320341 Programming in Java

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Lecture 14: Introduction - Swing User Interface Components

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Objectives

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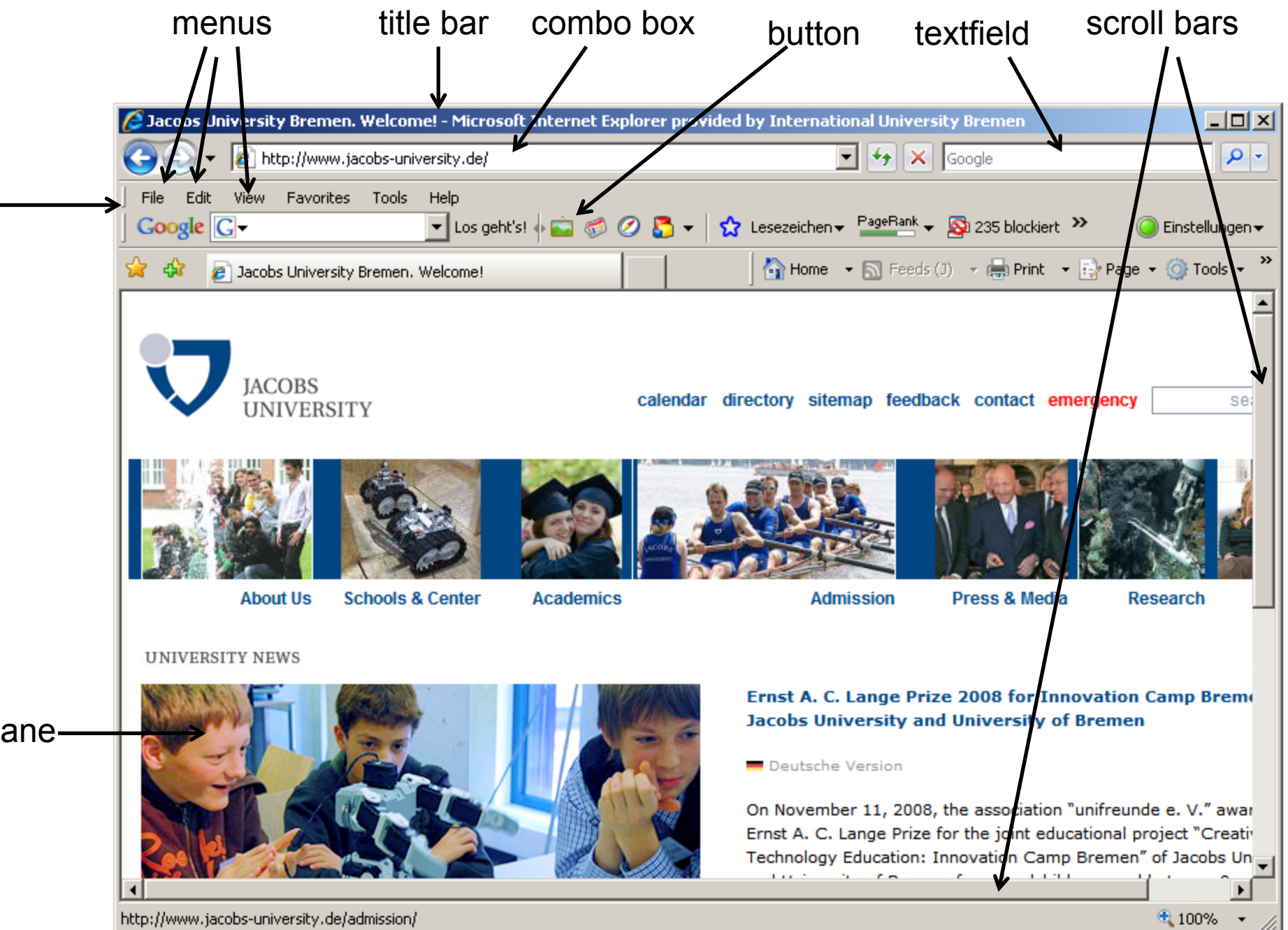
This lecture presents the following

- The **Model-View-Controller (MVC)** design pattern
- Basic **Layout Managers**
- **Text** input **Components**
- **Choice Components**

Introduction

Abstract Window Toolkit (AWT)

