GUI Programming I

GUI Components

An Example of GUI – Components

Title bar

Menus

Menu bar

Text field

Buttons

Tabbed pane

Frame
(*Top-level window*)

Scroll bar

Status bar

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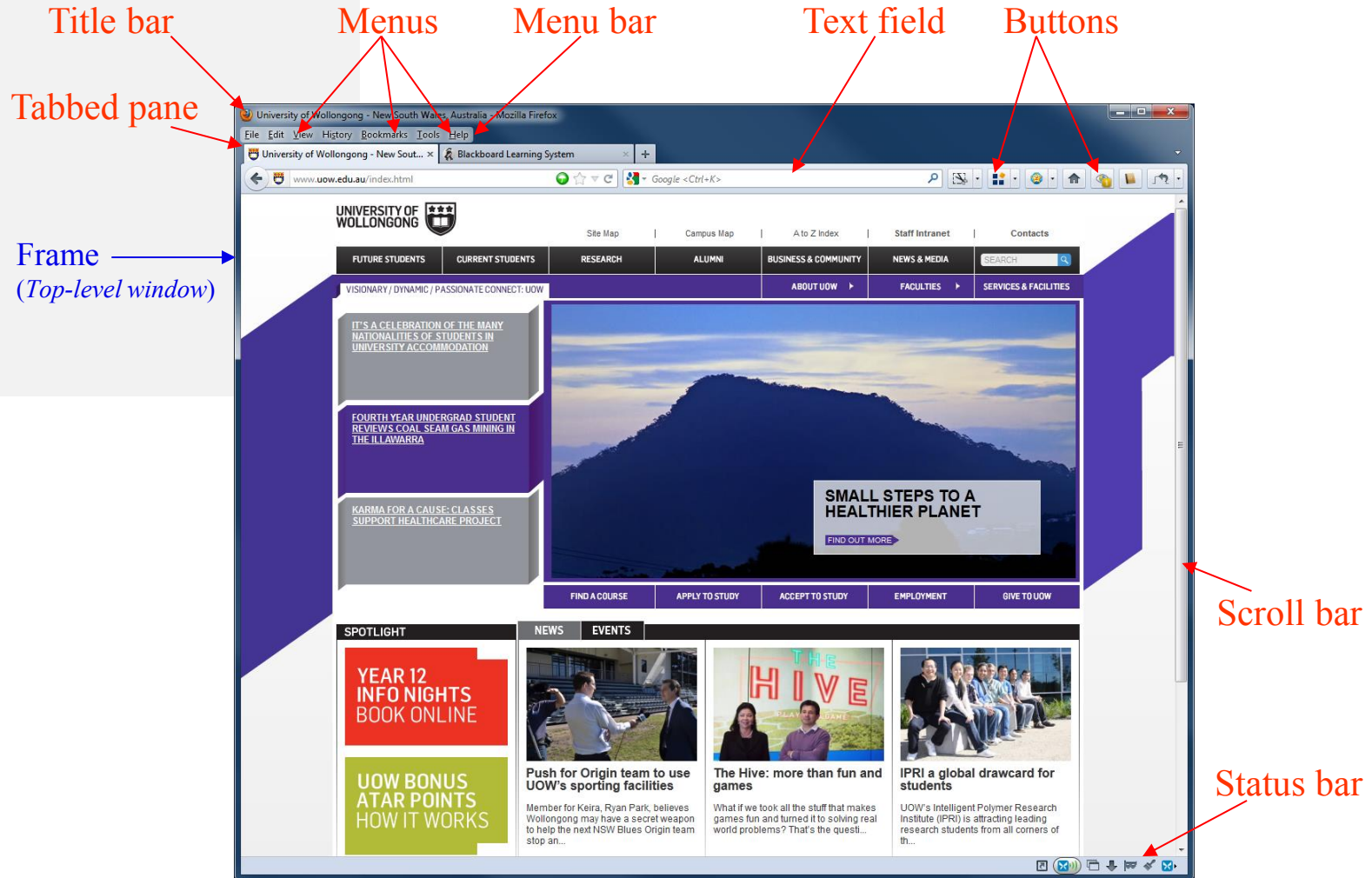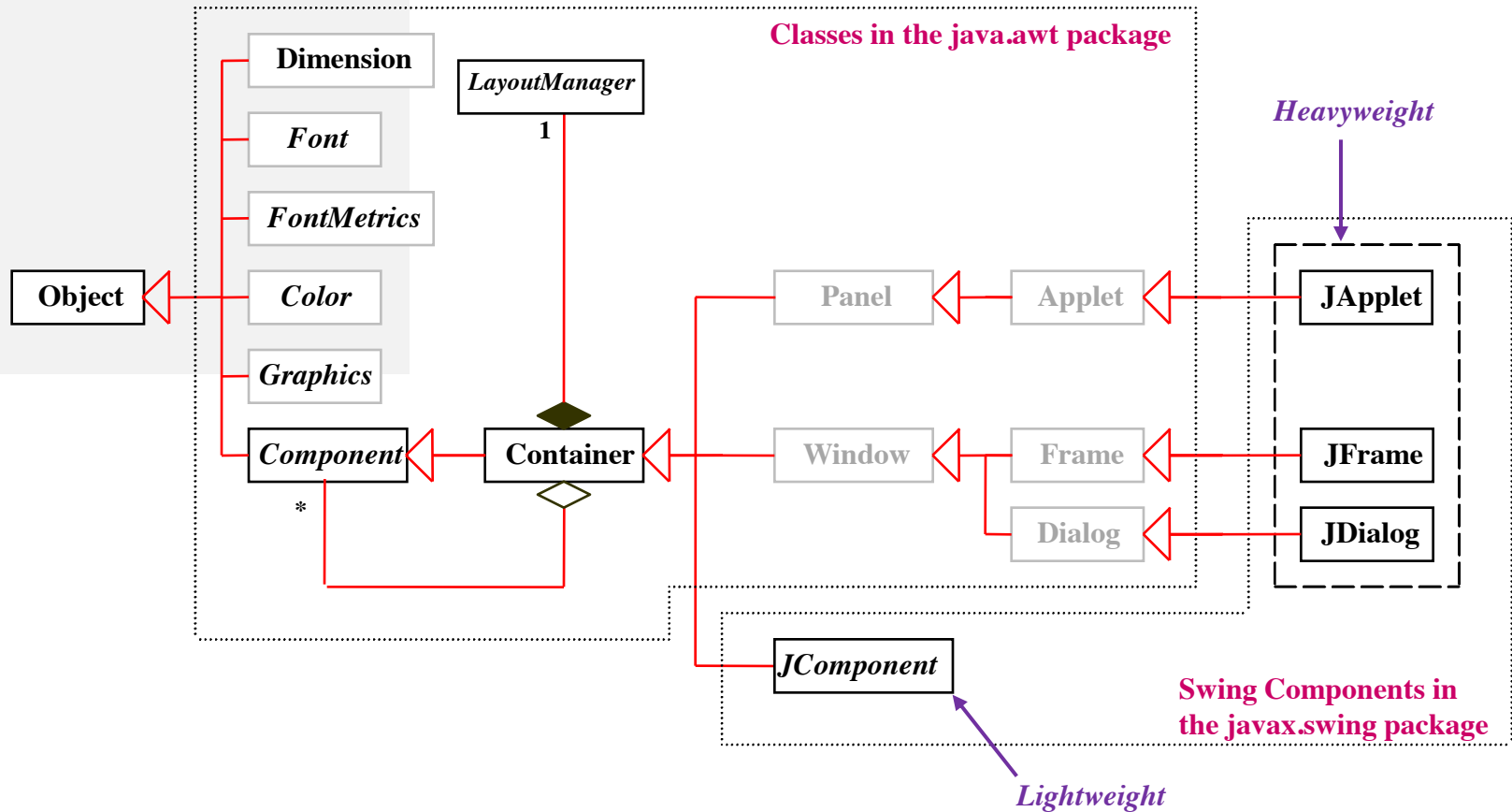
Concepts of GUI Programming

