Loops

Lecture 12, Tue Feb 21 2006

based on slides by Kurt Eiselt

http://www.cs.ubc.ca/~tmm/courses/cpsc111-06-spr
Welcome back!
- resume lectures, labs, tutorials, office hours

Midterm and Assignment 1 returned
- pick up after class if you don't have yet
- midterm solutions posted on WebCT

Assignment 2 posted soon
- probably later today
Reading

■ This week: Chapter 7 all (7.1-7.4)
Recap: Comparing Strings

- Relational operator `==` is wrong way to compare

```java
String name1 = "Bubba";
String name2 = "Bubba";
System.out.println(name1 == name2); // prints false
```

- `equals` method is right way to compare Strings

```java
String name1 = "Bubba";
String name2 = "Bubba";
System.out.println(name1.equals(name2)); // prints true
```

- why? diagrams will help
Recap: Comparing Strings

- `name1 == name2`: two different references, `false`
- `name1.equals(name2)`: contents same, `true`
Recap: Short-Circuiting Evaluation

- Java evaluates complex expressions left to right
  - **short-circuiting**: Java stops evaluating once value is clearly true or false
    - aka lazy evaluation

```java
if ((b > a) && (c == 10))
    System.out.println("when b<=a short-circuit");
if ((b > a) || (c == 10))
    System.out.println("when b>a short-circuit");
```

- Corollary: avoid statements with side effects

```java
if ((b > a) || (c++))
    System.out.println("Danger Will Robinson!");
```
Recap: Conditional Syntax

```java
if ( boolean expression ) statement
else if ( boolean expression ) statement
  ■ optional: zero, one, or many
else statement
  ■ optional

■ if, else are reserved words
■ parentheses mandatory
■ statement can be
  ■ single line
  ■ block of several lines enclosed in {   }
Recap: Comparing Floats/Doubles

- Relational operator for equality not safe for floating point comparison

```java
if (.3 == 1.0/10.0 + 1.0/10.0 + 1.0/10.0))
    System.out.println("Beware roundoff error");
```

- Check if difference close to 0 instead

```java
if (Math.abs(f1 - f2) < TOLERANCE)
    System.out.println ("Essentially equal.");
```
Recap: Comparing Characters

- Safe to compare character types with relational operators

```java
char c = 'a';
char d = 'b';
if (c == d)
    System.out.println("they match");
```
Recap: Switch Syntax

```plaintext
switch (expression) {
    case value:
        statements
        break;
    case value:
        statements
        break;
    default:
        statements
}
```

- `switch`, `case`, `break` are reserved words
- expression and value must be int or char
  - value cannot be variable
- break important, or else control flow continues to next set
- statements can be one line or several lines
- default executed if no values match expression
Objectives

- Practice with conditionals
- Understand basic loops
public class NestTest3 {
    public static void main (String[] args) {
        respondToName("Flocinaucinihilipiliphication");
        respondToName("Supercalifragilisticexpialidocious");
        respondToName("Ambrose");
        respondToName("Kermit");
        respondToName("Miss Piggy!!!");
        respondToName("Spot");
        respondToName("me");
    }
    public static void respondToName(String name) {
        System.out.println("You're named " + name);
        if (name.length() > 20) {
            System.out.println("Gosh, long name");
            System.out.println("Keeping typists busy...");
        } else if (name.length() > 30) {
            System.out.println("Over the top");
        } else if (name.length() < 10) {
            if (name.charAt(0) == 'A')
                System.out.println("You're first");
            else if (name == "Kermit")
                System.out.println("You're a frog");
                System.out.println("I love animals");
        } else if (name.equals("Spot")) {
            System.out.println("You're spotted");
        } else if (name.length() < 3) {
            System.out.println("Concise!");
        }
    }
}
Repetition, Iteration, Loops

- Computers good at performing same task many times
- **Loops** allow repetitive operations in programs
  - aka *iteration statements, repetition statements*
- Loops handy in real life too
Climbing Stairs

- Am I at the top of the stairs?
Climbing Stairs

- Am I at the top of the stairs?
- No.
- Climb up one step.
Climbing Stairs

- Am I at the top of the stairs?
- No.
- Climb up one step.
- Am I at the top of the stairs?
Climbing Stairs

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Climbing Stairs

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Climbing Stairs

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- No.
- Climb up one step.
- Am I at the top of the stairs?
- No.
- Climb up one step.
- Am I at the top of the stairs?
- No.
- Climb up one step.
- ...and so on...
Washing Hair

- Lather
Washing Hair

- Lather
- Rinse
Washing Hair

- Lather
- Rinse
- Repeat
Washing Hair

- Lather
- Rinse
- Repeat

When do you stop??
While Statement

while (boolean expression)
    body

- Simplest form of loop in Java
- Body of loop can be
  - single statement
  - whole block of many statements in curly braces
- Control flow
  - body executed if expression is true
  - then boolean expression evaluated again
  - if expression still true, body executed again
  - repetition continues until expression false
  - then processing continues with next statement after loop
If Versus While Statements

how if statement works

boolean expression

true

false

statement
If Versus While Statements

how if statement works

boolean expression

true

statement

false

how while statement works

boolean expression

true

statement

false
How can loop boolean change from false to true?
If Versus While Statements

how if statement works

true

false

statement

how while statement works

true

false

statement

These diagrams called flowcharts
Using while Statements

public class WhileDemo
{
    public static void main (String[] args)
    {
        int limit = 3;
        int counter = 1;

        while (counter <= limit)
        {
            System.out.println("The square of " + counter + " is " + (counter * counter));
            counter = counter + 1;
        }

        System.out.println("End of demonstration");
    }
}

- while statement
public class WhileDemo
{
    public static void main (String[] args)
    {
        int limit = 3;
        int counter = 1;

        while (counter <= limit)
        {
            System.out.println("The square of " + counter + " is " + (counter * counter));
            counter = counter + 1;
        }
        System.out.println("End of demonstration");
    }
}
Using `while` Statements

