Mat 2170
Chapter Two: Programming by Example
Java Programming
Spring 2014

Student Responsibilities

- Reading: Textbook, Chapter 2
- Assignments
  1. Lab 1: Rose Poem printout, web & submit due at beginning of lab 2 on Thursday
  2. Worksheet 2: Due at beginning of Lab 2 on Thursday
  3. Lab 2: Due at beginning of Lab 3 next week
- Attendance

Chapter Two Overview

Programming by Example

2.6 Graphical programs (used in Lab 2)
2.1 Parts of a program
2.2 Programming Perspectives
2.3 Add2Integers
2.4 Programming idioms and patterns
2.5 Classes and objects

2.6 Graphical Programs

- The GraphicsProgram class makes it possible to create simple pictures on the screen.
- The conceptual model is that of a collage composed of objects on a canvas or a felt board.
- Running a GraphicsProgram creates a window that serves as the background canvas for the collage.

GLabel Objects — Unnamed vs Named

In One Step:
Create and Send Directly to Graphics Window:

```java
public void run()
{
    add(new GLabel("Hello, World!", 100, 75));
}
```

In Two Steps:
Declare a Named Object (MyLabel) of type GLabel, which is then sent to Graphics Window:

```java
GLabel MyLabel = new GLabel("Hello, World!", 100, 75);
add(MyLabel);
```
Sending Messages to Objects

- We may wish to change the appearance (color) or location (position) of a graphical object after it's been created.
- In object-oriented languages such as Java, these changes are the responsibility of the object.
- Thus, to change the color of an object, you send a message to it telling it to change color.
- At this point in the semester, in order to send a message to an object, it must have been declared with a name — as the GLabel MyLabel was on the last slide.

Sending Messages to Objects

- To send a message to an object, Java uses the following syntax:

  ```java
  receiver.methodName(arguments);
  ```

  where:
  - `receiver` is the (named) object to which the message is directed
  - `methodName` identifies which message is sent
  - `arguments` is a list of values used to specify any other information associated with the message

Sending Messages to a GLabel

This program illustrates sending a message to an object. Note that the label doesn't appear until it is added to the canvas.

```java
public class HelloProgram extends GraphicsProgram {
    public void run() {
        GLabel MyLabel = new GLabel("Hello",100,75);
        MyLabel.setFont("SansSerif-36");
        MyLabel.setColor(Color.RED);
        add(MyLabel);
    }
}
```

MyLabel contents: "Hello", 100, 75, SansSerif-36, red

The Java Coordinate System

- Positions and distances in a graphics program are measured in terms of pixels, which are the individual dots that cover the screen.
- Unlike traditional mathematics, Java defines the origin of the graphics coordinate system to be the upper left corner of the window.
- Values for the x coordinate increase from left to right.
- Values for the y coordinate increase from top to bottom.
- Creating a GLabel at a particular x and y position means that the baseline of the first character in the label appears at that point — i.e., the (x, y) coordinate is for the lower left corner of the label.

The GObject Hierarchy

The classes that represent graphical objects form a hierarchy, part of which looks like this:

- Operations are defined at each level of the hierarchy.
- Operations that apply to all graphical objects are specified at the GObject level — where they are inherited by each subclass.
- Operations that apply to a particular subclass are specified as part of the definition of that class.
Operations on the GObject Class

The following operations apply to all GObject

- `object.setColor(color)` Sets the color of the object to the specified color constant (default is BLACK)
- `object.setLocation(x, y)` Changes the location of the object to the point (x, y)
- `object.move(dx, dy)` Moves the object on the screen by adding the displacements dx and dy to its current coordinates

The java.awt Package Standard Color Names

<table>
<thead>
<tr>
<th>Color Name</th>
<th>Color Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Color.BLACK</td>
<td>Color.RED</td>
</tr>
<tr>
<td>Color.DARK_GRAY</td>
<td>Color.YELLOW</td>
</tr>
<tr>
<td>Color.GRAY</td>
<td>Color.GRAY</td>
</tr>
<tr>
<td>Color.LIGHT_GRAY</td>
<td>Color.CYAN</td>
</tr>
<tr>
<td>Color.WHITE</td>
<td>Color.BLUE</td>
</tr>
<tr>
<td>Color.MAGENTA</td>
<td>Color.ORANGE</td>
</tr>
<tr>
<td>Color.PINK</td>
<td>Color.PINK</td>
</tr>
</tbody>
</table>

In order to use these colors, you will need to add:
```
import java.awt.*;
```
to your program.

