AWT Components: Simple User Interfaces

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Topics in This Section

- **Available GUI libraries in Java**
- **Basic AWT windows**
  - Canvas, Panel, Frame
- **Closing frames**
- **Processing events in GUI controls**
- **Basic AWT user interface controls**
  - Button, checkbox, radio button, list box

GUI Libraries in Java SE

GUI Libraries in Java

Part of Java SE

- AWT (Abstract Window Toolkit)
  - The original GUI library in Java 1.02. Native Look and Feel (LAF).
    - Covered in this lecture
  - Purposes
    - Easy building of simple-looking interfaces
      - Often for internal purposes only. Not seen by end users.
    - First step toward learning Swing
- Swing
  - GUI library added to Java starting in Java 1.1
    - Covered in later lectures
  - Purposes
    - Professional looking GUIs that follow standard
    - GUIs with the same look and feel on multiple platforms

Extensions

- SWT (Standard Widget Toolkit)
  - GUI from the Eclipse foundation. Native LAF ala AWT.
    - See http://www.eclipse.org/swt/
  - Purposes
    - Higher-performance professional looking GUIs
    - Native LAF
    - Interaction with the Eclipse Rich Client Platform
- Java FX
  - GUI library and tools now standardized separately
    - See http://javafx.com/
    - Part of Java SE starting in Java 8
  - Purposes
    - XML-based layout
    - Mobile platforms
    - Rich media: audio, video, etc.

Background

Windows and Layout Management

- **Containers**
  - Most windows are a `Container` that can hold other windows or GUI components. `Canvas` is the major exception.
- **Layout Managers**
  - Containers have a `LayoutManager` that automatically sizes and positions components that are in the window
  - You can change the behavior of the layout manager or disable it completely. Details in next lecture.
- **Events**
  - Windows and components can receive mouse and keyboard events, just as in previous lecture.

Windows and Layout Management (Continued)

- **Drawing in Windows**
  - To draw into a window, make a subclass with its own `paint` method
  - Having one window draw into another window is not usually recommended
- **Popup Windows**
  - Some windows (`Frame` and `Dialog`) have their own title bar and border and can be placed at arbitrary locations on the screen
  - Other windows (`Canvas` an `Panel`) are embedded into existing windows only

Foundational AWT Window Types

Summary

- **Canvas**
  - Purpose:
    - Reusable picture or drawing area. Basis for custom component.
  - Code
    - Allocate Canvas, give it a size, add it to existing window.
- **Panel**
  - Purpose
    - To group other components into rectangular regions.
  - Code
    - Allocate Panel, put other components in it, add to window.
- **Frame**
  - Purpose
    - Core popup window. Main window for your application.
  - Code
    - Allocate Frame, give it a size, add stuff to it, pop it up.

Canvas

- **Major purposes**
  - A drawing area
  - A custom component that does not need to contain any other component (e.g., an image button)
- **Default layout manager: none**
  - Canvas is not a Container, so cannot enclose components
- **Creating and using**
  - Allocate it
    - Canvas c = new Canvas();
  - Give it a size
    - c.setSize(width, height);
  - Drop it in existing window
    - someWindow.add(c);

Since Canvas is often the starting point for a component that has a custom paint method or event handlers, you often do

MySpecializedCanvas c = new MySpecializedCanvas(...).

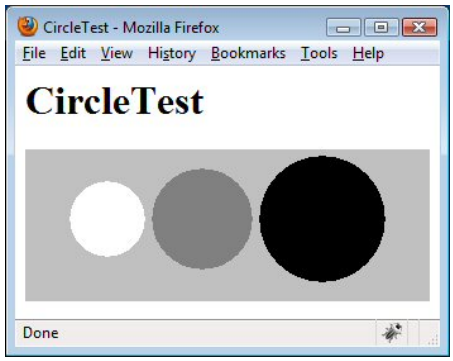
If this code is in the main window, then "someWindow" is "this" and can be omitted. I.e, the init method of an applet would add a Canvas to itself just with "add(c);".

