Interactors

CSBridge Summer 2019
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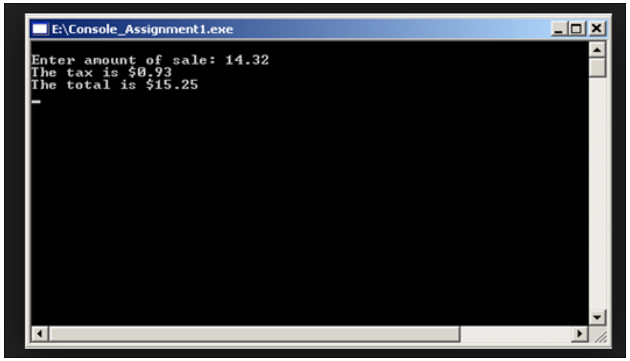
KOÇ ÜNİVERSİTESİ

How do programs interact with a user?

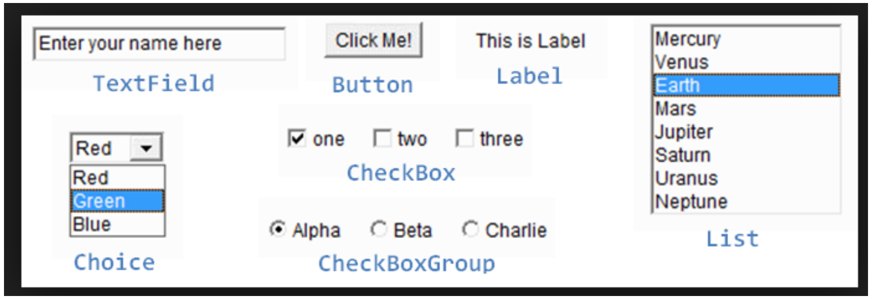
- Console Program



```
Enter amount of sale: 14.32
The tax is $0.93
The total is $15.25
_
```

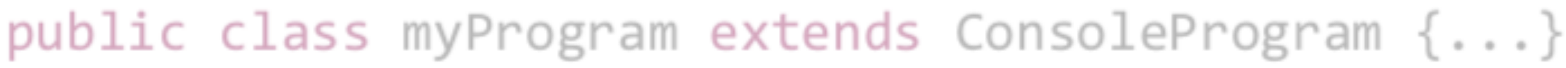
- Mouse and Keyboards

- GUI Elements



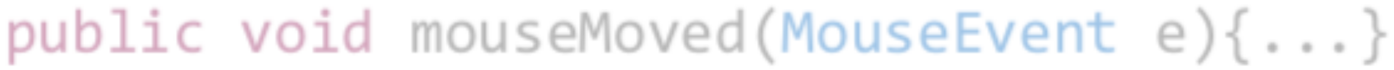
Different Type of Programs in Java

- Console Program



```
public class myProgram extends ConsoleProgram {...}
```

- Mouse and Keyboards



```
public void mouseMoved(MouseEvent e){...}
```

- GUI Elements

Interactive Program

- Most application programs today include a ***graphical user interface*** or ***GUI*** (pronounced *gooey*) consisting of buttons and other on-screen controls. Collectively, these controls are called ***interactors***.

- Graphical applications usually make it possible for the user to control the action of a program by using an input device such as a mouse. Programs that support this kind of user control are called ***interactive programs***.

- In modern interactive programs, user input doesn’t occur at predictable times. A running program doesn’t tell the user when to click the mouse. The user decides when to click the mouse, and the program responds. Because events are not controlled by the program, they are said to be ***asynchronous.***

Event Driven

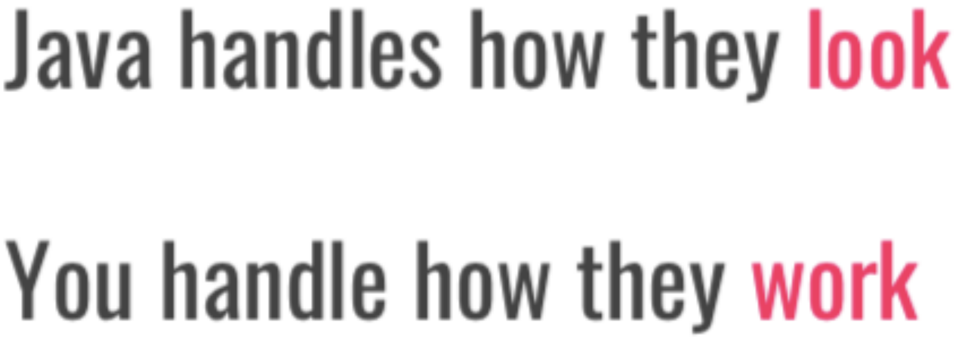
- User actions such as clicking the mouse are called *events.* Programs that respond to events are said to **be *event-driven.***

- When you write a Java program, you indicate the events to which you wish to respond by designating some object as a ***listener*** for that event.

- When the event occurs, a message is sent to the listener, which triggers the appropriate response.

Java Swing Library

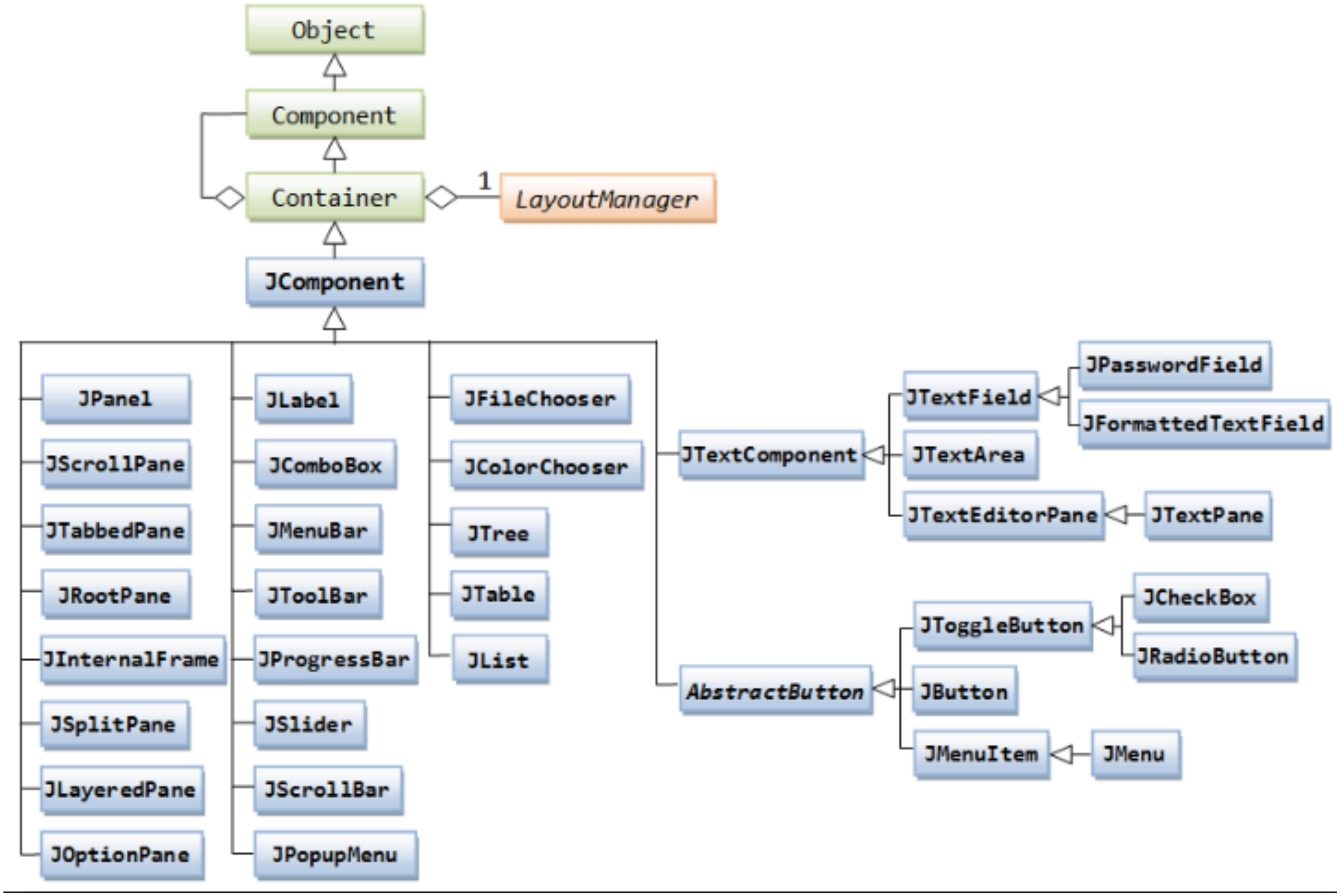
- Java defines many types of interactors, most of which are part of a collection called the ***Swing library***,
- You create a GUI by constructing the Swing interactors you need and then arranging them appropriately in the program window.