- The original goal of AWT was to allow building *GUIs that look good on all platforms – this goal was not achieved as AWT had implementation problems*
- AWT drawing used “native peers” (Linux, Mac, Win32) – to be synchronized
- **Java Foundation Classes (JFC)** replaced old AWT in Java 2
- The Graphical User Interface (GUI) portion of JFC is called **Swing**
- GUIs are built from GUI components called widgets (window gadgets)
- A widget is an object with which a user interacts via mouse, keyboard, voice ..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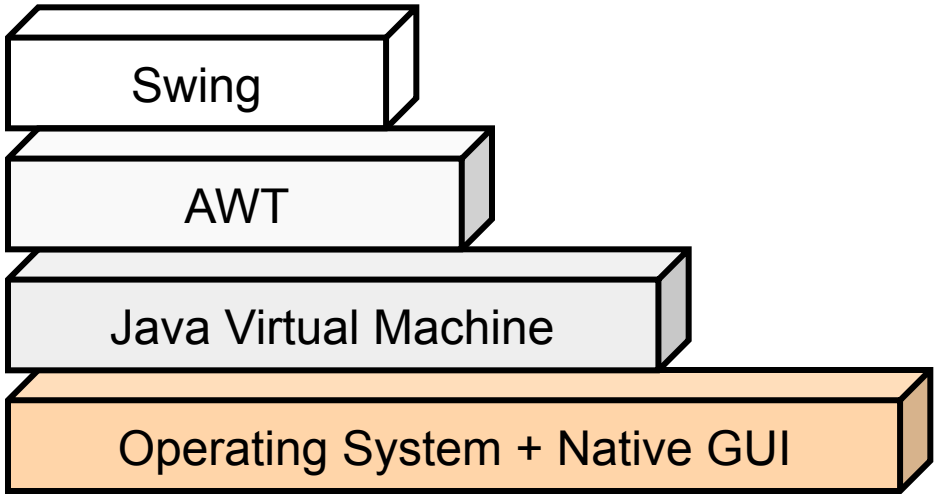
Swing

- Implemented in Java (rt.jar file contains java code for Swing)
- Built on the **AWT** primitives, but done right
- Has **pluggable look-and-feel** (look-and-feel is the appearance & way in which the user interacts with the application)



- Some old AWT classes (e.g., event model) are still used in Swing

Model-View-Controller (MVC) Design Pattern

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According to **MVC**, every component has three characteristics

- **Content** (e.g., state of a button, text in a text field)
- **Visual appearance** (e.g., color, size)
- **Behavior** (reaction to events)

MVC pattern distributes responsibilities to three specialized classes

- The **model** stores the content or data
- The **view** displays the content
- The **controller** handles user input

Model-View-Controller Design Pattern

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Text Field Example

Model	**View**	**Controller**
The quick brown fox jumps over the lazy dog	**The quick brown**	Handles user input events (e.g., mouse clicks and keystrokes)

- The **model** must implement methods to change the contents and to discover what the content is (*add*, *remove*, *getText*)
- The model is completely non-visual
- The controller handles user-input events

Model-View-Controller Design Pattern

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Wrapper classes (e.g., **JButton**, **JTextField**) store the ***model*** and ***view***

Queries about the **model** and **view** are handled by wrapper classes

It is possible to retrieve the model and work directly with it

The **Look-and-Feel** is responsible for the view

- Visual representation depends on the UI design of a particular look-and-feel
- Nimbus is an example Look and Feel used in Java (from Java SE 6)

MVC on Swing Buttons

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Model

- The model class implements an interface with name ending in **Model**
- For the button, this is the **ButtonModel** interface

Method	Description
getActionCommand()	The action command string associated with this button
getMnemonic()	The keyboard mnemonic for this button
isEnabled()	true if the button is selectable
…	

Each button stores a button model, which you can retrieve

```
JButton button = new JButton(“Blue“);
ButtonModel model = button.getModel();
```

Basic GUI Components

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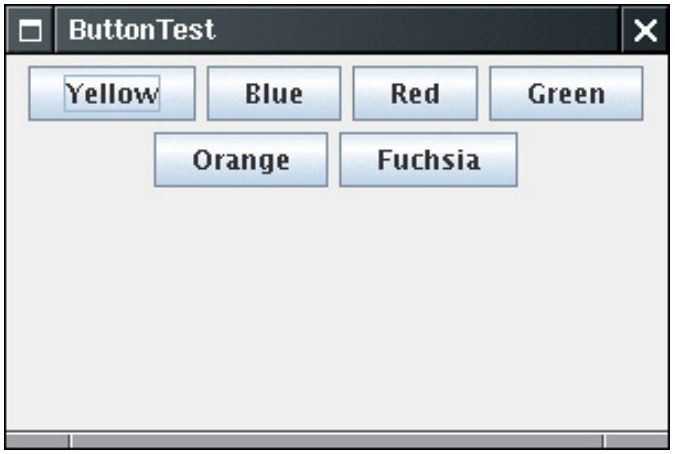
JLabel	Displays uneditable text or icons
JTextField	Enables user to enter data from the keyboard
JButton	Triggers an event when clicked with a mouse
JCheckBox	Specifies an option that can be selected or not selected
JComboBox	Provides a dropdown list of items from which the user can select
JList	Provides a *list of items* from which the user make a selection by clicking on any item in the list. Allows multiple element selection
JPanel	Provides an *area in which components can be placed and organized*. Can also be a drawing area for graphics