- GUI components
  - How to use them to construct GUI
    - Swing components
- Event handling
  - How to interact with them
    - Actions, listeners and event delegation model
- Layout management
  - How to visually arrange them
    - Layout managers

- MVC design pattern
  - How to efficiently program them
    - Model, view and controller
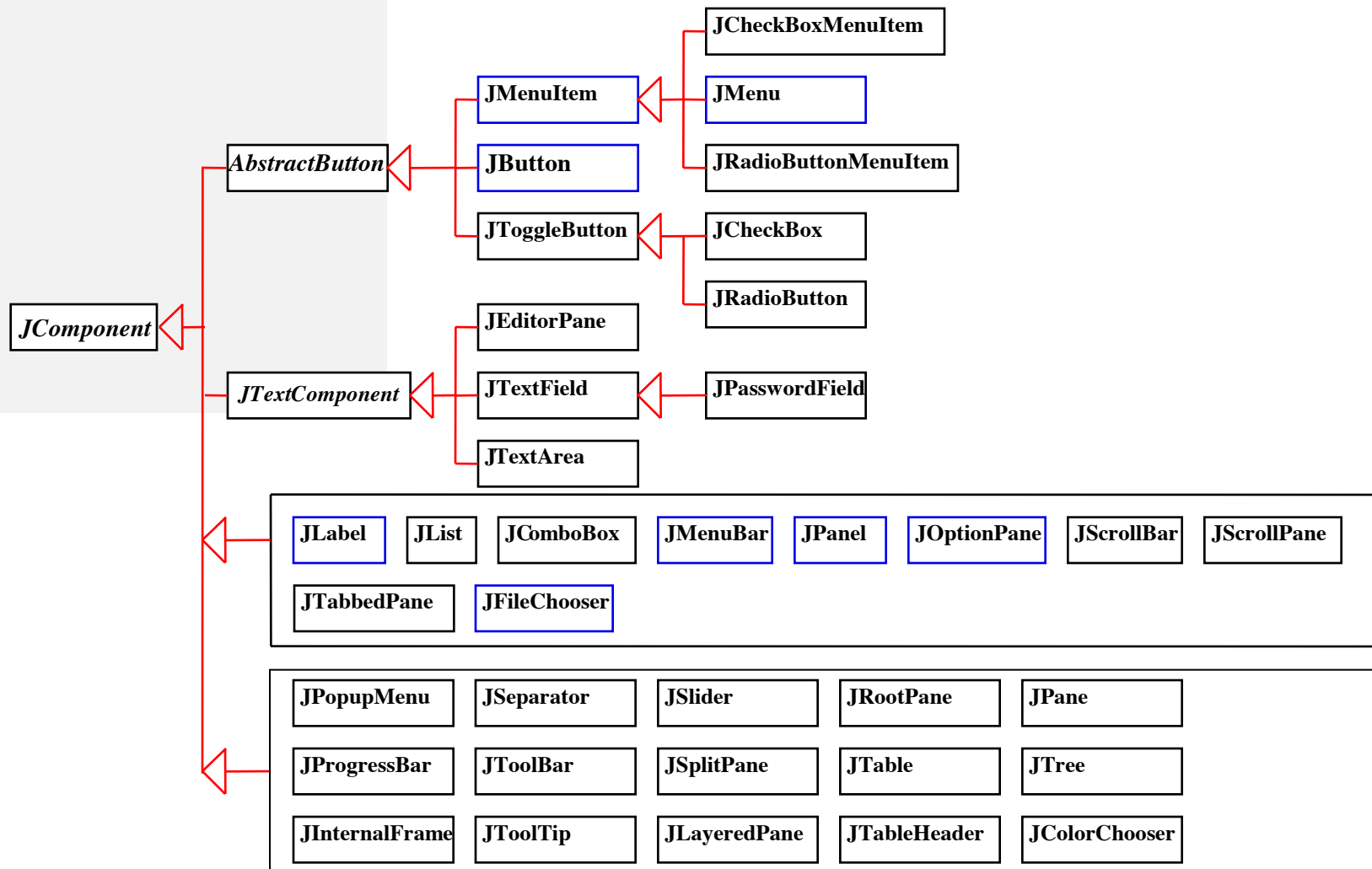   - Content, visual appearance and behaviour

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Overview of GUI Components

- Container Classes
  - To contain other components
    - **JFrame, JPanel, Japplet**

- Component Classes
  - UI components
    - **JButton, JMenu, JTextArea** etc.

