JDK 1.1 AWT Event Handling

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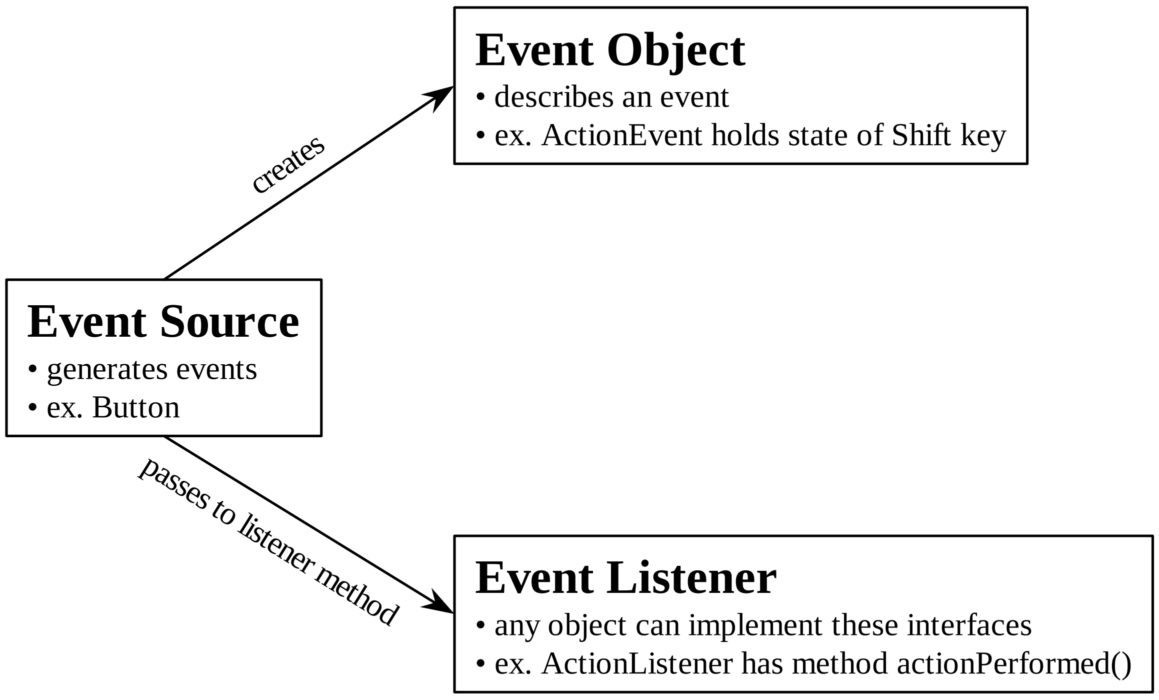
AWT

- Abstract Windowing Toolkit package
  - java.awt
- Easier to learn than Motif/X and MFC
- Not as easy as using graphical GUI builders
  - several companies are creating them for Java
  - will output Java code that uses the AWT package
- AWT classes fall in four categories
  - components
  - containers
  - layout managers
  - event handling

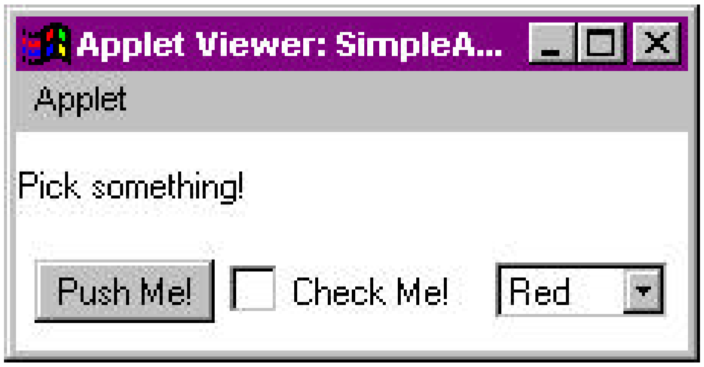
Steps To Use AWT

- Create a container
  - Frame, Dialog, Window, Panel, ScrollPane
- Select a LayoutManager
  - Flow, Border, Grid, GridBag, Card, none (null)
- Create components
  - Button, Checkbox, Choice, Label, List, TextArea, TextField, PopupMenu
- Add components to container
- Specify event handling (changed in 1.1)
  - listeners are objects interested in events
  - sources are objects that “fire” events
  - register listeners with sources
    - component.add<EventType>Listener
      - EventTypes are ActionEvent, AdjustmentEvent, ComponentEvent, FocusEvent, ItemEvent, KeyEvent, MouseEvent, TextEvent, WindowEvent
  - implement methods of listener interfaces in listener classes
    - an event object is passed to the methods
    - ActionListener, AdjustmentListener, ComponentListener, FocusListener, ItemListener, KeyListener, MouseListener, MouseMotionListener, TextListener, WindowListener

