

Overloading

- Each method has a *signature*: its name together with the number and types of its parameters

Methods	Signatures
String toString()	()
void move(int dx, int dy)	(int,int)
void paint(Graphics g)	(Graphics)

- Two methods can have the same name if they have different signatures. They are *overloaded*.

Overloading Example

```
public class Point {  
  
    protected double x, y;  
  
    public Point() {  
        x = 0.0; y = 0.0;  
    }  
  
    public Point(double x, double y) {  
        this.x = x; this.y = y;  
    }  
  
    /**calculate the distance between this point and the other point */  
    public double distance(Point other) {  
        double dx = this.x - other.x;  
        double dy = this.y - other.y;  
        return Math.sqrt(dx * dx + dy * dy);  
    }  
}
```

Overloading Example (cont'd)

(class Point continued.)

```
/**calculate the distance between this point and (x,y)*/  
public double distance(double x, double y) {  
    double dx = this.x - x;  
    double dy = this.y - y;  
    return Math.sqrt(dx * dx + dy * dy);  
}  
  
/**calculate the distance between this point and the origin*/  
public double distance() {  
    return Math.sqrt(x * x + y * y);  
}  
  
// other methods  
}
```

When to Overload

When there is a general, non-discriminative description of the functionality that can fit all the overloaded methods.

```
public class StringBuffer {  
    StringBuffer append(String str) { ... }  
    StringBuffer append(boolean b) { ... }  
    StringBuffer append(char c) { ... }  
    StringBuffer append(int i) { ... }  
    StringBuffer append(long l) { ... }  
    StringBuffer append(float f) { ... }  
    StringBuffer append(double d) { ... }  
    // ...  
}
```

When to Overload (cont'd)

When all the overloaded methods offer exactly the same functionality, and some of them provide default values for some of the parameters.

```
public class String {
    public String substring(int i, int j) {
        // base method: return substring [i .. j-1]
    }
    public String substring(int i) {
        // provide default argument
        return substring(i, length - 1);
    }
    // ...
}
```

Inheritance and Extended Classes

- *Extended classes* are also known as *subclasses*.
- Inheritance models the *is-a* relationship.
- If class E is an extended class of class B, then any object of E can *act-as* an object of B.
- Only single inheritance is allowed among classes.
- All public and protected members of a super class are accessible in the extended classes.
- All protected members are also accessible within the package.

Constructors of Extended Classes

- The constructor of the super class can be invoked.
- `super (. . .)` must be the first statement.
 - If the super constructor is not invoked explicitly, by default the no-arg `super ()` is invoked implicitly.
- You can also invoke another constructor of the same class.

Constructors of Extended Classes (cont'd)

```
public class ColoredPoint extends Point {
    public Color color;

    public ColoredPoint(double x, double y,
                        Color color) {
        super(x, y);
        this.color = color;
    }

    public ColoredPoint(double x, double y) {
        this(x, y, Color.black); // default value of color
    }

    public ColoredPoint() {
        color = Color.black;
    }
}
```

Default Constructor of Extended Classes

Default no-arg constructor is provided:

```
public class Extended extends Super {  
  
    public Extended() {  
        super();  
    }  
  
    // methods and fields  
}
```

Execution Order of Constructors

```
public class Super {  
    int x = ...; // executed first  
  
    public Super() {  
        x = ...; // executed second  
    }  
    // ...  
}  
  
public class Extended extends Super {  
    int y = ...; // executed third  
  
    public Extended() {  
        super();  
        y = ...; // executed fourth  
    }  
    // ...  
}
```

Overriding and Hiding

Overloading

More than one methods have the same name but different signatures

Overriding

Replacing the implementation of a methods in the superclass with one of your own.

- ◆ You can only override a method with the same signature.
- ◆ You can only override non-static methods.

Hiding

Fields and static methods can not be overridden. They can only be hidden.

- ◆ Hidden fields and static methods are still accessible via references to the superclass.
- ◆ A static method can be only be hidden by another static method.
- ◆ A static variable may be hidden by an instance variable.

Overriding and Hiding (cont'd)

Which implementation is used?

