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 & SUB-MIT 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.

- You cause a picture to appear by **creating** graphical objects of various kinds, and then **adding** those objects to the canvas.
- We will be learning how to work with labels (textual graphics), rectangles, ovals, and lines using the classes **GLabel**, **GRect**, **GOval**, and **GLine**.
- The complete set of graphics classes is discussed in Chap. 9.

GLabel Objects — Unnamed vs Named

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

```
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:

```
public void run()
{
  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:

```
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.

```
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**

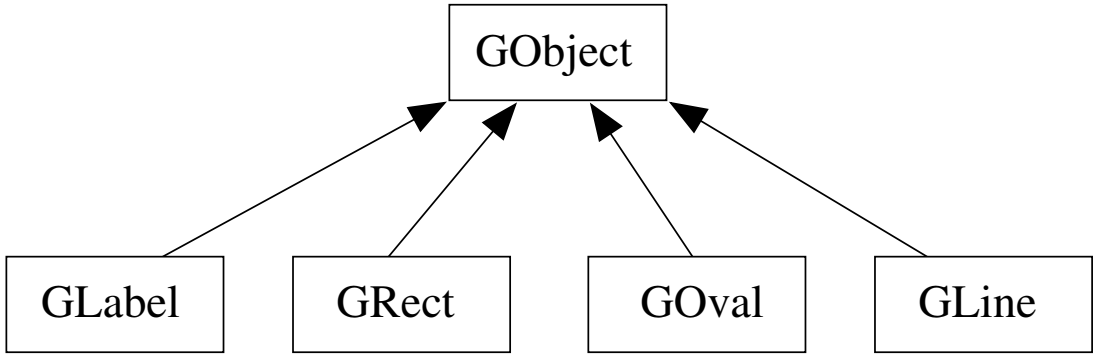
The Java Coordinate System

- 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 GObjects

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


```
Color.BLACK          Color.RED
Color.DARK_GRAY      Color.YELLOW
Color.GRAY           Color.GREEN
Color.LIGHT_GRAY     Color.CYAN
Color.WHITE          Color.BLUE
Color.MAGENTA        Color.ORANGE
Color.PINK
```

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)`

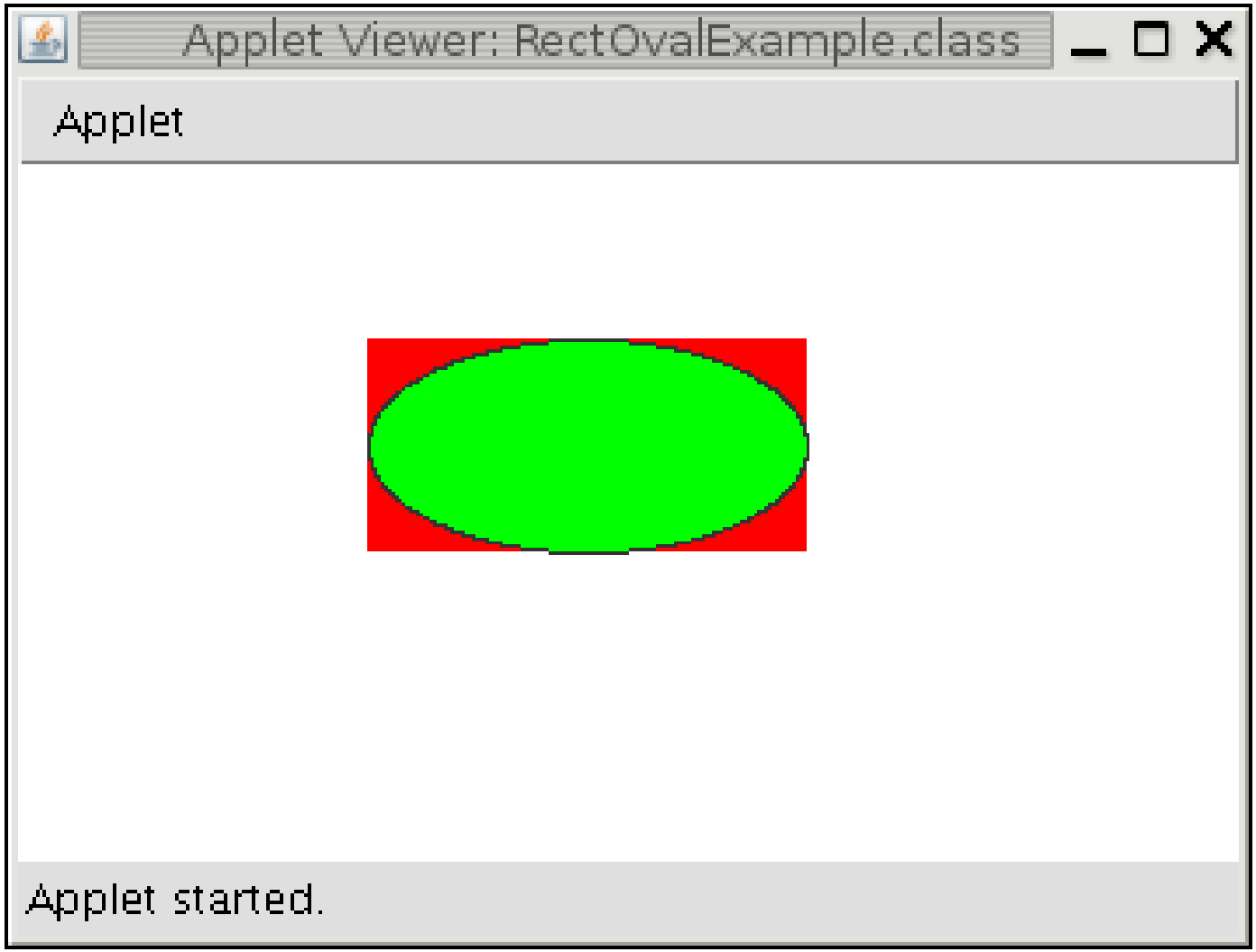
Sets the color used to fill the interior,
which can be different from the border.

