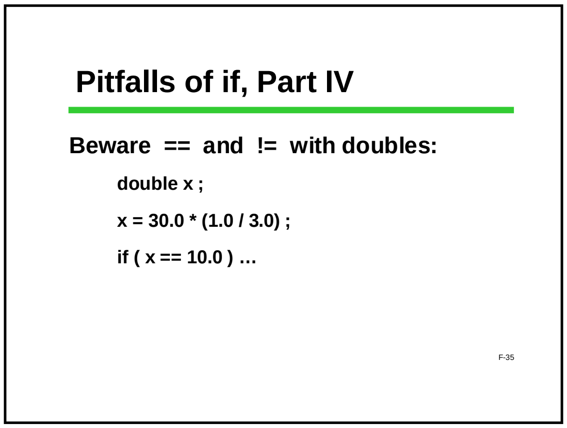


Pitfalls of if, Part III

&   is different from   &&
| is different from ||

& and | are not used in this class
If used by mistake, no syntax error, but program may operate incorrectly

F-34

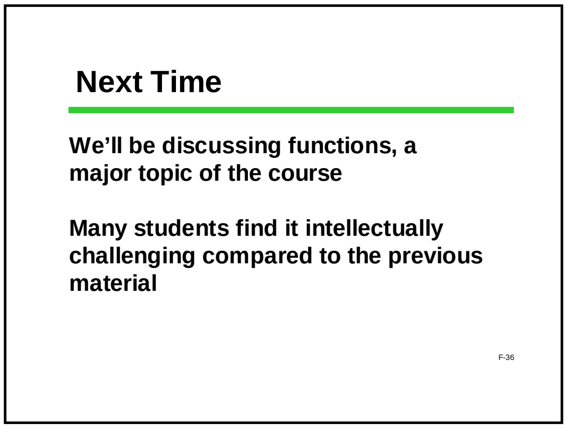


Pitfalls of if, Part IV

Beware == and != with doubles:

```
double x ;
x = 30.0 * (1.0 / 3.0) ;
if ( x == 10.0 ) …
```

F-35



Next Time

We’ll be discussing functions, a major topic of the course

Many students find it intellectually challenging compared to the previous material

F-36