core WEB programming

# Handling Mouse and Keyboard Events

## Agenda

- General event-handling strategy
- Handling events with separate listeners
- Handling events by implementing interfaces
- Handling events with named inner classes
- Handling events with anonymous inner classes
- The standard AWT listener types
- Subtleties with mouse events
- Examples

## General Strategy

- **Determine what type of listener is of interest**
  - 11 standard AWT listener types, described on later slide.
    - ActionListener, AdjustmentListener, ComponentListener, ContainerListener, FocusListener, ItemListener, KeyListener, MouseListener, MouseMotionListener, TextListener, WindowListener
- **Define a class of that type**
  - Implement interface (KeyListener, MouseListener, etc.)
  - Extend class (KeyAdapter, MouseAdapter, etc.)
- **Register an object of your listener class with the window**
  - w.add*Xxx*Listener(new MyListenerClass());
    - E.g., addKeyListener, addMouseListener

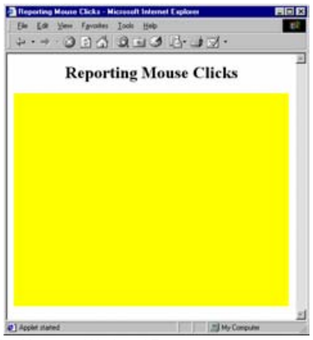
## Handling Events with a Separate Listener: Simple Case

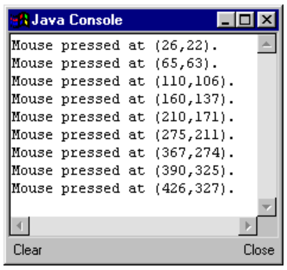
- **Listener does not need to call any methods of the window to which it is attached**

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

public class ClickReporter extends Applet {
  public void init() {
    setBackground(Color.yellow);
    addMouseListener(new ClickListener());
  }
}
```

## Separate Listener: Simple Case (Continued)

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

public class ClickListener extends MouseAdapter {
  public void mousePressed(MouseEvent event) {
    System.out.println("Mouse pressed at (" +
                       event.getX() + "," +
                       event.getY() + ").");
  }
}
```





```
Mouse pressed at (26,22).
Mouse pressed at (65,63).
Mouse pressed at (110,106).
Mouse pressed at (160,137).
Mouse pressed at (210,171).
Mouse pressed at (275,211).
Mouse pressed at (367,274).
Mouse pressed at (390,325).
Mouse pressed at (426,327).
```

## Generalizing Simple Case

- **What if ClickListener wants to draw a circle wherever mouse is clicked?**
- **Why can't it just call getGraphics to get a Graphics object with which to draw?**
- **General solution:**
  - Call event.getSource to obtain a reference to window or GUI component from which event originated
  - Cast result to type of interest
  - Call methods on that reference

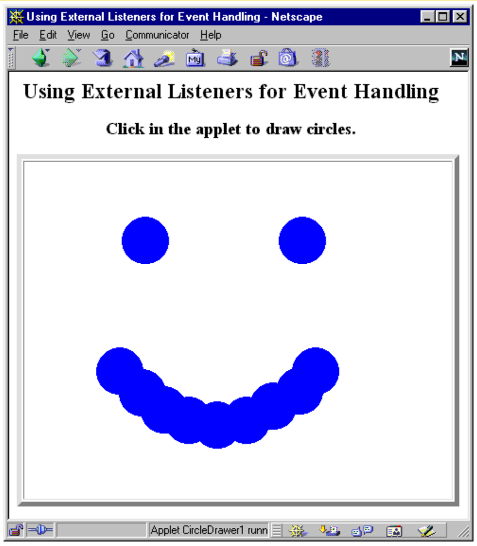
## Handling Events with Separate Listener: General Case

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

public class CircleDrawer1 extends Applet {
  public void init() {
    setForeground(Color.blue);
    addMouseListener(new CircleListener());
  }
}
```

## Separate Listener: General Case (Continued)

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

public class CircleListener extends MouseAdapter {
  private int radius = 25;

  public void mousePressed(MouseEvent event) {
    Applet app = (Applet)event.getSource();
    Graphics g = app.getGraphics();
    g.fillOval(event.getX()-radius,
               event.getY()-radius,
               2*radius,
               2*radius);
  }
}
```

## Separate Listener: General Case (Results)


Using External Listeners for Event Handling - Netscape
File Edit View Go Communicator Help
Applet CircleDrawer1 runn

Using External Listeners for Event Handling

Click in the applet to draw circles.

