

Program Flow Controls and If Statements

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Computer Science 106

Computing in Engineering and Science

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Northridge

Lab Schedule

- Posted on classroom door and on web <http://python.ecs.csun.edu/compsci/labhours/1600.pdf>
- Afternoons and evenings after class are free until 9:30 pm
- Monday and Wednesday afternoon and evening (12:30 to 9:30 pm) are open
- Friday is open from 10 am to 3 pm
- See schedule for mornings

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Outline

- Review last week
 - Formatting and file input/output
- Program flow controls
 - Sequence
 - Choice (if statements)
 - Looping
 - Functions
- If statements and type bool variables

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Review Formatting and Files

- Use manipulators in output statements
 - Requires use of `#include<iomanip>`
 - Know how to use **fixed/scientific** for appearance, **setw(w)** for width and **setprecision(p)** to set significant figures
- Use input and output files
 - `#include<fstream>`
 - `ifstream` and `ofstream` link program and operating system file names
 - Program file names replace `cin` and `cout`

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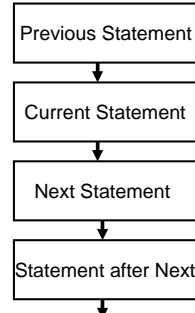
Program Control

- Basic operation is sequential
- Statements executed in order listed
 - Not so simple as it seems
 - Remember that statements are not equations, but actions taken by computer
 - What does `cout >> x; x = 2;` give?
- Other controls change order of operations
 - Choice, loop, function

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Sequential Flow



- Statements are normally executed in sequential order but you must have the correct sequence

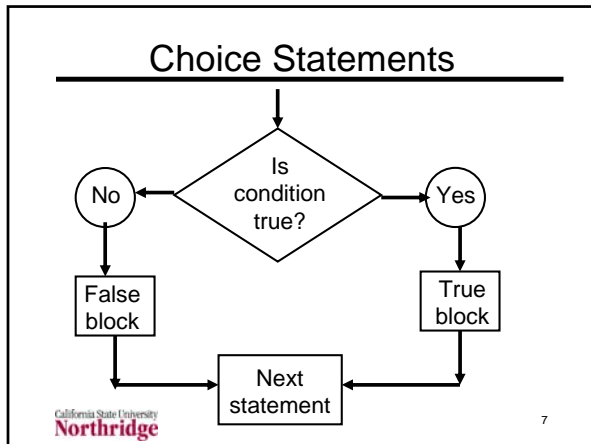
• What is wrong with

```

y = x * x;
cin >> x;
cout << y;
  
```

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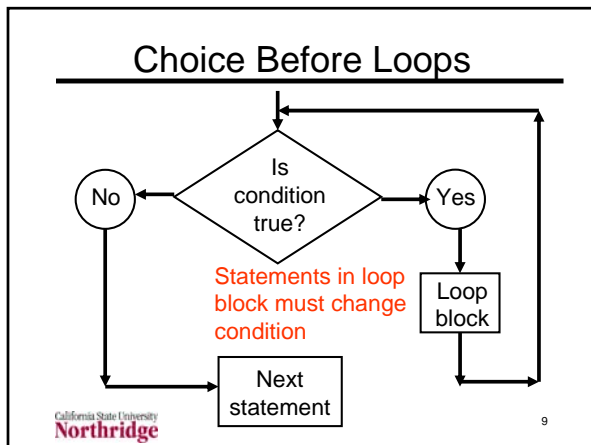


Choice Statements

- Translate from simple questions into computer code
- Does an employee qualify for overtime?
 - Yes: compute pay including overtime
 - No: compute regular pay
- Does a student qualify for the dean's list this semester?
 - Yes: Add students name to dean's list
 - No: No action required
- Is $b^2 < 4ac$?