```java
public class WhileDemo {
    public static void main (String[] args) {
        int limit = 3;
        int counter = 1;

        while (counter <= limit) {
            System.out.println("The square of " + counter + " is " + (counter * counter));
            counter = counter + 1;
        }
        System.out.println("End of demonstration");
    }
}

■ `while` statement body
```
Using while Statements

```java
public class WhileDemo {
    public static void main (String[] args) {
        int limit = 3;
        int counter = 1;

        while (counter <= limit) {
            System.out.println("The square of " + counter + " is " + (counter * counter));
            counter = counter + 1;
        }
        System.out.println("End of demonstration");
    }
}
```

■ statement after while

■ control flow resumes here when boolean is false
public class WhileDemo
{
    public static void main (String[] args)
    {
        int limit = 3;
        int counter = 1;

        while (counter <= limit)
        {
            System.out.println("The square of "+counter+" is "+(counter * counter));
            counter = counter + 1;
        }
        System.out.println("End of demonstration");
    }
}

trace what happens when execute
Using while Statements

```java
public class WhileDemo {
    public static void main (String[] args) {
        int limit = 3;
        int counter = 1;

        while (counter <= limit) {
            System.out.println("The square of " + counter + " is " + (counter * counter));
            counter = counter + 1;
        }
        System.out.println("End of demonstration");
    }
}
```
Using *while* Statements

```java
public class WhileDemo {
    public static void main (String[] args) {
        int limit = 3;
        int counter = 1;

        while (counter <= limit) {
            System.out.println("The square of " + counter + ", is " + (counter * counter));
            counter = counter + 1;
        }
        System.out.println("End of demonstration");
    }
}
```

limit 3  counter 1
Using **while** Statements

```java
public class WhileDemo {
    public static void main (String[] args) {
        int limit = 3;
        int counter = 1;

        while (counter <= limit) {
            System.out.println("The square of " + counter + 
                               " is " + (counter * counter));
            counter = counter + 1;
        }
        System.out.println("End of demonstration");
    }
}
```

| limit | 3     | counter | 1     | Is counter <= limit? | yes |
Using while Statements

```java
public class WhileDemo {
    public static void main (String[] args) {
        int limit = 3;
        int counter = 1;

        while (counter <= limit) {
            System.out.println("The square of "+ counter + " is "+ (counter * counter));
            counter = counter + 1;
        }
        System.out.println("End of demonstration");
    }
}
```

<table>
<thead>
<tr>
<th>limit</th>
<th>counter</th>
<th>Is counter &lt;= limit?</th>
<th>yes</th>
</tr>
</thead>
</table>

"The square of 1 is 1" printed on monitor
Using while Statements

public class WhileDemo
{
    public static void main (String[] args)
    {
        int limit = 3;
        int counter = 1;

        while (counter <= limit)
        {
            System.out.println("The square of " + counter + " is " + (counter * counter));
            //counter = counter + 1;  
            counter = counter + 1;
        }
        System.out.println("End of demonstration");
    }
}

limit 3  counter 2
Using while Statements

public class WhileDemo
{
    public static void main (String[] args)
    {
        int limit = 3;
        int counter = 1;

        while (counter <= limit)
        {
            System.out.println("The square of " + counter + 
            " is " + (counter * counter));
            counter = counter + 1;
        }
        System.out.println("End of demonstration");
    }
}

limit 3  counter 2  Is counter <= limit? yes
public class WhileDemo
{
    public static void main (String[] args)
    {
        int limit = 3;
        int counter = 1;

        while (counter <= limit)
        {
            System.out.println("The square of " + counter + ", is " + (counter * counter));
            counter = counter + 1;
        }
        System.out.println("End of demonstration");
    }
}

limit 3 counter 2 Is counter <= limit? yes

"The square of 2 is 4" printed on monitor
public class WhileDemo
{
    public static void main (String[] args)
    {
        int limit = 3;
        int counter = 1;

        while (counter <= limit)
        {
            System.out.println("The square of " + counter + " is " + (counter * counter));
            counter = counter + 1;
        }
        System.out.println("End of demonstration");
    }
}
Using while Statements

public class WhileDemo
{
    public static void main (String[] args)
    {
        int limit = 3;
        int counter = 1;

        while (counter <= limit)
        {
            System.out.println("The square of " + counter + " is " + (counter * counter));
            counter = counter + 1;
        }
        System.out.println("End of demonstration");
    }
}

limit 3  counter 3  Is counter <= limit? yes
Using **while** Statements

