University of British Columbia
CPSC 111, Intro to Computation
Jan-Apr 2006

Tamara Munzner

Graphical User Interfaces

Lecture 25, Thu Apr 6 2006

based on slides by Kurt Eiselt

http://www.cs.ubc.ca/~tmm/courses/cpsc111-06-spr

News

- Midterm solutions going out at end of week
- Assignment 3 due Friday Apr 7, 5pm
- CSLC will have special exam period hours
- Watch for review session announcement

- Final exam: Mon Apr 24, 3:30pm, HEBB TH

Weekly Questions

- Last one due today
- Grading: full credit if did 7 or more
- Check next week for grade in WebCT

Reading

- This week:
  - Chapter 5.1, 5.2, 11.5, 12.1, 12.2, 12.3

Exam

- Practice exam available under Challenge link from course page
  http://www.ugrad.cs.ubc.ca/~cs111/

What You Should Know

Chapter 1, 2, 3, 4,
Chapter 5.1, 5.2
Chapter 6, 7
Chapter 8 (but skip 8.2, 8.3, and 8.4)
Chapter 9.3, 9.6, 9.7, 9.8
Chapter 11.1, 11.2, 11.3, 11.5
Chapter 12.1, 12.2, 12.3
Chapter 13 (except for 13.8.3)

plus UML diagrams as you've seen in labs/tutorials
go back in the powerpoint slides and review sorting

How to prepare

Read everything that we told you to read on the previous slide

Review lecture notes and code written in class (available from web)

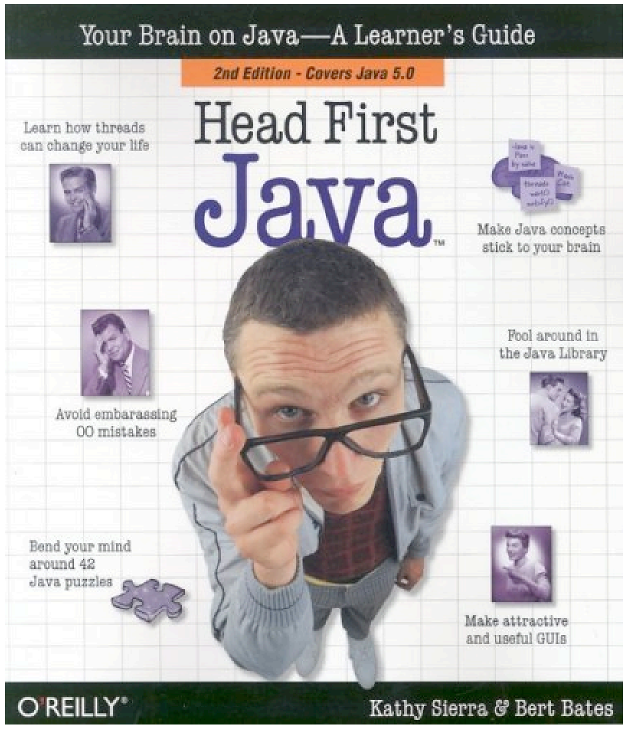
Practice, practice, practice -- write programs (especially using inheritance and abstract classes)

If you're not getting it and want to try a different approach, run to the bookstore (or head to Amazon.ca or Indigo.ca) and get a copy of...

How to prepare

Head First Java by Kathy Sierra and Bert Bates

Read this book, work all the problems (there are zillions), and you should have a better grasp of what's going on with Java. (I have no financial interest in this book or any bookseller.)


Your Brain on Java—A Learner's Guide
2nd Edition - Covers Java 5.0
Head First Java
Learn how threads can change your life
Make Java concepts stick to your brain
Fool around in the Java Library
Avoid embarassing OO mistakes
Bend your mind around 42 Java puzzles
Make attractive and useful GUIs
O'REILLY
Kathy Sierra & Bert Bates

A Problem

The Coca-Cola Company has founded Vending University. VU has two kinds of students. The full time students pay $250.00 per credit in tuition up to a maximum of $3000.00 (12 credits), even if they enroll in more than 12 credits. Tuition for students in the executive program is computed differently; these students pay a $3000.00 "executive fee" plus $400.00 per credit, with no ceiling or cap on the total. Each student has a name and is enrolled for some integer number of credits.