## Case 2: Implementing a Listener Interface

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

public class CircleDrawer2 extends Applet
                       implements MouseListener {
  private int radius = 25;

  public void init() {
    setForeground(Color.blue);
    addMouseListener(this);
  }
```

## Implementing a Listener Interface (Continued)

```
  public void mouseEntered(MouseEvent event) {}
  public void mouseExited(MouseEvent event) {}
  public void mouseReleased(MouseEvent event) {}
  public void mouseClicked(MouseEvent event) {}

  public void mousePressed(MouseEvent event) {
    Graphics g = getGraphics();
    g.fillOval(event.getX()-radius,
               event.getY()-radius,
               2*radius,
               2*radius);
  }
}
```

## Case 3: Named Inner Classes

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

public class CircleDrawer3 extends Applet {
  public void init() {
    setForeground(Color.blue);
    addMouseListener(new CircleListener());
  }
```

## Named Inner Classes (Continued)

- Note: still part of class from previous slide

```
  private class CircleListener
                extends MouseAdapter {
    private int radius = 25;

    public void mousePressed(MouseEvent event) {
      Graphics g = getGraphics();
      g.fillOval(event.getX()-radius,
                 event.getY()-radius,
                 2*radius,
                 2*radius);
    }
  }
}
```

## Case 4: Anonymous Inner Classes

```
public class CircleDrawer4 extends Applet {
  public void init() {
    setForeground(Color.blue);
    addMouseListener
      (new MouseAdapter() {
         private int radius = 25;

         public void mousePressed(MouseEvent event) {
           Graphics g = getGraphics();
           g.fillOval(event.getX()-radius,
                      event.getY()-radius,
                      2*radius,
                      2*radius);
         }
      });
  }
}
```

## Event Handling Strategies: Pros and Cons

- **Separate Listener**
  - Advantages
    - Can extend adapter and thus ignore unused methods
    - Separate class easier to manage
  - Disadvantage
    - Need extra step to call methods in main window
- **Main window that implements interface**
  - Advantage
    - No extra steps needed to call methods in main window
  - Disadvantage
    - Must implement methods you might not care about

## Event Handling Strategies: Pros and Cons (Continued)

- **Named inner class**
  - Advantages
    - Can extend adapter and thus ignore unused methods
    - No extra steps needed to call methods in main window
  - Disadvantage
    - A bit harder to understand
- **Anonymous inner class**
  - Advantages
    - Same as named inner classes
    - Even shorter
  - Disadvantage
    - Much harder to understand

## Standard AWT Event Listeners (Summary)

| Listener | Adapter Class (If Any) | Registration Method |
|---|---|---|
| ActionListener | | addActionListener |
| AdjustmentListener | | addAdjustmentListener |
| ComponentListener | ComponentAdapter | addComponentListener |
| ContainerListener | ContainerAdapter | addContainerListener |
| FocusListener | FocusAdapter | addFocusListener |
| ItemListener | | addItemListener |
| KeyListener | KeyAdapter | addKeyListener |
| MouseListener | MouseAdapter | addMouseListener |
| MouseMotionListener | MouseMotionAdapter | addMouseMotionListener |
| TextListener | | addTextListener |
| WindowListener | WindowAdapter | addWindowListener |

## Standard AWT Event Listeners (Details)

- **ActionListener**
  - Handles buttons and a few other actions
    - actionPerformed(ActionEvent event)
- **AdjustmentListener**
  - Applies to scrolling
    - adjustmentValueChanged(AdjustmentEvent event)
- **ComponentListener**
  - Handles moving/resizing/hiding GUI objects
    - componentResized(ComponentEvent event)
    - componentMoved (ComponentEvent event)
    - componentShown(ComponentEvent event)
    - componentHidden(ComponentEvent event)

## Standard AWT Event Listeners (Details Continued)

- **ContainerListener**
  - Triggered when window adds/removes GUI controls
    - componentAdded(ContainerEvent event)
    - componentRemoved(ContainerEvent event)
- **FocusListener**
  - Detects when controls get/lose keyboard focus
    - focusGained(FocusEvent event)
    - focusLost(FocusEvent event)

