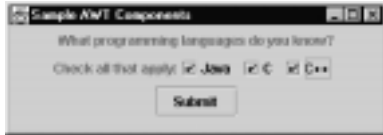


Chap 8 - GUIs

- Swing vs AWT
- Objects that make up a GUI are called components.
- This example uses two JLabel components, three JCheckBox components, and a JButton.



1

```
import javax.swing.*;
import java.awt.*;
class SampleAWT {
    public static void main(String[] args) {
        JFrame frame = new JFrame("Sample AWT Components");
        Container display = frame.getContentPane();
        display.setLayout(new FlowLayout());
        display.add(new JLabel(
            "What programming languages do you know?"));
        display.add(new JLabel("Check all that apply:"));
        display.add(new JCheckBox("Java",true));
        display.add(new JCheckBox("C",false));
        display.add(new JCheckBox("C++",false));
        display.add(new JButton("Submit"));
        frame.pack();
        frame.show();
        System.out.println("The end of main().");
    }
}
```

2

The Event Thread

- Notice that although main() ends, the program is still running.
- Creating a JFrame, implicitly creates a separate thread of execution that enters an infinite loop, looking for events.
- This is called an *event driven* program.
- How do we get it to do something when an event occurs?

3

The Event Model

- Swing components are *event sources* - e.g. clicking a JButton creates an *ActionEvent*.
- To respond to an event you create an *event listener*, and tell the event source about the event listener.
- Event sources have methods like `addSomethingListener()`, where *Something* is a particular event type.

4

```
import javax.swing.*;
import java.awt.*;
class SampleAWT2 {
    public static void main(String[] args) {
        JFrame frame = new JFrame("Sample AWT Components");
        Container display = frame.getContentPane();
        // some lines deleted - same as before
        display.add(new JCheckBox("C++",false));
        JButton submit;
        display.add(submit = new JButton("Submit"));
        submit.addActionListener(new Submit());
        frame.pack();
        frame.show();
        System.out.println("The end of main().");
    }
}
```

5

```
import java.awt.event.*;
class Submit implements ActionListener {
    public void actionPerformed(ActionEvent e) {
        System.out.println("Submitted");
    }
}
```

6

```

import javax.swing.*;
import java.awt.*;
class SampleAWT2 {
    public static void main(String[] args) {
        JFrame frame = new JFrame("Sample AWT Components");
        Container display = frame.getContentPane();
        // some lines deleted - same as before
        display.add(new JCheckBox("C++",false));
        JButton submit;
        display.add(submit = new JButton("Submit"));
        submit.addActionListener(new Submit());
        frame.addWindowListener(new Exiter());
        frame.pack();
        frame.show();
        System.out.println("The end of main().");
    }
}

```

7

```

import java.awt.event.*;
class Exiter extends WindowAdapter {
    public void windowClosing(WindowEvent e) {
        System.out.println("Exiting.");
        System.exit(0);
    }
}
/*
This uses a WindowAdapter. We will talk about adapters
later. We could have implemented this class using
"implements WindowListener" but it would have required
a bit more code as will be explained later.
*/

```

8

Listening to a JButton

- Create the button with new JButton()
- Get the Container for the JFrame using getContentPane().
- Add the button to the content pane using add().
- Create an ActionListener by
 - adding implements ActionListener to the class declaration and
 - defining an actionPerformed() method.
- Add the listener object to the list of listeners for the button by calling button.addActionListener(listener)

9

The Event Loop

```

while (true)
    wait for next event;
    determine event type, call it T;
    determine GUI object where event
        occurred, call it O;
    call appropriate method in each T
        listener added to O
end while loop

```

10

```

//TextInput.java
import java.awt.*;
import javax.swing.*;

class TextInput {
    public static void main(String[] args) {
        JFrame frame = new JFrame("TextInput");
        Container pane = frame.getContentPane();
        JTextField input = new
            JTextField("Edit this text then hit <return>");
        Echo listener = new Echo();
        input.addActionListener(listener);
        pane.add(input);
        frame.pack();
        frame.show();
    }
}