Canvas Example

```
import java.awt.*;

/** A Circle component built using a Canvas. */

public class Circle extends Canvas {
  private int width, height;

  public Circle(Color foreground, int radius) {
    setForeground(foreground);
    width = 2*radius;
    height = 2*radius;
    setSize(width, height);
  }

  public void paint(Graphics g) {
    g.fillOval(0, 0, width, height);
  }

  public void setCenter(int x, int y) {
    setLocation(x - width/2, y - height/2);
  }
}
```

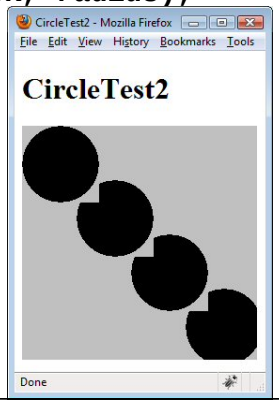
Canvas Example (Continued)

```
import java.awt.*;
import java.applet.Applet;

public class CircleTest extends Applet {
  public void init() {
    setBackground(Color.LIGHT_GRAY);
    add(new Circle(Color.WHITE, 30));
    add(new Circle(Color.GRAY, 40));
    add(new Circle(Color.BLACK, 50));
  }
}
```



Canvases are Rectangular and Opaque: Example

```
public class CircleTest2 extends Applet {
  public void init() {
    setBackground(Color.LIGHT_GRAY);
    setLayout(null); // Turn off layout manager.
    Circle circle;
    int radius = getSize().width/6;
    int deltaX = round(2.0 * (double)radius / Math.sqrt(2.0));
    for (int x=radius; x<6*radius; x=x+deltaX) {
      circle = new Circle(Color.BLACK, radius);
      add(circle);
      circle.setCenter(x, x);
    }
  }

  private int round(double num) {
    return((int)Math.round(num));
  }
}
```

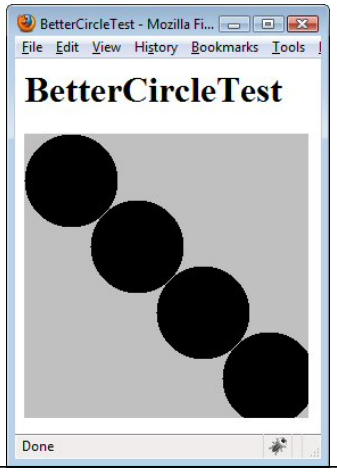


Lightweight Components

- **Idea**
  - Regular AWT windows are native windows behind the scenes. So, they are rectangular and opaque.
  - You can make "lightweight components" – components that are really pictures, not windows, behind the scenes.
    - These don't have the rectangular/opaque restrictions, but building them is usually more trouble than it is worth in the AWT library. The Swing library makes it simple with a "setOpaque" method.
- **Code**
  - If you really want to do it yourself in AWT, you have to tell Java how to calculate the minimum and preferred sizes (see later section on layout managers).
    - Even so, it can have tricky interactions if the enclosing window has a custom paint method. Use Swing instead!

Lightweight Components: Example

```
public class BetterCircle extends Component {
  private Dimension preferredDimension;
  private int width, height;

  public BetterCircle(Color foreground, int radius) {
    setForeground(foreground);
    width = 2*radius; height = 2*radius;
    preferredDimension = new Dimension(width, height);
    setSize(preferredDimension);
  }

  public void paint(Graphics g) {
    g.setColor(getForeground());
    g.fillOval(0, 0, width, height);
  }

  public Dimension getPreferredSize() {
    return(preferredDimension);
  }
   public Dimension getMinimumSize() {
    return(preferredDimension);
  }
  ...
```



Component Class

- **Idea**
  - Ancestor of all graphical components in Java (even Swing). So, methods here are shared by all windows and controls.
- **Useful methods**
  - getBackground/setBackground
  - getForeground/setForeground
    - Change/lookup the default foreground color
    - Color is inherited by the Graphics object of the component
  - getFont/setFont
    - Returns/sets the current font
    - Inherited by the Graphics object of the component
  - paint
    - Called whenever the user call repaint or when the component is obscured and reexposed

Component Class (Continued)

- **Useful methods**
  - setVisible
    - Exposes (`true`) or hides (`false`) the component
    - Especially useful for frames and dialogs
  - setSize/setBounds/setLocation
  - getSize/getBounds/getLocation
    - Physical aspects (size and position) of the component
  - list
    - Prints out info on this component and any components it contains; useful for debugging
  - invalidate/validate
    - Tell layout manager to redo the layout
  - getParent
    - Returns enclosing window (or `null` if there is none)