- Helper Classes
  - Used by components and containers to draw and place objects
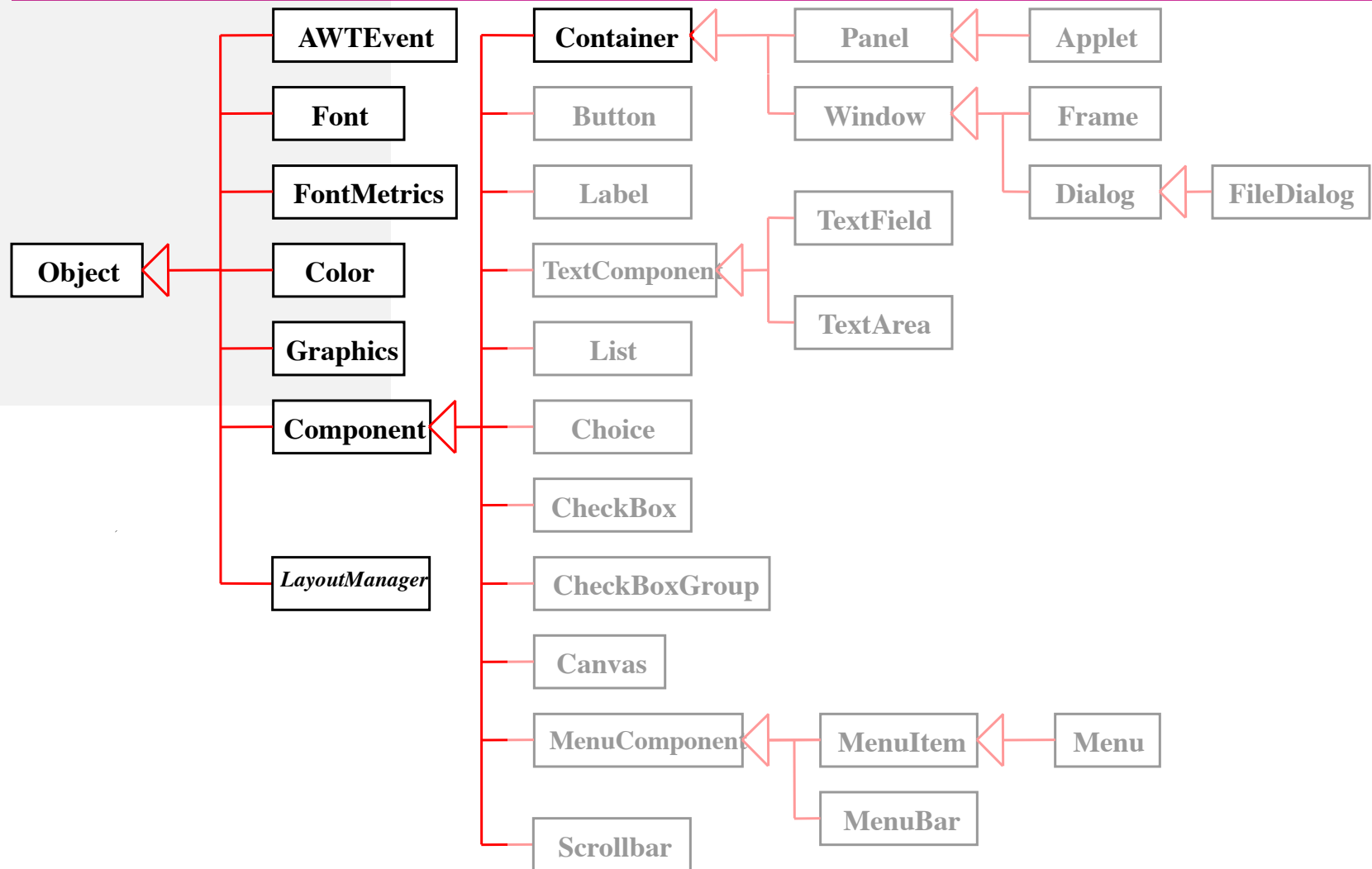   - **Graphics, Color, Font, LayoutManager** etc

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Java GUI Class Hierarchy

Classes in the java.awt package

Heavyweight

Swing Components in the javax.swing package

Lightweight

Object — Dimension, *Font*, *FontMetrics*, *Color*, *Graphics*, *Component*

LayoutManager 1

Component * — **Container**

Container — *Window* — *Frame* — *Dialog*

Panel — *Applet* — **JApplet**

Window — *Frame* — **JFrame**

Dialog — **JDialog**

JComponent

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JComponent and Basic GUI Classes

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AWT GUI Components

AWT and Swing GUI Components

- AWT - Abstract Window Toolkit

  – Delegate GUI component creation and behaviour to *native GUI toolkit* on each platform (Windows, Solaris, Macintosh, Linux/unix)
  – Hard to have consistent and predicable experience
  – Some platforms do not have rich collection of GUI components
  – Fine for simple GUI
  – Prone to platform-specific bugs

- Swing

  – Much richer and more convenient set of GUI components (>250 classes)
  – Class names start with J, replacing AWT components with the same name
  – Depends far less on the underlying platform
  – Lightweight components written in Java
  – Consistent user experience across platforms
  – Pluggable Look and Feel
  – Always use `paintComponent()` method, not `paint()` method

Recommendation: Use Swing for GUI construction

Example 1: Creating a Frame

```java
import javax.swing.*;

public class HelloWorld {
    public static void main(String[] args){

        //Create and set up the frame (window).
①      JFrame frame = new JFrame();
        frame.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
②      frame.setSize(350, 200);


        //Create and add the label
        JLabel helloLabel = new JLabel("Hello World !", JLabel.CENTER);
③      frame.add(helloLabel);


        //Display the frame
④      frame.setVisible(true);
    }
}
```

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Example 2: Creating a Frame

```java
import javax.swing.*;

public class HelloFrameWorld extends JFrame {

    public static void main(String args[]) {
        new HelloFrameWorld();  //The frame (window) is created
    }

    HelloFrameWorld() {
        //Set up the frame (window).
        setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
        setSize(350, 200);
        //Create and add the label
        JLabel helloLabel = new JLabel("Hello Frame World !",
        JLabel.CENTER);
        add(helloLabel);
        //Display the frame
        setVisible(true);
    }
}
```

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Example 3: Creating a Frame

```java
import javax.swing.*;

public class HelloClassWorld {

    public static void main(String[] args) {
        //Create and set up your own frame (window).
        HelloFrame frame = new HelloFrame();
        frame.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
        //Display the frame
        frame.setVisible(true);
    }
}

class HelloFrame extends Jframe {
    public HelloFrame(){
        setSize(350, 200);
        //Create and add the label
        JLabel helloLabel = new JLabel("Hello Class World !", JLabel.CENTER);
        add(helloLabel);
    }
}
```

