Repetition

CSC 1051 – Data Structures and Algorithms I
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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
Topic Thread

• 2.1 Character Strings
• 2.2 Variables, Assignment
• 2.3 Data Types, in particular int, double
• 2.4 Expressions (simple)
• 2.5 Data Conversion
• 2.6 Interactive Programs
• 5.1 Boolean Expressions
• 5.2 The if Statement
• 5.4 The while Statement
Flow of Control

The order of statement execution

• Unless specified otherwise, the order of statement execution through a method is linear

• Some programming statements allow us to:
  – decide whether or not to execute a particular statement
  – execute a statement over and over, repetitively

• These decisions are based on boolean expressions (or conditions) that evaluate to true or false
Flow of Control

The order of statement execution

• Unless specified otherwise, the order of statement execution through a method is **linear**

• Some programming statements allow us to:
  – decide whether or not to execute a particular statement
  – **execute a statement over and over, repetitively**

• These decisions are based on **boolean expressions** (or **conditions**) that evaluate to **true** or **false**
Example

- **Investment problem:** You put $10,000 into a bank account that earns 5% interest per year.

<table>
<thead>
<tr>
<th>year</th>
<th>interest</th>
<th>balance</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$10,000.00</td>
<td>$10,000.00</td>
</tr>
<tr>
<td>1</td>
<td>$500.00</td>
<td>$10,500.00</td>
</tr>
<tr>
<td>2</td>
<td>$525.00</td>
<td>$11,025.00</td>
</tr>
<tr>
<td>3</td>
<td>$551.25</td>
<td>$11,576.25</td>
</tr>
<tr>
<td>4</td>
<td>$578.81</td>
<td>$12,155.06</td>
</tr>
</tbody>
</table>

- … How many years does it take for the account balance to be double the original?

This example is adapted from Cay Horstmann’s *Big Java, Early Objects, 5th edition*.
Example

- **Investment problem:** You put $10,000 into a bank account that earns 5% interest per year. How many years does it take for the account balance to be double the original?

- **Algorithm:**
The while Statement

• A while statement has the following syntax:
  
  ```
  while ( condition )
  statement;
  ```

• If the condition is true, the statement is executed

• Then the condition is evaluated again, and if it is still true, the statement is executed again

• The statement is executed repeatedly until the condition becomes false
Logic of a while Loop

condition evaluated

true

false

statement
Example

- A counting loop that prints the numbers 1, 2, 3,…

Algorithm:

- initialize a counter to 1
- while the counter <= upper limit
  - print counter
  - increment counter
The while Statement

```java
int count = 1;
while (count <= 3)
{
    System.out.println (count);
    count++;
}
```
The while Statement

```java
int count = 1;
while (count <= 3) {
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The while Statement

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int count = 1;
while (count <= 3) {
    System.out.println (count);
    count++;
}
```

Output:

```
1
```
The while Statement

```java
int count = 1;
while (count <= 3) {
    System.out.println (count);
    count++;
}
```

Output:
1
int count = 1;
while (count <= 3) {
    System.out.println (count);
    count++;
}

Output:
1

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int count = 1;
while (count <= 3) {
    System.out.println (count);
    count++;
}

Output:
1
2
3

Print count
The while Statement

```java
int count = 1;
while (count <= 3)
{
    System.out.println (count);
    count++;
}
```

Output:
1
2
The while Statement

```java
int count = 1;
while (count <= 3) {
    System.out.println (count);
    count++;
}
```

**Output:**

```
1
2
3
```
The while Statement

```
int count = 1;
while (count <= 3) {
    System.out.println (count);
    count++;
}
```

Output:
1
2
3

Print count

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The while Statement

```java
int count = 1;
while (count <= 3)
{
    System.out.println (count);
    count++;
}
```

Output:
1
2
3
The while Statement

```java
int count = 1;
while (count <= 3) {
    System.out.println(count);
    count++;
}
```

Output:
1
2
3

count <= 3 is false
The while Statement “unraveled”

```java
int count = 1;
while (count <= 3) {
    System.out.println(count);
    count++;
}
```

Output:
1
2
3
If the condition of a `while` loop is false initially, the statement is never executed

```java
int count = 8;
while (count <= 3) {
    System.out.println (count);
    count++;
}
```

- Therefore, the body of a `while` loop will execute zero or more times
Example: Input validation

```java
System.out.println("type in a number > 5");
int num = scan.nextInt();
while (num <= 5)
{
    System.out.println("Please try again");
    System.out.println("type a number > 5");
    num = scan.nextInt();
}
```
• Let’s try this with the **Wages.java** program

```java
import java.text.NumberFormat;
import java.util.Scanner;

public class Wages
{
    public static void main (String[] args)
    {
        final double RATE = 8.25; // regular pay rate
        final int STANDARD = 40; // standard hours in a work week

        Scanner scan = new Scanner (System.in);

        double pay = 0.0;
    }
}
```
System.out.print ("Enter the number of hours worked: ");
int hours = scan.nextInt();

// Pay overtime at "time and a half"
if (hours > STANDARD)
    pay = STANDARD * RATE + (hours-STANDARD) * (RATE * 1.5);
else
    pay = hours * RATE;

NumberFormat fmt = NumberFormat.getCurrencyInstance();
System.out.println ("Gross earnings: " + fmt.format(pay));
What if we want to do a calculation over and over again?

- **Example**: Keep calculating wages until user quits program (infinite loop).

- **Example**: Keep calculating wages and ask each time whether to keep going.

- **Example**: Keep calculating wages until user inputs zero for the hours

- **Example**: Calculate wages for 20 employees
Nested loops

**Example: Investment problem repetition**


→ the repeated action (calculating the number of years it take for investment to double) involves repetition

General pattern for algorithms: A nested loop

**while** (condition for repeating action)

initialize variables (?)

**while** (condition for reaching goal)

calculations

print results
Homework

• Read Section 5.4,
  – the example of Nested loops (PalindromeTester.java, pp 237-238) uses some concepts we have not covered, so you can skip that for now).
  – **Always** do all self-review exercises when you review material

• Do end of chapter Exercises EX 5.7 – 5.11