Introduction to Layout Managers

All components in a container are positioned by a **layout manager**

FlowLayout Manager

- The **FlowLayout** is the *default* layout manager for a panel
- Lines the components horizontally until there is no more room; and then starts a new row of components



The **FlowLayout** manager automatically reflows the components on resizing

Introduction to Layout Managers

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FlowLayout Manager cont…

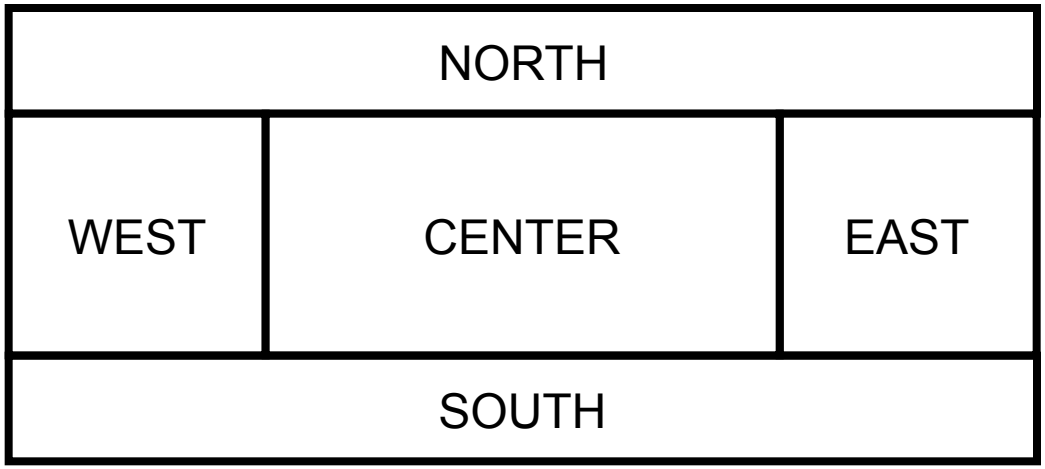
- Choose how to arrange components in a row
- Choose **LEFT**, **RIGHT** (default is **CENTER**)

Example

```
Panel.setLayout(new FlowLayout(FlowLayout.LEFT));
```

BorderLayout Manager

- The default layout manager of the content pane of every **JFrame**
- This manager lets you choose where you want to place components
- Components can be placed in the **CENTER**, **NORTH**, **SOUTH**, **EAST**, **WEST** of the content pane



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BorderLayout Manager Example

```
panel.setLayout(new BorderLayout());
panel.add(yellowButton, BorderLayout.SOUTH);
```

BorderLayout Manager Features

- Edge components are laid out first; remaining space is occupied by center
- On resizing, edge components don't change, but center components do
- Border layout grows all components to fill available space

Introduction to Layout Managers

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Panels

- A border layout is not very useful on its own
- Components grow to fill entire region
- Example

- Button fills entire southern region
- Adding another displaces the first one

Nest panels inside containers and use different layout managers

- Ex. Create a panel in the southern region to hold buttons
- Ex. Create another panel in the center to hold text

Introduction to Layout Managers

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Example

- A panel with three buttons

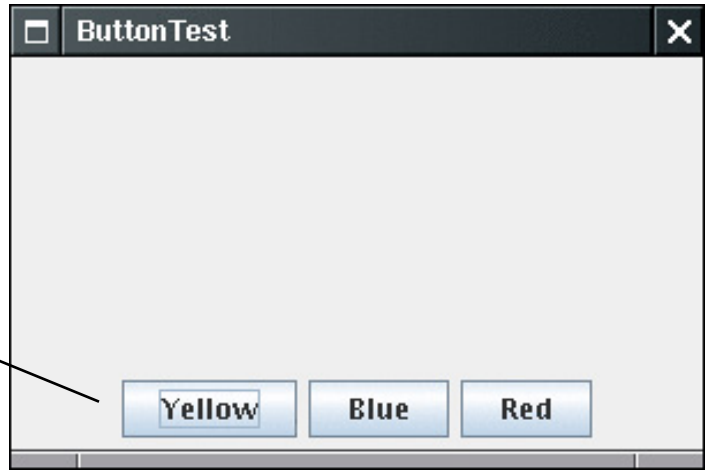
Create **JPanel** object

Buttons under **FlowLayout**

```
JPanel panel = new JPanel();
panel.add(yellowButton);
panel.add(blueButton);
panel.add(redButton);
frame.add(panel, BorderLayout.SOUTH);
```