Panel

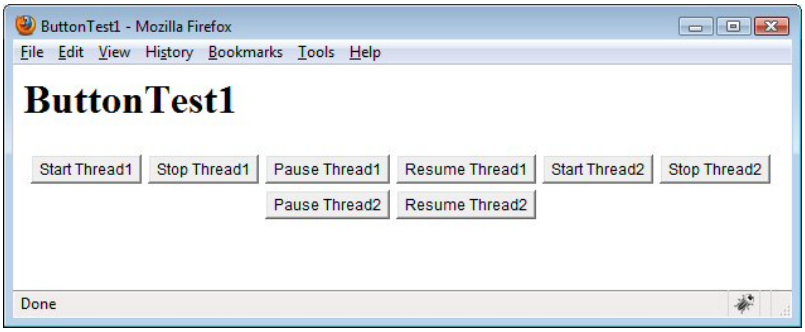
- **Major purposes**
  - To group/organize components
  - A custom component that requires embedded components
- **Default layout manager: FlowLayout**
  - Shrinks components to their preferred (minimum) size
  - Places them left to right in centered rows
- **Creating and using**
  - Allocate it
    - Panel p = new Panel();
  - Put stuff into it
    - p.add(someButton);
    - p.add(someOtherWidget);
  - Drop the Panel in an existing window
    - someWindow.add(p);

Note the lack of an explicit setSize. The size of a Panel is usually determined by a combination of what the Panel contains and the layout manager of the window that contains the Panel.

No Panels: Example

```
import java.applet.Applet;
import java.awt.*;

public class ButtonTest1 extends Applet {
  public void init() {
    String[] labelPrefixes = { "Start", "Stop", "Pause",
                               "Resume" };
    for (int i=0; i<4; i++) {
      add(new Button(labelPrefixes[i] + " Thread1"));
    }
    for (int i=0; i<4; i++) {
      add(new Button(labelPrefixes[i] + " Thread2"));
    }
  }
}
```

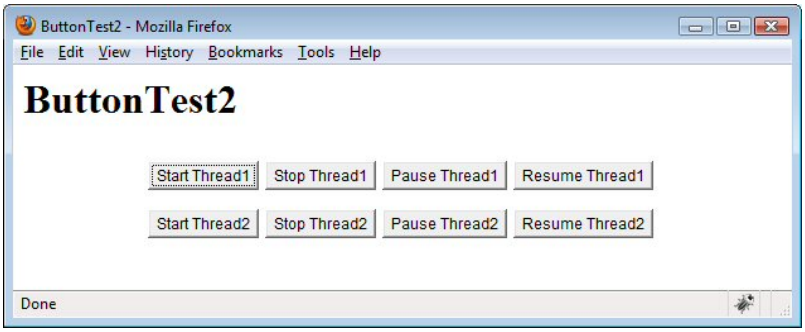
No Panels: Result



Panels: Example

```
import java.applet.Applet;
import java.awt.*;

public class ButtonTest2 extends Applet {
  public void init() {
    String[] labelPrefixes = { "Start", "Stop", "Pause",
                               "Resume" };
    Panel p1 = new Panel();
    for (int i=0; i<4; i++) {
      p1.add(new Button(labelPrefixes[i] + " Thread1"));
    }
    Panel p2 = new Panel();
    for (int i=0; i<4; i++) {
      p2.add(new Button(labelPrefixes[i] + " Thread2"));
    }
    add(p1);
    add(p2);
  }
}
```

Panels: Result



Container Class

- **Idea**
  - Ancestor of all window types except Canvas. So, these methods are common among almost all windows.
- **Useful Container methods**
  - add
    - Add a component to the container (in the last position in the component array)
    - If using BorderLayout, you can also specify in which region to place the component
  - remove
    - Remove the component from the window (container)
  - getComponents
    - Returns an array of components in the window
    - Used by layout managers
  - setLayout
    - Changes the layout manager associated with the window

Frame Class

- **Major Purpose**
  - A stand-alone window with its own title and menu bar, border, cursor, and icon image
    - Can contain other GUI components
- **Default layout manager: BorderLayout**
  - BorderLayout
    - Divides the screen into 5 regions: North, South, East, West, and Center
  - To switch to the applet's layout manager use
    - setLayout(new FlowLayout());
- **Creating and using – two approaches:**
  - A fixed-size Frame
  - A Frame that stretches to fit what it contains

Creating a Fixed-Size Frame

- **Approach**

```
Frame frame = new Frame(titleString);
frame.add(somePanel, BorderLayout.CENTER);
frame.add(otherPanel, BorderLayout.NORTH);
...
frame.setSize(width, height);
frame.setVisible(true);
```

- **Note: be sure you pop up the frame last**
  - Odd behavior results if you add components to a window that is already visible (unless you call `doLayout` on the frame)

Creating a Frame that Stretches to Fit What it Contains

- **Approach**

```
Frame frame = new Frame(titleString);
frame.setLocation(left, top);
frame.add(somePanel, BorderLayout.CENTER);
...
frame.pack();
frame.setVisible(true);
```