Event Sources, Listeners, and Objects


Event Object
• describes an event
• ex. ActionEvent holds state of Shift key
creates
Event Source
• generates events
• ex. Button
passes to listener method
Event Listener
• any object can implement these interfaces
• ex. ActionListener has method actionPerformed()

Simple AWT Example



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

public class SimpleAWT extends java.applet.Applet
implements ActionListener, ItemListener {

    private Button button = new Button("Push Me!");
    private Checkbox checkbox = new Checkbox("Check Me!");
    private Choice choice = new Choice();
    private Label label = new Label("Pick something!");

    public void init() {
        button.addActionListener(this);
        checkbox.addItemListener(this);
        choice.addItemListener(this);

        // An Applet is a Container because it extends Panel.
        setLayout(new BorderLayout());

        choice.addItem("Red");
        choice.addItem("Green");
        choice.addItem("Blue");

        Panel panel = new Panel();
        panel.add(button);
        panel.add(checkbox);
        panel.add(choice);

        add(label, "Center");
        add(panel, "South");
    }
```

Simple AWT Example (Cont’d)

```
    public void actionPerformed(ActionEvent e) {
        if (e.getSource() == button) {
            label.setText("The Button was pushed.");
        }
    }

    public void itemStateChanged(ItemEvent e) {
        if (e.getSource() == checkbox) {
            label.setText("The Checkbox is now " +
                          checkbox.getState() + ".");
        } else if (e.getSource() == choice) {
            label.setText(choice.getSelectedItem() + “ was selected.”);
        }
    }
}
```

Event Classes

- Hierarchy
  java.util.EventObject
  - java.awt.AWTEvent
    - java.awt.event.ComponentEvent
      - java.awt.event.FocusEvent
      - java.awt.event.InputEvent
        - java.awt.event.KeyEvent
        - java.awt.event.MouseEvent
    - java.awt.event.ActionEvent
    - java.awt.event.AdjustmentEvent
    - java.awt.event.ItemEvent
    - java.awt.event.TextEvent
- Can create custom, non-AWT event classes
  - extend java.util.EventObject

Event Object Contents

- java.util.**EventObject**
  - **source** holds a reference to the object that fired the event
  - java.awt.**AWTEvent**
    - **id** indicates event type
      - set to a constant in specific event classes (listed on following pages)
    - java.awt.event.**ActionEvent**
      - **modifiers** indicates state of control, shift, and meta (alt) keys
      - **actionCommand** holds the action specific command string
        - usually the label of a Button or MenuItem
    - java.awt.event.**AdjustmentEvent**
      - for Scrollbars
      - **value** holds value
      - **adjustmentType** is unit +/-, block +/-, track
    - java.awt.event.**ItemEvent**
      - for Choice, List, Checkbox, and CheckboxMenuItem
      - **stateChange** indicates selected or deselected
    - java.awt.event.**TextEvent**
      - listeners are notified of every keystroke that changes the value
      - listeners are also notified when setText() is called
    - other subclasses are on the following pages

used for checkboxes and radio buttons

Event Object Contents (Cont'd)

- java.awt.**AWTEvent**
  - java.awt.event.**ComponentEvent**
    - **id** indicates moved, resized, shown, or hidden
    - java.awt.event.**ContainerEvent**
      - **id** indicates added or removed
      - **child** holds a reference to the component added or removed
    - java.awt.event.**FocusEvent**
      - **id** indicates gained or lost
      - **temporary** indicates temporary or permanent (see documentation in source)
    - java.awt.event.**WindowEvent**
      - **id** indicates opened, closing, closed, iconified, deiconified, activated, and deactivated

brought to front

Event Object Contents (Cont’d)

- java.awt.AWTEvent
  - java.awt.event.InputEvent
    - **modifiers** is a mask that holds