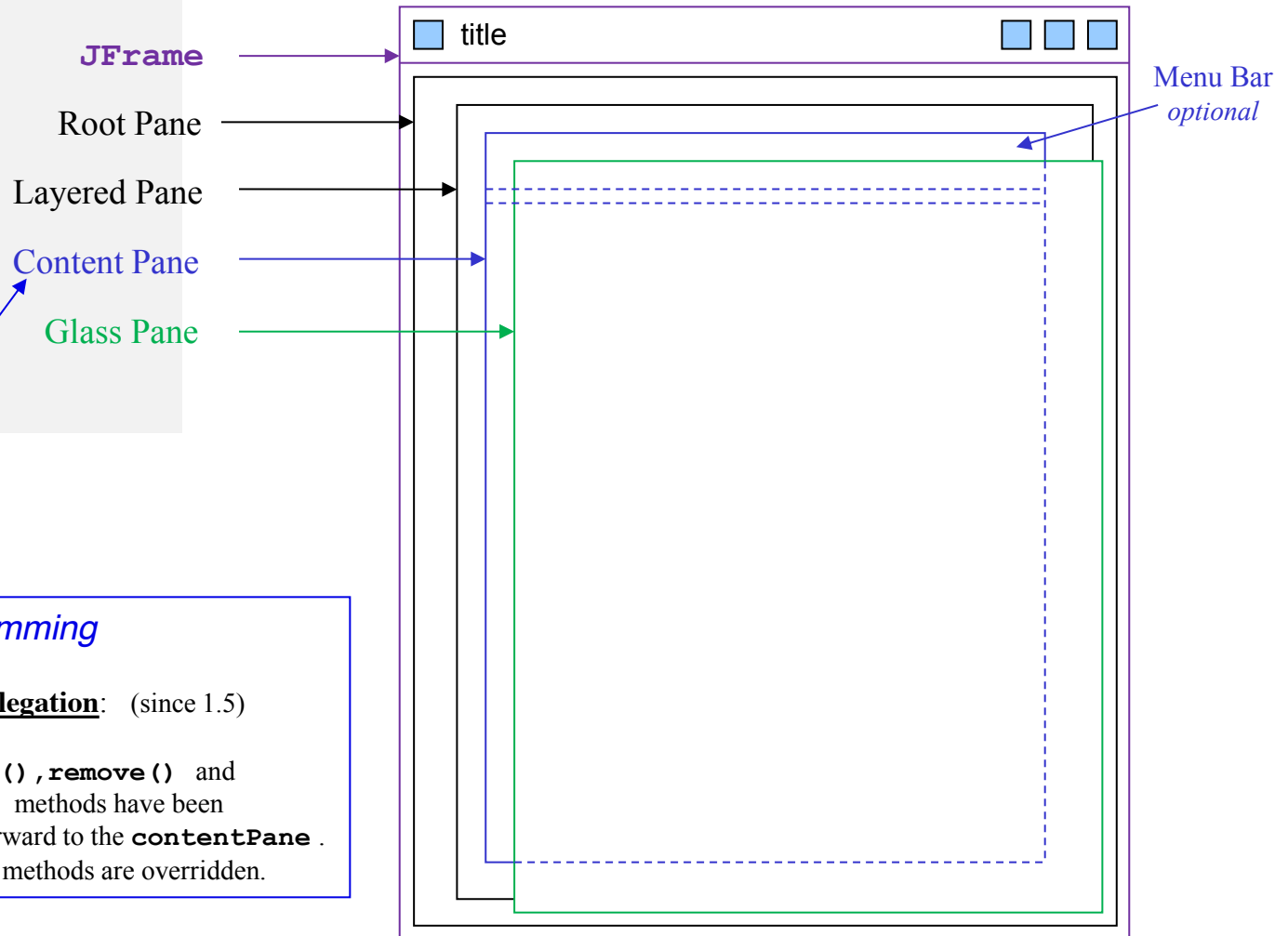UNIVERSITY OF WOLLONGONG

Example 4: Creating a Frame

```java
import javax.swing.*;

public class HelloSafeWorld {
    // Create the GUI and show it.  For thread safety, this method should be invoked
    // from the event-dispatching thread.
    private static void createAndShowGUI() {
        //Create and set up the frame (window).
        JFrame frame = new JFrame();
        frame.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
        frame.setSize(350, 200);
        //Create and add the label
        JLabel helloLabel = new JLabel("Hello Safe World !", JLabel.CENTER);
        frame.add(helloLabel);
        //Display the frame
        frame.setVisible(true);
    }
    public static void main(String[] args) {
        //Schedule a job for the event-dispatching thread:
        //creating and showing this application's GUI.
        javax.swing.SwingUtilities.invokeLater(new Runnable() {
            public void run() {
                createAndShowGUI();
            }
        });
    }
}
```

Do this in your product code

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Internal Structure of `JFrame`

JFrame

Root Pane

Layered Pane

Content Pane

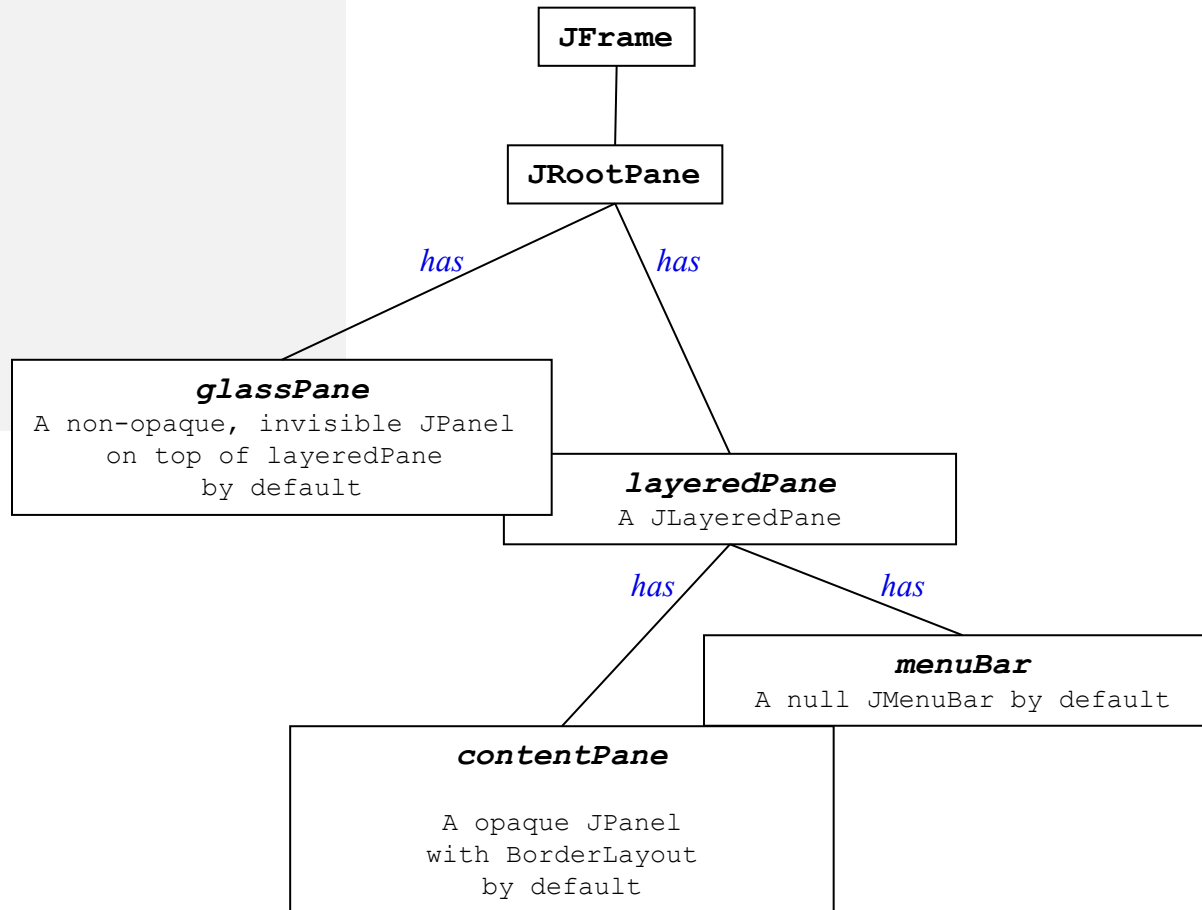Glass Pane

title

Menu Bar
optional

Swing Programming

Content Pane Delegation: (since 1.5)

- **JFrame**'s **add(),remove()** and **setLayout()** methods have been overridden to forward to the **contentPane** .
- Only these three methods are overridden.