```

11

```

//Echo.java
import javax.swing.*;
import java.awt.event.*;

class Echo implements ActionListener {
    public void actionPerformed(ActionEvent e) {
        JTextField source = (JTextField)e.getSource();
        String text = source.getText();
        System.out.println(text);
    }
}

```

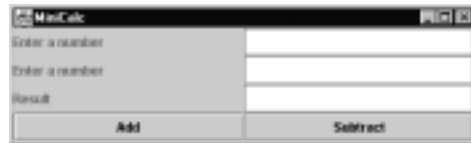
12

Using Several Components

- How do we arrange the GUI components?
 - Using layout managers.
- How do we respond to event from several sources?
 - Create separate listeners, or
 - determine the source of the event with a single listener.

13

A Mini-Calculator



14

```
//MiniCalc.java - demo GridLayout
import java.awt.*;
import javax.swing.*;

class MiniCalc {
    public static void main(String[] args) {
        JFrame frame = new JFrame("MiniCalc");
        Container pane = frame.getContentPane();
        // create the major components
        JTextField firstNumber = new JTextField(20);
        JTextField secondNumber = new JTextField(20);
        JTextField result = new JTextField(20);
        JButton addButton = new JButton("Add");
        JButton subButton = new JButton("Subtract");
```

15

```
// there will be 4 rows of 2 components each
pane.setLayout(new GridLayout(4, 2));
// add all of the components to the content pane
pane.add(new JLabel("Enter a number"));
pane.add(firstNumber);
pane.add(new JLabel("Enter a number"));
pane.add(secondNumber);
pane.add(new JLabel("Result"));
pane.add(result);
pane.add(addButton);
pane.add(subButton);
// setup the listener, listening to the buttons
DoMath listener =
    new DoMath(firstNumber, secondNumber, result);
subButton.addActionListener(listener);
addButton.addActionListener(listener);
frame.pack();
frame.show(); } // ran out of room on the page :*)
```

```
//DoMath.java - respond to two different buttons
import javax.swing.*;
import java.awt.event.*;

class DoMath implements ActionListener {
    private JTextField inputOne, inputTwo, output;

    DoMath(JTextField first, JTextField second,
           JTextField result)
    {
        inputOne = first;
        inputTwo = second;
        output = result;
    }
}
```

17

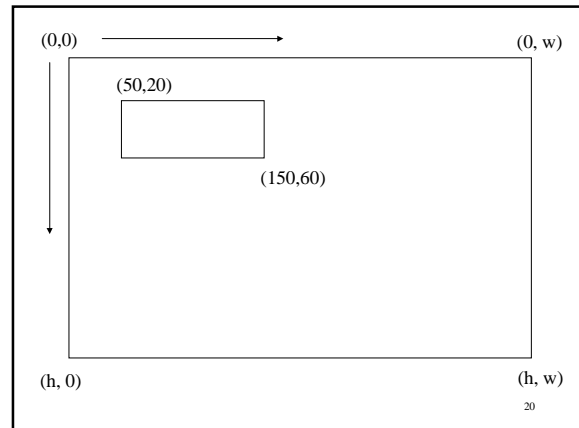
```
public void actionPerformed(ActionEvent e) {
    double first, second;
    first =
        Double.parseDouble(inputOne.getText().trim());
    second =
        Double.parseDouble(inputTwo.getText().trim());
    if (e.getActionCommand().equals("Add"))
        output.setText(String.valueOf(first + second));
    else
        output.setText(String.valueOf(first - second));
}
```

18

Drawing with Swing

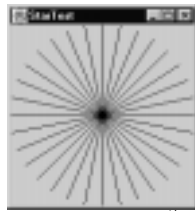
- Drawing is done on an instance of class `java.awt.Graphics` (or `java.awt.Graphics2D`).
- Using `Graphics`, units are always in terms of pixels.
- The origin is in the upper left corner with positive directions being down and to the right.