Java handles how they look

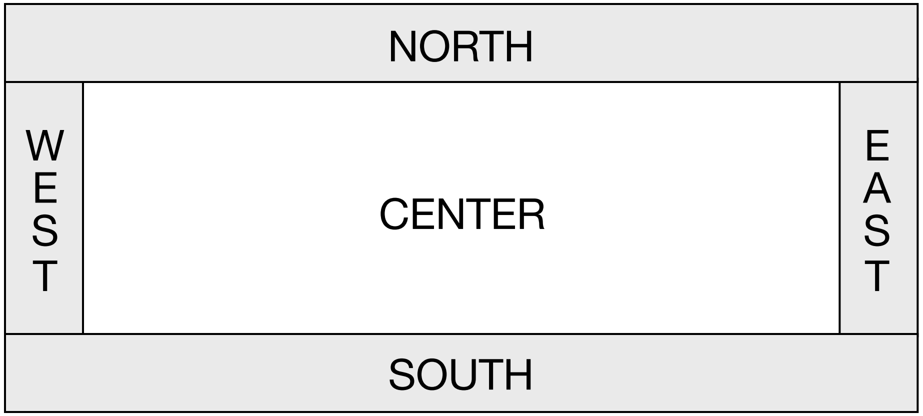
You handle how they work

Java Swing Classes



Layout

- When you create an instance of any **Program** subclass, Java divides the window area into five regions as follows:



NORTH

WEST

CENTER

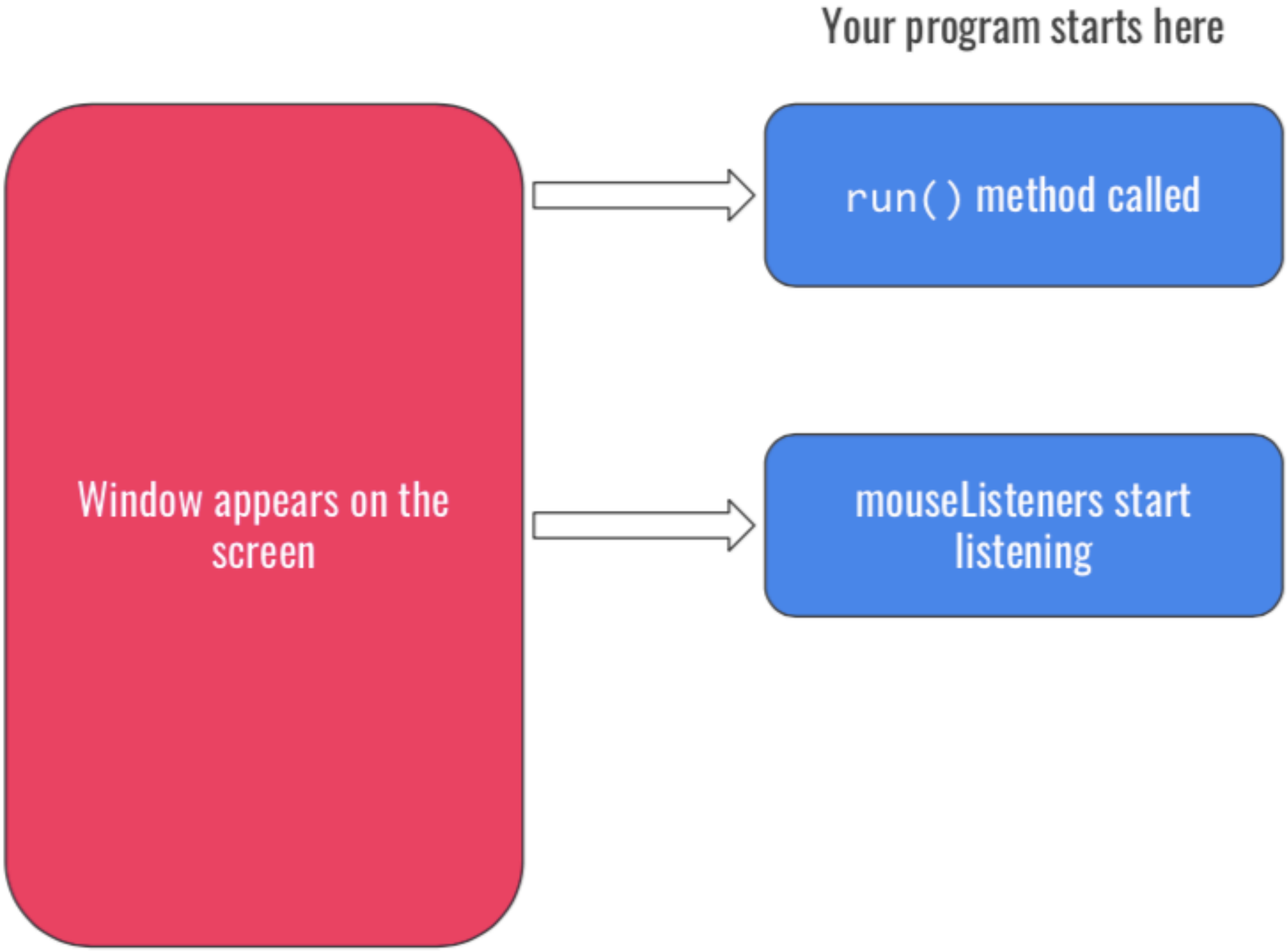
EAST

SOUTH

- The **CENTER** region is typically where the action takes place. A **ConsoleProgram** adds a console to the **CENTER** region, and a **GraphicsProgram** puts a **GCanvas** there.

- The other regions are visible only if you add an interactor to them. The examples in the text use the **SOUTH** region as a control strip containing a set of interactors, which are laid out from left to right in the order in which they were added.