```java
public class WhileDemo {
    public static void main (String[] args) {
        int limit = 3;
        int counter = 1;

        while (counter <= limit) {
            System.out.println("The square of " + counter + " is " + (counter * counter));
            counter = counter + 1;
        }
        System.out.println("End of demonstration");
    }
}
```

- **limit**: 3
- **counter**: 3
- **Is counter <= limit?**: yes

"The square of 3 is 9" printed on monitor
Using while Statements

```java
public class WhileDemo {
    public static void main (String[] args) {
        int limit = 3;
        int counter = 1;

        while (counter <= limit) {
            System.out.println("The square of " + counter + 
                                " is " + (counter * counter));
            counter = counter + 1;
        }
        System.out.println("End of demonstration");
    }
}
```

limit 3  counter 4
Using **while** Statements

```java
public class WhileDemo {
    public static void main (String[] args) {
        int limit = 3;
        int counter = 1;

        while (counter <= limit) {
            System.out.println("The square of " + counter +
                                " is " + (counter * counter));
            counter = counter + 1;
        }
        System.out.println("End of demonstration");
    }
}
```

<table>
<thead>
<tr>
<th>limit</th>
<th>counter</th>
<th>Is counter &lt;= limit?</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>4</td>
<td>NO!</td>
</tr>
</tbody>
</table>
Using while Statements

```java
public class WhileDemo
{
    public static void main (String[] args)
    {
        int limit = 3;
        int counter = 1;

        while (counter <= limit)
        {
            System.out.println("The square of " + counter + " is " + (counter * counter));
            counter = counter + 1;
        }
        System.out.println("End of demonstration");
    }
}
```

limit 3  counter 4  Is counter <= limit? NO!

"End of demonstration" printed on monitor
Climbing Stairs Again

- Am I at the top of the stairs?
  - No.
  - Climb up one step.
  - Am I at the top of the stairs?
  - No.
  - Climb up one step.
  - Am I at the top of the stairs?
  - No.
  - Climb up one step.
  - Am I at the top of the stairs?
  - No.
  - Climb up one step.
  - ...and so on...
Climbing Stairs Again

while (I’m not at the top of the stairs)
{
    Climb up one step
}

- Climbing stairs is a while loop!
public class WhileDemo
{
    public static void main (String[] args)
    {
        int limit = 3;
        int counter = 1;

        while (counter >= limit)
        {
            System.out.println("The square of " + counter + " is " + (counter * counter));
            counter = counter + 1;
        }  
        System.out.println("End of demonstration");
    }
}
Using while Statements

public class WhileDemo
{
    public static void main (String[] args)
    {
        int limit = 3;
        int counter = 1;

        while (counter >= limit)
        {
            System.out.println("The square of "+ counter +" is "+ (counter * counter));
            counter = counter + 1;
        }
        System.out.println("End of demonstration");
    }
}

- change termination condition
- body of loop never executed
Using **while** Statements

```java
public class WhileDemo
{
    public static void main (String[] args)
    {
        int limit = 3;
        int counter = 1;

        while (counter >= counter) // change termination condition
        {
            System.out.println("The square of " + counter + " is " + (counter * counter));
            counter = counter + 1;
        }
        System.out.println("End of demonstration");
    }
}
```

- change termination condition
  - always true
Infinite Loops

public class WhileDemo
{
   public static void main (String[] args)
   {
      int limit = 3;
      int counter = 1;

      while (counter >= counter)
      {
         System.out.println("The square of " + counter + " is " + (counter * counter));
         counter = counter + 1;
      }
      System.out.println("End of demonstration");
   }
}

■ if termination condition always true, loop never ends
   ■ infinite loop goes forever
Infinite Loops

```java
public class WhileDemo {
    public static void main (String[] args) {
        int limit = 3;
        int counter = 1;

        while (counter <= limit) {
            System.out.println("The square of " + counter + " is " + (counter * counter));
            counter = counter - 1;
        }
        System.out.println("End of demonstration");
    }
}
```

- good termination condition
- but process never gets closer to condition
Infinite Loops

public class WhileDemo
{
    public static void main (String[] args)
    {
        int limit = 9;
        int counter = 0;

        while (counter != limit)
        {
            System.out.println("The square of " + counter + " is " + (counter * counter));
            counter = counter + 2;
        }

        System.out.println("End of demonstration");
    }
}

- process gets closer to termination condition
- but never satisfies condition, keeps going past it
Another while Example

```java
public class PrintFactorials {
    public static void main (String[] args) {
        int limit = 10;
        int counter = 1;
        int product = 1;

        while (counter <= limit) {
            System.out.println("The factorial of "+ counter + " is "+ product);
            counter = counter + 1;
            product = product * counter;
        }
        System.out.println("End of demonstration");
    }
}
```

- accumulate product
Questions?