- Panel nested inside frame

- Buttons centered in panel and do not fill entire panel area



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GridLayout

- Arranges all components in rows and columns like a spreadsheet
- Cells are always the same size
- Buttons grow and shrink upon window resize
- All buttons have the same size

GridLayout Constructor

Sets panel to 5 rows, 4 cols

```
panel.setLayout(new GridLayout(5, 4));
```

- Components are added row-wise

Introduction to Layout Managers

GridLayout Example (Calculator)

Matrix of equally sized cells

Buttons must be attached to event listeners

Basic Swings UI Components

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Component Classes

- Classes are found in the `javax.swing` package
- Component class names all begin with "**J**"
- The remainder of the class name is the name of the component
- Examples: **JButton**, **JTextField**, **JTextArea**, **JScrollBar** classes

- All Swing components are subclasses of `java.awt.Container`
- Most Swing components emit *events* from the `java.awt.event` package

Basic Swings Components

Container Components

- These are components that can contain other components (including other containers)

- **Containers** use layout managers to determine size and position of their child components

Examples of **Container** Components

- **JFrame**
- **JPanel**

Basic Swings UI Components

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Container Components - **JFrame**

- A **JFrame** is an independent window that can be moved around on the screen independently of any other GUI windows

- Any application that requires a GUI must use one or more frames to contain the desired components

Example

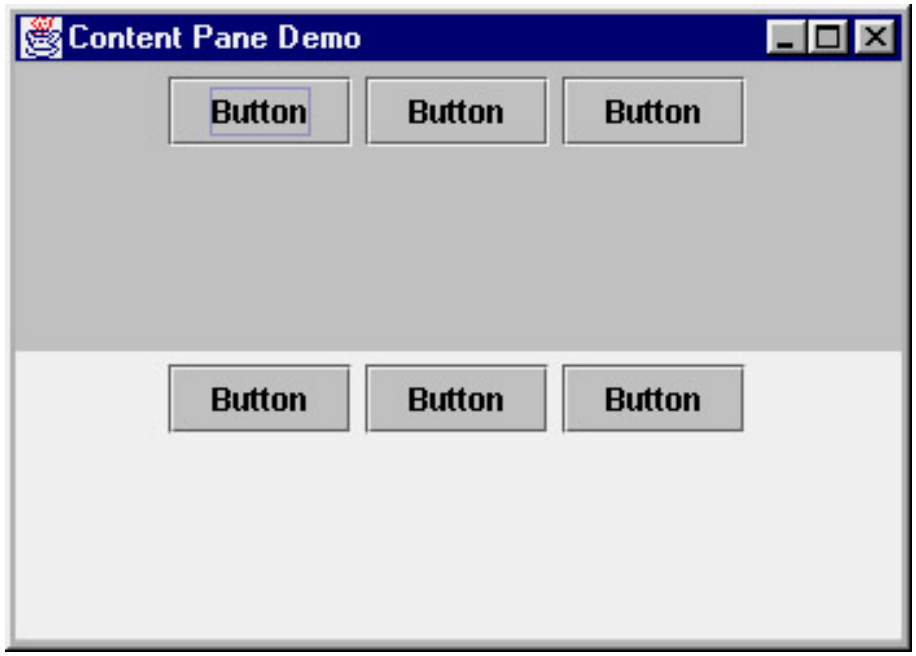
```
import javax.swing.JFrame;

 public class FrameDemo {

  public static void main(String[] args) {
        JFrame frame = new JFrame("Frame Demo");
        frame.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
        frame.setSize(350, 250);
        frame.setVisible(true);
  }
 }
```

Container Components – JPanel

- A **JPanel** is a blank rectangular component that can contain other components
- Example : Two panels inside a frame, containing three buttons each



JTextField and JTextArea

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Text Input

- Lets the user input and edit text
- Two components: **JTextField** and **JTextArea** components
- Both classes inherit from **JTextComponent** abstract class
- **JTextComponent** text manipulation methods:

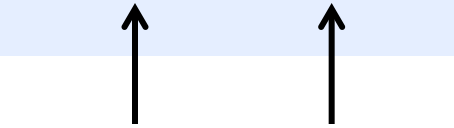
```
void setText (String t)
String getText ()
void setEditable(boolean b)
```