The GRectPlusGOval Program


```
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);
 }
}
```

Resulting Output

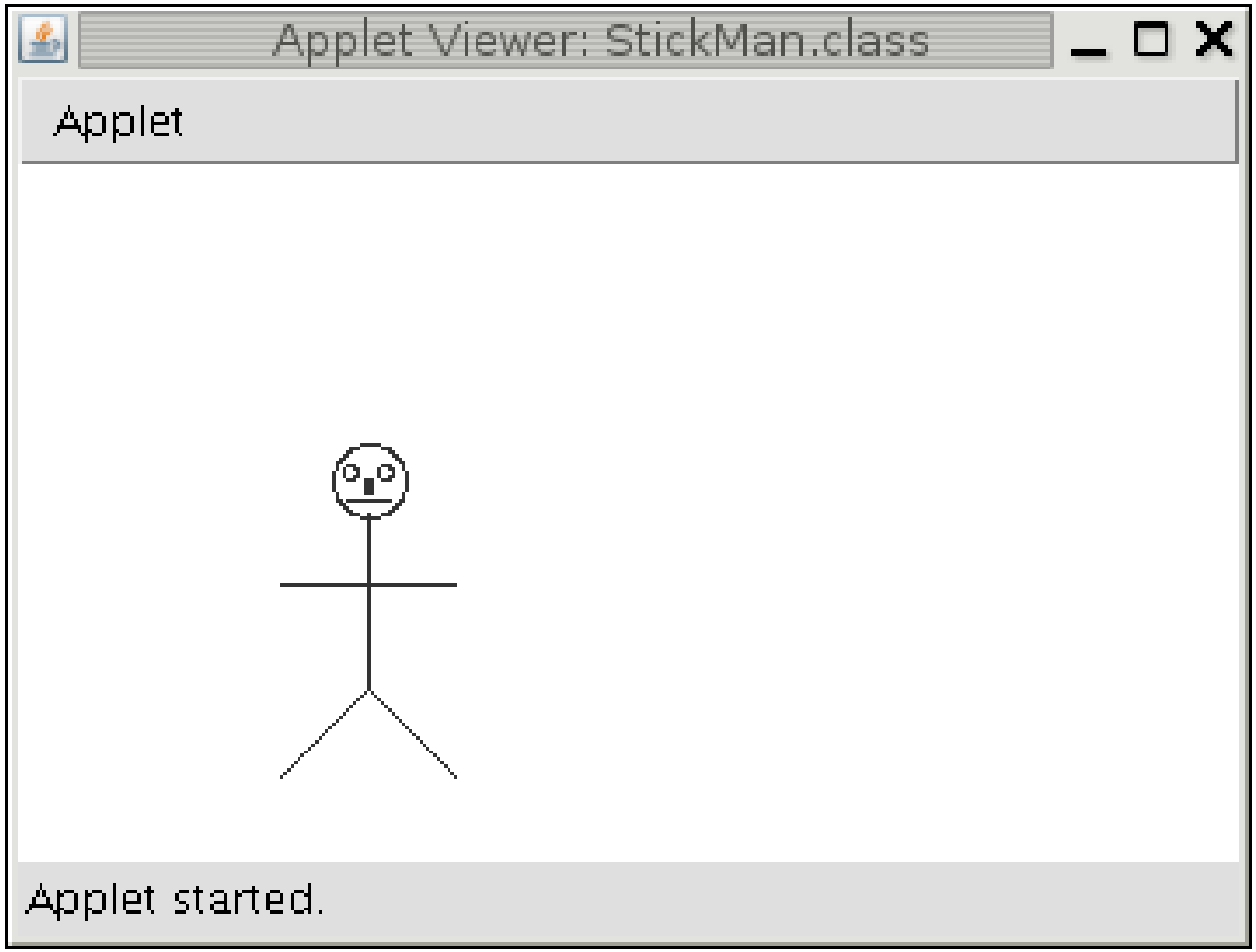


Questions, Questions, Questions...

- 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?

- What is the difference between the `GRect` and `GOval` methods: **setColor()** and the **setFillColor()**?
- What `GraphicsProgram` method displays a `GObject` in the graphics window?
- Suppose we'd like to draw a stick figure in a graphics window. How could we go about determining the coordinates of the parts?

The Stick Figure



Comments Are Desirable


```
// 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 GLine(101,90,101,94));
add(new GLine(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));
  }
}
```

- Header Comments, line comments (for humans)
- Imports: Allows use of shorter names for library classes
- The main class – `HelloProgram` – and its `run()` method

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:

```
int n1 = readInt("Enter first number:  ");
```

as a holistic **pattern** to read an integer from the user:

```
int variable = readInt("prompt");
```