19



20

```
//StarTest.java - display a starburst
import java.awt.*;
import javax.swing.*;
class StarTest {
    public static void main(String[] args) {
        JFrame frame = new JFrame("StarTest");
        Container pane = frame.getContentPane();
        Star star = new Star();
        pane.add(star);
        frame.pack();
        frame.show();
    }
}
```



21

```
import java.awt.*;
import javax.swing.*;
class Star extends JComponent {
    public void paint(Graphics g) {
        for (double angle = 0; angle < Math.PI;
             angle = angle + Math.PI / 16) {
            double x1, x2, y1, y2;
            // compute coordinates of endpoints of a line
            // cosine and sine range from -1 to 1
            // multiplying by RADIUS changes the
            // range to be from -RADIUS to RADIUS
            // adding RADIUS gives the final range of
            // 0 to 2 * RADIUS
            x1 = Math.cos(angle) * RADIUS + RADIUS;
            y1 = Math.sin(angle) * RADIUS + RADIUS;
            x2 = Math.cos(angle + Math.PI) * RADIUS + RADIUS;
            y2 = Math.sin(angle + Math.PI) * RADIUS + RADIUS;
            g.drawLine((int)x1, (int)y1, (int)x2, (int)y2);
        }
    }
}
```

22

```
// make the JComponent big enough to show the image
public Dimension getMinimumSize() {
    return new Dimension(2 * RADIUS, 2 * RADIUS);
}
public Dimension getPreferredSize() {
    return new Dimension(2 * RADIUS, 2 * RADIUS);
}
private static final int RADIUS = 100;
}
```

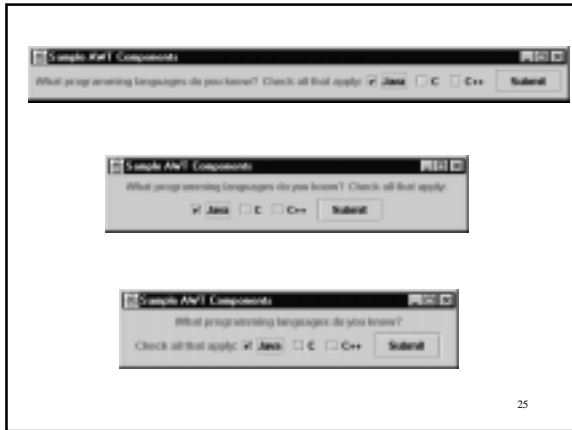
What happens if these two methods are omitted?

23

FlowLayout

- The first example `SampleAWT` used a `FlowLayout`.
- If we resize the window, the components move around.

24



```
import javax.swing.*;
import java.awt.*;
class SampleAWT {
    public static void main(String[] args) {
        JFrame frame = new JFrame("Sample AWT Components");
        Container display = frame.getContentPane();
        display.setLayout(new FlowLayout());
        display.add(new JLabel(
            "What programming languages do you know?"));
        display.add(new JLabel("Check all that apply:"));
        display.add(new JCheckBox("Java",true));
        display.add(new JCheckBox("C",false));
        display.add(new JCheckBox("C++",false));
        display.add(new JButton("Submit"));
        frame.pack();
        frame.show();
        System.out.println("The end of main().");
    }
}
```

```
import javax.swing.*;
import java.awt.*;
class SampleAWT {
    public static void main(String[] args) {
        JFrame frame = new JFrame("Sample AWT Components");
        Container display = frame.getContentPane();
        display.setLayout(new FlowLayout(FlowLayout.LEFT));
        // code omitted
    }
}
```

We can have the FlowLayout center the components on a line, left justify them, or right justify them.