Example

Text Input – **Text Fields**

- To add a text field to a window, add the text field to a panel (or other container)

```
JPanel panel = new JPanel();
JTextField textField = new JTextField("Default input", 20);
panel.add(textField);
```



Text Fields usually start off blank

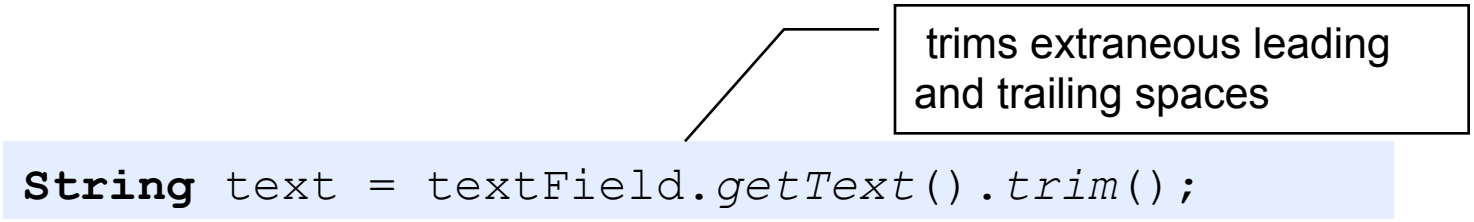
- Use constructor without text portion

```
JPanel panel = new JPanel();
JTextField textField = new JTextField(20);
panel.add(textField);
```

Example

Reading Text Fields

- Use *getText*() method to read what the user typed



Labels

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Labels and Labeling Components

- Labels are components that hold text and used to identify components
- They do not react to user input

Constructing a **JLabel**

```
JLabel label = new JLabel("Minutes", JLabel.RIGHT);
```

- Labels can be positioned inside a container like any other component

Password Fields

Password Fields

- A special kind of text field
- Typed characters are represented by an echo character (*)

- Swing supplies a **JPasswordField** to implement the password text field

JPasswordField (**String** text, int columns)
char[] *getPassword()*
void *setEchoChar(char echo)*

Example:

JFormattedTextField

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Formatted Input Fields

- Use **JFormattedTextField** class to validate user input

- Example – Integer input validation

```
JFormattedTextField intField = new
        JFormattedTextField(NumberFormat.getIntegerInstance());
```

JFormattedTextField

- The **NumberFormat**.*getIntegerInstance*() returns a formatter object that formats integers, using the current *locale*

- Reading the values from integer formatted text field

```
Number value = (Number) intField.getValue();
int v = value.intValue();
```

FormattedTextFieldVerifier

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Verifiers

- Verifiers are useful for alerting users to invalid input
- A verifier can be attached to any **JComponent**
- The verifier extends the abstract **InputVerifier** class & define *verify* method

```
class FormattedTextFieldVerifier extends InputVerifier {
  public boolean verify(JComponent component)    {
       JFormattedTextField field = (JFormattedTextField) component;
    return field.isEditValid();
  }
}
```

Attach verifier to **JFormattedTextField** as follows

```
intField.setInputVerifier(new FormattedTextFieldVerifier());
```

Standard Formatters

- getNumberInstance
- getCurrencyInstance
- getPercentInstance

Editing Dates (call of one of the static methods of the **DateFormat** class)

- getDateInstance
- getTimeInstance
- getDateTimeInstance

DefaultFormatter

DefaultFormatter

- Can format any class that has a constructor with a string parameter and a matching `toString` method like for example

```
DefaultFormatter formatter = new DefaultFormatter();
formatter.setOverwriteMode(false);
JFormattedTextField urlField = new JFormattedTextField(formatter);
urlField.setValue(new URL("http://java.sun.com"));
```

MaskFormatter

- Used to format fixed-size patterns

#	Digit	A	Letter or digit
?	Letter	H	Hexadecimal digit[0-9A-Fa-f]
U	Upper case letter	*	Any character
L	Lowercase letter	‘	Escape character

JTextArea

- The **JTextArea** class allows a user to enter any number of lines
- Specify the number of rows and columns when calling the constructor

```
JTextArea textArea = new JTextArea(8, 40); // 8 lines of 40 columns each
```

- Avoid clipping long lines by turning on line wrapping

```
textArea.setLineWrap(true); // long lines are wrapped
```

- Insert text area inside a scroll pane

```
textArea = new JTextArea(8, 40);
JScrollPane scrollPane = new JScrollPane(textArea);
```