Operations on the GLabel Class

Constructor:
```
new GLabel(text, x, y)
```
Creates a label containing the specified text that begins at the point (x, y).

GLabel Example

```
public void run()
{
    GLabel msg = new GLabel("Hello, World!", 100, 75);
    add(msg);
}
```

Creating Geometric Objects

Constructors:
```
new GRect(x, y, width, height)
```
Creates a rectangle whose upper left corner is at (x, y) of the specified size.
```
new GOval(x, y, width, height)
```
Creates an oval that fits inside the rectangle with the same dimensions.
```
new GLine(x0, y0, x1, y1)
```
Creates a line extending from (x0, y0) to (x1, y1).

Methods Shared by the GRect and GOval Classes

- `object.setFilled(fill)` If fill is true, the interior of the object is shaded; if false, only the outline is shown.
- `object.setFillColor(color)` Sets the color used to fill the interior, which can be different from the border.
The GRectPlusGOval Program

```java
public class GRectPlusGOval extends GraphicsProgram {
    public void run() {
        // Create & draw a red rectangle
        GRect MyRect = new GRect(100, 50, 125, 60);
        MyRect.setFilled(true);
        MyRect.setColor(Color.RED);
        add(MyRect);

        // Create & draw a green oval inside
        GOval MyOval = new GOval(100, 50, 125, 60);
        MyOval.setFilled(true);
        MyOval.setFillColor(Color.GREEN);
        add(MyOval);
    }
}
```

Questions, Questions, Questions...

- What would we need to change in the last program to have the rectangle be drawn after the oval? What would happen in that case?
- What would we need to change if we wanted a cyan oval with a blue border?

The Stick Figure

```java
// body
add(new GLine(100, 100, 100, 150));
// legs
add(new GLine(100, 150, 75, 175));
add(new GLine(100, 150, 125, 175));
// arms
add(new GLine(75, 120, 125, 120));
// head
add(new GOval(90, 80, 20, 20));
// eyes
add(new GOval(93, 86, 3, 3));
add(new GOval(103, 86, 3, 3));
// nose
add(new GLine(99, 90, 99, 94));
add(new GLine(100, 90, 100, 94));
add(new GOval(101, 90, 101, 94));
add(new GOval(101, 90, 101, 94));
```

What must change to make a Blue Man?
2.1 Parts of a Java Program

/* file: HelloProgram.java */
import acm.graphics.*;
import acm.program.*;
public class HelloProgram
extends GraphicsProgram {
    public void run() {
        // create and display a greeting
        add(new GLabel("hello, world", 100, 75));
    }
}

Comments

- Comments are for humans; computer ignores them
- Block comments:
  - use /* and */ around text
  - can extend over several lines
- Line comments:
  - start with //
  - extend only to end of line

A Program to Add Two Numbers — Dialog

/* file: Add2Integers.java */
import acm.program.*;
public class Add2Integers
extends DialogProgram {
    public void run() {
        println("This program adds two integers");
        int n1 = readInt("Enter first number: ");
        int n2 = readInt("Enter second number: ");
        int total = n1 + n2;
        println("The total is "+total+".");
    }
}

A Program to Add Two Numbers — Console

/* file: Add2Integers.java */
import acm.program.*;
public class Add2Integers
extends ConsoleProgram {
    public void run() {
        println("This program adds two integers");
        int n1 = readInt("Enter first number: ");
        int n2 = readInt("Enter second number: ");
        int total = n1 + n2;
        println("The total is "+total+".");
    }
}