- **Note**
  - Again, be sure to pop up the frame *after* adding the components

Frame Example 1

- **Creating the Frame object in main**

```
public class FrameExample1 {
  public static void main(String[] args) {
    Frame f = new Frame("Frame Example 1");
    f.setSize(400, 300);
    f.setVisible(true);
  }
}
```

Frame Example 2

- **Using a Subclass of Frame**

```
public class FrameExample2 extends Frame {
  public FrameExample2() {
    super("Frame Example 2");
    setSize(400, 300);
    setVisible(true);
  }

  public static void main(String[] args) {
    new FrameExample2();
  }
}
```

The "main" method that instantiates the Frame need not reside in FrameExample2. The idea is that you make a reusable Frame class, and then that class can be popped up various different ways (from main, when the user clicks a button, when certain events occur in your app, etc.)

A Closeable Frame

- **CloseableFrame.java**

```
public class CloseableFrame extends Frame {
  public CloseableFrame(String title) {
    super(title);
    addWindowListener(new ExitListener());
  }
}
```

- **ExitListener.java**

```
public class ExitListener extends WindowAdapter {
  public void windowClosing(WindowEvent event) {
    System.exit(0);
  }
}
```

Download these two classes from the source code in the tutorial, then use CloseableFrame wherever you would have used Frame.

Frame Example 3

- **Using a Subclass of CloseableFrame**

```
public class FrameExample3 extends CloseableFrame {
  public FrameExample3() {
    super("Frame Example 3");
    setSize(400, 300);
    setVisible(true);
  }

  public static void main(String[] args) {
    new FrameExample3();
  }
}
```

Same as previous example, but now the Frame closes when you click on the x.

AWT GUI Controls and Event Processing

AWT GUI Controls

- **Characteristics (vs. windows)**
  - Automatically drawn – you don't override `paint`
  - Positioned by layout manager
  - Use native window-system controls (widgets)
    - Controls adopt look and feel of underlying window system
  - Higher level events typically used
    - For example, for buttons you don't monitor mouse clicks, since most OS's also let you trigger a button by hitting RETURN when the button has the keyboard focus

GUI Event Processing Strategies

- **Decentralized event processing**
  - Component (e.g., Button) has its own event handler
    - Harder to call methods in the main app, so works best when operations are relatively independent
- **Centralized event processing**
  - Have main app implement listener. Send all events there.
    - Easier for handler to call methods from the main app
    - But, if you have multiple buttons, you will need if/then/else in the event-handler method
- **Semi-centralized event processing**
  - Use inner class for event handling
    - Better than interface if you have many different buttons

Decentralized Event Processing: Example

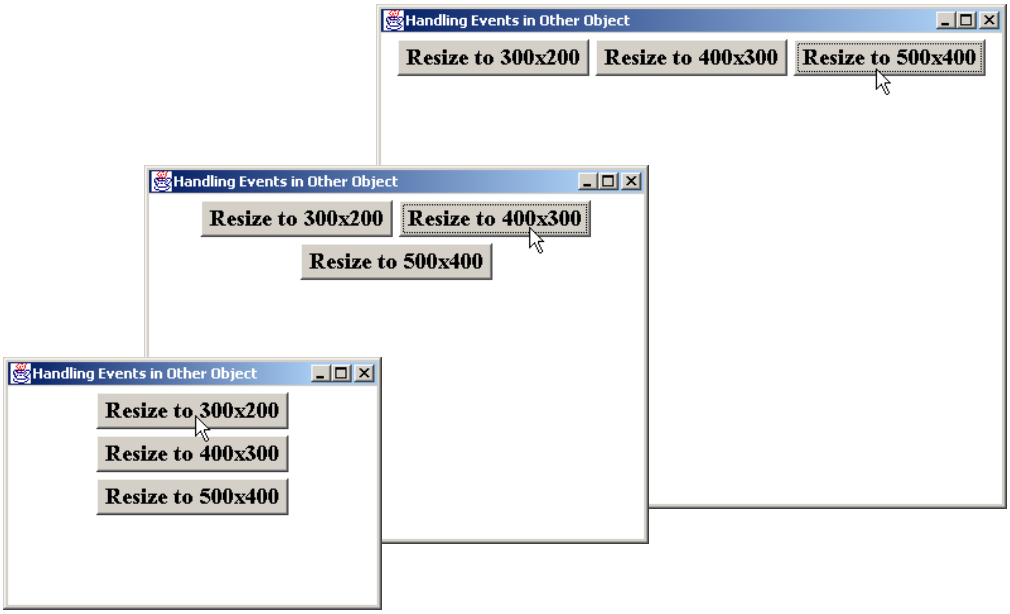
```
import java.awt.*;

public class ActionExample1 extends CloseableFrame {
  public ActionExample1() {
    super("Handling Events in Component");
    setLayout(new FlowLayout());
    setFont(new Font("Serif", Font.BOLD, 18));
    add(new SetSizeButton(300, 200));
    add(new SetSizeButton(400, 300));
    add(new SetSizeButton(500, 400));
    setSize(400, 300);
    setVisible(true);
  }

  public static void main(String[] args) {
    new ActionExample1();
  }
}
```

Very closely analogous to the first approach from the event-handling lecture (separate classes for event handlers).