Basic Swings UI Components

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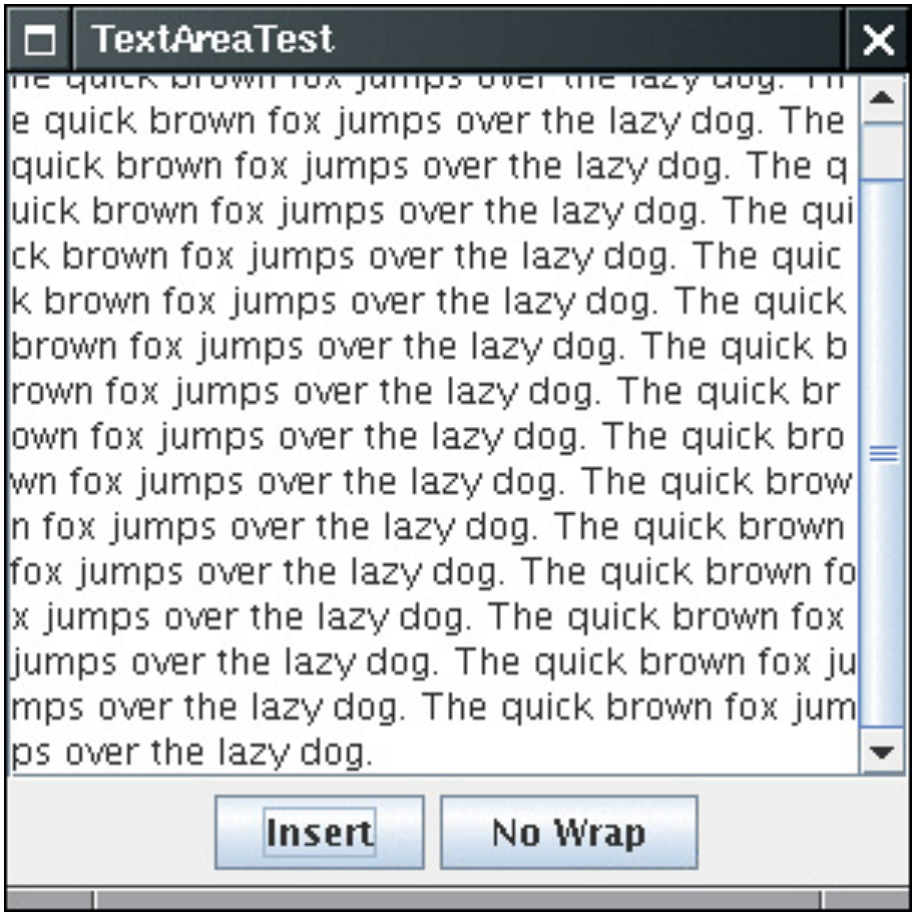
Text Areas - Example



CheckBoxes

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Choice Components

- Allow to give users a finite set of choices

Checkboxes

- Checkbox component used to collect “yes” or “no” input
- Constructor

```
JCheckBox  bold = new JCheckBox("Bold");
```

- Use *setSelected* method to turn a checkbox on or off

```
bold.setSelected(true);
```

CheckBoxes

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Choice Components - Checkboxes

- When a checkbox is clicked, an **ActionEvent** is triggered
- Attach an action listener to the checkbox

```
ActionListener listener = . . .
bold.addActionListener(listener);
italic.addActionListener(listener);
```

- The *actionPerformed* method of the **ActionListener** interface queries the state of the source events

```
public void actionPerformed(ActionEvent event) {
    int mode = 0;
    if (bold.isSelected()) mode += Font.BOLD;
    if (italic.isSelected()) mode += Font.ITALIC;
    label.setFont(new Font("Serif", mode, FONTSIZE));
}
```