## Standard AWT Event Listeners (Details Continued)

- **ItemListener**
  - Handles selections in lists, checkboxes, etc.
    - itemStateChanged(ItemEvent event)
- **KeyListener**
  - Detects keyboard events
    - keyPressed(KeyEvent event) -- any key pressed down
    - keyReleased(KeyEvent event) -- any key released
    - keyTyped(KeyEvent event) -- key for printable char released

## Standard AWT Event Listeners (Details Continued)

- **MouseListener**
  - Applies to basic mouse events
    - mouseEntered(MouseEvent event)
    - mouseExited(MouseEvent event)
    - mousePressed(MouseEvent event)
    - mouseReleased(MouseEvent event)
    - mouseClicked(MouseEvent event) -- Release without drag
      - Applies on release if no movement since press
- **MouseMotionListener**
  - Handles mouse movement
    - mouseMoved(MouseEvent event)
    - mouseDragged(MouseEvent event)

## Standard AWT Event Listeners (Details Continued)

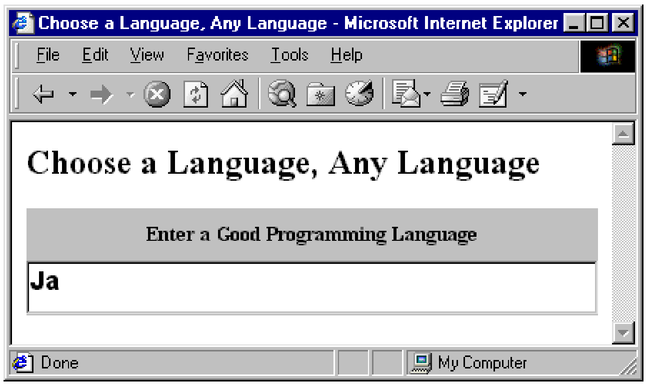
- **TextListener**
  - Applies to textfields and text areas
    - textValueChanged(TextEvent event)
- **WindowListener**
  - Handles high-level window events
    - windowOpened, windowClosing, windowClosed, windowIconified, windowDeiconified, windowActivated, windowDeactivated
      - windowClosing particularly useful

## Mouse Events: Details

- **MouseListener and MouseMotionListener share event types**
- **Location of clicks**
  - event.getX() and event.getY()
- **Double clicks**
  - Determined by OS, not by programmer
  - Call event.getClickCount()
- **Distinguishing mouse buttons**
  - Call event.getModifiers() and compare to MouseEvent.Button2_MASK for a middle click and MouseEvent.Button3_MASK for right click.
  - Can also trap Shift-click, Alt-click, etc.

## Simple Example: Spelling-Correcting Textfield

- **KeyListener corrects spelling during typing**
- **ActionListener completes word on ENTER**
- **FocusListener gives subliminal hints**


Choose a Language, Any Language - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Done
My Computer

Choose a Language, Any Language

Enter a Good Programming Language

Ja

## Example: Simple Whiteboard

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

public class SimpleWhiteboard extends Applet {
  protected int lastX=0, lastY=0;

  public void init() {
    setBackground(Color.white);
    setForeground(Color.blue);
    addMouseListener(new PositionRecorder());
    addMouseMotionListener(new LineDrawer());
  }

  protected void record(int x, int y) {
    lastX = x; lastY = y;
  }
```

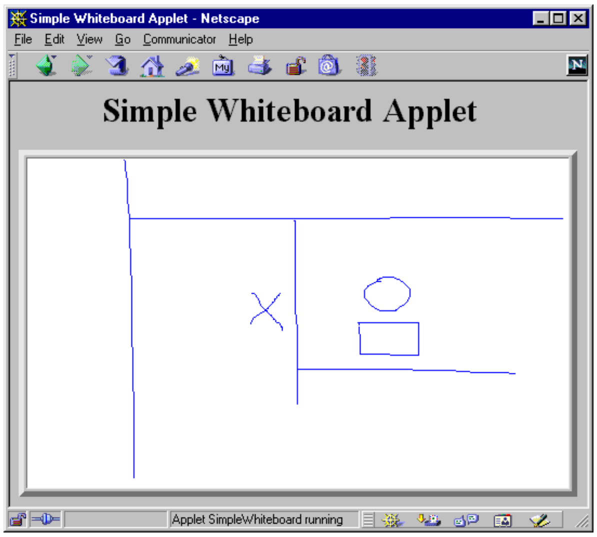
## Simple Whiteboard (Continued)