Decentralized Event Processing: Example (Continued)

```
import java.awt.*;
import java.awt.event.*;

public class SetSizeButton extends Button
                           implements ActionListener {
  private int width, height;

  public SetSizeButton(int width, int height) {
    super("Resize to " + width + "x" + height);
    this.width = width;
    this.height = height;
    addActionListener(this);
  }

  public void actionPerformed(ActionEvent event) {
    Container parent = getParent();
    parent.setSize(width, height);
    parent.invalidate();
    parent.validate();
  }
```

Decentralized Event Processing: Result



Centralized Event Processing: Example

```
import java.awt.*;
import java.awt.event.*;

public class ActionExample2 extends CloseableFrame
                           implements ActionListener {
  private Button button1, button2, button3;

  public ActionExample2() {
    super("Handling Events in Other Object");
    setLayout(new FlowLayout());
    setFont(new Font("Serif", Font.BOLD, 18));
    button1 = new Button("Resize to 300x200");
    button1.addActionListener(this);
    add(button1);
    // Add button2 and button3 in the same way…
    ...
    setSize(400, 300);
    setVisible(true);
  }
```

Centralized Event Processing: Example (Continued)

```
  public void actionPerformed(ActionEvent event) {
    if (event.getSource() == button1) {
      updateLayout(300, 200);
    } else if (event.getSource() == button2) {
      updateLayout(400, 300);
    } else if (event.getSource() == button3) {
      updateLayout(500, 400);
    }
  }

  private void updateLayout(int width, int height) {
    setSize(width, height);
    invalidate();
    validate();
  }

 public static void main(String[] args) {
    new ActionExample2();
  }
}
```

Very closely analogous to the second approach from the event-handling lecture (main class implements interface).

Semi-Centralized Event Processing: Example

```
import java.awt.*;
import java.awt.event.*;

public class ActionExample3 extends CloseableFrame {
  private Button button1, button2, button3;

  public ActionExample3() {
    super("Handling Events in Other Object");
    setLayout(new FlowLayout());
    setFont(new Font("Serif", Font.BOLD, 18));
    button1 = new Button("Resize to 300x200");
    button1.addActionListener(new ResizeHandler(300, 200));
    add(button1);
    // Add button2 and button3 in the same way…
    ...
    setSize(400, 300);
    setVisible(true);
  }
```

Semi-Centralized Event Processing: Example (Cont)

```
  private void updateLayout(int width, int height) {
    setSize(width, height);
    invalidate();
    validate();
  }

  private class ResizeHandler implements ActionListener {
    private int width, height;

    public ResizeHandler(int width, int height) {
      this.width= width;
      this.height = height;
    }

    public void actionPerformed(ActionEvent event) {
      updateLayout(width, height);
    }
  }

public static void main(String[] args) {
    new ActionExample3();
  }
}
```

Very closely analogous to the third approach from the event-handling lecture (inner classes for event handlers).

Basic AWT GUI Controls

Buttons

- **Constructors**
  - Button()
    Button(String buttonLabel)
    - The button size (preferred size) is based on the height and width of the label in the current font, plus some extra space determined by the OS
- **Useful Methods**
  - getLabel/setLabel
    - Retrieves or sets the current label
    - If the button is already displayed, setting the label does not automatically reorganize its `Container`
      - The containing window should be invalidated and validated to force a fresh layout

```
someButton.setLabel("A New Label");
someButton.getParent().invalidate();
someButton.getParent().validate();
```


Buttons (Continued)

- **Event processing methods**
  - addActionListener/removeActionListener
    - Add/remove an **`ActionListener`** that processes **`ActionEvent`**s in **`actionPerformed`**
  - processActionEvent
    - Low-level event handling
- **General methods inherited from component**
  - getForeground/setForeground
  - getBackground/setBackground
  - getFont/setFont