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Hierarchy of a `JFrame`

```
                    ┌──────────┐
                    │  JFrame  │
                    └──────────┘
                         │
                   ┌───────────┐
                   │ JRootPane │
                   └───────────┘
                    has    has
        ┌────────────────────────────┐
        │         glassPane          │
        │ A non-opaque, invisible JPanel │
        │    on top of layeredPane   │
        │         by default         │
        └────────────────────────────┘
                    ┌──────────────────────┐
                    │     layeredPane      │
                    │   A JLayeredPane     │
                    └──────────────────────┘
                      has          has
                              ┌──────────────────────────────┐
                              │           menuBar            │
                              │ A null JMenuBar by default   │
                              └──────────────────────────────┘
        ┌────────────────────────────┐
        │         contentPane        │
        │                            │
        │       A opaque JPanel      │
        │      with BorderLayout     │
        │         by default         │
        └────────────────────────────┘
```

glassPane , *layeredPane*, *contentPane* and
menuBar are all variable names used by `JRootPane`

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JFrame methods

javax.swing.JFrame
+JFrame()
+JFrame(title: String)
+setSize(width: int, height: int): void
+setLocation(x: int, y: int): void
+setVisible(visible: boolean): void
+setDefaultCloseOperation(mode: int): void
+setLocationRelativeTo(c: Component): void
+pack(): void
+setIconImage(image: Image): void
+setTitle(title: String): void
+setDefaultLookAndFeelDecorated(decorated: boolean): void
+getContentPane(): Container
+setJMenuBar(menuBar: JMenuBar): void
+getGlassPane(): Component

Some methods are omitted

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Responding to Window–Closing

- By default, when the user closes a frame onscreen, the frame is hidden. The program ***does not*** terminate !
  - Although invisible, the frame still exists and the program can make it visible again
- Specify default close behaviour using

  setDefaultCloseOperation()

- Window constants:

  - **DO_NOTHING_ON_CLOSE**
  - **HIDE_ON_CLOSE**
    - the default for **JDialog** and **JFrame**
  - **DISPOSE_ON_CLOSE**
    - the default for **JInternalFrame**
  - **EXIT_ON_CLOSE**
    - defined in the **JFrame** class
    - recommended for applications only

Hello World !

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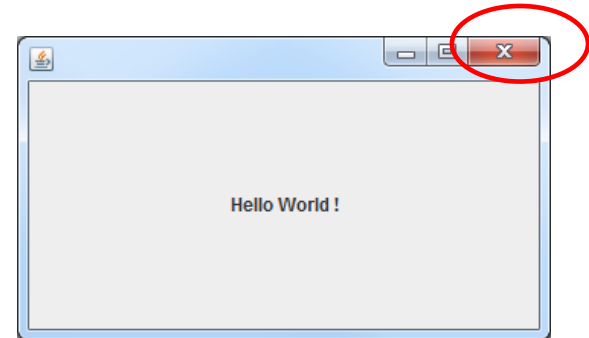
Superclasses of Swing Component

```
Object
```

```
Component
```

```
Container
```

```
JComponent
```

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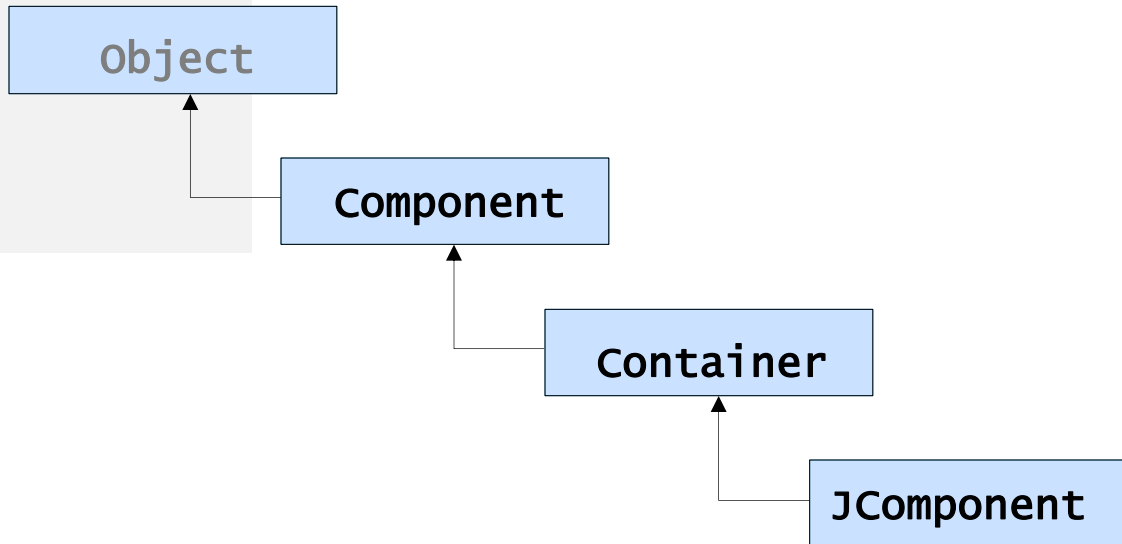
Common Methods of JCompoments

```
┌─────────────────────────────────────────┐
│           java.awt.Component             │
├─────────────────────────────────────────┤
│ -font: java.awt.Font                     │
│ -background: java.awt.Color              │
│ -foreground: java.awt.Color              │
│ -preferredSize: java.awt.Dimension       │
│ -visible: boolean                        │
├─────────────────────────────────────────┤
│ +getWidth(): int                         │
│ +getHeight(): int                        │
│ +getX(): int                             │
│ +getY(): int                             │
└─────────────────────────────────────────┘
```

```
┌─────────────────────────────────────────────┐
│            java.awt.Container                 │
├─────────────────────────────────────────────┤
│ +add(comp: Component): Component              │
│ +add(comp: Component, index: int): Component  │
│ +remove(comp: Component): void                │
│ +getLayout(): LayoutManager                   │
│ +setLayout(l: LayoutManager): void            │
│ +paintComponents(g: Graphics): void           │
└─────────────────────────────────────────────┘
```

```
┌─────────────────────────────────────────┐
│         javax.swing.JComponent           │
├─────────────────────────────────────────┤
│ -toolTipText: String                     │
│ -border: javax.swing.border.Border       │
└─────────────────────────────────────────┘
```

All accessor (get) and mutator (set) methods for private properties are provided in the class but omitted here

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Overview of Swing Components

- Class **Component**
  - Contains **paint** method for drawing **Component** onscreen

- Class **Container**
  - Collection of related components
  - Contains **add()** method for adding components

- Class **JComponent**
  - *Pluggable look and feel* for customizing look and feel
  - Shortcut keys (*mnemonics*)
  - Common event-handling capabilities
  - All Swing components whose names begin with "J" descend from the **JComponent** class, with the exception of top-level containers,
    - For example, **JPanel**, **JScrollPane**, **JButton**, and **JTable**

Some Basic GUI Components

Component	Description
JLabel	An area where uneditable text or icons can be displayed.
JTextField	An area in which the user inputs data from the keyboard. The area can also display information.
JButton	An area that triggers an event when clicked with the mouse.
JCheckBox	A GUI component that is either selected or not selected.
JComboBox	A drop-down list of items from which the user can make a selection by clicking an item in the list or possibly by typing into the box.
JList	An area containing a list of items from which the user can make a selection by clicking on any element in the list. Multiple elements can be selected.
JPanel	A container in which components can be placed and organized.