      - state of control, shift, and meta (alt) keys
      - state of mouse buttons 1, 2, & 3
    - **when** holds time the event occurred
      - probably should have been put in java.util.EventObject!
    - java.awt.event.**KeyEvent**
      - **id** indicates typed, pressed, or released
      - **keyChar** holds the ascii code of the key pressed
      - **keyCode** holds a constant identifying the key pressed (needed for non-printable keys)
    - java.awt.event.**MouseEvent**
      - **id** indicates clicked, pressed, released, moved, entered, exited, or dragged
      - **clickCount** holds # of times button was clicked
      - **x,y** hold location of mouse cursor

Event Listener Interfaces

- Class hierarchy and methods
  - java.util.**EventListener**
    - java.awt.event.**ActionListener**
      - actionPerformed
    - java.awt.event.**AdjustmentListener**
      - adjustmentValueChanged
    - java.awt.event.**ComponentListener**
      - componentHidden, componentMoved, componentResized, componentShown
    - java.awt.event.**FocusListener**
      - focusGained, focusLost
    - java.awt.event.**ItemListener**
      - itemStateChanged
    - java.awt.event.**KeyListener**
      - keyPressed, keyReleased, keyTyped
    - java.awt.event.**MouseListener**
      - mouseEntered, mouseExited, mousePressed, mouseReleased, mouseClicked
    - java.awt.event.**MouseMotionListener**
      - mouseDragged, mouseMoved
    - java.awt.event.**TextListener**
      - textValueChanged
    - java.awt.event.**WindowListener**
      - windowOpened, windowClosing, windowClosed, windowActivated, windowDeactivated, windowIconified, windowDeiconified

Event Sources and Their Listeners

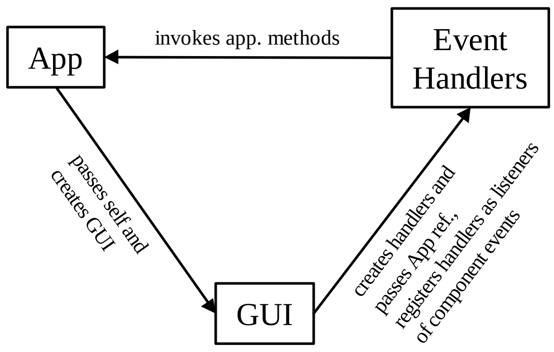
- Component (**ALL** components extend this)
  - ComponentListener, FocusListener, KeyListener, MouseListener, MouseMotionListener
- Dialog - WindowListener
- Frame - WindowListener
- Button - ActionListener
- Choice - ItemListener
- Checkbox - ItemListener
- CheckboxMenuItem - ItemListener
- List - ItemListener, ActionListener ← when an item is double-clicked
- MenuItem - ActionListener
- Scrollbar - AdjustmentListener
- TextField - ActionListener, TextListener
- TextArea - TextListener

Listener Adapter Classes

- Provide empty default implementations of methods in listener interfaces with more than one method
- They include
  - java.awt.event.**ComponentAdapter**
  - java.awt.event.**FocusAdapter**
  - java.awt.event.**KeyAdapter**
  - java.awt.event.**MouseAdapter**
  - java.awt.event.**MouseMotionAdapter**
  - java.awt.event.**WindowAdapter**
- To use, extend from them
  - override methods of interest
  - usefulness is limited by single inheritance
    - can’t do if another class is already being extended
    - implementation for methods that are not of interest could look like this

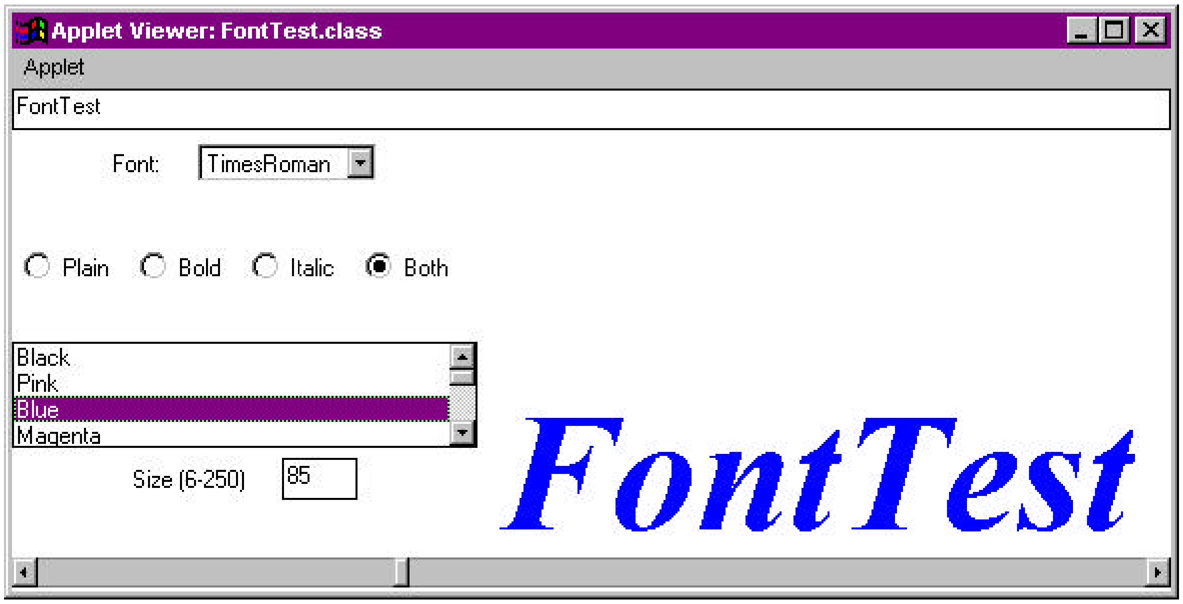
```
public void windowIconified(WindowEvent e) {}
```

Design For Flexibility and Maintainability


App
invokes app. methods
Event Handlers
passes self and creates GUI
GUI
creates handlers and passes App ref., registers handlers as listeners of component events

- Can separate
  - application code
  - GUI code
  - event handling code
- Steps to achieve this separation
  - create a single class whose constructor creates the entire GUI, possibly using other GUI-only classes
  - create the GUI by invoking this constructor from an application class
  - create classes whose only function is to be notified of GUI events and invoke application methods
    - their constructors should accept references to application objects whose methods they will invoke
  - create event handling objects in a GUI class and register them with the components whose events they will handle

AWT Example



- FontTest allows specification of text to be displayed, font name, style, color and size
- It illustrates
  - creation of GUI components
  - use of the Canvas and PopupMenu
  - component layout using BorderLayout, FlowLayout, and GridLayout
  - event handling
- Invoke with