Button: Example

```
public class Buttons extends Applet {
  private Button button1, button2, button3;
  public void init() {
    button1 = new Button("Button One");
    button2 = new Button("Button Two");
    button3 = new Button("Button Three");
    add(button1);
    add(button2);
    add(button3);
  }
}
```

Handling Button Events

- **Attach an ActionListener to the Button and handle the event in actionPerformed**

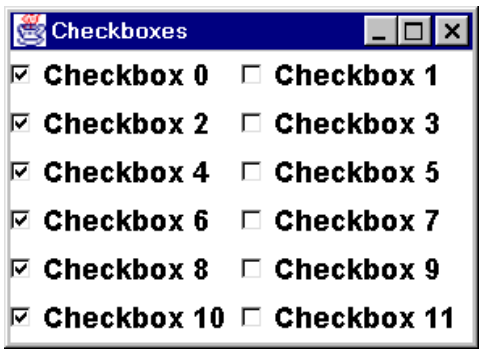
```
public class MyActionListener
             implements ActionListener {
  public void actionPerformed(ActionEvent event) {
    ...
  }
}

public class SomeClassThatUsesButtons {
  ...
  MyActionListener listener = new MyActionListener(...);
  Button b1 = new Button("...");
  b1.addActionListener(listener);
  ...
}
```

Checkboxes

- **Constructors**
  - These three constructors apply to checkboxes that operate independently of each other (i.e., not radio buttons)
  - Checkbox()
    - Creates an initially unchecked checkbox with no label
  - Checkbox(String checkboxLabel)
    - Creates a checkbox (initially unchecked) with the specified label; see `setState` for changing it
  - Checkbox(String checkboxLabel, boolean state)
    - Creates a checkbox with the specified label
      - The initial state is determined by the boolean value provided
      - A value of true means it is checked

Checkbox, Example

```
public class Checkboxes extends CloseableFrame {
  public Checkboxes() {
    super("Checkboxes");
    setFont(new Font("SansSerif", Font.BOLD, 18));
    setLayout(new GridLayout(0, 2));
    Checkbox box;
    for(int i=0; i<12; i++) {
      box = new Checkbox("Checkbox " + i);
      if (i%2 == 0) {
        box.setState(true);
      }
      add(box);
    }
    pack();
    setVisible(true);
  }
}
```



Other Checkbox Methods

- **getState/setState**
  - Retrieves or sets the state of the checkbox: checked (true) or unchecked (false)
- **getLabel/setLabel**
  - Retrieves or sets the label of the checkbox
  - After changing the label invalidate and validate the window to force a new layout

```
someCheckbox.setLabel("A New Label");
someCheckbox.getParent().invalidate();
someCheckbox.getParent().validate();
```

- **addItemListener/removeItemListener**
  - Add or remove an `ItemListener` to process `ItemEvents` in `itemStateChanged`
- **processItemEvent(ItemEvent event)**
  - Low-level event handling

Handling Checkbox Events

- **Attach an ItemListener**
  - Add it with addItemListener and process the ItemEvent in itemStateChanged

```
public void itemStateChanged(ItemEvent event) {
  ...
}
```

    - The ItemEvent class has a getItem method which returns the item just selected or deselected
    - The return value of getItem is an Object so you should cast it to a String before using it
- **Ignore the event**
  - With checkboxes, it is relatively common to ignore the select/deselect event when it occurs
  - Instead, you look up the state (checked/unchecked) of the checkbox later using the getState method of Checkbox when you are ready to take some other sort of action

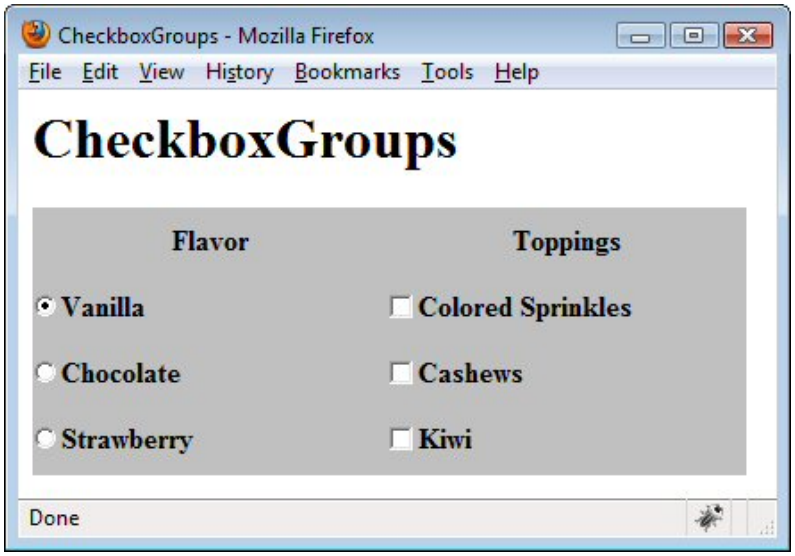
Checkbox Groups (Radio Buttons)