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Top–Level Containers

Top-Level Containers – At least one of these components must be present
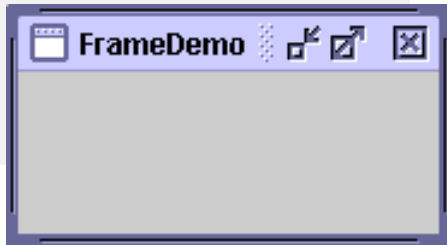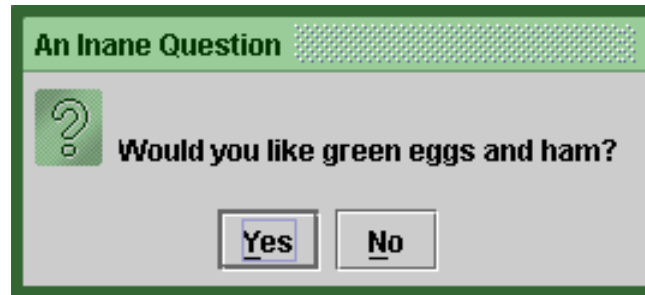
Frame   Dialog   Applet

They are heavyweight and created by *native OS windowing system*, while other Swing GUI components, lightweight and created by *Java*, are added into them

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Top–level Container Classes

- To appear onscreen, every GUI component must be part of a *containment hierarchy*.
  - A containment hierarchy is a tree of components that has a top-level container as its root.
- Each GUI component can be contained only once.
  - If a component is already in a container and you try to add it to another container, the component will be removed from the first container and then added to the second.
- Each top-level container has a content pane
  - that contains the visible components in that top-level container's GUI.
- You can optionally add a menu bar to a top-level container.
  - The menu bar is by convention positioned within the top-level container, but outside the content pane.

Containment Hierarchy

- Standalone Application has at least one containment hierarchy with the **JFrame** as its root

```java
import javax.swing.*;

public class HelloWorld {
    public static void main(String[] args){

        //Create and set up the frame (window).
        JFrame frame = new JFrame();
        frame.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
        frame.setSize(350, 200);

        //Create and add the label
        JLabel helloLabel = new JLabel("Hello World !"
        frame.add(helloLabel);

        //Display the frame
        frame.setVisible(true);
    }
}
```

A top-level container

JFrame

. . .

Menue Bar   **Content Pane**

JLabel

Hello World !

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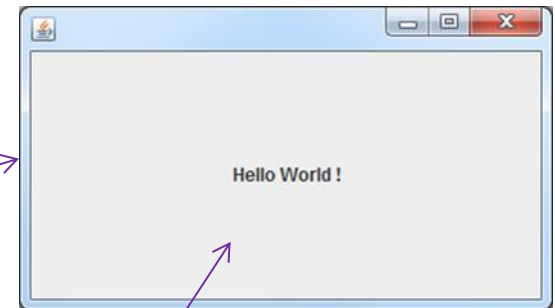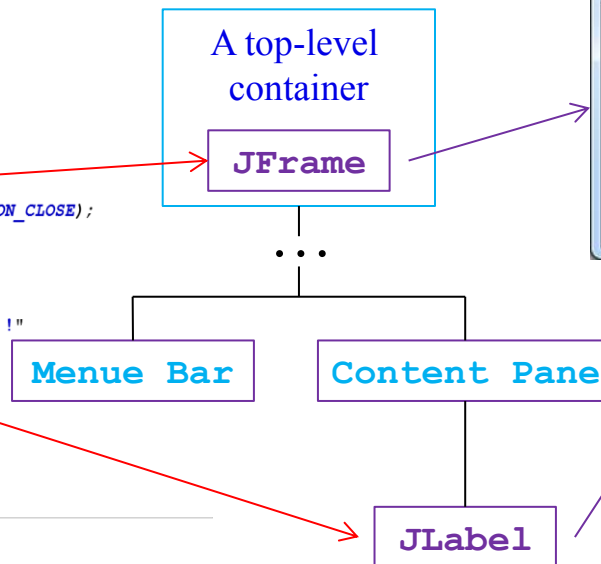
General–Purpose Containers

General-Purpose Containers – used to contain other components
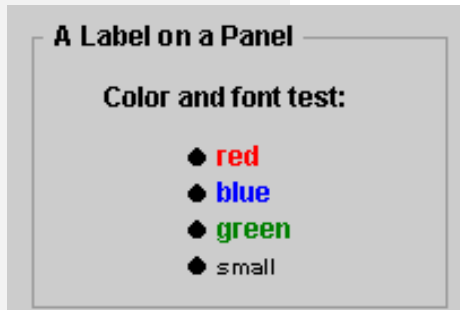
Panel
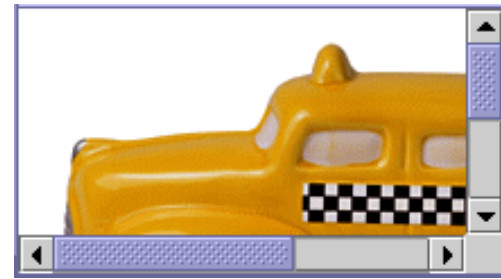
Scroll Pane
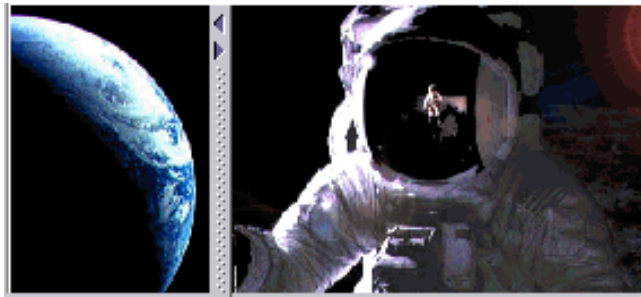
Split Pane

Tabbed Pane

Tool Bar

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Special–Purpose Containers

Special-Purpose Containers – play specific roles in the GUI
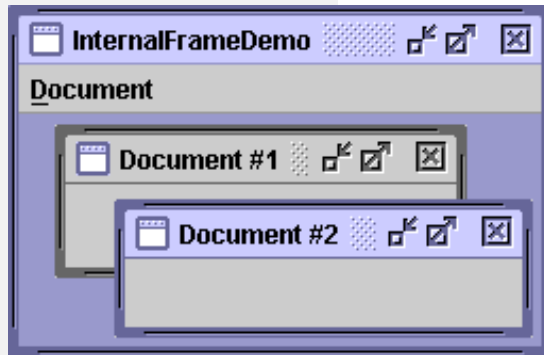
Internal Frame

Root Pane

Layered Pane

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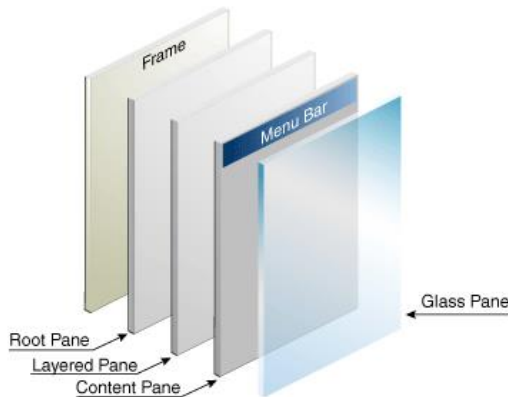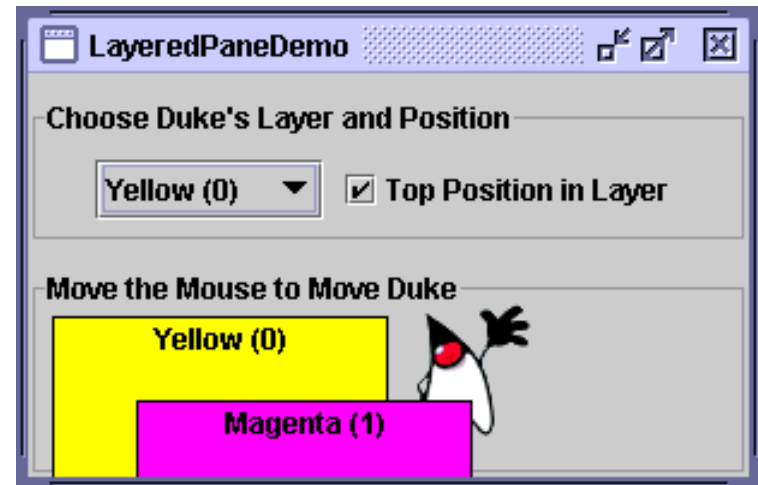
Basic Controls