```
<APPLET CODE=FontTest.class WIDTH=580 HEIGHT=250>
</APPLET>
```

FontTest.java

```
import java.awt.*;
import java.awt.event.*;
import java.util.Enumeration;
import COM.ociweb.awt.ColorMap;

public class FontTest extends java.applet.Applet
implements ActionListener, AdjustmentListener, ItemListener, MouseListener {

    static final String DEFAULT_FONT = "Helvetica";
    static final String DEFAULT_TEXT = "FontTest";
    static final int DEFAULT_SIZE = 24;

    private static final int BOX_SIZE = 3;
    private static final int MIN_SIZE = 6;
    private static final int MAX_SIZE = 250;

    private CheckboxGroup styleGroup = new CheckboxGroup();
    private Checkbox boldRadio = new Checkbox("Bold", false, styleGroup);
    private Checkbox bothRadio = new Checkbox("Both", false, styleGroup);
    private Checkbox italicRadio =
        new Checkbox("Italic", false, styleGroup);
    private Checkbox plainRadio = new Checkbox("Plain", true, styleGroup);
    private Choice fontChoice = new Choice();
    private List colorList = new List(4, false);
    private MyCanvas myCanvas = new MyCanvas();
    private PopupMenu popup = new PopupMenu("Font");
    private Scrollbar scrollbar =
        new Scrollbar(Scrollbar.HORIZONTAL, DEFAULT_SIZE, BOX_SIZE,
                      MIN_SIZE, MAX_SIZE + BOX_SIZE);
    private TextField sizeField =
        new TextField(String.valueOf(DEFAULT_SIZE), 3);
    private TextField textField = new TextField(DEFAULT_TEXT, 40);
```

FontTest.java (Cont’d)