- **CheckboxGroup Constructors**
  - CheckboxGroup()
    - Creates a non-graphical object used as a “tag” to group checkboxes logically together
    - Checkboxes with the same tag will look and act like radio buttons
    - Only one checkbox associated with a particular tag can be selected at any given time
- **Checkbox Constructors**
  - Checkbox(String label, CheckboxGroup group, boolean state)
    - Creates a radio button associated with the specified group, with the given label and initial state
    - If you specify an initial state of **`true`** for more than one Checkbox in a group, the last one will be shown selected

CheckboxGroup: Example

```
import java.applet.Applet;
import java.awt.*;

public class CheckboxGroups extends Applet {
  public void init() {
    setLayout(new GridLayout(4, 2));
    setBackground(Color.LIGHT_GRAY);
    setFont(new Font("Serif", Font.BOLD, 16));
    add(new Label("Flavor", Label.CENTER));
    add(new Label("Toppings", Label.CENTER));
    CheckboxGroup flavorGroup = new CheckboxGroup();
    add(new Checkbox("Vanilla", flavorGroup, true));
    add(new Checkbox("Colored Sprinkles"));
    add(new Checkbox("Chocolate", flavorGroup, false));
    add(new Checkbox("Cashews"));
    add(new Checkbox("Strawberry", flavorGroup, false));
    add(new Checkbox("Kiwi"));
  }
}
```

CheckboxGroup: Result



By tagging Checkboxes with a CheckboxGroup, the Checkboxes in the group function as radio buttons

Other Methods for Radio Buttons

- **CheckboxGroup**
  - getSelectedCheckbox
    - Returns the radio button (**`Checkbox`**) that is currently selected or **`null`** if none is selected
- **Checkbox**
  - In addition to the general methods described in Checkboxes, `Checkbox` has the following two methods specific to CheckboxGroup's:
  - getCheckboxGroup/setCheckboxGroup
    - Determines or registers the group associated with the radio button
- **Note: Event-handling is the same as with Checkboxes**

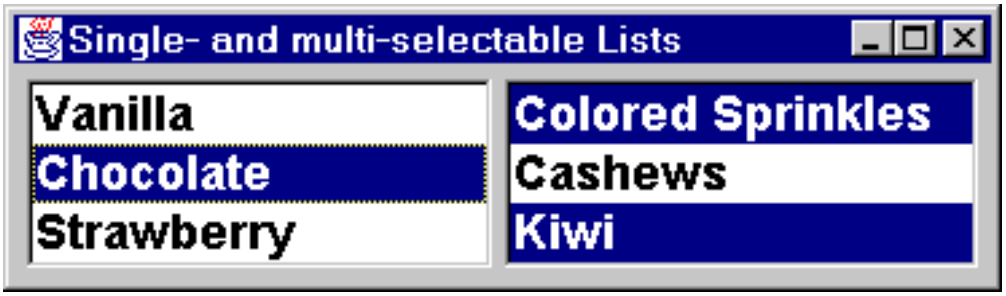
List Boxes

- **Constructors**
  - List(int rows, boolean multiSelectable)
    - Creates a listbox with the specified number of visible rows (not items)
    - Depending on the number of item in the list (addItem or add), a scrollbar is automatically created
    - The second argument determines if the List is multiselectable
    - The preferred width is set to a platform-dependent value, and is typically not directly related to the width of the widest entry
  - List()
    - Creates a single-selectable list box with a platform-dependent number of rows and a platform-dependent width
  - List(int rows)
    - Creates a single-selectable list box with the specified number of rows and a platform-dependent width

List Boxes: Example

```
import java.awt.*;

public class Lists extends CloseableFrame {
  public Lists() {
    super("Lists");
    setLayout(new FlowLayout());
    setBackground(Color.LIGHT_GRAY);
    setFont(new Font("SansSerif", Font.BOLD, 18));
    List list1 = new List(3, false);
    list1.add("Vanilla");
    list1.add("Chocolate");
    list1.add("Strawberry");
    add(list1);
    List list2 = new List(3, true);
    list2.add("Colored Sprinkles");
    list2.add("Cashews");
    list2.add("Kiwi");
    add(list2);
    pack();
    setVisible(true);
  }}
```