Mouse Input

- One of the earliest examples of a GUI and of using a Mouse, involved drawing on the screen with the mouse.
- Here is a program that lets us draw on the screen with the mouse.

```
//SimplePaint.java - a program to draw with the mouse
import java.awt.*;
import javax.swing.*;

class SimplePaint {
    public static void main(String[] args) {
        JFrame frame = new JFrame("SimplePaint");
        Container pane = frame.getContentPane();
        DrawingCanvas canvas = new DrawingCanvas();
        PaintListener listener = new PaintListener();
        canvas.addMouseMotionListener(listener);
        pane.add(canvas);
        frame.pack();
        frame.show();
    }
}
```

```
// DrawingCanvas.java - a blank Canvas
import java.awt.*;
import javax.swing.*;

class DrawingCanvas extends JComponent {
    //these methods are needed to give the component a size
    public Dimension getMinimumSize() {
        return new Dimension(SIZE, SIZE);
    }
    public Dimension getPreferredSize() {
        return new Dimension(SIZE, SIZE);
    }
    private static final int SIZE = 500;
}
```

```
//PaintListener.java - do the actual drawing
import java.awt.*;
import java.awt.event.*;

public class PaintListener implements MouseMotionListener
{
    public void mouseDragged(MouseEvent e) {
        DrawingCanvas canvas =
            (DrawingCanvas)e.getSource();
        Graphics g = canvas.getGraphics();
        g.fillOval(e.getX() - radius, e.getY() - radius,
            diameter, diameter);
    }
    public void mouseMoved(MouseEvent e){}
    private int radius = 3;
    private int diameter = radius * 2;
}

```

31

Refreshing the display

- The previous program doesn't "remember" what was drawn.
- If we obscure part of the drawing, it won't come back.
- The following program remedies that problem.

32

```
//DrawingCanvas2.java - remember drawing operations
// using an offscreen image
import java.awt.*;
import javax.swing.*;

class DrawingCanvas2 extends JComponent {
    // transfer the offscreen image to the screen
    public void paint(Graphics g) {
        if (offscreenImage != null)
            g.drawImage(offscreenImage,0,0,SIZE,SIZE,null);
    }
}

```

33

```
// return the offscreen image, if one doesn't exist
// create one
public Image getOffscreenImage() {
    if (offscreenImage == null)
        offscreenImage = createImage(SIZE, SIZE);
    return offscreenImage;
}

public Dimension getMinimumSize() {
    return new Dimension(SIZE, SIZE);
}

public Dimension getPreferredSize() {
    return new Dimension(SIZE, SIZE);
}

private static final int SIZE = 500;
private Image offscreenImage;
}

```

34

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

public class PaintListener2 implements MouseMotionListener {
    public void mouseDragged(MouseEvent e) {
        DrawingCanvas2 canvas = (DrawingCanvas2)e.getSource();
        Graphics g = canvas.getGraphics();
        g.fillOval(e.getX() - radius, e.getY() - radius,
            diameter, diameter);
        // duplicate the drawing on the offscreen image
        Image image = canvas.getOffscreenImage();
        g = image.getGraphics();
        g.fillOval(e.getX() - radius, e.getY() - radius,
            diameter, diameter);
    }
    public void mouseMoved(MouseEvent e){}
    protected int radius = 3;
    protected int diameter = radius * 2;
}

```

35

Applets

- An Applet is a special Java program, intended to be executed inside of a Web browser.
- An Applet is a Java class that extends Applet or JApplet.
- An Applet is started when a special HTML tag is encountered in a Web document.

36

```

<html>
<body>
Below is the beginning of an applet calculator. This
calculator can be used only for addition and
subtraction. You enter a number in each of the first
...
<p>
<center>
<applet code="MiniCalcApplet.class"
width=200 height=100>
</applet>
<p>
MiniCalcApplet
</center>
</body>
</html>

```

37

