Control flow and conditionals

Dr. Mary-Angela Papalaskari
Department of Computing Sciences
Villanova University

Course website: www.csc.villanova.edu/~map/1051/

Some slides in this presentation are adapted from the slides accompanying:
- Java Software Solutions by Lewis & Loftus
- Introduction to Programming in Java: An Interdisciplinary Approach by Robert Sedgewick and Kevin Wayne

variables: qp, credits, gpa

Algorithm:
1. Input qp
2. Input credits
3. if credits equals 0
   • Print "No gpa yet"
   else
   • gpa = qp / credits
   • Print gpa
4. Print gpa goodbye message

Java code
```java
if (credits == 0)
    System.out.println("\n\tGPA: None");
else
    {
        gpa = qp / credits;
        System.out.println("\n\tGPA: " + gpa);
    }
```

What if credits is 0 ????
Updated program

variables: qp, credits, gpa

Algorithm:
1. Input qp
2. Input credits
3. If credits equals 0
   • Print "No gpa yet"
   else
   • gpa = qp / credits
   • Print gpa
4. Print goodbye message

Control flow
- Sequence of statements that are actually executed in a program

Conditional and Repetition statements: enable us to alter control flow

Control flow
- Sequence of statements that are actually executed in a program
- Example:
Control flow and conditionals

### Control flow
- Sequence of statements that are actually executed in a program
- Example:

```
input qp
input credits

true

credits is zero?
false

if true, do this
else

statement1
statement2
...```

### Java Conditional statements
Alter the linear flow of control. They use **boolean expressions** to determine what to do next.

Example:

```
if (credits == 0)
    System.out.println("GPA: None"); // if true, do this
else
    {  
gpa = qp / credits;
    System.out.println("\n\tGPA: "+ gpa);
    }
```

### Java relational operators
- Relational operators can be used with numeric types and produce **boolean** results:
  - `==` equal to
  - `!=` not equal to
  - `<` less than
  - `>` greater than
  - `<=` less than or equal to
  - `>=` greater than or equal to

- Note the difference between the equality operator (==) and the assignment operator (=)

### Conditional statements
```
if ( condition )
    statement;
// no else clause

if ( condition )
    statement1;
else
    statement2;
```
Control flow and conditionals

Example:

How do we fix output to use singular/plural as appropriate?
For example:
- Enter the total amount to be given as change: 18
- That amount can be given as:
  0 quarters
  1 dime
  1 nickels
  3 pennies

How do we fix output to use singular/plural as appropriate?
For example:
- Enter the total amount to be given as change: 18
- That amount can be given as:
  0 quarters
  1 dime
  1 nickels
  3 pennies

Nested conditionals

statement 1;
if (condition 1)
  statement 2;
else
  if (condition 2)
    statement 4;
  else
    statement 3;
statement 5;

Another example:

Create an application called Vacation that prompts for and inputs an integer representing someone’s age and then suggests an appropriate vacation destination. One of two destinations should be suggested depending on whether person is over 30.

How old is the traveler?: 15
Suggestion: Grand Canyon.

sample output

Create an application called Vacation that prompts for and inputs an integer representing someone’s age and then suggests an appropriate vacation destination. One of three destinations should be suggested depending on whether the answer is less than 20, between 20 and 50, or over 50.

How old is the traveler?: 59
Suggestion: Florida.

sample output
Java Logical Operators

- Logical operators can be used with boolean operands to express more complex conditions:
  - `!` Logical NOT
  - `&&` Logical AND
  - `||` Logical OR

Boolean Expressions

- The reserved words `true` and `false` are the only valid values for a boolean type
- Example: boolean variables:

  ```java
  boolean aboveAgeLimit = false;
  boolean usePlural = hours > 1;
  ```

Vacation example revisited:

Create an application called Vacation that prompts for and inputs an integer representing someone’s age and then suggests an appropriate vacation destination. One of three destinations should be suggested depending on whether the answer is less than 20, between 20 and 50, or over 50.