Write an abstract superclass called Student, and write concrete subclasses called FullTimeStudent and ExecutiveStudent. The method for computing the tuition should be called computeTuition().

Now do it again, but with an interface called Student instead of an abstract superclass.

Provide a test program that uses polymorphism to test your classes and methods.

Programming Practice

- Two kinds of practice, both are important!
  - Using computer, open book, Internet, discussing approach with friends, take as long as you need to fully understand
  - Closed book, write on paper, don't talk to anybody about the question, time pressure

Objectives

- Taste of what's under the hood with graphical programming
  - note: taste, not mastery!

Recap: Making a frame window

Step 1: Construct an object of the JFrame class.

Step 2: Set the size of the frame.

Step 3: Set the title of the frame to appear in the title bar (title bar will be blank if no title is set).

Step 4: Set the default close operation. When the user clicks the close button, the program stops running.

Step 5: Make the frame visible.

Recap: Drawing boxes

Step 1: Define RectangleComponent extending JComponent

Step 2: Override paintComponent() method.

- Step 2.1: Create Rectangle object
- Step 2.2: Draw Rectangle using Graphics2D object
- Step 2.3: Move Rectangle, Draw Rectangle, …

Step 3: In driver, construct RectangleComponent, add to JFrame

Recap: RectangleComponent code

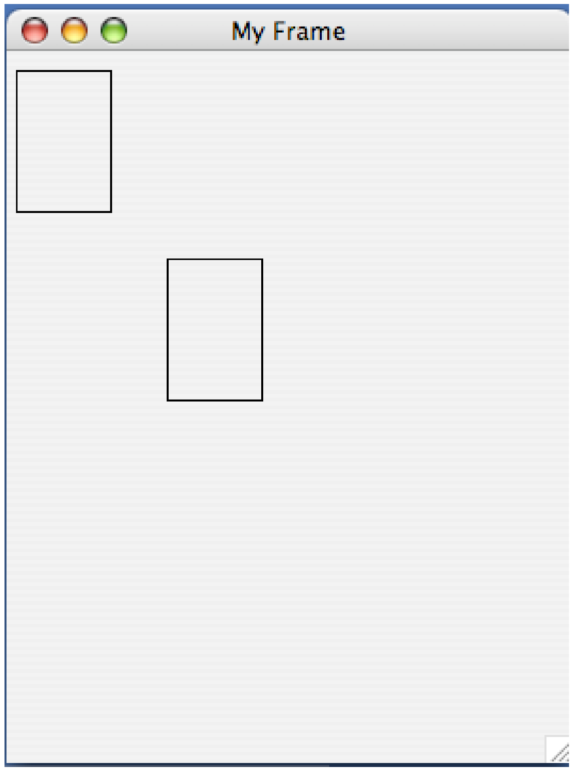
```
import java.awt.Graphics;   // AWT is the Abstract Windowing Toolkit,
import java.awt.Graphics2D; // an older graphical user interface
import java.awt.Rectangle;  // toolkit
import javax.swing.JPanel;
import javax.swing.JComponent;

public class RectangleComponent extends JComponent
{
  public void paintComponent(Graphics g)
  {
    Graphics2D g2 = (Graphics2D) g;

    Rectangle box = new Rectangle(5, 10, 50, 75);
    g2.draw(box);

    box.translate(80,100);

    g2.draw(box);
  }
}
```

Recap: FrameViewer code

```
import javax.swing.JFrame;

public class FrameViewer
{
  public static void main(String[] args)
  {
    JFrame myframe = new JFrame();  // make a new JFrame object

    final int F_WIDTH = 300;        // 300 pixels wide
    final int F_HEIGHT = 400;       // 400 pixels high

    myframe.setSize(F_WIDTH, F_HEIGHT);
    myframe.setTitle("My Frame");   // this is optional
    myframe.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);

    RectangleComponent component = new RectangleComponent();
    myframe.add(component);

    myframe.setVisible(true);
  }
}
```

Recap: Here's what we drew

```
> java FrameViewer
```



Graphical user interfaces (GUIs)

The graphical user interface allows us to interact with our programs through mouse movements, button clicks, key presses, and so on.