```

// MiniCalcApplet.java
/* <applet code="MiniCalcApplet.class" width=200
height=100></applet> */
import javax.swing.*;
import java.awt.*;

public class MiniCalcApplet extends JApplet {
    public void init() {
        Container pane = getContentPane();
        // create the major components
        JTextField firstNumber = new JTextField(20);
        JTextField secondNumber = new JTextField(20);
        JTextField result = new JTextField(20);
        JButton addButton = new JButton("Add");
        JButton subButton = new JButton("Subtract");

```

38

```

// there will be 4 rows of 2 components each
pane.setLayout(new GridLayout(4, 2));
// add all of the components to the content pane
pane.add(new JLabel("Enter a number"));
pane.add(firstNumber);
pane.add(new JLabel("Enter a number"));
pane.add(secondNumber);
pane.add(new JLabel("Result"));
pane.add(result);
pane.add(addButton);
pane.add(subButton);
// setup the listener, listening to the buttons
DoMath listener =
    new DoMath(firstNumber, secondNumber, result);
subButton.addActionListener(listener);
addButton.addActionListener(listener);
}
}

```

39

```

//SimplePaintApplet.java - applet version of program
// that draws with the mouse
/* <applet code="SimplePaintApplet.class"
width=500 height=500> </applet> */
import java.awt.*;
import javax.swing.*;

public class SimplePaintApplet extends JApplet {
    public void init() {
        Container pane = getContentPane();
        DrawingCanvas2 canvas = new DrawingCanvas2();
        PaintListener2 listener = new PaintListener2();
        canvas.addMouseMotionListener(listener);
        pane.add(canvas);
    }
}

```

40

```

//SimplePaintCombined.java - combine all of the
// features of SimplePaint, PaintListener, and
// DrawingCanvas into a single class.
// This style of programming isn't recommended.
import java.awt.*;
import javax.swing.*;
import java.awt.event.*;

class SimplePaintCombined
    extends JComponent implements MouseMotionListener
{
    private static final int SIZE = 500;
    public static void main(String[] args) {
        JFrame frame = new JFrame("SimplePaint");
        Container pane = frame.getContentPane();
        SimplePaintCombined canvas =
            new SimplePaintCombined();

```

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```

        canvas.addMouseMotionListener(canvas);
        pane.add(canvas);
        frame.pack();
        frame.show();
    }
    public void mouseDragged(MouseEvent e) {
        SimplePaintCombined canvas =
            (SimplePaintCombined)e.getSource();
        Graphics g = canvas.getGraphics();
        g.fillOval(e.getX() - 3, e.getY() - 3, 6, 6);
    }
    public void mouseMoved(MouseEvent e) {}
    public Dimension getMinimumSize() {
        return new Dimension(SIZE, SIZE);
    }
    public Dimension getPreferredSize() {
        return new Dimension(SIZE, SIZE);
    }
}

```

42

Can a program be both an Applet and a regular application?

Yes, as shown in the following example.

43

```
// MiniCalcBoth.java
/* <applet code="MiniCalcBoth.class" width=200
height=100></applet> */
import javax.swing.*;
import java.awt.*;

public class MiniCalcBoth extends JApplet {
    public void init() {
        buildGUI(getContentPane());
    }
    public static void main(String[] args) {
        JFrame frame = new JFrame("MiniCalc");
        buildGUI(frame.getContentPane());
        frame.pack();
        frame.show();
    }
}
```

44

```
private static void buildGUI(Container pane) {
    // create the major components
    JTextField firstNumber = new JTextField(20);
    ...
    JButton subButton = new JButton("Subtract");
    // there will be 4 rows of 2 components each
    pane.setLayout(new GridLayout(4, 2));
    // add all of the components to the content pane
    pane.add(new JLabel("Enter a number"));
    pane.add(firstNumber);
    ...
    pane.add(subButton);
    // setup the listener, listening to the buttons
    DoMath listener =
        new DoMath(firstNumber, secondNumber, result);
    subButton.addActionListener(listener);
    addButton.addActionListener(listener);
}
}
```

45