- ◆ When invoking a non-static method, the actual class of the object determines. (run-time)
- ◆ When accessing a field, the declared type determines. (compile time)
- ◆ When invoking a static method, the declared type determines. (compile time)

Object Reference: super

Keyword `super` is an reference to the current object but acts as an instance of its superclass.

Consider the `equals()` method in `ColoredPoint`

```
public boolean equals(Object other) {
    if (other != null &&
        other instanceof ColorPoint) {
        ColorPoint p = (ColorPoint) other;
        return (super.equals(p) &&
            p.color.equals(this.color));
    } else {
        return false;
    }
}
```

Type Conversion --- Implicit

Java allows two kinds of implicit type conversions:

Numeric variables

Any numeric types can be converted to another numeric type with larger range,
e.g. `char ==> int`, `int ==> long`,
`int ==> float`, `float ==> double`.

Object reference

An object reference of class `C` can be converted to a reference of a superclass of `C`.

Type Conversion --- Explicit Cast

Numeric variables

Any numeric types can be explicitly cast to any other numeric type. May lose bits, precision.

Object reference

Cast an object reference of a class to a reference of any other class is:

- ♦ syntactically allowed; but
- ♦ runtime checked.

Cast Object References

```
class Student { ... }
class Undergraduate extends Student { ... }
class Graduate extends Student { ... }
```

```
Student student1, student2;
student1 = new Undergraduate(); // ok
student2 = new Graduate();      // ok
```

```
Graduate student3;
student3 = student2; // compilation error
```

```
student3 = (Graduate) student2; // explicit cast, ok
```

```
student3 = (Graduate) student1; // compilation ok
// run-time exception
```

Graphical User Interfaces (GUI)

Abstract Windows Toolkit (AWT): `java.awt`

- ◆ GUI elements:

 - Primitive**

 - Button, Label, Checkbox, Scrollbar, etc.

 - Container**

 - Panel, Frame, Dialog, etc.

- ◆ Layout managers:

 - FlowLayout, BorderLayout, etc.

- ◆ Supporting classes:

 - Event handling**

 - `java.awt.event` package

 - Graphics**

 - Color, Font, Graphics, etc.

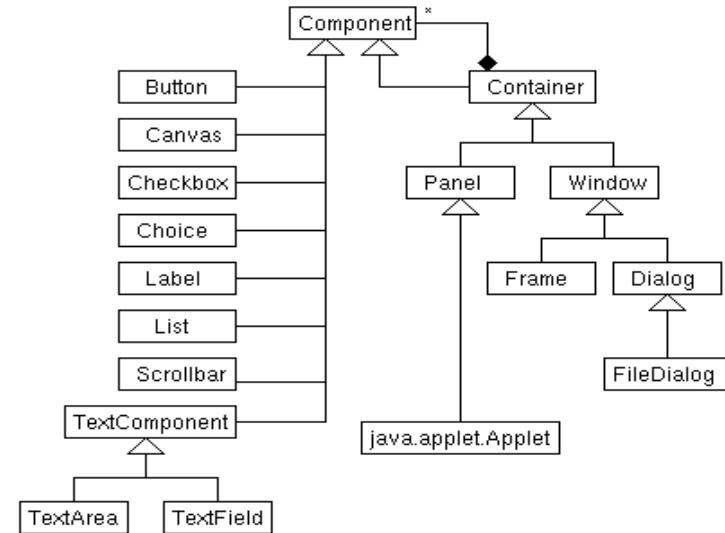
 - Geometry**

 - Point, Rectangle, Dimension, etc.