A Program to Add Two Numbers — Floating Point

/* file: Add2Doubles.java */
import acm.program.*;
public class Add2Doubles
extends ConsoleProgram {
    public void run() {
        println("This program adds two floating point values");
        double n1 = readDouble("Enter first number: ");
        double n2 = readDouble("Enter second number: ");
        double total = n1 + n2;
        println("The total is "+total+".");
    }
}

Two Perspectives on the Programming Process

- Reductionism: a whole can be understood completely if you understand its parts and the nature of their 'sum'.
  When programming, you need to understand the language (such as Java) well before you can write correct, efficient programs.
- Holism: the whole is greater than the sum of its parts.
  When programming, you need to be able to see the logical “big picture” and create the underlying logic (algorithm) before you can write correct, efficient programs.
2.4 Programming Idioms and Patterns — A Holistic Approach to Programming

- There are a variety of common operations
- A standard solution strategy exists for common operations
- The code that implements such a solution strategy is called a programming idiom or programming pattern
- Learning to use these patterns saves time

- For example, it is helpful to think of a statement like:
  ```java
  int n1 = readInt("Enter first number: ");
  ```
as a holistic pattern to read an integer from the user:
  ```java
  int variable = readInt("prompt");
  ```

- Then, switching to floating point values is much easier:
  ```java
  double variable = readDouble("prompt");
  ```

- The concept or pattern is the same
- The pattern serves as a template
- Don’t have to remember so many details
- Recognize pattern and apply standard solution strategy
- This approach is scalable

2.5 Classes and Objects

- Java programs are written as collections of classes, which serve as templates for individual objects.
- Each object is an instance of a particular class.
- Classes can serve as a pattern for many different objects.
- Java classes form hierarchies — like a family tree.
- Except for the class named Object at the top of the hierarchy, every Java class is a subclass (derived) of some other superclass (parent class).
- A class can have many subclasses, but only one superclass.

Inheritance

- A class represents a specialization of its superclass.
- If you create an object that is an instance of a class, that object is also an instance of all other classes in the hierarchy above it in the superclass chain.
- When a new Java class is defined, that class automatically inherits the behavior of its superclass.
- The structure of Java’s class hierarchy resembles the biological classification scheme which subdivides species to reflect anatomical similarities.

Biological Class Hierarchy

[Diagram of biological class hierarchy]
The Red Ant

Classification of the red ant *Iridomyrmex purpureus*

Note that there can be many individual red ants, each of which is an instance of the same basic class.

Java Class Hierarchies

- Java class hierarchies are similar to the biological class hierarchy.
- For example, on the next slide, we see the program hierarchy formed by the classes in the `acm.program` package.
- Every `ConsoleProgram` is also a `Program`, a `JApplet`, and an `Applet`.
- This means that every `ConsoleProgram` can (or is suppose to be able to) run as an applet on the web.
- The same is true for any `DialogProgram` or `GraphicsProgram`.

The Program Hierarchy

```
Applet
  \|-- JApplet
      \|-- Program
          \|-- ConsoleProgram
          \|-- DialogProgram
          \|-- GraphicsProgram
```

The DialogProgram Class

- The class definition specifies the behavior of objects of that class.
- The `DialogProgram` class has exactly the same operations as the `ConsoleProgram` class — the only difference is that the input and output operations use pop-up dialogs instead of a console.

Project Creature Skeleton

```
// Header comments go here
public class Creature extends GraphicsProgram {
    // Display a creature, one part at a time
    public void run() {
        drawHead();
        drawFace();
        drawBody();
        drawAppendages();
    } // end of run()
}
```

Drawing Method Example

```
// Purpose:
// Written by:
public void drawHead() {
    GOval head = new GOval(100, 150, 75, 100);
    head.setFilled(true);
    head.setFillColor(Color.magenta);
    add(head);
}
```

) // end of class Creature