```
public void init() {
    fontChoice.addItem("TimesRoman");
    fontChoice.addItem("Helvetica");
    fontChoice.addItem("Courier");
    fontChoice.select(DEFAULT_FONT);

    Panel fontPanel = new Panel();
    fontPanel.add(new Label("Font:"));
    fontPanel.add(fontChoice);

    Panel stylePanel = new Panel();
    stylePanel.add(plainRadio);
    stylePanel.add(boldRadio);
    stylePanel.add(italicRadio);
    stylePanel.add(bothRadio);

    Enumeration e = ColorMap.getColorNames();
    while (e.hasMoreElements()) {
        colorList.addItem((String) e.nextElement());
    }
    colorList.select(0);

    Panel sizePanel = new Panel();
    sizePanel.add
        (new Label("Size (" + MIN_SIZE + "-" + MAX_SIZE + ")"));
    sizePanel.add(sizeField);

    Panel westPanel = new Panel(new GridLayout(0, 1));
    westPanel.add(fontPanel);
    westPanel.add(stylePanel);
    westPanel.add(colorList);
    westPanel.add(sizePanel);
```

unknown # of rows, one column

FontTest.java (Cont'd)

```
        setLayout(new BorderLayout());
        add(myCanvas, "Center");
        add(westPanel, "West");
        add(textField, "North");
        add(scrollbar, "South");

        fontChoice.addItemListener(this);
        plainRadio.addItemListener(this);
        boldRadio.addItemListener(this);
        italicRadio.addItemListener(this);
        bothRadio.addItemListener(this);
        colorList.addItemListener(this);
        sizeField.addActionListener(this);
        textField.addActionListener(this);
        scrollbar.addAdjustmentListener(this);
        fontPanel.addMouseListener(this);
        stylePanel.addMouseListener(this);
        sizePanel.addMouseListener(this);
        myCanvas.addMouseListener(this);

        MenuItem timesRomanItem = new MenuItem("TimesRoman");
        MenuItem helveticaItem = new MenuItem("Helvetica");
        MenuItem courierItem = new MenuItem("Courier");
        timesRomanItem.addActionListener(this);
        helveticaItem.addActionListener(this);
        courierItem.addActionListener(this);
        popup.add(timesRomanItem);
        popup.add(helveticaItem);
        popup.add(courierItem);
        add(popup);
    }
```

FontTest.java (Cont’d)

```
 public void actionPerformed(ActionEvent e) {
    Object source = e.getSource();
    if (source == textField) {
        myCanvas.setText(textField.getText());
    } else if (source == sizeField) {
        int size = Integer.parseInt(sizeField.getText());
        scrollbar.setValue(size);
        setFont();
    } else if (source instanceof MenuItem) {
        MenuItem menuItem = (MenuItem) source;
        if (menuItem.getParent() == popup) {
            fontChoice.select(e.getActionCommand());
            setFont();
        }
    }
}

public void adjustmentValueChanged(AdjustmentEvent e) {
    if (e.getSource() == scrollbar) {
        sizeField.setText(String.valueOf(scrollbar.getValue()));
        setFont();
    }
}

public void itemStateChanged(ItemEvent e) {
    Object source = e.getSource();
    if (source == fontChoice) {
        setFont();
    } else if (source instanceof Checkbox) {
        Checkbox checkbox = (Checkbox) source;
        if (checkbox.getCheckboxGroup() == styleGroup) {
            setFont();
        }
    } else if (source == colorList) {
        Color color = ColorMap.getColor(colorList.getSelectedItem());
        myCanvas.setColor(color);
    }
}
```

FontTest.java (Cont'd)

```
    // MouseListener methods that need no action.
    public void mouseEntered(MouseEvent e) {}
    public void mouseExited(MouseEvent e) {}
    public void mouseClicked(MouseEvent e) {}
    public void mouseReleased(MouseEvent e) {}

    public void mousePressed(MouseEvent e) {
        popup.show((Component) e.getSource(), e.getX(), e.getY());
    }

    private void setFont() {
        int style = Font.PLAIN;