Basic Controls – To get input from the user; also show simple state
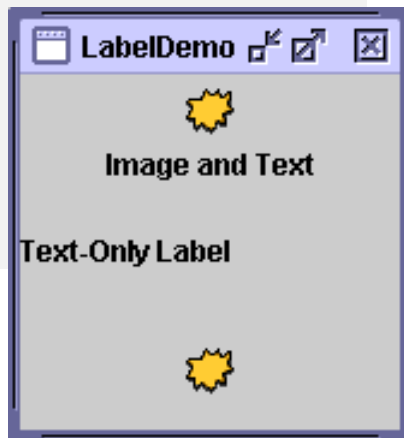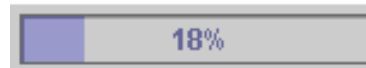

Buttons
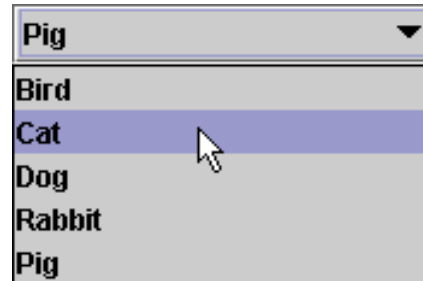
Combo Box
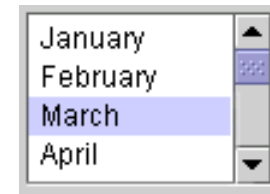
List
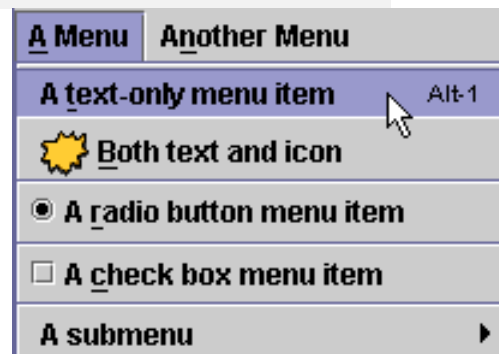
Menu

Check Box

Spinner

Slider

Text Field
Formatted Text Field

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Uneditable Information Displays

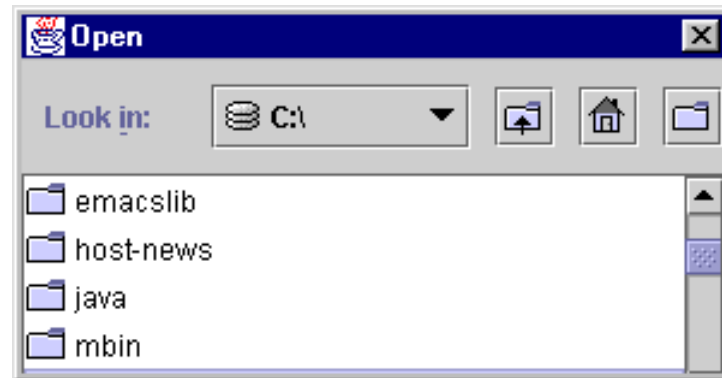Uneditable Information Displays – To give the user information

Label

Progress Bar

Tool Tip

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Interactive Displays

Interactive Displays of Highly Formatted Information – modifiable by the user
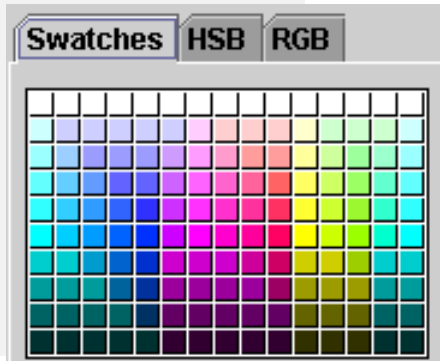
Color Chooser

File Chooser

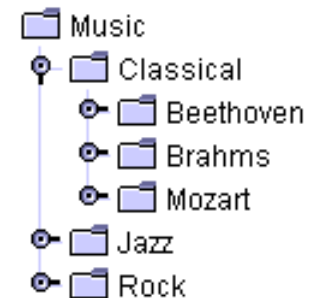Table

Text

Tree

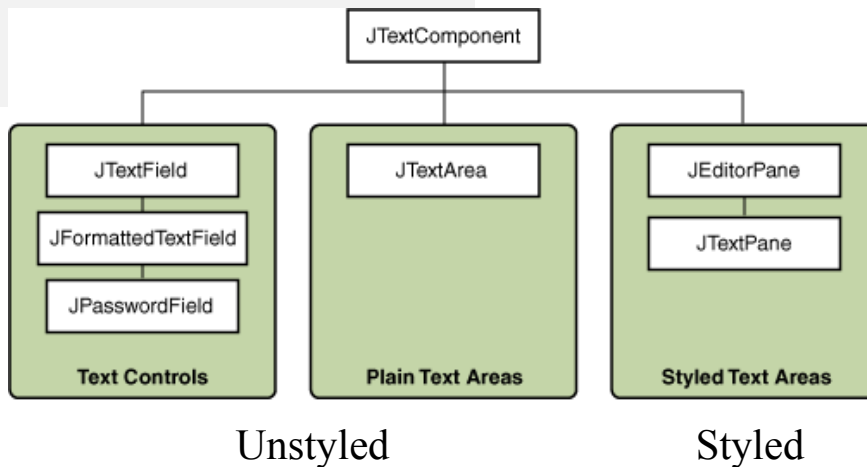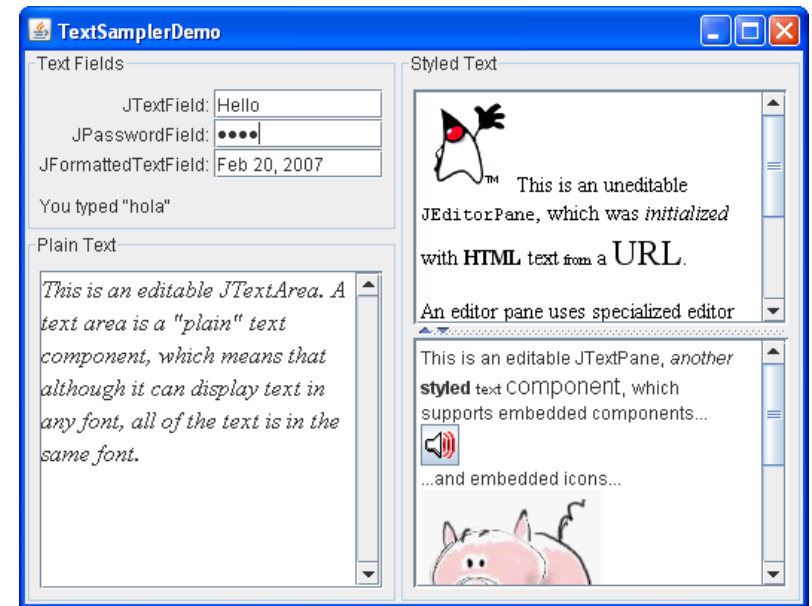UNIVERSITY OF WOLLONGONG