Execution of a Java Program



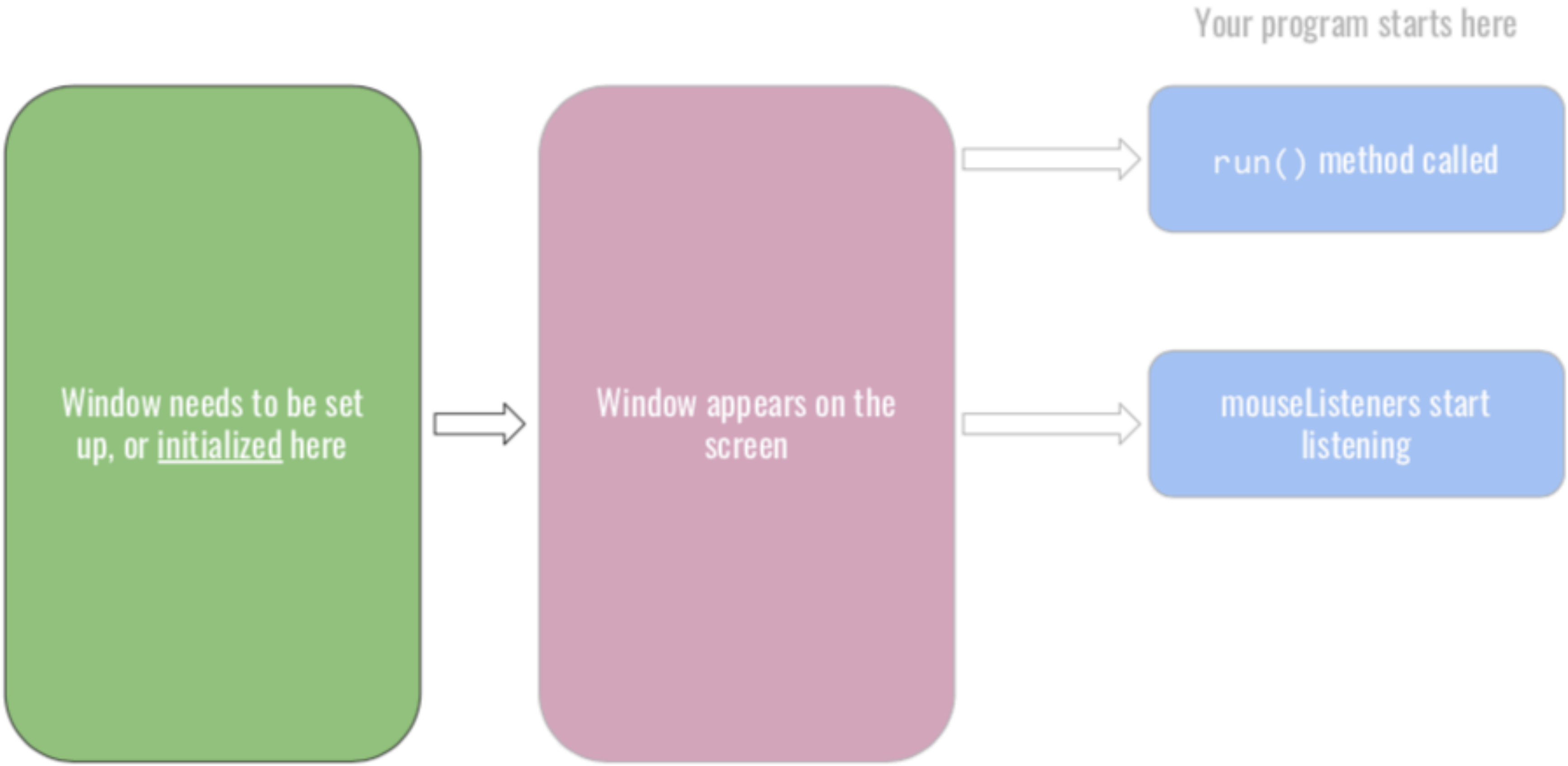
Your program starts here

Window appears on the screen

run() method called

mouseListeners start listening

Execution of a Interactive Program



Your program starts here

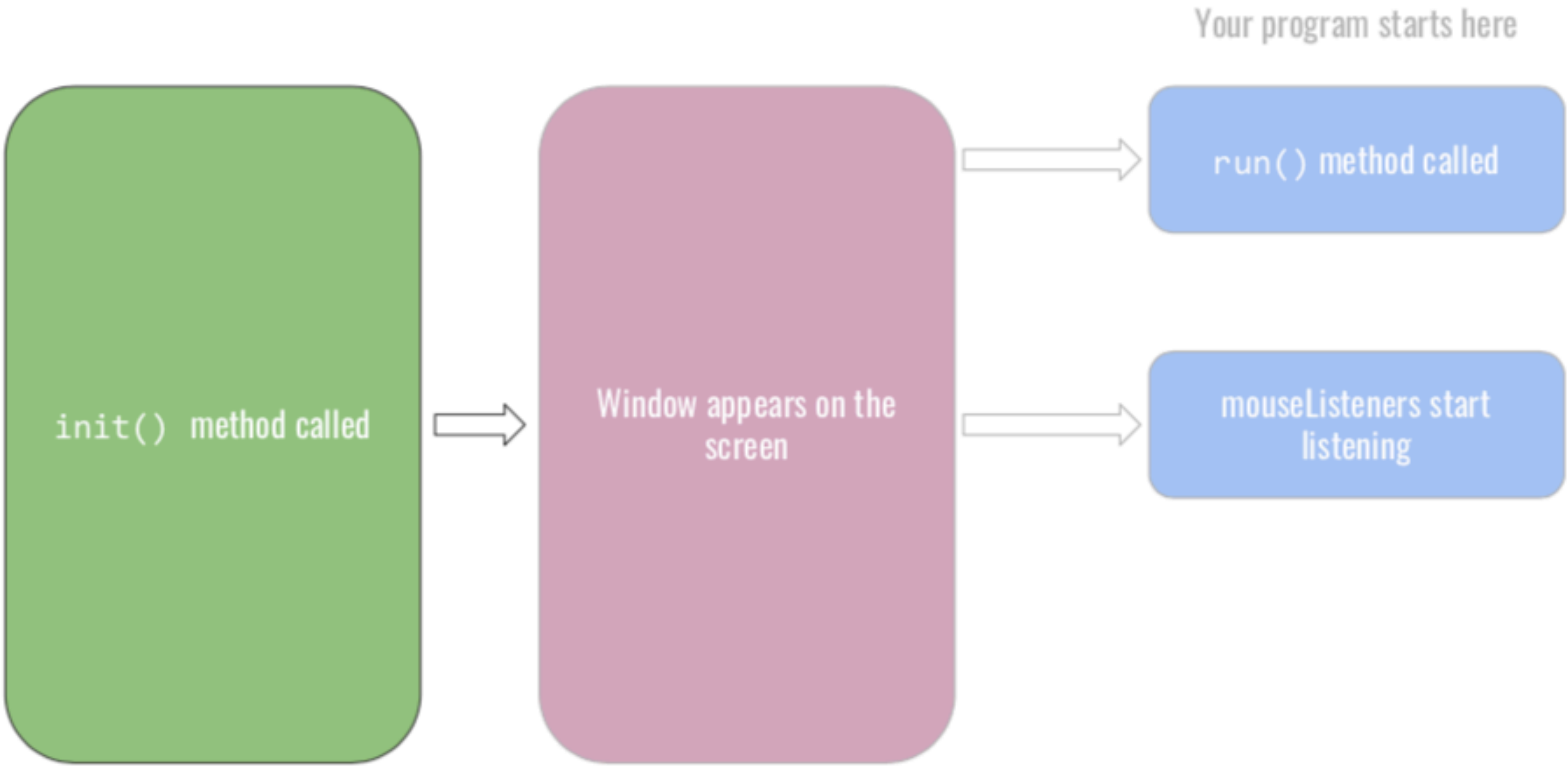
Window needs to be set up, or initialized here

Window appears on the screen

`run()` method called

mouseListeners start listening

Init()



Your program starts here

init() method called

Window appears on the screen

run() method called

mouseListeners start listening

Responding to Events

- On a more practical level, the process of making a program respond to mouse events requires the following steps:

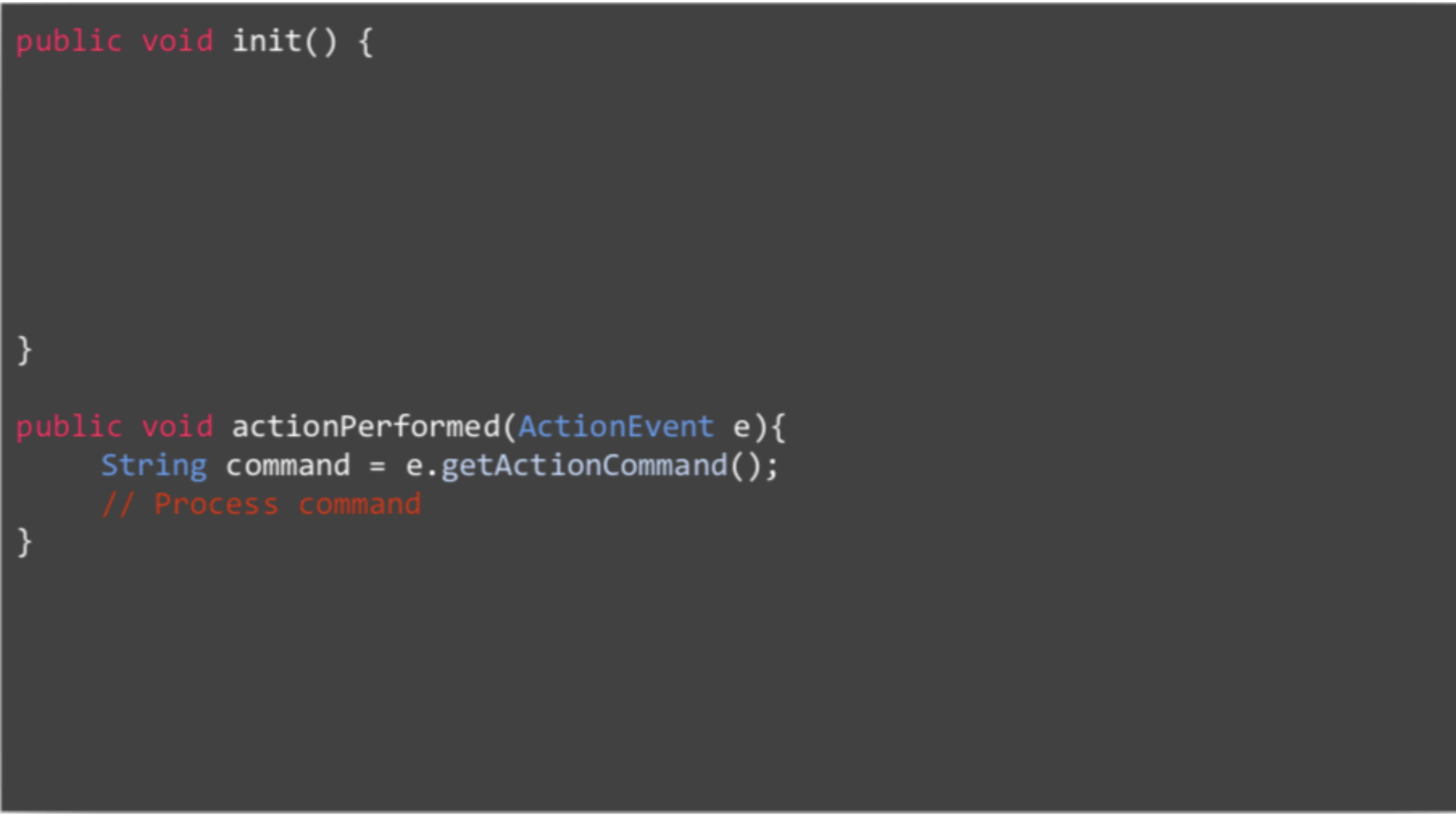
1. Call `addMouseListeners`.
2. Write new definitions of any listener methods you need.

- The most common mouse events are shown in the following table, along with the name of the appropriate listener method:

`mouseClicked(`*e*`)`	Called when the user clicks the mouse
`mousePressed(`*e*`)`	Called when the mouse button is pressed
`mouseReleased(`*e*`)`	Called when the mouse button is released
`mouseMoved(`*e*`)`	Called when the user moves the mouse
`mouseDragged(`*e*`)`	Called when the mouse is dragged with the button down

The parameter *e* is a `MouseEvent` object, which gives more data about the event, such as the location of the mouse.