- Then, switching to **floating point** values is much easier:

```
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

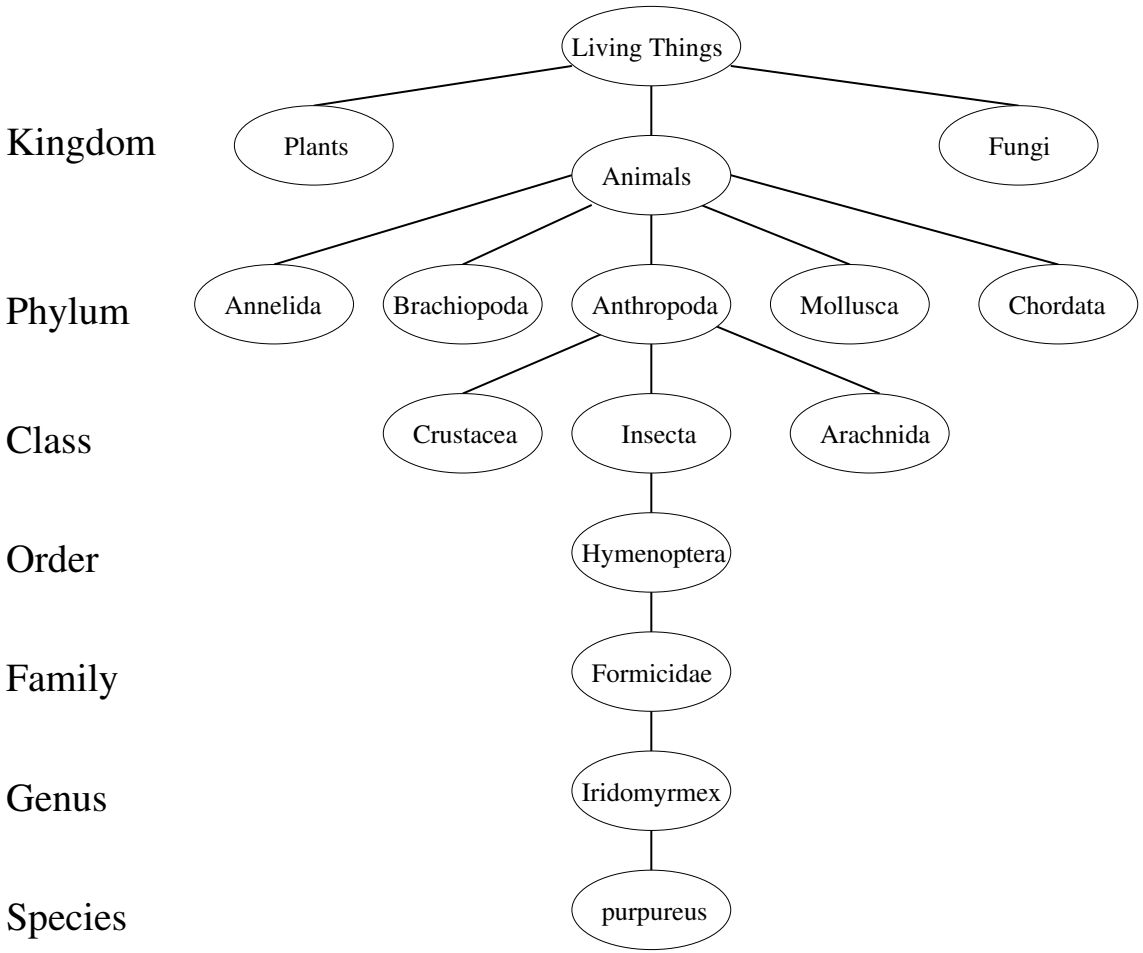
2.5 Classes and Objects

- 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