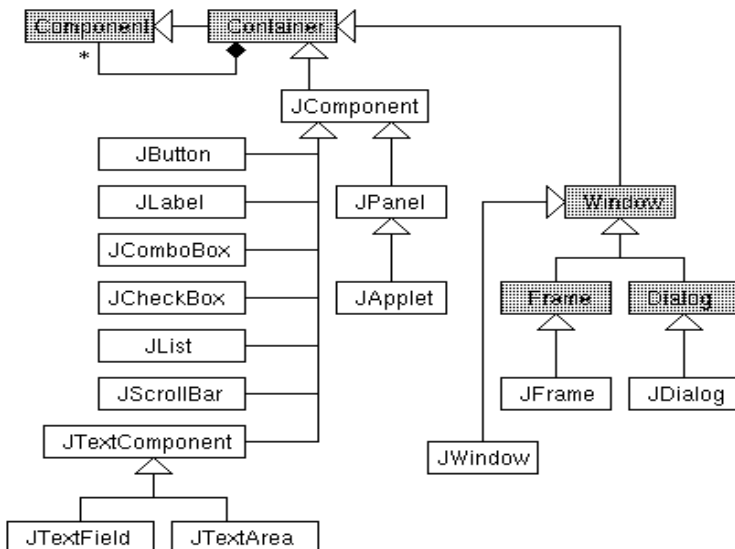
 - Imaging**

 - Image class and `java.awt.image` package

The Component Hierarchy



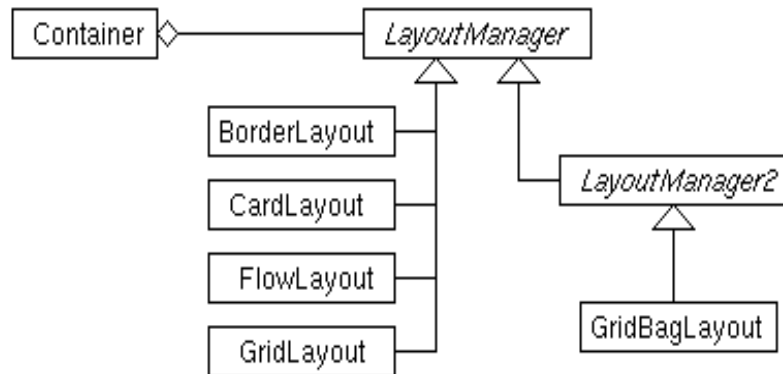
The Swing Components



Layout Managers

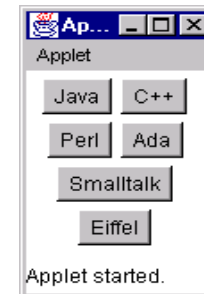
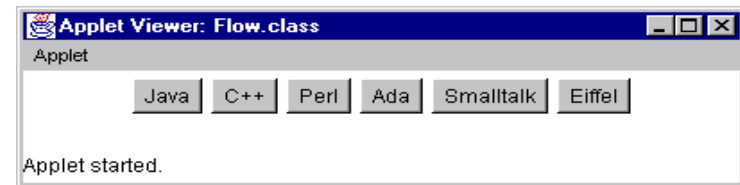
- ◆ The layout of the elements in a container is handled by the *layout manager* associated with the container.
- ◆ Relative positions of the elements are specified, not their absolute coordinates.
- ◆ The positions and sizes of the element will be automatically adjusted when the window is resized.

The Layout Manager Hierarchy



Buttons and Flow Layout

width=400 height=50



width=100 height=120

Buttons and Flow Layout (cont'd)

Layout elements in horizontal rows.

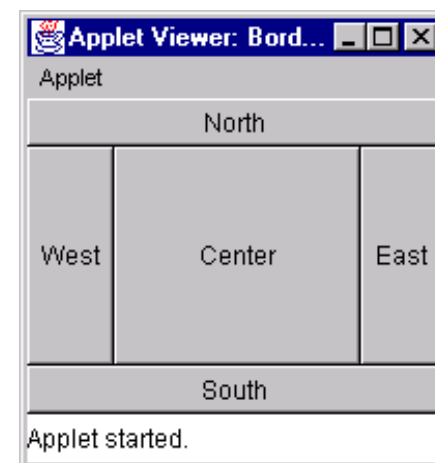
```

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

public class Flow extends Applet {
    public Flow () {
        setLayout(new FlowLayout());
        add(new Button("Java"));
        add(new Button("C++"));
        add(new Button("Perl"));
        add(new Button("Ada"));
        add(new Button("Smalltalk"));
        add(new Button("Eiffel"));
    }
}

```

Border Layout



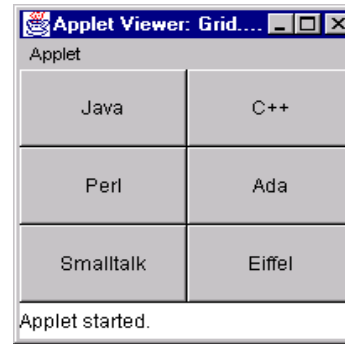
Border Layout (cont'd)