List Boxes: Result



A list can be *single*-selectable or *multi*-selectable

Other List Methods

- **add**
  - Add an item at the end or specified position in the list box
  - All items at that index or later get moved down
- **isMultipleMode**
  - Determines if the list is multiple selectable (`true`) or single selectable (`false`)
- **remove/removeAll**
  - Remove an item or all items from the list
- **getSelectedIndex**
  - For a single-selectable list, this returns the index of the selected item
  - Returns –1 if nothing is selected or if the list permits multiple selections
- **getSelectedIndexes**
  - Returns an array of the indexes of all selected items
    - Works for single- or multi-selectable lists
    - If no items are selected, a zero-length (but non-null) array is returned

Other List Methods (Continued)

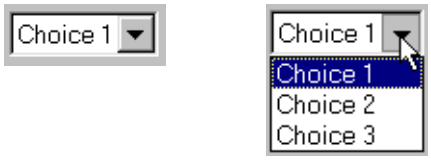
- **getSelectedItem**
  - For a single-selectable list, this returns the label of the selected item
  - Returns null if nothing is selected or if the list permits multiple selections
- **getSelectedItems**
  - Returns an array of all selected items
  - Works for single- or multi-selectable lists
    - If no items are selected, a zero-length (but non-null) array is returned
- **select**
  - Programmatically selects the item in the list
  - If the list does not permit multiple selections, then the previously selected item, if any, is also deselected

Handling List Events

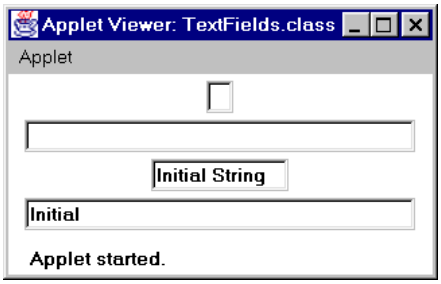
- **addItemListener/removeItemListener**
  - **`ItemEvent`**s are generated whenever an item is selected or deselected (single-click)
  - Handle **`ItemEvent`**s in **`itemStateChanged`**
- **addActionListener/removeActionListener**
  - `ActionEvent`s are generated whenever an item is double-clicked or RETURN (ENTER) is pressed while selected
  - Handle **`ActionEvent`**s in **`actionPerformed`**

Other GUI Controls

- **Choice Lists (Combo Boxes)**

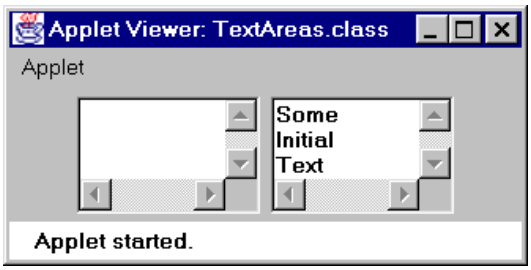


- **Textfields**

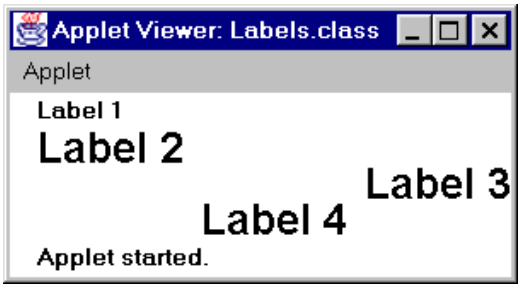


Other GUI Controls (Continued)

- **Text Areas**



- **Labels**



Summary

- **Native components behind the scenes**
  - So, all windows and graphical components are rectangular and opaque, and take look-and-feel of underlying OS.
- **Windows**
  - Canvas: drawing area or custom component
  - Panel: grouping other components
  - Frame: popup window
- **GUI Controls**
  - Button: handle events with ActionListener
  - Checkbox, radio button: handle events with ItemListener
  - List box: handle single click with ItemListener, double click with ActionListener
  - To quickly determine the event handlers for a component, simply look at the online API
    - add*Xxx*Listener methods are at the top

Questions?

More info:
http://courses.coreservlets.com/Course-Materials/java.html – General Java programming tutorial
http://www.coreservlets.com/java-8-tutorial/ – Java 8 tutorial
http://courses.coreservlets.com/java-training.html – Customized Java training courses, at public venues or onsite at *your* organization
http://coreservlets.com/ – JSF 2, PrimeFaces, Java 7 or 8, Ajax, jQuery, Hadoop, RESTful Web Services, Android, HTML5, Spring, Hibernate, Servlets, JSP, GWT, and other Java EE training

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