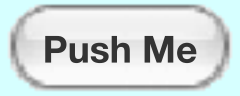
Anatomy of the Program



```
public void init() {







}

public void actionPerformed(ActionEvent e){
     String command = e.getActionCommand();
     // Process command
}
```

JButton

- The most common interactor in GUI-based applications is an on-screen button, which is implemented in Swing by the class **JButton**. A **JButton** object looks something like



- The constructor for the **JButton** class is

```
new JButton(label)
```

  where *label* is a string telling the user what the button does. The button shown earlier on this slide is therefore created by

```
JButton pushMeButton = new JButton("Push Me");
```

- When you click on a button, Java generates an ***action event***, which in turn invokes a call to **actionPerformed** in any listeners that are waiting for action events.

Detecting Event

- Before you can detect action events, you need to enable an action listener for the buttons on the screen. The easiest strategy is to call **addActionListeners** at the end of the **init** method. This call adds the program as a listener to all the buttons on the display.

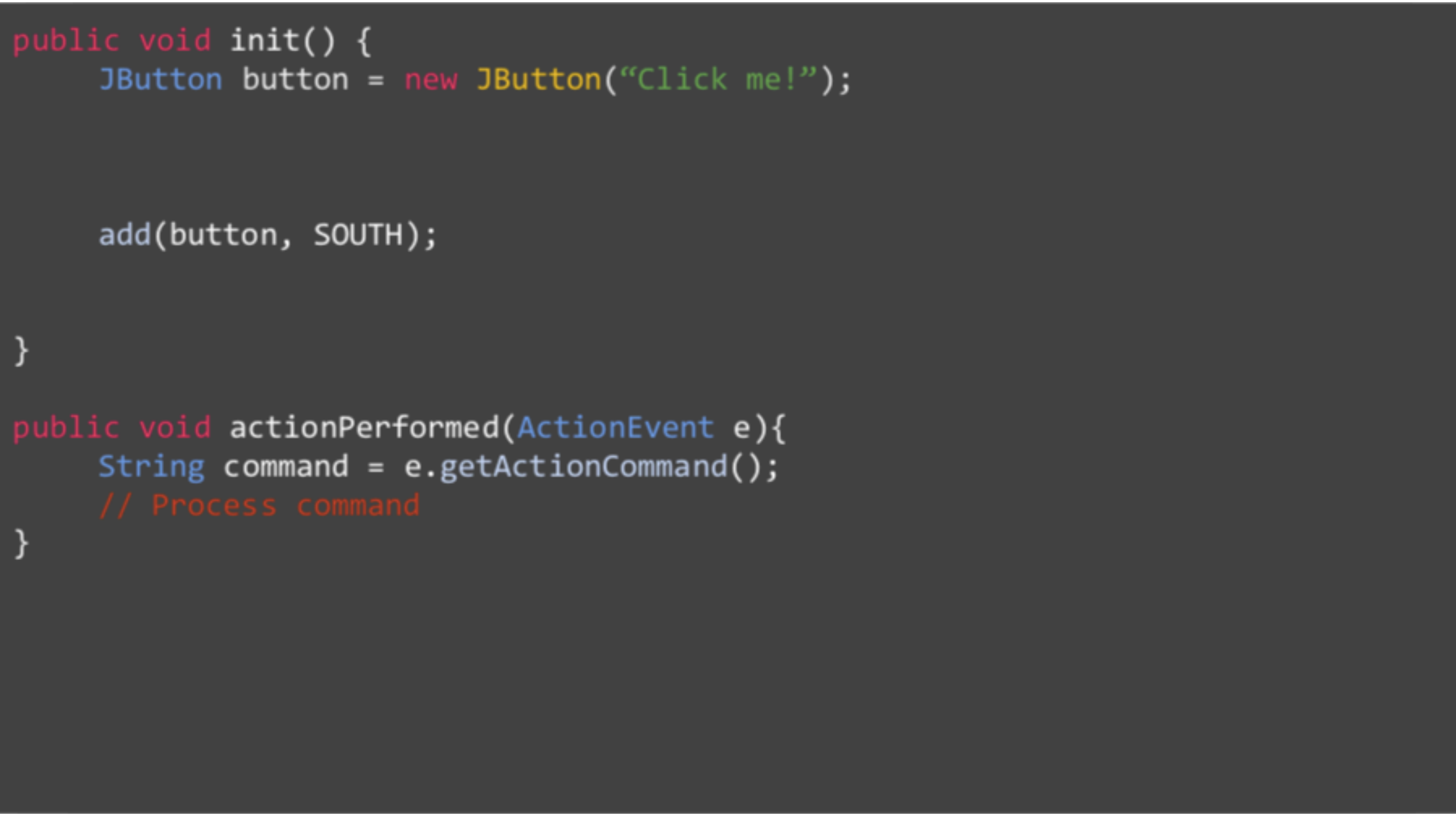
- You specify the response to a button click by overriding the definition of **actionPerformed** with a new version that implements the correct actions for each button.

- If there is more than one button in the application, you need to be able to tell which one caused the event. There are two strategies for doing so:

1. Call **`getSource`** on the event to obtain the button itself.

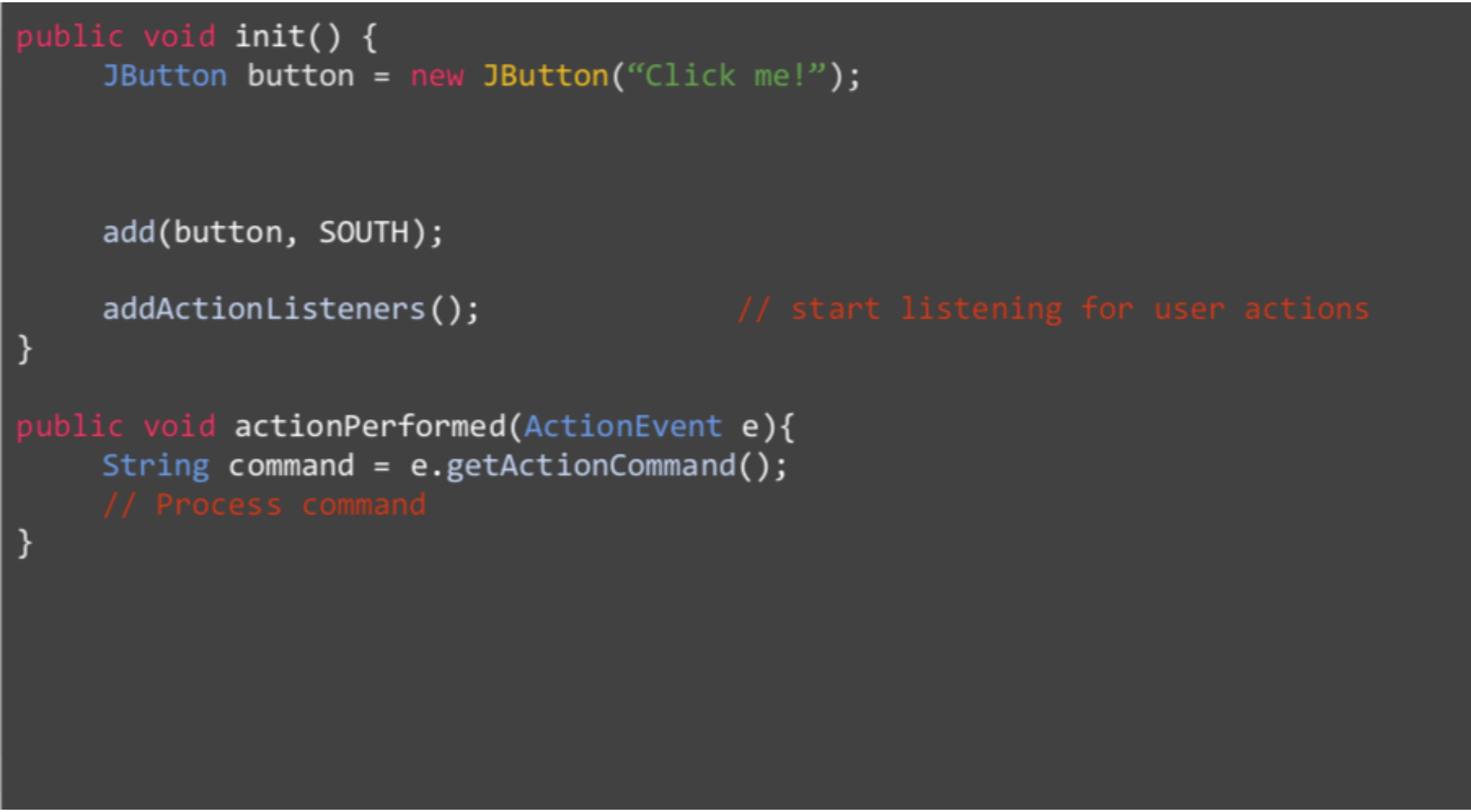
2. Call **`getActionCommand`** on the event to get the ***action command*** string, which is initially set to the button label.