The Red Ant

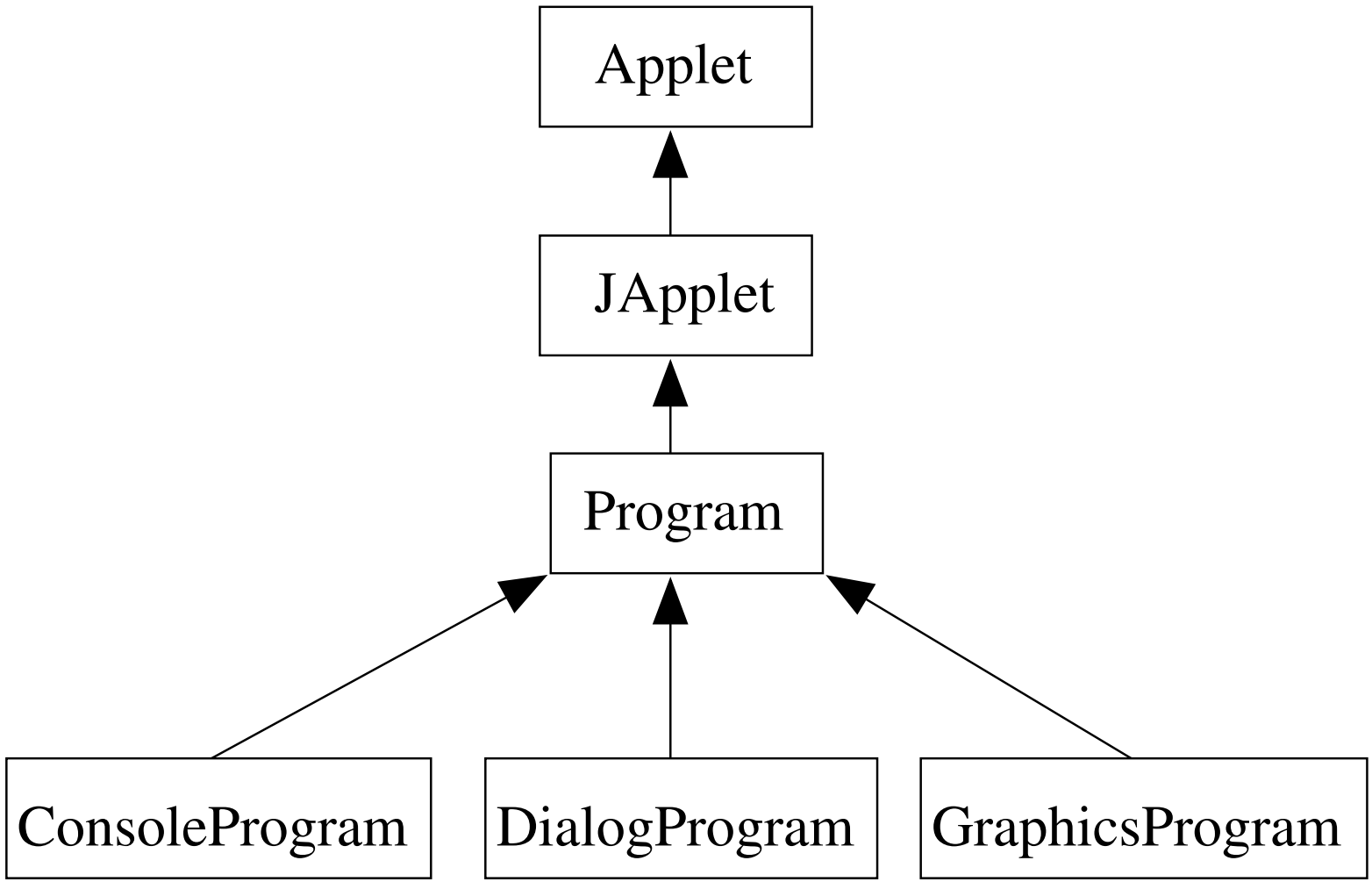
Classification of the red ant *Iridomyrmex purpureus*

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



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
```