Control flow, conditionals, boolean expressions, block statements, nested statements

CSC 1051 – Algorithms and Data Structures I
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Course website:
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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. Output values entered
   if credits equals 0
      • Print "No gpa yet"
   else
      • gpa = qp / credits
      • Print gpa
4. Print goodbye message

Improved algorithm

Java Program

variables: qp, credits, gpa
Algorithm:
1. Input qp
2. Input credits
3. Output values entered
4. gpa = qp / credits
5. Print gpa
6. Print goodbye message

What if credits is 0 ??

Java code

if (credits == 0)
   System.out.println ("No GPA yet");
else
   { 
      gpa = qp / credits; 
      System.out.println ("GPA: "+ gpa);
   }
Control flow and conditionals

variables: qp, credits, gpa

Algorithm:
1. Input qp
2. Input credits
3. Output values entered

4. If credits equals 0
   • Print "No gpa yet"
   else
   • gpa = qp / credits
   • Print gpa

5. Print goodbye message

Updated program

import java.util.Scanner;

public class GPA_Updated {
  public static void main(String[] args) {
    //double qp, credits, gpa;
    Scanner scan = new Scanner(System.in);

    System.out.println("Enter Quality Points > ");
    qp = scan.nextInt();

    System.out.println("Enter Credits > ");
    credits = scan.nextInt();

    if (credits == 0)
      System.out.println("No GPA yet");
    else
      gpa = qp / credits;

    System.out.println("GPA: "+gpa);

    System.out.println("Thanks for using my program.");
  }
}

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:

input qp
input credits
qp = qp / credits
print gpa
print goodbye message

Dr Papalaskari
Control flow and conditionals

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

![Control flow diagram](image)

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

```java
if (credits == 0)
    System.out.println("No GPA yet");
else
    { 
        gpa = qp / credits;
        System.out.println("GPA: "+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

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.

age > 30?
true
false

print "Florida"
print "Grand Canyon"

input age

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

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 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.
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.

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

Logical Operators – Another 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 \( !a \) is false; if \( a \) is false, then \( !a \) is true.
- Logical expressions can be shown using a *truth table*:

<table>
<thead>
<tr>
<th>a</th>
<th>!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.

<table>
<thead>
<tr>
<th>a</th>
<th>b</th>
<th>a &amp;&amp; b</th>
<th>a || b</th>
</tr>
</thead>
<tbody>
<tr>
<td>true</td>
<td>true</td>
<td>true</td>
<td>true</td>
</tr>
<tr>
<td>true</td>
<td>false</td>
<td>false</td>
<td>true</td>
</tr>
<tr>
<td>false</td>
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<td>false</td>
<td>true</td>
</tr>
<tr>
<td>false</td>
<td>false</td>
<td>false</td>
<td>false</td>
</tr>
</tbody>
</table>

Quick Check 1
What does this statement do?

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

**found** false **done** false

Quick Check 2
What does this statement do?

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

**total** 20 **stock** 7 **warehouse** 12

**inventoryError** false
Boolean Expressions

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

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

Boolean Expressions

• using truth tables – another example:

<table>
<thead>
<tr>
<th>total &gt; MAX</th>
<th>found</th>
<th>!found</th>
<th>total &gt; 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>false</td>
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<td>true</td>
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<td>true</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