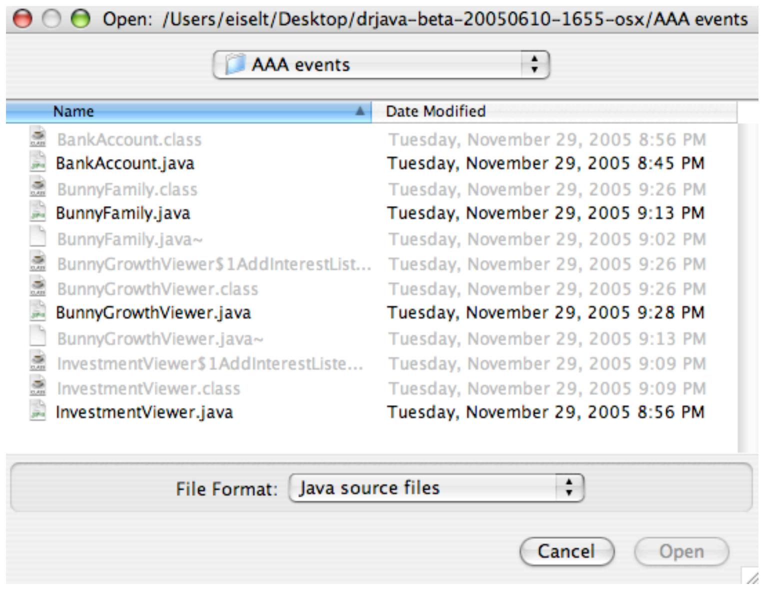
Your Windows or Macintosh operating system provides you with a GUI so you don't have to remember all sorts of instructions to type at the command line.

Graphical user interfaces (GUIs)

The graphical user interface allows us to interact with our programs through mouse movements, button clicks, key presses, and so on.

Your Windows or Macintosh operating system provides you with a GUI so you don't have to remember all sorts of instructions to type at the command line.

Here's a GUI you've seen me use many times.



Open: /Users/eiselt/Desktop/drjava-beta-20050610-1655-osx/AAA events

Name	Date Modified
BankAccount.class	Tuesday, November 29, 2005 8:56 PM
BankAccount.java	Tuesday, November 29, 2005 8:45 PM
BunnyFamily.class	Tuesday, November 29, 2005 9:26 PM
BunnyFamily.java	Tuesday, November 29, 2005 9:13 PM
BunnyFamily.java~	Tuesday, November 29, 2005 9:02 PM
BunnyGrowthViewer$1AddInterestList...	Tuesday, November 29, 2005 9:26 PM
BunnyGrowthViewer.class	Tuesday, November 29, 2005 9:26 PM
BunnyGrowthViewer.java	Tuesday, November 29, 2005 9:28 PM
BunnyGrowthViewer.java~	Tuesday, November 29, 2005 9:13 PM
InvestmentViewer$1AddInterestListe...	Tuesday, November 29, 2005 9:09 PM
InvestmentViewer.class	Tuesday, November 29, 2005 9:09 PM
InvestmentViewer.java	Tuesday, November 29, 2005 8:56 PM

File Format: Java source files

Event handling

How do we make a GUI in Java? We install event listeners.

An event listener is an object that belongs to a class which you define. The methods in your event listener contain the instructions to be executed when the events occur.

Any event listener is specific to an event source. For example, you'd have one kind of event listener to respond to the click of a button on your mouse, and another to respond to the press of a key on your keyboard.

When an event occurs, the event source calls the appropriate methods of all associated event listeners.

Event handling

Here comes an example, straight from your book. This example is a simple program that prints a message when a button is clicked.

An event listener that responds to button clicks must belong to a class that implements the ActionListener interface. That interface, supplied by the Abstract Windowing Toolkit (AWT), looks like this:

```
public interface ActionListener
{
  void actionPerformed(ActionEvent event);
}
```

Java uses the event parameter to pass details about the event. We don't need to worry about it.

Event handling

Here's what our example class that implements the ActionListener interface looks like:

```
import java.awt.event.ActionEvent;
import java.awt.event.ActionListener;

public class ClickListener implements ActionListener
{
  public void actionPerformed(ActionEvent event)
  {
    System.out.println("I was clicked.");
  }
}
```

The actionPerformed() method contains the instructions we want to be executed when our button is clicked.

Event handling

Next we'll see a program that tests our `ClickListener` class. It looks very much like the program we wrote earlier.

First we create a frame window object so we have a place to put the button that we want to click.