JButton Code



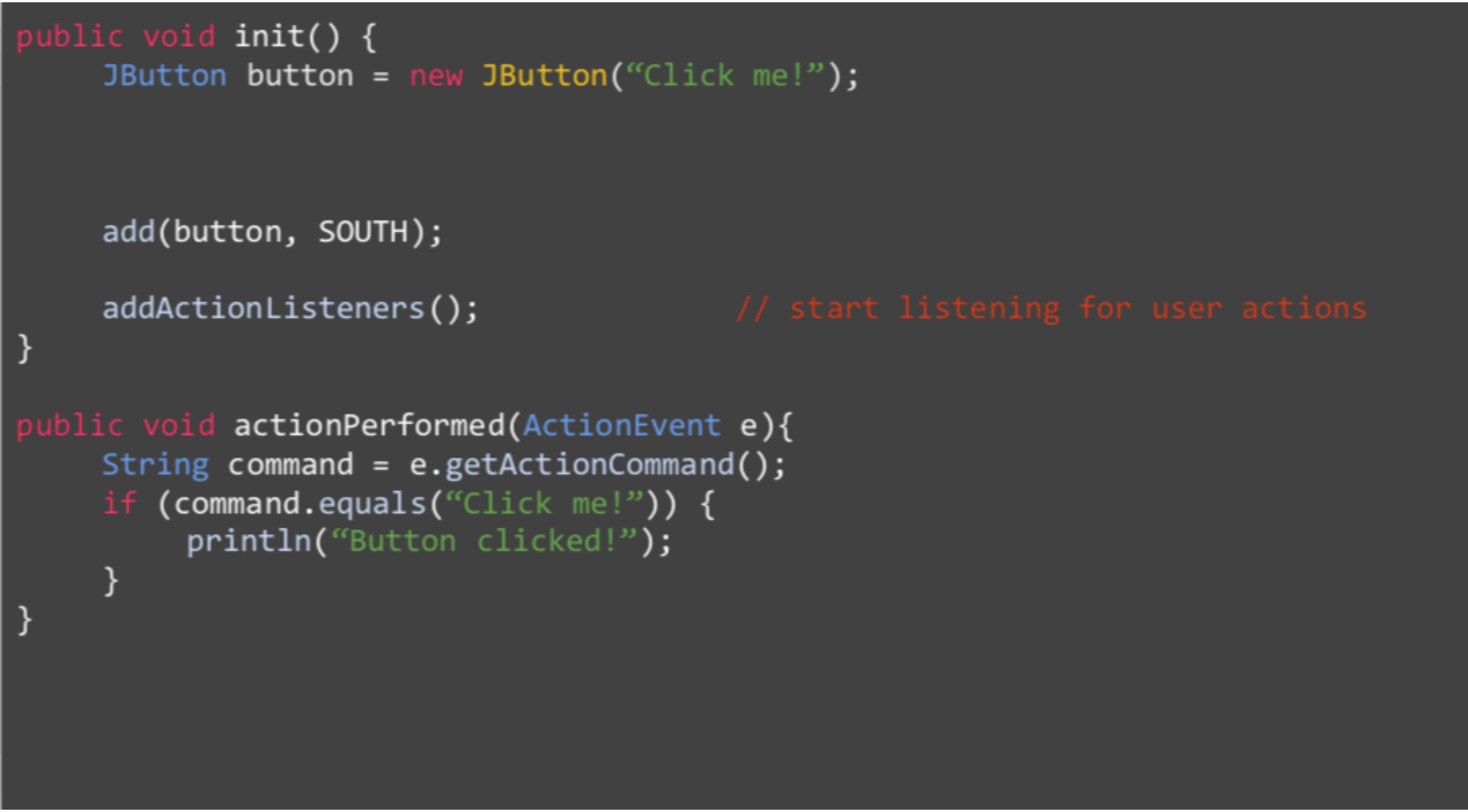
```
public void init() {
     JButton button = new JButton(“Click me!”);



     add(button, SOUTH);


}

public void actionPerformed(ActionEvent e){
     String command = e.getActionCommand();
     // Process command
}
```

JButton Code



```
public void init() {
     JButton button = new JButton(“Click me!”);



     add(button, SOUTH);

     addActionListeners();                // start listening for user actions
}

public void actionPerformed(ActionEvent e){
     String command = e.getActionCommand();
     // Process command
}
```

JButton Code



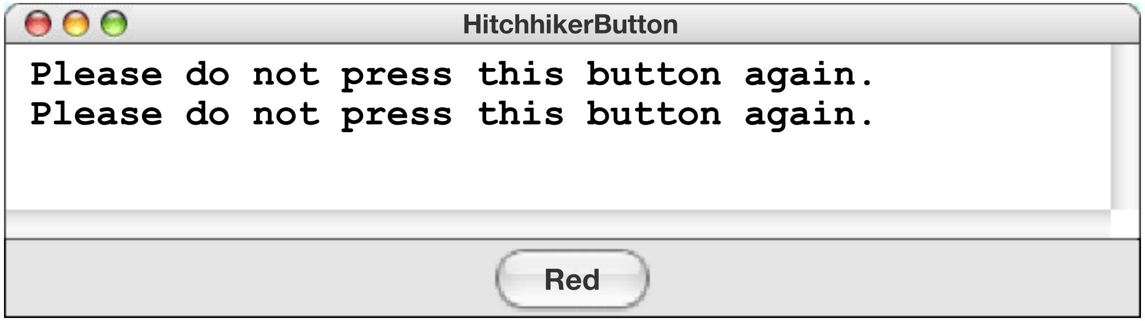
```
public void init() {
    JButton button = new JButton(“Click me!”);



    add(button, SOUTH);

    addActionListeners();               // start listening for user actions
}

public void actionPerformed(ActionEvent e){
    String command = e.getActionCommand();
    if (command.equals(“Click me!”)) {
        println(“Button clicked!”);
    }
}
```

Hitchhiker Button

Arthur listened for a short while, but being unable to understand the vast majority of what Ford was saying he began to let his mind wander, trailing his fingers along the edge of an incomprehensible computer bank, he reached out and pressed an invitingly large red button on a nearby panel. The panel lit up with the words "Please do not press this button again."

—Douglas Adams, *Hitchhiker's Guide to the Galaxy*, 1979

The **`HitchhikerButton`** program on the next slide uses this vignette from *Hitchhiker's Guide to the Galaxy* to illustrate the process of creating a GUI without focusing on the details. The code creates a single button and adds it to the **`SOUTH`** region. It then waits for the user to click the button, at which point the program responds by printing a simple message on the console.



```
Please do not press this button again.
Please do not press this button again.
```

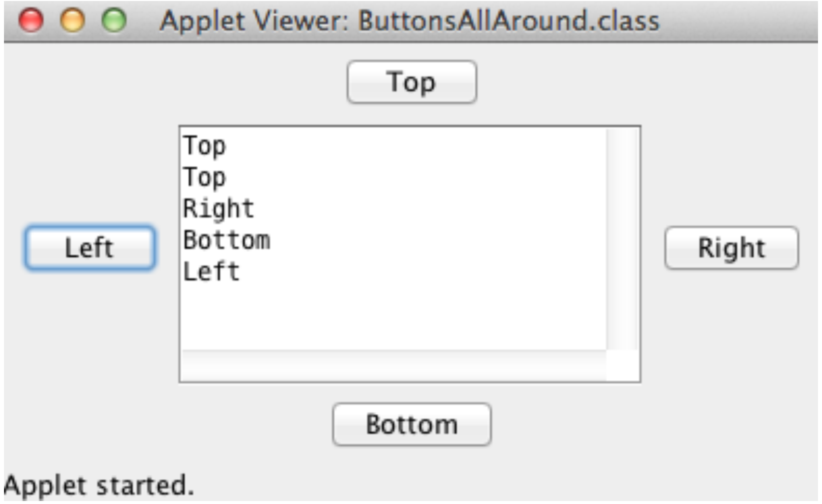
Hitchhiker Button

```
import acm.program.*;
import java.awt.event.*;
import javax.swing.*;

/*
 * This program puts up a button on the screen, which triggers a
 * message inspired by Douglas Adams's novel.
 */
public class HitchhikerButton extends ConsoleProgram {

/* Initializes the user-interface buttons */
   public void init() {
      add(new JButton("Red"), SOUTH);
      addActionListeners();
   }

/* Responds to a button action */
   public void actionPerformed(ActionEvent e) {
      if (e.getActionCommand().equals("Red")) {
         println("Please do not press this button again.");
      }
   }
}
```

Let's get our hands dirty

- Creating a ConsoleProgram including action buttons:
  - add buttons to the 4 sides and print which one is clicked on the console.

Keywords: JButton, addActionListeners, actionPerformed(ActionEvent e), e.getActionCommand()



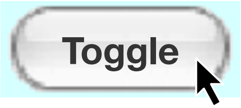
```
Top
Top
Right
Bottom
Left
```

Applet started.

JToggle Button

- The **JToggleButton** class is another type of button that is similar to **JButton** but maintains an on/off state. On the screen, a **JToggleButton** looks just like a **JButton** except for the fact that it stays on after you release the mouse button.