```java
How old is the traveler?: 59
Suggestion: Florida.
```

Example

```java
if (total < MAX+5 && !found)
    System.out.println ("Processing...");
```

- All logical operators have lower precedence than the relational operators
- The `!` operator has higher precedence than `&&` and `||`
Logical NOT

- The *logical NOT* operation is also called *logical negation* or *logical complement*.
- If some boolean condition $a$ is true, then $\neg a$ is false; if $a$ is false, then $\neg a$ is true.
- Logical expressions can be shown using a truth table:

<table>
<thead>
<tr>
<th>a</th>
<th>$\neg a$</th>
</tr>
</thead>
<tbody>
<tr>
<td>true</td>
<td>false</td>
</tr>
<tr>
<td>false</td>
<td>true</td>
</tr>
</tbody>
</table>

Logical AND and Logical OR

- The *logical AND* expression $a \&\& b$ is true if both $a$ and $b$ are true, and false otherwise.
- The *logical OR* expression $a || b$ is true if $a$ or $b$ or both are true, and false otherwise.

Quick Check 1

What do the following statements do?

```java
if (total != stock + warehouse)
    inventoryError = true;

if (found || !done)
    System.out.println("Ok");
```

<table>
<thead>
<tr>
<th>total</th>
<th>stock</th>
<th>warehouse</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>8</td>
<td>12</td>
</tr>
</tbody>
</table>

inventoryError | false
found | false
done | true
Quick Check 2
Try again with different values

if (total != stock + warehouse)
    inventoryError = true;

if (found || !done)
    System.out.println("Ok");

Quick Check 3
Try again with different values

if (total != stock + warehouse)
    inventoryError = true;

if (found || !done)
    System.out.println("Ok");

Boolean Expressions
• using truth tables – let’s try this one:

| found | done | !done | found || !done |
|-------|------|-------|-----------|
| false | false|       | false     |
| false | true |       | true      |
| true  | false|       | false     |
| true  | true |       | true      |

Boolean Expressions
• using truth tables – another example:

<table>
<thead>
<tr>
<th>total &lt; MAX</th>
<th>found</th>
<th>!found</th>
<th>total &lt; MAX &amp;&amp; !found</th>
</tr>
</thead>
<tbody>
<tr>
<td>false</td>
<td>false</td>
<td></td>
<td>false</td>
</tr>
<tr>
<td>false</td>
<td>true</td>
<td></td>
<td>true</td>
</tr>
<tr>
<td>true</td>
<td>false</td>
<td></td>
<td>false</td>
</tr>
<tr>
<td>true</td>
<td>true</td>
<td></td>
<td>true</td>
</tr>
</tbody>
</table>
How much of a boolean expression do we need to evaluate before determining its value?

*** Short-Circuited Operators

• The processing of && and || is "short-circuited" in cases where the left operand is sufficient to determine the result (the right operand is not evaluated at all)

• This can be both useful and dangerous!

```java
if (count != 0 && total/count > MAX)
    System.out.println("Testing.");
```

Indentation Revisited

• Remember that indentation is for the human reader, and is ignored by the computer

```java
if (total > MAX)
    System.out.println("Error!!");
    errorCount = errorcount + 1;;
```

Despite what is implied by the indentation, the increment will occur whether the condition is true or not

More examples in textbook, Section 5.2

• [http://www.csc.villanova.edu/~map/1051/Chap05/Age.java](http://www.csc.villanova.edu/~map/1051/Chap05/Age.java)
• [http://www.csc.villanova.edu/~map/1051/Chap05/Wages.java](http://www.csc.villanova.edu/~map/1051/Chap05/Wages.java)
• [http://www.csc.villanova.edu/~map/1051/Chap05/Guessing.java](http://www.csc.villanova.edu/~map/1051/Chap05/Guessing.java)
• [http://www.csc.villanova.edu/~map/1051/Chap05/MinOfThree.java](http://www.csc.villanova.edu/~map/1051/Chap05/MinOfThree.java)