Event handling

```
import javax.swing.JFrame;
import javax.swing.JButton;
import java.awt.event.ActionListener;

public class ButtonTester
{
  public static void main(String[] args)
  {
    JFrame myframe = new JFrame();
    final int F_WIDTH = 100;
    final int F_HEIGHT = 60;
    myframe.setSize(F_WIDTH, F_HEIGHT);
    myframe.setTitle("Button Tester");
    myframe.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);






    myframe.setVisible(true);
  }
}
```

Event handling

Next we'll see a program that tests our ClickListener class. It looks very much like the program we wrote earlier.

First we create a frame window object so we have a place to put the button that we want to click.

Then we create a button object and add it to the frame, just like the rectangles before.

Event handling

```
import javax.swing.JFrame;
import javax.swing.JButton;
import java.awt.event.ActionListener;

public class ButtonTester
{
  public static void main(String[] args)
  {
    JFrame myframe = new JFrame();
    final int F_WIDTH = 100;
    final int F_HEIGHT = 60;
    myframe.setSize(F_WIDTH, F_HEIGHT);
    myframe.setTitle("Button Tester");
    myframe.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);

    JButton button = new JButton("Click me!");
    myframe.add(button);



    myframe.setVisible(true);
  }
}
```

Event handling

Next we'll see a program that tests our **`ClickListener`** class. It looks very much like the program we wrote earlier.

First we create a frame window object so we have a place to put the button that we want to click.

Then we create a button object and add it to the frame, just like the rectangles before.

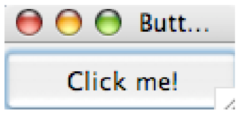
Finally we create an event listener object called **`ClickListener`** and attach it to the button we just made.

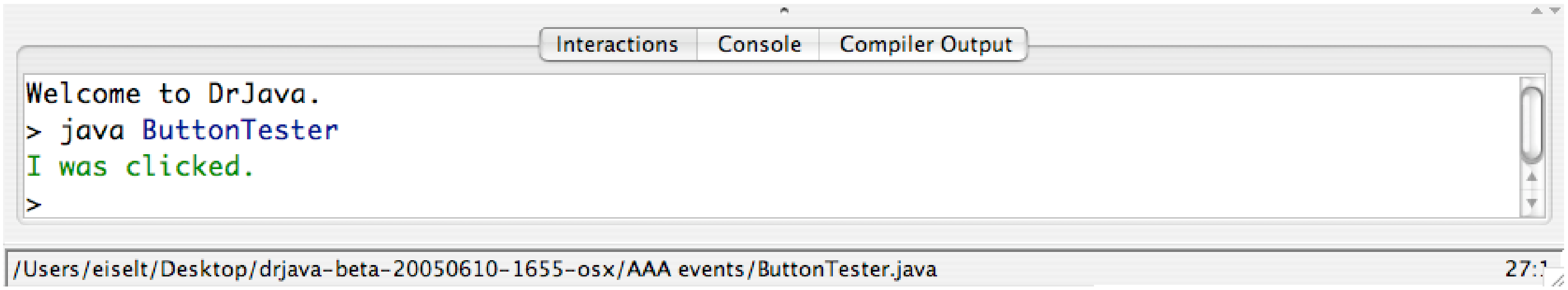
Event handling

```
import javax.swing.JFrame;
import javax.swing.JButton;
import java.awt.event.ActionListener;

public class ButtonTester
{
  public static void main(String[] args)
  {
    JFrame myframe = new JFrame();
    final int F_WIDTH = 100;
    final int F_HEIGHT = 60;
    myframe.setSize(F_WIDTH, F_HEIGHT);
    myframe.setTitle("Button Tester");
    myframe.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);

    JButton button = new JButton("Click me!");
    myframe.add(button);
    ActionListener listener = new ClickListener();
    button.addActionListener(listener);

    myframe.setVisible(true);
  }
}
```

Event handling

```
> java ButtonTester
```





```
Welcome to DrJava.
> java ButtonTester
I was clicked.
>
```

/Users/eiselt/Desktop/drjava-beta-20050610-1655-osx/AAA events/ButtonTester.java 27:1

Event handling

A button listener class like ClickListener is likely to be specific to a particular button, so we don't really need it to be widely accessible. We can put the class definition inside the method or class that needs it. So we can put this class:

```
import java.awt.event.ActionEvent;
import java.awt.event.ActionListener;

public class ClickListener implements ActionListener
{
  public void actionPerformed(ActionEvent event)
  {
    System.out.println("I was clicked.");
  }
}
```

inside the main method of the ButtonTester class as an inner class.