- As its name suggests, a **JToggleButton** toggles back and forth between on and off when it is clicked. Clicking the first time turns it from off to on; clicking a second time turns it off.



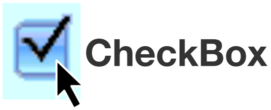
- You can determine whether a **JToggleButton** is on by calling **isSelected**, which returns **true** if the button is on.

- The **JToggleButton** class itself is not used as much as two of its subclasses, **JCheckBox** and **JRadioButton**, which are described on the next two slides.

JCheckBox

- The **JCheckBox** class is a subclass of **JToggleButton** and therefore inherits its behavior.

- In terms of its operation, a **JCheckBox** works exactly like an instance of its parent class. The only difference is in what the button looks like on the screen. In a **JCheckBox**, the button label appears to the right of a small square that either contains or does not contain a check mark, like this:

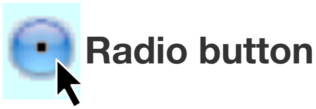


- Because a **JCheckBox** is a **JToggleButton**, you can call the **isSelected** method to determine its state.

- Like a **JButton**, a **JCheckBox** generates action events when it is clicked. Both of these classes inherit this behavior from **AbstractButton**, which is their common superclass.

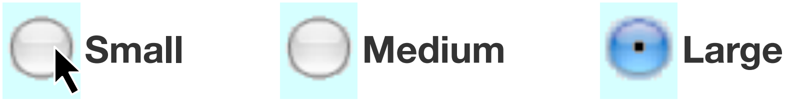
JRadio Button

- The **JRadioButton** class also extends **JToggleButton** and behaves in much the same way. In this case, the button is displayed as a circle that is tinted and marked with a dot when it is selected, as follows:

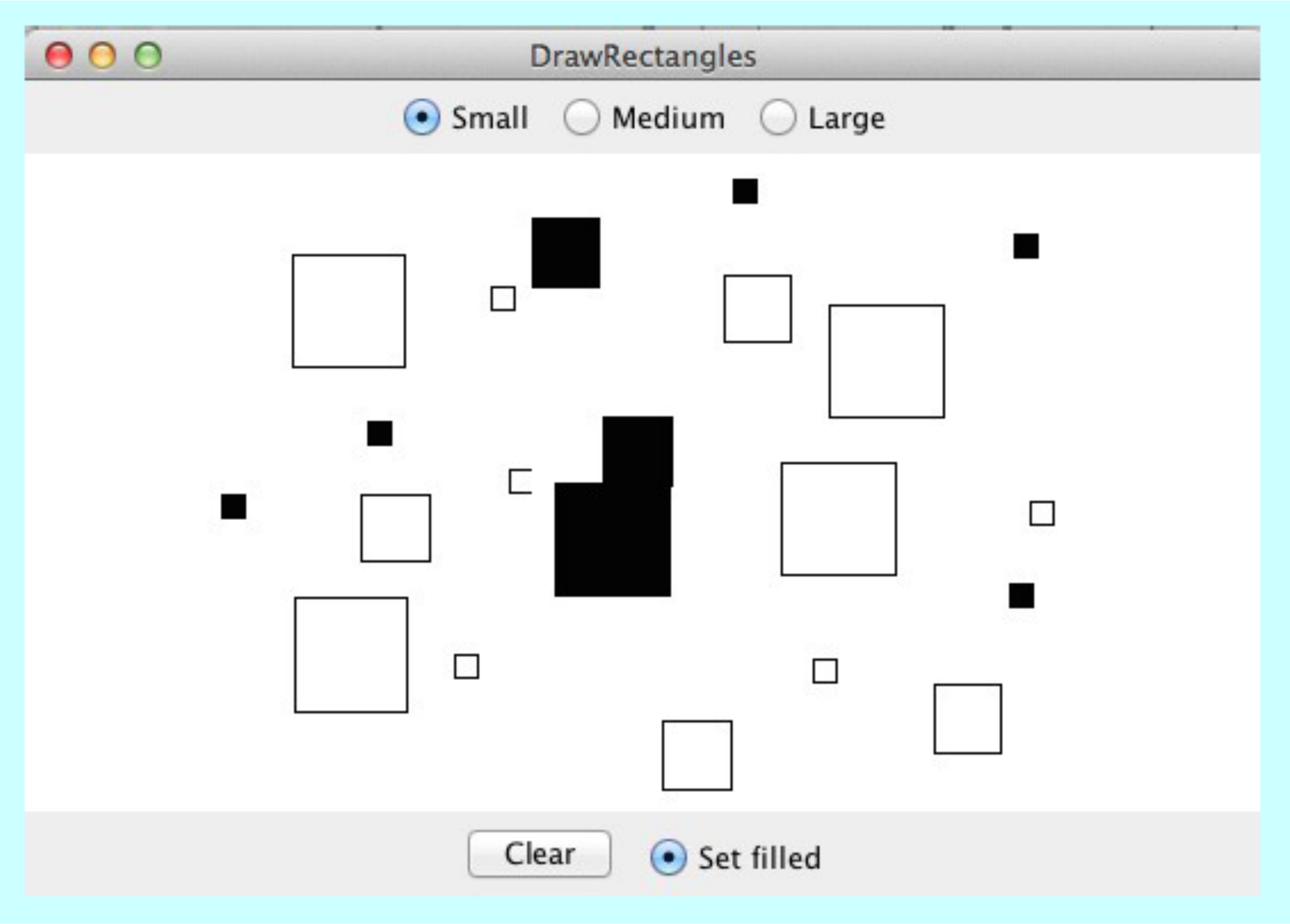


- Radio buttons are ordinarily not used individually but instead as a set. If you create a **ButtonGroup** object and then add several radio buttons to it, the Swing libraries make sure that only one of those buttons is selected at a time.

- Grouped radio buttons are used to allow the user to choose among several mutually exclusive options. As an example, the text extends the **DrawStarMap** program to allow the user to choose the size of the star by selecting a radio button:



Let's implement an event-driven program from scratch



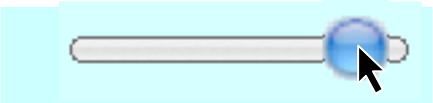
● Small ○ Medium ○ Large

● Set filled

JSlider Button

- In many applications, you want to let the user adjust a value over a wide range instead of selecting among a set of options.

- The Swing libraries include several different interactors that allow the user to adjust a parameter. The text uses the **JSlider** class, which appears on the screen like this:

  The user can adjust a **JSlider** by dragging the slider knob.

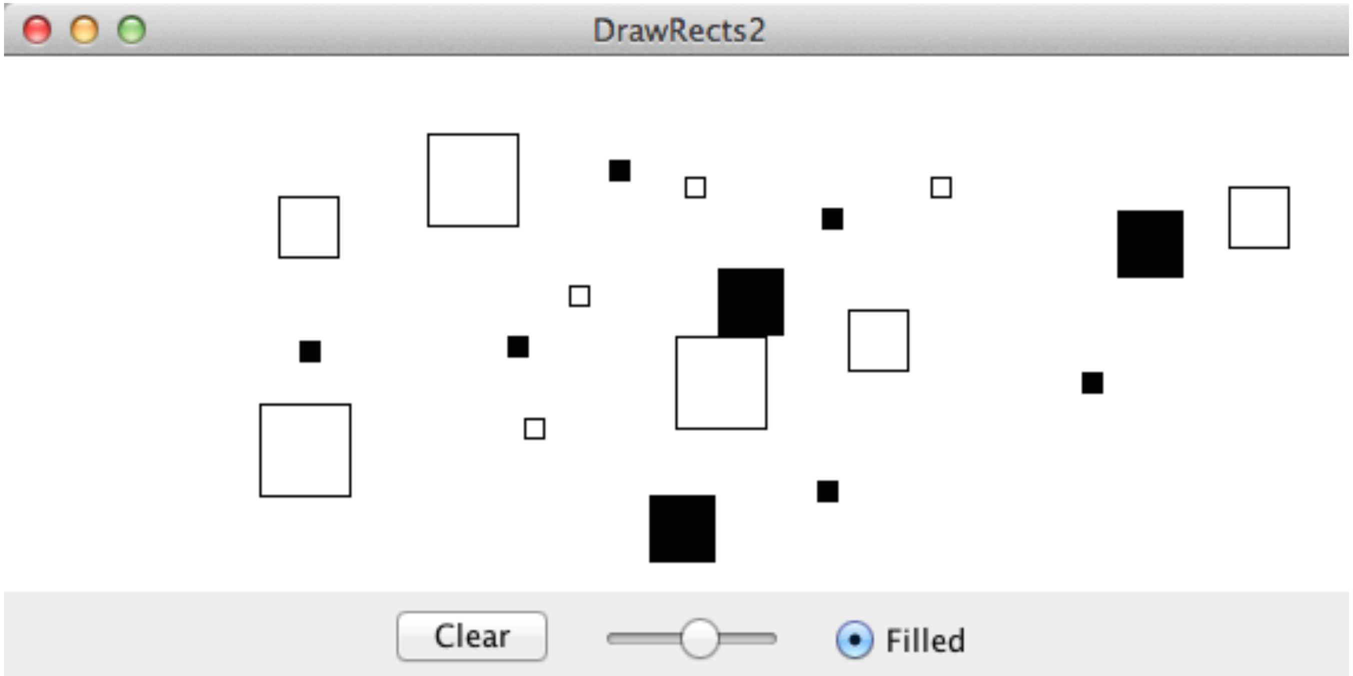
- The simplest form of the **JSlider** constructor looks like this:

  new JSlider(*min*, *max*, *value*)

  where *min* and *max* are integers giving the minimum and maximum values of the slider and *value* is the initial value.