        Checkbox styleRadio = styleGroup.getSelectedCheckbox();
        if (styleRadio == plainRadio) {
            style = Font.PLAIN;
        } else if (styleRadio == boldRadio) {
            style = Font.BOLD;
        } else if (styleRadio == italicRadio) {
            style = Font.ITALIC;
        } else if (styleRadio == bothRadio) {
            style = Font.BOLD + Font.ITALIC;
        }

        Font font =
            new Font(fontChoice.getSelectedItem(),
                     style,
                     Integer.parseInt(sizeField.getText()));

        myCanvas.setFont(font);
    }
}
```

FontTest.java (Cont'd)

```
class MyCanvas extends Canvas {
    private Color color = Color.black;
    private Font font =
        new Font(FontTest.DEFAULT_FONT,
                 Font.PLAIN,
                 FontTest.DEFAULT_SIZE);
    private String text = FontTest.DEFAULT_TEXT;

    public void setColor(Color color) {
        this.color = color;
        repaint();
    }

    public void setFont(Font font) {
        this.font = font;
        repaint();
    }

    public void setText(String text) {
        this.text = text;
        repaint();
    }

    public void paint(Graphics g) {
        g.setColor(color);
        g.setFont(font);
        g.drawString(text, 10, 200);
    }
}
```

ColorMap.java

```
package COM.ociweb.awt;

import java.awt.Color;
import java.util.Enumeration;
import java.util.Hashtable;

public class ColorMap {
    private static Hashtable hashtable = new Hashtable();

    static {
        hashtable.put("White", Color.white);
        hashtable.put("Gray", Color.gray);
        hashtable.put("DarkGray", Color.darkGray);
        hashtable.put("Black", Color.black);
        hashtable.put("Red", Color.red);
        hashtable.put("Pink", Color.pink);
        hashtable.put("Orange", Color.orange);
        hashtable.put("Yellow", Color.yellow);
        hashtable.put("Green", Color.green);
        hashtable.put("Magenta", Color.magenta);
        hashtable.put("Cyan", Color.cyan);
        hashtable.put("Blue", Color.blue);
    }

    public static Color getColor(String name) {
        return (Color) hashtable.get(name);
    }

    public static Enumeration getColorNames() {
        return hashtable.keys();
    }
}
```

Appendix A

JDK 1.0
AWT
Event Handling

1.0 Default Event Handling

(delegation-based event handling was added in Java 1.1)

- Provided by Component class
- handleEvent(Event evt)
  - first method invoked when an event occurs
  - default implementation tests for specific types of events and invokes the methods below
- Methods to handle specific types of events
  - default implementations do nothing
  - they are
    - mouseDown and mouseUp
    - mouseDrag and mouseMove
    - mouseEnter and mouseExit
    - keyDown and keyUp
    - gotFocus and lostFocus
      - from mouse click, tab key, or requestFocus method
    - action (discussed two slides ahead)
- All event handling methods return boolean
  - indicates whether they handled the event
  - if false, the event is handled recursively by containers

Overriding 1.0 Default Event Handling

- Custom event handling methods other than handleEvent
  - created by overriding implementations in Component which do nothing
  - invoked by the default handleEvent implementation
- Custom handleEvent method
  - created by overriding implementation in Component
  - can handle all events by comparing id field to constants in Event class to see what kind of event occurred
  - if overridden, other event handling methods will not be invoked unless
    - they are invoked directly from this method
      - not recommended approach
    - this method invokes the handleEvent method of a superclass
      - recommended approach
      - do this if the event is not one you wish to handle in your handleEvent method
      - invoke with "`return super.handleEvent(e);`"
      - first superclass to implement handleEvent is typically Component which disperses the event to methods which handle specific types of events

1.0 Action Events

- Most user interface components generate "action" events
  - Label and TextArea don't generate any events
  - List and Scrollbar generate events that are not "action" events
    - must be handled in a handleEvent method, not an action method
- Default handleEvent invokes
  `public boolean action(Event evt, Object what)`
- Second argument varies based on the component
  - Button
    - String representing button label
  - Checkbox (and radiobutton)
    - Boolean state (true for on, false for off)
    - generated when picked
  - Choice (option menu)
    - String representing selected item
  - TextField
    - null
    - generated when user presses return key
    - not when field is exited with mouse or tab key
      - use lostFocus method to catch that