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

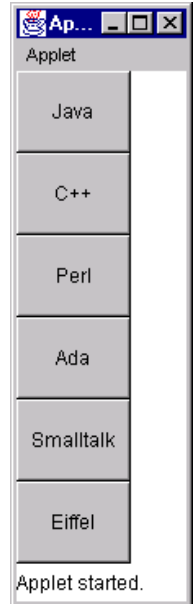
public class Border extends Applet {
    public Border () {
        setLayout(new BorderLayout());
        add(new Button("North"), BorderLayout.NORTH);
        add(new Button("South"), BorderLayout.SOUTH);
        add(new Button("East"), BorderLayout.EAST);
        add(new Button("West"), BorderLayout.WEST);
        add(new Button("Center"), BorderLayout.CENTER);
    }
}
```

Grid Layout

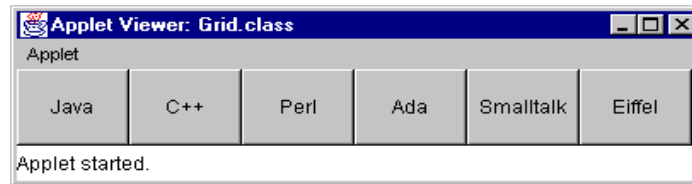
row=3 col=2



row=0 col=1



row=1 col=0



Grid Layout (cont'd)

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

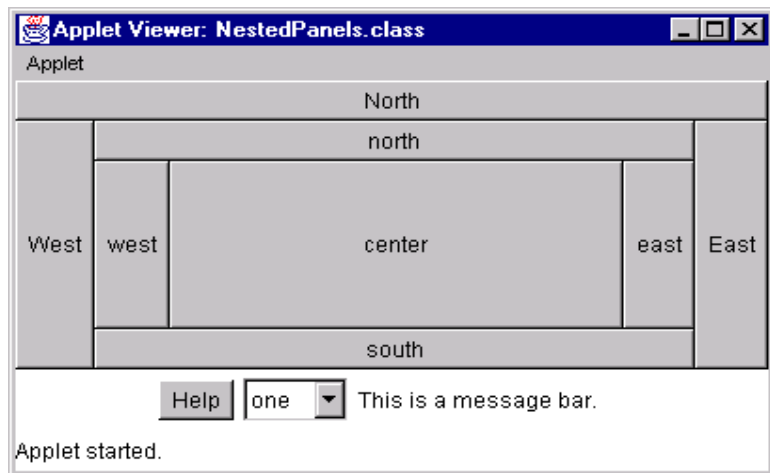
public class Grid extends Applet {
    public void init () {
        int row = 0, col = 0;
        String att = getParameter("row");
        if (att != null)
            row = Integer.parseInt(att);
        att = getParameter("col");
        if (att != null)
            col = Integer.parseInt(att);
        if (row == 0 && col == 0) {
            row = 3; col = 2;
        }
    }
}
```

Grid Layout (cont'd)

(class Grid continued.)

```
        setLayout(new GridLayout(row, col));
        add(new Button("Java"));
        add(new Button("C++"));
        add(new Button("Perl"));
        add(new Button("Ada"));
        add(new Button("Smalltalk"));
        add(new Button("Eiffel"));
    }
}
```

Nested Panels



Nested Panels (cont'd)

```
public class NestedPanels extends Applet {
    protected Label messageBar;
    protected Choice choice;

    public NestedPanels () {
        // set up the center panel
        Panel center = new Panel();
        center.setLayout(new BorderLayout());
        center.add(new Button("south"),
            BorderLayout.SOUTH);
        center.add(new Button("north"),
            BorderLayout.NORTH);
        center.add(new Button("east"),
            BorderLayout.EAST);
        center.add(new Button("west"),
            BorderLayout.WEST);
        center.add(new Button("center"),
            BorderLayout.CENTER);
    }
}
```

Nested Panels (cont'd)

(class NestedPanels continued.)

```
// set up the south panel
Panel south = new Panel();
south.setLayout(new FlowLayout());
south.add(new Button("Help"));
choice = new Choice();
choice.addItem("one");
choice.addItem("two");
choice.addItem("three");
choice.addItem("four");
choice.addItem("five");
south.add(choice);
messageBar = new Label("This is a message bar.");
south.add(messageBar);
```