CheckBoxes

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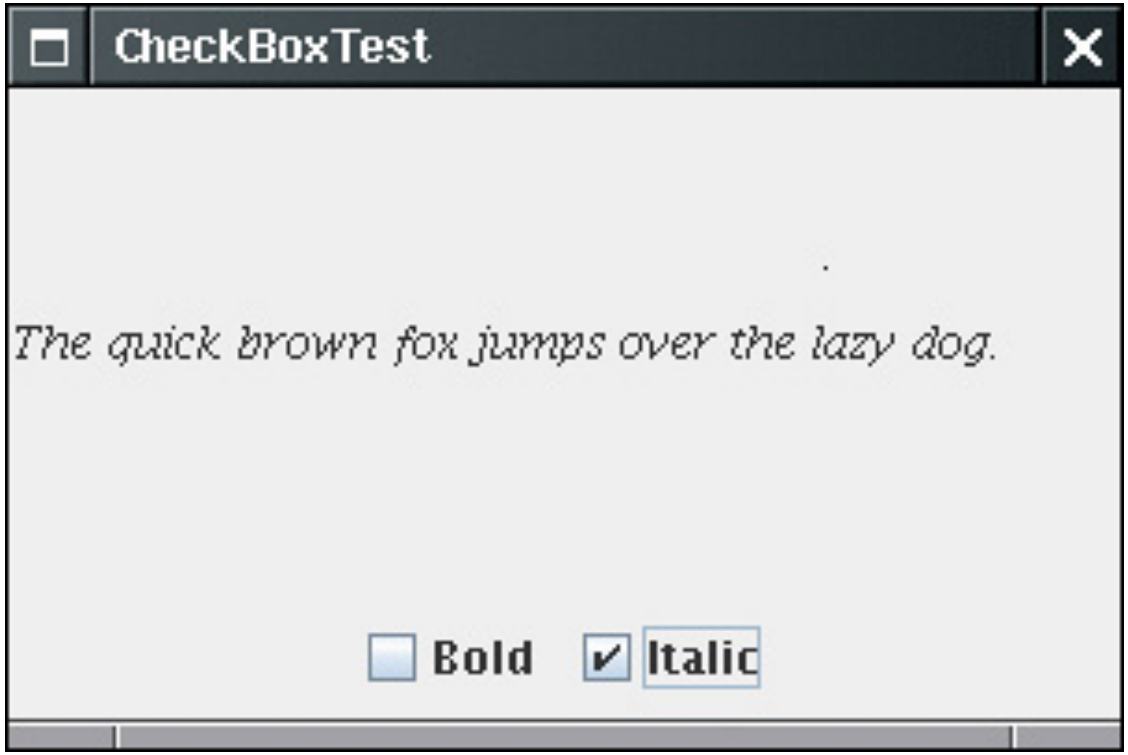
Choice Components - Checkboxes

- Example



Radio Buttons

Choice Components – Radio Buttons

- Used when user must select only one of several options
- Construct one object of type **ButtonGroup** for every group of buttons

```
ButtonGroup group = new ButtonGroup();
JRadioButton smallButton = new JRadioButton("Small", false);
group.add(smallButton);
JRadioButton mediumButton = new JRadioButton("Medium", true);
group.add(mediumButton);
. . .
```

Event Notification

```
ActionListener listener = new   ActionListener()   {
      public void actionPerformed(ActionEvent event)  {
            // size refers to the final parameter of the addRadioButton method
            label.setFont(new Font("Serif", Font.PLAIN, size));
      }
};
```

Basic Swings UI Components

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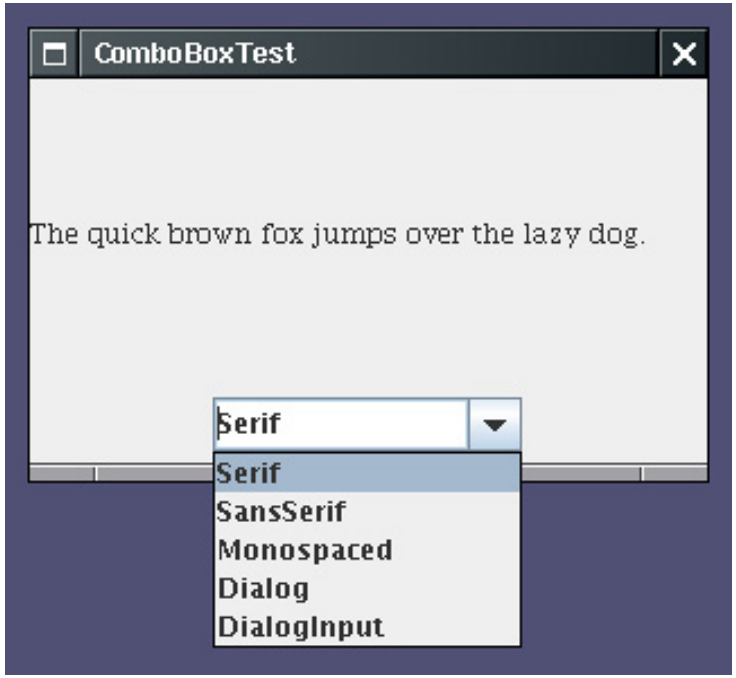
Choice Components – Radio Buttons

- Example

Combo Boxes

Choice Components – Combo Boxes

- Used to minimize the amount of space required for choice components
- When user clicks the combo box, a list of choices drops down



- The user can select one option

Combo Boxes

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Choice Components – Combo Boxes (A generic class as of Java SE 7

- Creating a Combo Box

```
JComboBox<String>  faceCombo = new JComboBox<String>();
faceCombo.setEditable(true);
faceCombo.addItem("Serif");
faceCombo.addItem("SansSerif");. . .
```