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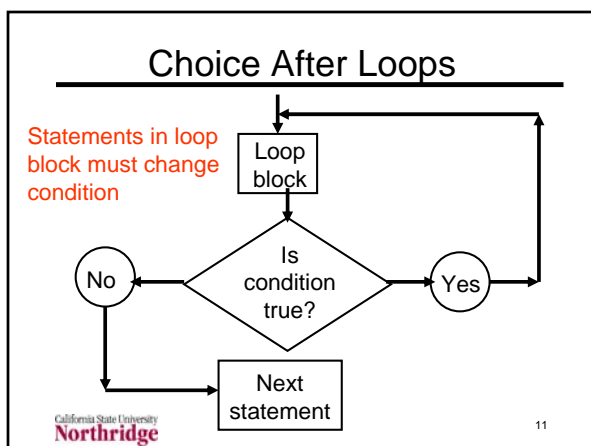


Choice Before Loop Examples

- Are there more data to read on the file of employee work data?
 - Yes: Read data, compute wages and print check for next employee on the file
- Is the error in a trial-and-error calculation too large?
 - Yes: Do another iteration and compute the error for the current iteration
- A "No" answer exits the loop

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Choice After Loop Example

- Make the initial guess for a trial-and-error calculation
- Start the loop for a trial and error calculation
 - Calculate the next iteration value and compute the error for the current iteration
 - Is the error too large?
 - Yes: Do another iteration
- A "No" answer exits the loop

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Function

- Transfer control and “input” data to separate part of program
- Return control and “output” results

Math library functions are an example
You will create your own functions later

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Function Examples

- Mathematical library functions accept input data, compute and return results
 - pow(n, p), atan(x), exp(value), ...
- Dean’s list function
 - Accepts data on student status (graduate or undergraduate), units taken, and GPA
 - Determines if student meets qualifications for being on dean’s list
 - Returns value of true or false

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Combination of Controls

- Can have nested controls
- Consider a program that looks at data for all students to find which ones made the dean’s list
 - Use a loop to access record for every student
 - Call a function to determine if student made dean’s list
 - Function has choice statements

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if Statements

- Implementation of choice statements in most high-level languages uses an if statement
- The C++ format is

```
if (<condition>)
{
    <statements done if condition true>
}
```

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What is a Condition?

- A condition is an expression that evaluates to a **boolean** value of true or false
- Use relational operators to set conditions with variables
 - Greater than > Equal to ==
 - Less than < Not equal to !=
 - Greater than or equal to >=
 - Less than or equal to <=

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Examples of Conditions

- hours > 40
- year % 4 == 0
- name != “Smith”
- double x, y, z;
- x == y // may not give what you think
- fabs(x - y) <= 1e-14 * fabs(x + y)
- What is difference between the last two conditions?
 - If x = 1.23456789012345 and y = 1.23456789012344, x==y is false but second condition is true

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Condition Quiz

- What condition tests to see if a variable, x, is not equal to zero?
 - $x \neq 0$ or $!(x == 0)$
- What condition tests to see if the expression $b^2 - 4ac$ is less than zero?
 - $b * b - 4 * a * c < 0$
- What is the opposite of this condition?
 - $b * b - 4 * a * c >= 0$

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More on Relational Operators

- Have lower precedence than arithmetic operators
 - $X + 1 > 10$ is true if $X > 9$
- Operators $>$, $<$, $>=$, and $<=$ have same precedence
- Operators $==$ and $!=$ have same precedence
- Operators $>$, $<$, $>=$, $<=$, have higher precedence than $==$ and $!=$

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Logical Operators

- Use **boolean** results that are true or false to get a combined condition
- The temperature is less than 20°F and the wind speed is more than 30 mph
- Logical operators (precedence order)
 - Not ! And && Or ||
 - Example: $temp < 20 \ \&\& \ wind > 30$
- Not has higher precedence, but and/or have lower precedence than relational operators (&& higher than ||)

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Logical Operators II

- The and test (**<condition 1> && <condition 2>**) is true if and only if both **<condition 1> && <condition 2>** are true
 - It is false otherwise
- The or test (**<condition 1> || <condition 2>**) is false if and only if both **<condition 1> && <condition 2>** are false
 - It is true otherwise

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Truth Tables

condition1	condition2	condition1 && condition2	condition1 condition2
true	true	true	true
true	false	false	true
false	true	false	true
false	false	false	false