Text Components

- Display text and optionally allow users to edit the text

Unstyled   Styled

JTextComponent Hierarchy

Examples of text components

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Helper Classes

- Helper classes are not subclasses of **Component** class
- Used to describe the properties of GUI components

- In **java.awt** package

  - **Color, Font, Dimension**
  - **Border, Cursor**
  - **Graphics, LayoutManager**

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Color Class

```
Color myColor = new Color(int r, int g, int b);
```

- **r**, **g**, and **b** specify a color by its red, green, and blue components.

- There are some `Color` class constants (standard colors):

```
Color.BLACK, Color.WHITE, Color.RED, Color.CYAN, …
```

Example:

```
Color myColor = new Color(128, 100, 100);
setColor(myColor);
setBackground(myColor);
```

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Color Constants and Their RGB Values

Color constant	Color	RGB value
public final static Color ORANGE	orange	255, 200, 0
public final static Color PINK	pink	255, 175, 175
public final static Color CYAN	cyan	0, 255, 255
public final static Color MAGENTA	magenta	255, 0, 255
public final static Color YELLOW	yellow	255, 255, 0
public final static Color BLACK	black	0, 0, 0
public final static Color WHITE	white	255, 255, 255
public final static Color GRAY	gray	128, 128, 128
public final static Color LIGHT_GRAY	light gray	192, 192, 192
public final static Color DARK_GRAY	dark gray	64, 64, 64
public final static Color RED	red	255, 0, 0
public final static Color GREEN	green	0, 255, 0
public final static Color BLUE	blue	0, 0, 255

Difficult to read? Read the API Documentation

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Font Class

```
Font myFont = new Font(String name, int style, int size);
```

- Font name
  - **Monospaced**, **SansSerif**, **Serif**, etc.
- Font style
  - **Font.PLAIN**, **Font.ITALIC** and **Font.BOLD**
- Font size
  - Measured in points (1/72 of inch)

Example:

```
Font myFont = new Font("SansSerif ", Font.BOLD, 16);
Font myFont = new Font("Serif", Font.BOLD+Font.ITALIC, 12);

setFont(new Font("SansSerif", Font.BOLD, 17));
```

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Example: Setting Up GUI

```java
public class HelloBeautifulWorld {
    public static void main(String[] args){

        /* Create and set up the frame (window) */
        JFrame frame = new JFrame("Creating A Beautiful Frame"); //with a window title
        frame.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
        frame.setSize(350, 200);                        //Set the frame size
        frame.setLocationRelativeTo(null);              //Center the frame
        frame.getContentPane().setBackground(Color.MAGENTA);    //Set background color
                                                        //  of the ContentPane

        /* Create, setup and add the label */
        JLabel helloLabel = new JLabel("Hello Beautiful World !", JLabel.CENTER);
        helloLabel.setForeground(new Color(255,250,0));
        helloLabel.setFont(new Font("Serif", Font.BOLD+Font.ITALIC, 28));
        helloLabel.setCursor(Cursor.getPredefinedCursor(Cursor.HAND_CURSOR));
                                                        //Set the cursor

        frame.add(helloLabel);

        /* Display the frame */
        frame.setVisible(true);
    }
}
```

HTML in Swing Components

- Many Swing components display a text string as part of their GUI.
  - By default, a component's text is displayed in a single font and color, all on one line. You can determine the font and color of a component's text by invoking the component's setFont and setForeground methods

```
label = new JLabel("A label");
label.setFont(new Font("Serif", Font.PLAIN, 14));
label.setForeground(new Color(0xffffdd));
```

- HTML can be used to mix fonts or colors within text or multiple lines
  - buttons, menu items, labels, tool tips, and tabbed panes
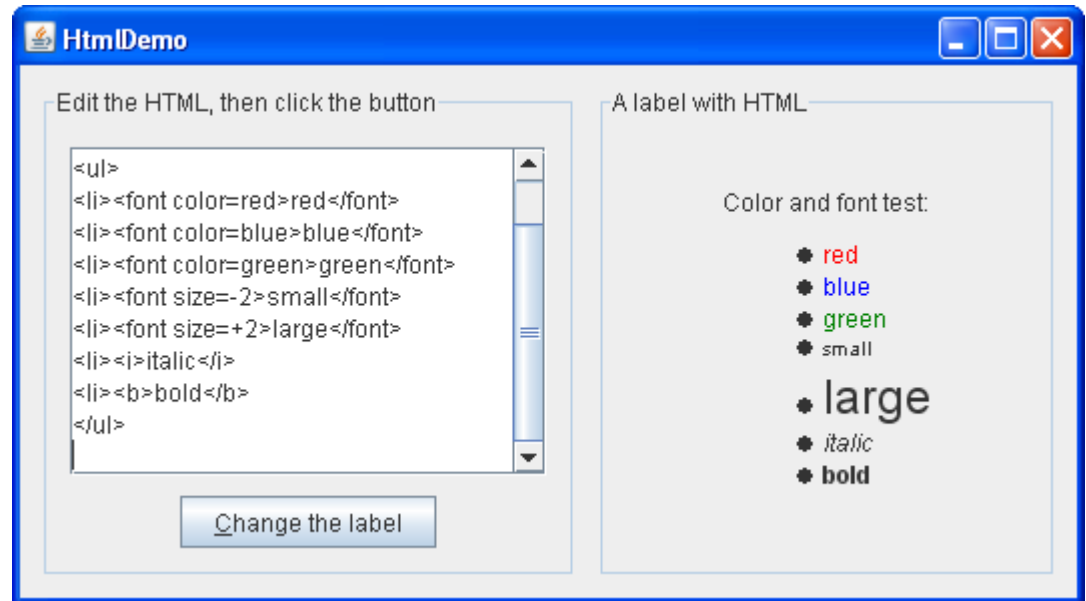
Exceptions in GUI Applications

- An error message appears on the console with unhandled exceptions, but the GUI application may or may not continue running

- A dialog box often is used to display messages for handled exceptions

- An event may be ignored in GUI applications, but an exception can not be ignored

Unhandled exception: **ErrorDemo.java**

Handled exception: **ErrorDemo2.java**

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Swing Demo

- JDK Demos includes useful demonstration programs (`SwingSet2` and `SwingSet3`) that show all the Swing components and enables you to explore with them interactively
- They display the source code for each demo
- `SwingSet2` can be found in `demo\jfc\SwingSet2` under your JDK Demo directory and `SwingSet3` can be run using JavaWebstart at

`http://download.java.net/javadesktop/swingset3/SwingSet3.jnlp`

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