- You can retrieve the current value by calling **`getValue`**.

Let's replace our size buttons with a slider

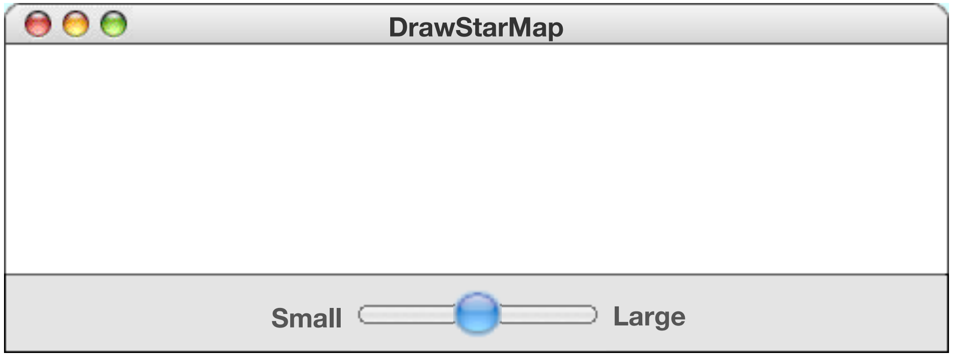


JLabel

- The interactors you display on the screen sometimes don’t provide the user with enough information. In such cases, it is useful to include **JLabel** objects, which appear as text strings in the user interface but do not respond to any events.

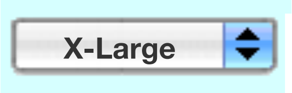
- As an example, if you wanted to label a slider so that it was clear it controlled size, you could use the following code to produce the control strip shown at the bottom of the screen:

```
add(new JLabel("Small"), SOUTH);
add(sizeSlider, SOUTH);
add(new JLabel("Large"), SOUTH);
```



JComboBox

- In some applications, you may need to allow the user to chose among a set of options that would take up too much space on the screen if you listed them all. In such situations, you can use the `JComboBox` class, which lists the available options in a popup menu that goes away once the selection is made.
- A `JComboBox` used to select T-shirt sizes might look like this on the screen:



- From the user's point of view, a `JComboBox` works like this:
  - Depressing the mouse brings up a popup menu.
  - Dragging the mouse selects from the different options.
  - Releasing the mouse sets the state to the current option.
- Given that its purpose is to offer the user a choice of options, the `JComboBox` interactor is sometimes called a ***chooser***.

JComboBox

- The standard constructor for a **JComboBox** creates an empty interactor that contains no options; you then add the desired options by calling the **addItem** method for each one.

- The code to create the T-shirt size chooser looks like this:

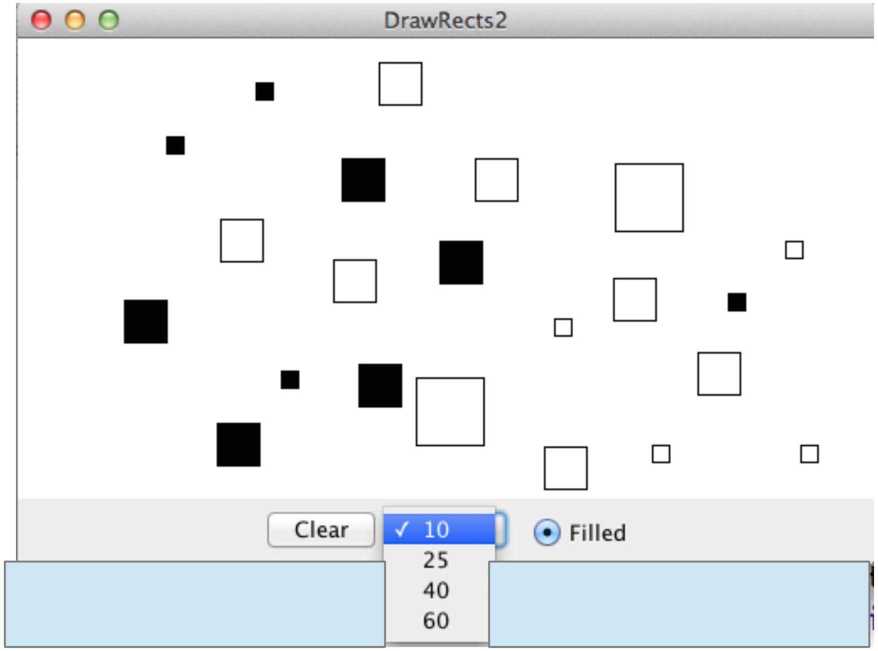
```
JComboBox sizeChooser = new JComboBox();
sizeChooser.addItem("Small");
sizeChooser.addItem("Medium");
sizeChooser.addItem("Large");
sizeChooser.addItem("X-Large");
sizeChooser.setEditable(false);
```

The last line prevents the user from typing in some other size.

- The items in a **JComboBox** need not be strings but can instead be any object. The label that appears in the popup menu is determined by applying the object’ s **toString** method.

- The **getSelectedItem** and **setSelectedItem** methods allow you to determine and set which item is selected.

Let's use JComboBox as alternative to selecting radio buttons

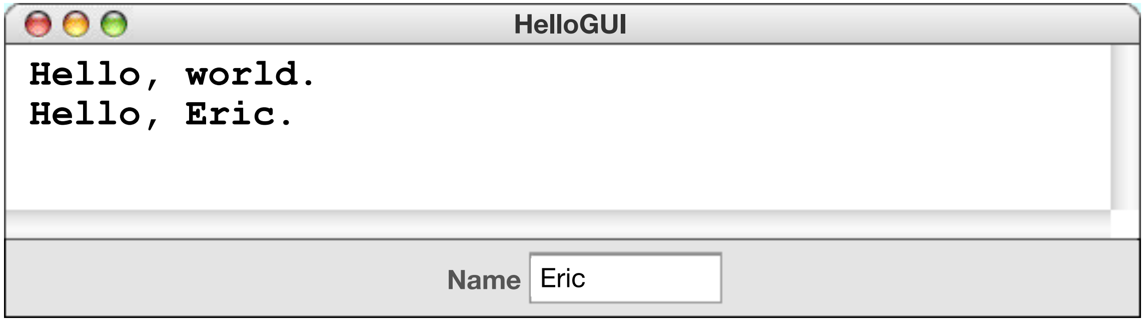


JTextField

- Although Swing's set of interactors usually make it possible for the user to control an application using only the mouse, there are nonetheless some situations in which keyboard input is necessary.

- You can accept keyboard input in a user interface by using the **JTextField** class, which provides the user with an area in which it is possible to enter a single line of text.

- The **HelloGUI** program on the next slide illustrates the use of the **JTextField** class in a **ConsoleProgram** that prints a greeting each time a name is entered in the text field.



```
Hello, world.
Hello, Eric.
```

Name: Eric

JTextField

- The constructor for the **JTextField** class has the form

  new JTextField(*columns*)

  where *columns* is the number of text columns assigned to the field. The space often appears larger than one might expect, because Java reserves space for the widest characters.

- You can get and set the string entered in a **JTextField** by calling the **getText** and **setText** methods.

- A **JTextField** generates an action event if the user presses the ENTER key in the field. If you want your program to respond to that action event, you need to register the program as an action listener for the field. In the **HelloGUI** example, the action listener is enable by the statement

```
nameField.addActionListener(this);
```

Hello GUI

```
import acm.program.*;
import java.awt.event.*;
import javax.swing.*;

/** This class displays a greeting whenever a name is entered */
public class HelloGUI extends ConsoleProgram {

   public void init() {
      nameField = new JTextField(10);
      add(new JLabel("Name"), SOUTH);
      add(nameField, SOUTH);
      nameField.addActionListener(this);
   }

   public void actionPerformed(ActionEvent e) {
      if (e.getSource() == nameField) {
         println("Hello, " + nameField.getText());
      }
   }

/* Private instance variables */
   private JTextField nameField;
}
```

DoubleField, IntField

- The **acm.gui** package includes two **JTextField** subclasses that simplify the process of reading numeric input within a graphical user interface. The **IntField** class interprets its text string as an **int**; the **DoubleField** class interprets the text string as a **double**.

- In addition to the usual operations on a **JTextField**, the **IntField** and **DoubleField** classes export **getValue** and **setValue** methods that get and set the numeric value of the field.

- Although it is beyond the scope of the text, the **IntField** and **DoubleField** classes support numeric formatting so that you can control the number of digits in the display. The methods that support this capability are described in the **javadoc** documentation for these classes.