Event handling

```
import javax.swing.JFrame;
import javax.swing.JButton;
import java.awt.event.ActionListener;
import java.awt.event.ActionEvent; // note this addition

public class ButtonTester2
{
  public static void main(String[] args)
  {
    JFrame myframe = new JFrame();
    final int F_WIDTH = 100;
    final int F_HEIGHT = 60;
    myframe.setSize(F_WIDTH, F_HEIGHT);
    myframe.setTitle("Button Tester");
    myframe.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);

    JButton button = new JButton("Click me!");
    myframe.add(button);
```

Event handling

```
    class ClickListener implements ActionListener
    {
      public void actionPerformed(ActionEvent event)
      {
        System.out.println("I was clicked.");
      }
    }

    ActionListener listener = new ClickListener();
    button.addActionListener(listener);

    myframe.setVisible(true);
  }
}
```

Making buttons do more

This next example is from the book too, but I've changed the BankAccount class to the BunnyFamily class. Why? Because everybody likes bunnies.

Let's say we want to compute the growth in the number of bunnies in my bunny family through successive clicks of a button. (OK, it's a stretch, but it's still better than the boring bank account example.)

We'd start with a BunnyFamily class, of course. It has a method for retrieving the number of bunnies in the family, and another method for increasing the number of bunnies according to the Fibonacci numbers.

Fibonacci numbers

Leonardo Pisano (1170 - 1250), also known as Fibonacci, came up with a model of growth in an idealised bunny (really) population.

Assuming that

> in the first month there is just one newly-born pair
> new-born pairs become fertile from their second month
> each month every fertile pair spawns a new pair, and
> the bunnies never die

Then if we have A pairs of fertile and newly-born bunnies in month N and we have B pairs in month N+1, then in month N+2 we'll have A+B pairs.

Fibonacci numbers

The numbers for our purposes are 2, 3, 5, 8, 13, 21, 34 and so on.

Fibonacci was wrong about the growth of bunny populations, but his numbers live on in mathematical history.

Making buttons do more

```
public class BunnyFamily
{
  private int totalBunniesNow;
  private int totalBunniesLastTime;

  public BunnyFamily()
  {
    totalBunniesNow = 2;        // first two numbers in the
    totalBunniesLastTime = 1;   // Fibonacci sequence
  }

  public int getBunnies()
  {
    return totalBunniesNow;
  }

  public void updateBunnies()
  {
    totalBunniesNow = totalBunniesNow + totalBunniesLastTime;
    totalBunniesLastTime = totalBunniesNow - totalBunniesLastTime;
  }
}
```

Making buttons do more

We start by importing everything but the proverbial kitchen sink. Then we create our frame window.

Making buttons do more

```
import java.awt.event.ActionEvent;
import java.awt.event.ActionListener;
import javax.swing.JButton;
import javax.swing.JFrame;
import javax.swing.JLabel;
import javax.swing.JPanel;
import javax.swing.JTextField;

public class BunnyGrowthViewer
{
  public static void main (String[] args)
  {
    JFrame frame = new JFrame();
    frame.setSize(400, 100);
    frame.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);

    JButton button = new JButton("Add Bunnies");

    final BunnyFamily mybunnies = new BunnyFamily();
```

Making buttons do more

We start by importing everything but the proverbial kitchen sink. Then we create our frame window.

Next we create the button object.

Making buttons do more

```
import java.awt.event.ActionEvent;
import java.awt.event.ActionListener;
import javax.swing.JButton;
import javax.swing.JFrame;
import javax.swing.JLabel;
import javax.swing.JPanel;
import javax.swing.JTextField;

public class BunnyGrowthViewer
{
  public static void main (String[] args)
  {
    JFrame frame = new JFrame();
    frame.setSize(400, 100);
    frame.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);

    JButton button = new JButton("Add Bunnies");

    final BunnyFamily mybunnies = new BunnyFamily();
```

Making buttons do more

We start by importing everything but the proverbial kitchen sink. Then we create our frame window.

Next we create the button object.