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Write Some Conditions

- Use relational ($<$, $>$, $<=$, $>=$, $==$, $!=$) and logical ($!$, $\&\&$, $||$) operators to write conditions for the following:
 - A number x is not negative
 - $x >= 0$ or $!(x < 0)$
 - A number y is greater than or equal to yMin and less than or equal to yMax (a condition for valid input)
 - $y >= yMin \ \&\& \ y <= yMax$

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Write Some More Conditions

- Use relational (<, >, <=, >=, ==, !=) and logical (!, &&, ||) operators to write conditions for the following:
- A number y is greater than yMax or less than yMin (an error condition for input)
- `y > yMax || y < yMin`
- The opposite of the previous condition (a condition for valid input)
- `!(y > yMax || y < yMin)`

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Write Still More Conditions

- Use relational (<, >, <=, >=, ==, !=) and logical (!, &&, ||) operators to write conditions for the following:
- An integer variable year is **not** evenly divisible by four
- `year % 4 != 0` `!(year % 4 == 0)`
- A string variable status equals "single" and an integer variable dependents is 0
- `status == "single" && dependents == 0`

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Back to if Statements

- Placement of braces is at option of user
 - Use programming styles for clarity
 - One alternative shown below

```
if (<condition>) {
    <statements done if condition true>
}
```

- Braces not required for single statement

```
if ( x == 0 ) y = 0;
```

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Two Examples of if Statements

```
if ( hours > 40 )
{
    overtime = hours - 40;
    pay = pay + 1.5 * overtime
        * salary;
}

if ( hours > 40 ) pay = pay +
    1.5 * ( hours - 40 ) * salary;
```

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Use of Braces {}

- Braces are not required, but allowed if there is only one statement in the body of the structure
- Recall that white space (including new lines) is not important in C++ code
- Result is that many possible styles for simple if statements are possible

```
if ( x < 0 ) y = 0;
if ( x < 0 ) {y = 0;}
```

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Use of Braces {} Part Two

- All boxes below have the same if statements and result

<code>if (x < 0) y = 0;</code>	<code>if (x < 0)</code>
<code>if (x < 0)</code>	<code>{</code>
<code> y = 0;</code>	<code> y = 0;</code>
<code>if (x < 0) {y = 0;}</code>	<code>}</code>
<code>if (x < 0)</code>	<code>if (x < 0){</code>
<code> { y = 0; }</code>	<code> y = 0;</code>
	<code>}</code>

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The if-else statement

- Executes different statement blocks if condition is true or false

```
if (<condition>
{
  <statements done if condition true>
}
else
{
  <statements done if condition false>
}
<Next statement after one block done>
```

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Example of if-else Statement

```
if ( hours > 40 )
{
  pay = ( 40 + ( hours - 40 )
        * 1.5 ) * salary;
}
else
{
  pay = hours * salary;
}
// Next statement for any hours
```

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Previous Example No Braces

```
if ( hours > 40 )

    pay = ( 40 + ( hours - 40 )
          * 1.5 ) * salary;

else
    pay = hours * salary;

// Next statement executed if
// condition is true or false
```

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Exercise

- A crediting score on the fundamentals of engineering exam is 70 or higher
 - Write the code that does an if test on a variable named score and writes the correct message "You passed" or "You failed" to the screen

```
if ( score >= 70 )
  { cout << "You passed"; }
else
  { cout << "You failed"; }
```

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Writing if Statements

- Define variables for "income", "deductions" and "taxable income"
- Taxable income is income minus deductions, but is never less than zero
- Write code to compute taxable income

```
double ti = inc - deduct;
if ( ti < 0 )
  { ti = 0; }
```

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Assignments

- Reading pages in text
 - Today – pp 167 – 178, 181 – 187 and 200 – 210
 - Thursday – pp 188 – 195
 - February 28 – pp 179 – 180 and pp 196 – 199
- This week's homework problems
 - Page 184, check-point 4.7; page 200, checkpoint 4.18; page 248, program 5
- Exercise 4 due Thursday
- Quiz in Laboratory – this Thursday
 - Exercises 1 – 3; text pages 1 – 106; homework for February 7, 14, and 21 (first three problems)

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