```
  private class PositionRecorder extends MouseAdapter {
    public void mouseEntered(MouseEvent event) {
      requestFocus(); // Plan ahead for typing
      record(event.getX(), event.getY());
    }

    public void mousePressed(MouseEvent event) {
      record(event.getX(), event.getY());
    }
  }
  ...
```

## Simple Whiteboard (Continued)

```
  ...
  private class LineDrawer extends MouseMotionAdapter {
    public void mouseDragged(MouseEvent event) {
      int x = event.getX();
      int y = event.getY();
      Graphics g = getGraphics();
      g.drawLine(lastX, lastY, x, y);
      record(x, y);
    }
  }
}
```

## Simple Whiteboard (Results)


Simple Whiteboard Applet - Netscape
File Edit View Go Communicator Help
Simple Whiteboard Applet
Applet SimpleWhiteboard running

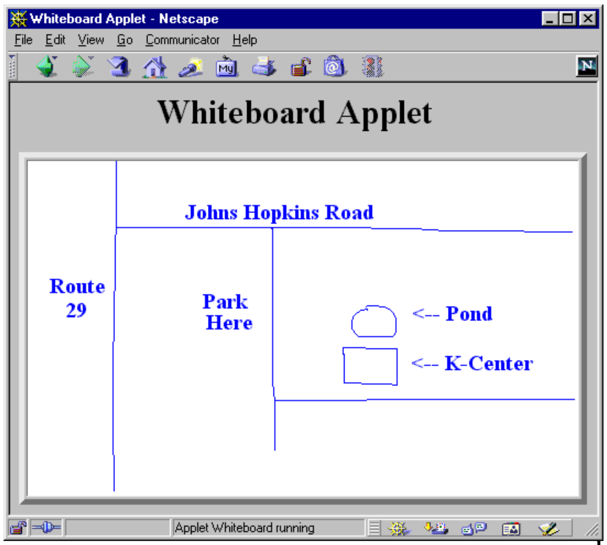
## Whiteboard: Adding Keyboard Events

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

public class Whiteboard extends SimpleWhiteboard {
  protected FontMetrics fm;

  public void init() {
    super.init();
    Font font = new Font("Serif", Font.BOLD, 20);
    setFont(font);
    fm = getFontMetrics(font);
    addKeyListener(new CharDrawer());
  }
```

## Whiteboard (Continued)

```
  ...
  private class CharDrawer extends KeyAdapter {
    // When user types a printable character,
    // draw it and shift position rightwards.

    public void keyTyped(KeyEvent event) {
      String s = String.valueOf(event.getKeyChar());
      getGraphics().drawString(s, lastX, lastY);
      record(lastX + fm.stringWidth(s), lastY);
    }
  }
}
```

## Whiteboard (Results)


Whiteboard Applet - Netscape
File Edit View Go Communicator Help
Whiteboard Applet
Johns Hopkins Road
Route 29
Park Here
<-- Pond
<-- K-Center
Applet Whiteboard running

## Summary

- **General strategy**
  - Determine what type of listener is of interest
    - Check table of standard types
  - Define a class of that type
    - Extend adapter separately, implement interface, extend adapter in named inner class, extend adapter in anonymous inner class
  - Register an object of your listener class with the window
    - Call add*Xxx*Listener
- **Understanding listeners**
  - Methods give specific behavior.
    - Arguments to methods are of type XxxEvent
      - Methods in MouseEvent of particular interest

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## Questions?

## Preview

- **Whiteboard had freehand drawing only**
  - Need GUI controls to allow selection of other drawing methods
- **Whiteboard had only "temporary" drawing**
  - Covering and reexposing window clears drawing
  - After cover multithreading, we'll see solutions to this problem
    - Most general is double buffering
- **Whiteboard was "unshared"**
  - Need network programming capabilities so that two different whiteboards can communicate with each other