Nested Panels (cont'd)

(class NestedPanels continued.)

```
// set up the outer panel
setLayout(new BorderLayout());
add(new Button("North"), BorderLayout.NORTH);
add(new Button("East"), BorderLayout.EAST);
add(new Button("West"), BorderLayout.WEST);
add(south, BorderLayout.SOUTH);
add(center, BorderLayout.CENTER);
}
}
```

Event Handling

- ◆ Event source: buttons, checkboxes, choices
- ◆ Event listener: any class interested in handling certain events
- ◆ A listener must
 - ◆ implement an appropriate *listener* interface;
 - ◆ inform the source that it is interested in handling a certain type of events.
- ◆ A listener may listen to several sources and different types of events.
- ◆ The source may also be the listener.
- ◆ Listeners can be full-fledged classes or *inner* classes.

The Event Object and Listener Classes

ActionEvent	ActionListener	
ItemEvent	ItemListener	
MouseEvent	MouseListener	MouseMotionListener
	MouseAdapter	MouseMotionAdapter
KeyEvent	KeyListener	
	KeyAdapter	
WindowEvent	WindowListener	
	WindowAdapter	

- ◆ *XYZListener* are interfaces.
- ◆ *XYZAdapter* are classes that implement the corresponding listener interfaces.

Nested Panels, Handling Events

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

public class NestedPanels2 extends NestedPanels
    implements ActionListener, ItemListener {

    public NestedPanels2() {
        super(); // create all the components
        // register item listener
        choice.addItemListener(this);
        // register action listener
        registerButtonHandler(this);
    }

    <Event handling methods>
    <Method registerButtonHandler()>
}
```

Event Handling Methods

```
public void itemStateChanged(ItemEvent event) {
    if (event.getStateChange() ==
        ItemEvent.SELECTED) {
        messageBar.setText("Choice selected: " +
            event.getItem());
    }
}

public void actionPerformed(ActionEvent event) {
    Button source = (Button) event.getSource();
    messageBar.setText("Button pushed: " +
        source.getLabel());
}
```

Register The Listener

```
protected
void registerButtonHandler(Component comp) {
    if (comp != null) {
        if (comp instanceof Button) {
            Button button = (Button) comp;
            button.addActionListener(this);
        } else if (comp instanceof Container) {
            Container container = (Container) comp;
            int n = container.getComponentCount();
            for (int i = 0; i < n; i++)
                registerButtonHandler(
                    container.getComponent(i));
        }
    }
}
```

Event Handling Using Inner Class

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

public class NestedPanels3
    extends NestedPanels {
    public NestedPanels3() {
        super();
        ChoiceEventHandler cHandler =
            new ChoiceEventHandler();
        choice.addItemListener(cHandler);
        ButtonEventHandler bHandler =
            new ButtonEventHandler();
        bHandler.registerButtonHandler(this);
    }

    <Inner class ChoiceEventHandler>
    <Inner class ButtonEventHandler>
}
```

Inner Class Listener

Inner classes

- ◆ classes that reside inside other (full-fledged) classes.
- ◆ Intended to be small.
- ◆ serve as helpers to the enclosing class.

```
class ChoiceEventHandler implements ItemListener {
    public void itemStateChanged(ItemEvent event) {
        if (event.getStateChange() ==
            ItemEvent.SELECTED) {
            messageBar.setText("Choice selected: " +
                event.getItem());
        }
    }
}
```

Inner Class Listener (cont'd)

```
class ButtonEventHandler
    implements ActionListener {

    public void actionPerformed(ActionEvent event){
        Button source = (Button) event.getSource();
        messageBar.setText("Button pushed: " +
            source.getLabel());
    }
}
```

Inner Class Listener (cont'd)

(class ButtonEventHandler continued.)

```
protected void
registerButtonHandler(Component comp) {
    if (comp != null) {
        if (comp instanceof Button) {
            Button button = (Button) comp;
            button.addActionListener(this);
        } else if (comp instanceof Container) {
            Container container = (Container) comp;
            int n = container.getComponentCount();
            for (int i = 0; i < n; i++)
                registerButtonHandler(
                    container.getComponent(i));
        }
    }
}
```