Reading Current Selection

- Use the *getSelectedItem* method

To remove items from Combo Box

- Use *removeItem()*, *removeItemsAt()*, *removeAllItems()*

Combo Boxes

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You can also insert items at specific positions

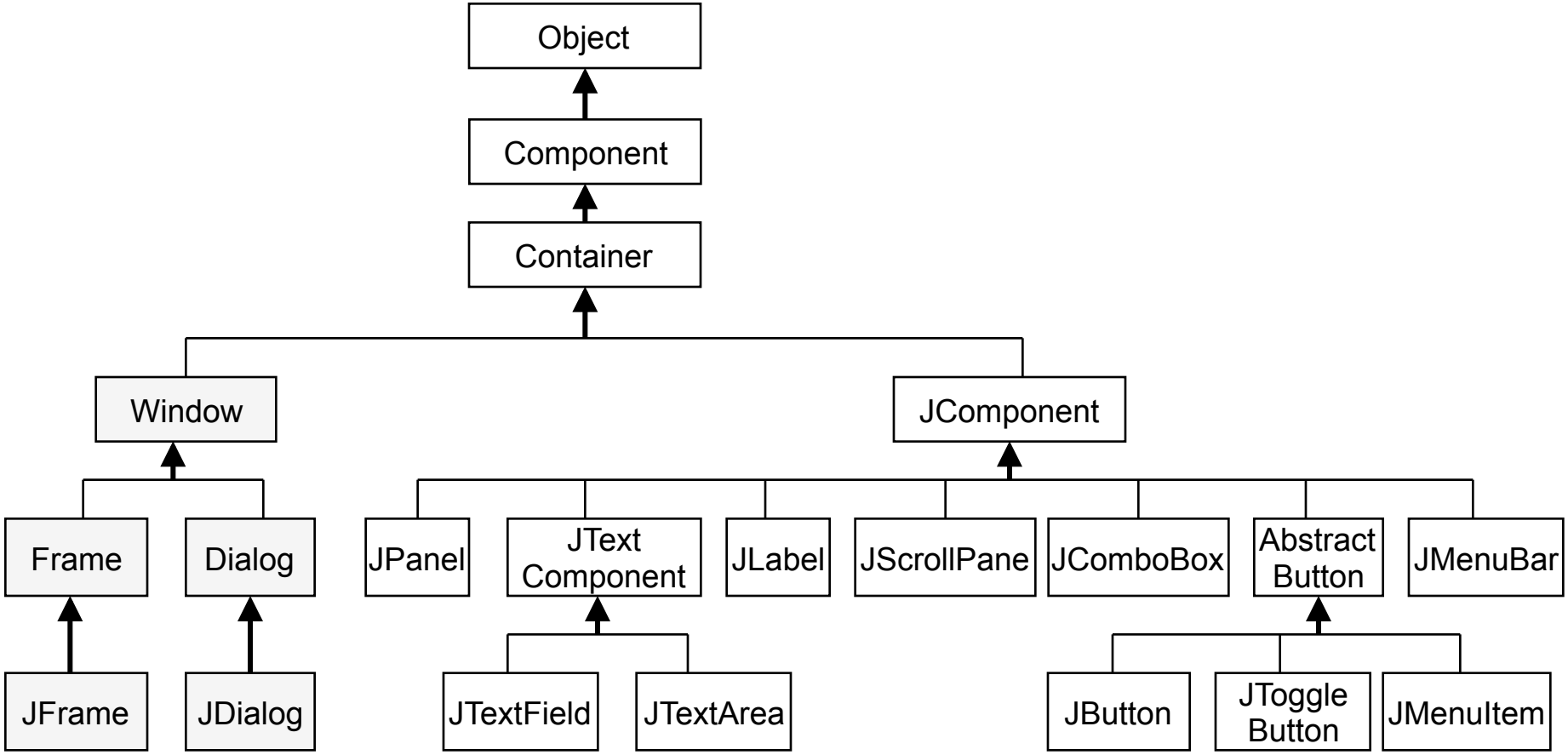
- Example

```
faceCombo.insertItemAt("Monospaced", 0); // add at the beginning
```

Layout Managers Overview

Basic Principles

- Inheritance hierarchy for the **Component** class



Reading Assignment

Horstmann & Cornell (2013) Core Java 2 Volume I, Chapter 9. 9th ed. User Interface Components with Swing by

Deitel, P., Deitel, H., Mukherjee, S. & Bhattacharjee, A. K. (2011) Java™: How to Program, Chapter 14. 9th Edition. Pearson Higher Education.