Now we instantiate a **`BunnyFamily`** and call the object **`mybunnies`**. Why is it final? Because inner classes can access local variables from the surrounding scope only if the variables are final, and we're going to want to access some local variables from the surrounding scope inside the inner class. (Note that final doesn't keep the internal state of the **`mybunnies`** object from changing...it only means that once **`mybunnies`** holds a reference to a particular **`BunnyFamily`** object, **`mybunnies`** cannot then be assigned a different reference.)

Making buttons do more

```
import java.awt.event.ActionEvent;
import java.awt.event.ActionListener;
import javax.swing.JButton;
import javax.swing.JFrame;
import javax.swing.JLabel;
import javax.swing.JPanel;
import javax.swing.JTextField;

public class BunnyGrowthViewer
{
  public static void main (String[] args)
  {
    JFrame frame = new JFrame();
    frame.setSize(400, 100);
    frame.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);

    JButton button = new JButton("Add Bunnies");

    final BunnyFamily mybunnies = new BunnyFamily();
```

Making buttons do more

We need a user interface component that displays a message containing the current number of bunnies. Such a component is called a label. Here's how it's created...

Making buttons do more

```
    final JLabel label = new JLabel("bunnies = " +
                                    mybunnies.getBunnies());

    JPanel panel = new JPanel();
    panel.add(button);
    panel.add(label);
    frame.add(panel);

    class AddBunniesListener implements ActionListener
    {
      public void actionPerformed(ActionEvent event)
      {
        mybunnies.updateBunnies();
        label.setText("bunnies = " + mybunnies.getBunnies());
      }
    }

    ActionListener listener = new AddBunniesListener();
    button.addActionListener(listener);
    frame.setVisible(true);
  }
}
```

Making buttons do more

We need a user interface component that displays a message containing the current number of bunnies. Such a component is called a label. Here's how it's created...

We now want to put the button and label components in the frame, but Java will place one on top of the other. Instead, we create a panel object -- a panel is a container for other user interface components -- and then add the panel to the frame.

Making buttons do more

```
    final JLabel label = new JLabel("bunnies = " +
                                    mybunnies.getBunnies());

    JPanel panel = new JPanel();
    panel.add(button);
    panel.add(label);
    frame.add(panel);

    class AddBunniesListener implements ActionListener
    {
      public void actionPerformed(ActionEvent event)
      {
        mybunnies.updateBunnies();
        label.setText("bunnies = " + mybunnies.getBunnies());
      }
    }

    ActionListener listener = new AddBunniesListener();
    button.addActionListener(listener);
    frame.setVisible(true);
  }
}
```

Making buttons do more

We need a user interface component that displays a message containing the current number of bunnies. Such a component is called a label. Here's how it's created...

We now want to put the button and label components in the frame, but Java will place one on top of the other. Instead, we create a panel object -- a panel is a container for other user interface components -- and then add the panel to the frame.

Next we define our specific event listener class.

Making buttons do more

```
    final JLabel label = new JLabel("bunnies = " +
                                    mybunnies.getBunnies());

    JPanel panel = new JPanel();
    panel.add(button);
    panel.add(label);
    frame.add(panel);

    class AddBunniesListener implements ActionListener
    {
      public void actionPerformed(ActionEvent event)
      {
        mybunnies.updateBunnies();
        label.setText("bunnies = " + mybunnies.getBunnies());
      }
    }

    ActionListener listener = new AddBunniesListener();
    button.addActionListener(listener);
    frame.setVisible(true);
  }
}
```

Making buttons do more

We need a user interface component that displays a message containing the current number of bunnies. Such a component is called a label. Here's how it's created...

We now want to put the button and label components in the frame, but Java will place one on top of the other. Instead, we create a panel object -- a panel is a container for other user interface components -- and then add the panel to the frame.

Next we define our specific event listener class.

Then we create an event listener object and associate it with the button. Finally, we make sure that everything is visible.

Making buttons do more

```
    final JLabel label = new JLabel("bunnies = " +
                                    mybunnies.getBunnies());

    JPanel panel = new JPanel();
    panel.add(button);
    panel.add(label);
    frame.add(panel);

    class AddBunniesListener implements ActionListener
    {
      public void actionPerformed(ActionEvent event)
      {
        mybunnies.updateBunnies();
        label.setText("bunnies = " + mybunnies.getBunnies());
      }
    }

    ActionListener listener = new AddBunniesListener();
    button.addActionListener(listener);
    frame.setVisible(true);
  }
}
```