Managing Layout

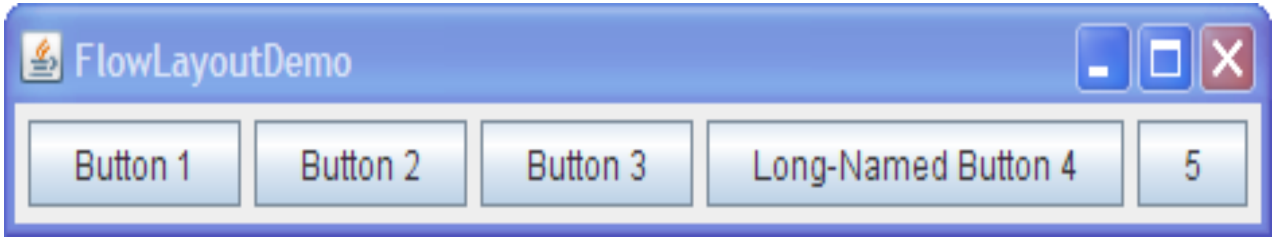
- So far, the interactors live in control strips on each side of the window. Although using control strips makes sense for simple applications, creating a more sophisticated user interface requires you to be able to place interactors anywhere inside a window.

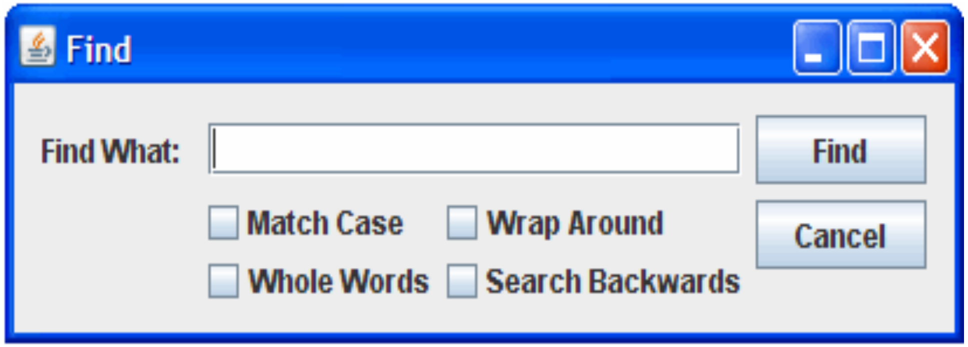
- Arranging interactors to form an elegant, easy-to-use interface is a difficult design challenge. One of the factors that complicates the design is the fact that the size of the program window can change over time. A layout that makes sense for a large window may not be appropriate for a small one.

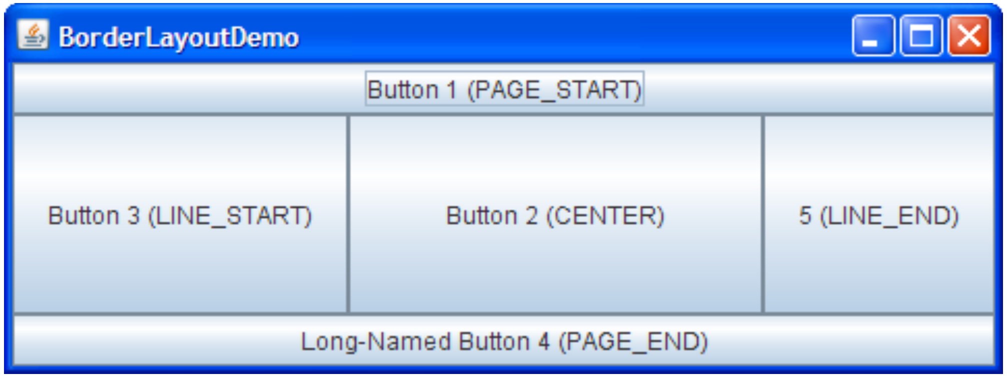
- Java seeks to solve the problem of changing window size by using ***layout managers***, which are responsible for arranging interactors and other components when the windows that contain them change size.

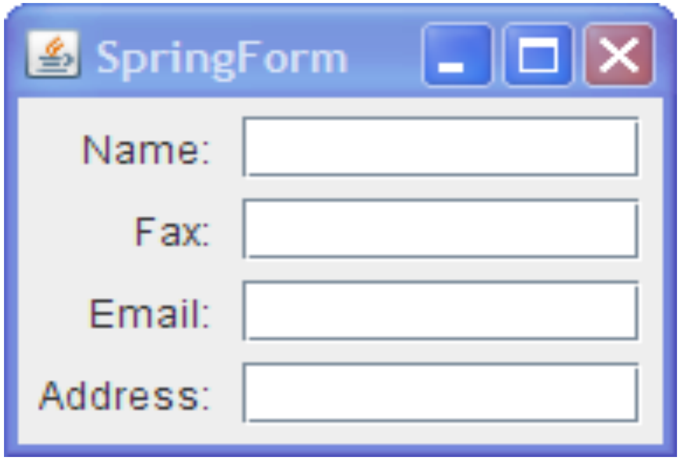
Various Layout Managers exist in Swing

- BorderLayout
- BoxLayout
- CardLayout
- FlowLayout
- GridBagLayout
- GridLayout
- GroupLayout
- SpringLayout









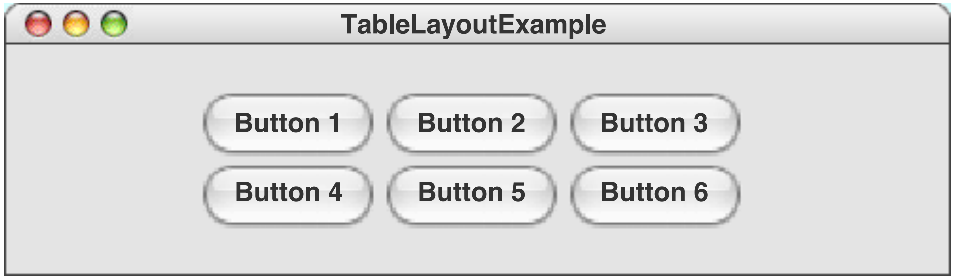
TableLayout

- The **`TableLayout`** manager arranges components into a two-dimensional grid.

- The **`TableLayout`** constructor takes the number of rows and columns in the grid:

```
new TableLayout(rows, columns)
```

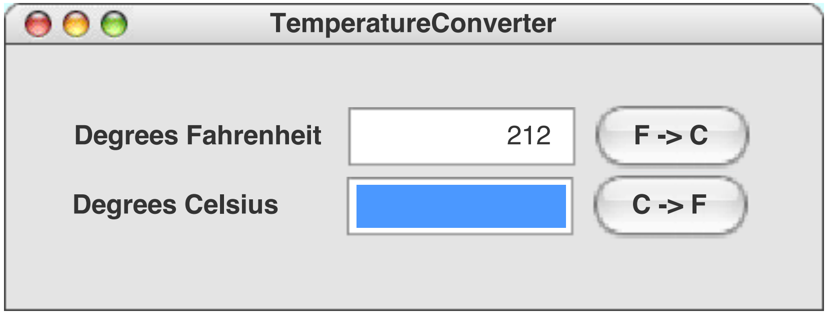
- **`Example:`**



Temperature Convertor

The **`TemperatureConverter`** program on the next slide uses the **`TableLayout`** manager to create a simple user interface for a program that converts temperatures back and forth from Celsius to Fahrenheit. The steps involved in using the program are:

1. Enter an integer into either of the numeric fields.
2. Hit ENTER or click the conversion button.
3. Read the result from the other numeric field.



Degrees Fahrenheit 212

Degrees Celsius

Temperature Convertor Code

```
/**
 * This program allows users to convert temperatures back and forth
 * from Fahrenheit to Celsius.
 */
public class TemperatureConverter extends Program {

/* Initializes the graphical user interface */
   public void init() {
      setLayout(new TableLayout(2, 3));
      fahrenheitField = new IntField(32);
      fahrenheitField.setActionCommand("F -> C");
      fahrenheitField.addActionListener(this);
      celsiusField = new IntField(0);
      celsiusField.setActionCommand("C -> F");
      celsiusField.addActionListener(this);
      add(new JLabel("Degrees Fahrenheit"));
      add(fahrenheitField);
      add(new JButton("F -> C"));
      add(new JLabel("Degrees Celsius"));
      add(celsiusField);
      add(new JButton("C -> F"));
      addActionListeners();
   }
```

Temperature Convertor Code

```
/* Listens for a button action */
   public void actionPerformed(ActionEvent e) {
      String cmd = e.getActionCommand();
      if (cmd.equals("F -> C")) {
         int f = fahrenheitField.getValue();
         int c = GMath.round((5.0 / 9.0) * (f - 32));
         celsiusField.setValue(c);
      } else if (cmd.equals("C -> F")) {
         int c = celsiusField.getValue();
         int f = GMath.round((9.0 / 5.0) * c + 32);
         fahrenheitField.setValue(f);
      }
   }

/* Private instance variables */
   private IntField fahrenheitField;
   private IntField celsiusField;
}
```