Chapter 12:
A First Look at GUI Applications

Starting Out with Java:
From Control Structures through Objects

Fifth Edition

by Tony Gaddis

PEARSON ALWAYS LEARNING

Chapter Topics

Chapter 12 discusses the following main topics:

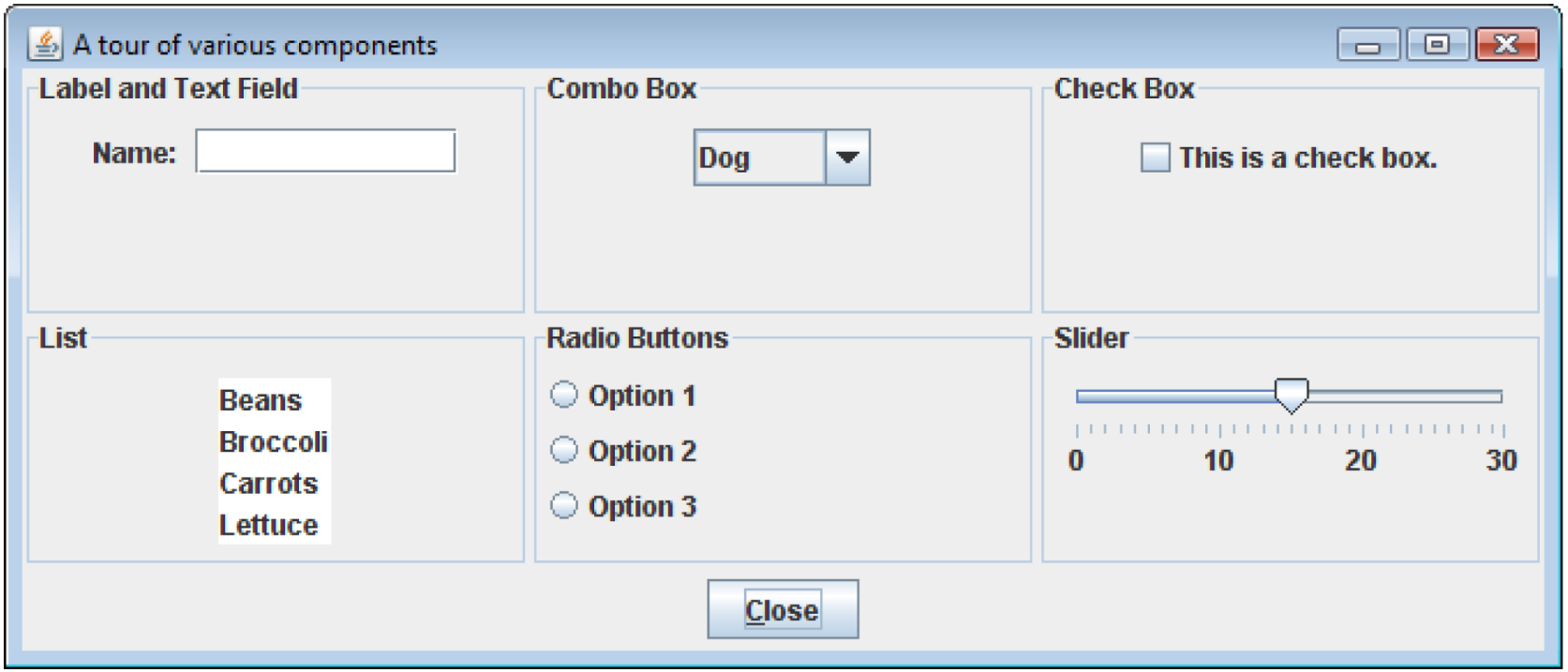
- Introduction
- Creating Windows
- Equipping GUI Classes with a main method
- Layout Managers
- Radio Buttons and Check Boxes
- Borders
- Focus on Problem Solving: Extending Classes from `JPanel`

Introduction

- Many Java application use a *graphical user interface* or *GUI* (pronounced “gooey”).
- A GUI is a graphical window or windows that provide interaction with the user.
- GUI’s accept input from:
  - the keyboard
  - a mouse.
- A window in a GUI consists of *components* that:
  - present data to the user
  - allow interaction with the application.

Introduction

- Some common GUI components are:
  - buttons, labels, text fields, check boxes, radio buttons, combo boxes, and sliders.



JFC, AWT, Swing

- Java programmers use the *Java Foundation Classes (JFC)* to create GUI applications.
- The JFC consists of several sets of classes, many of which are beyond the scope of this book.
- The two sets of JFC classes that we focus on are AWT and Swing classes.
- Java is equipped with a set of classes for drawing graphics and creating graphical user interfaces.
- These classes are part of the *Abstract Windowing Toolkit (AWT)*.

JFC, AWT, Swing

- The AWT allows creation of applications and applets with GUI components.
- The AWT does not actually draw user interface components on the screen.
- The AWT communicates with a layer of software, *peer classes*.
- Each version of Java for a particular operating system has its own set of peer classes.

JFC, AWT, Swing

- Java programs using the AWT:
  - look consistent with other applications on the same system.
  - can offer only components that are common to all the operating systems that support Java.
- The behavior of components across various operating systems can differ.
- Programmers cannot easily extend the AWT components.
- AWT components are commonly called *heavyweight components*.

JFC, AWT, Swing

- Swing was introduced with the release of Java 2.
- *Swing* is a library of classes that provide an improved alternative for creating GUI applications and applets.
- Very few Swing classes rely on peer classes, so they are referred to called *lightweight components.*
- Swing draws most of its own components.
- Swing components have a consistent look and predictable behavior on any operating system.
- Swing components can be easily extended.

Event Driven Programming

- Programs that operate in a GUI environment must be *event-driven*.
- An *event* is an action that takes place within a program, such as the clicking of a button.
- Part of writing a GUI application is creating event listeners.
- An *event listener* is an object that automatically executes one of its methods when a specific event occurs.

`javax.swing` and `java.awt`

- In an application that uses Swing classes, it is necessary to use the following statement:

```
import javax.swing.*;
```

  - Note the letter `x` that appears after the word `java`.
- Some of the AWT classes are used to determine when events, such as the clicking of a mouse, take place in applications.
- In an application that uses an AWT class, it is necessary to use the following statement.

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

  Note that there is no `x` after `java` in this package name.

Creating Windows

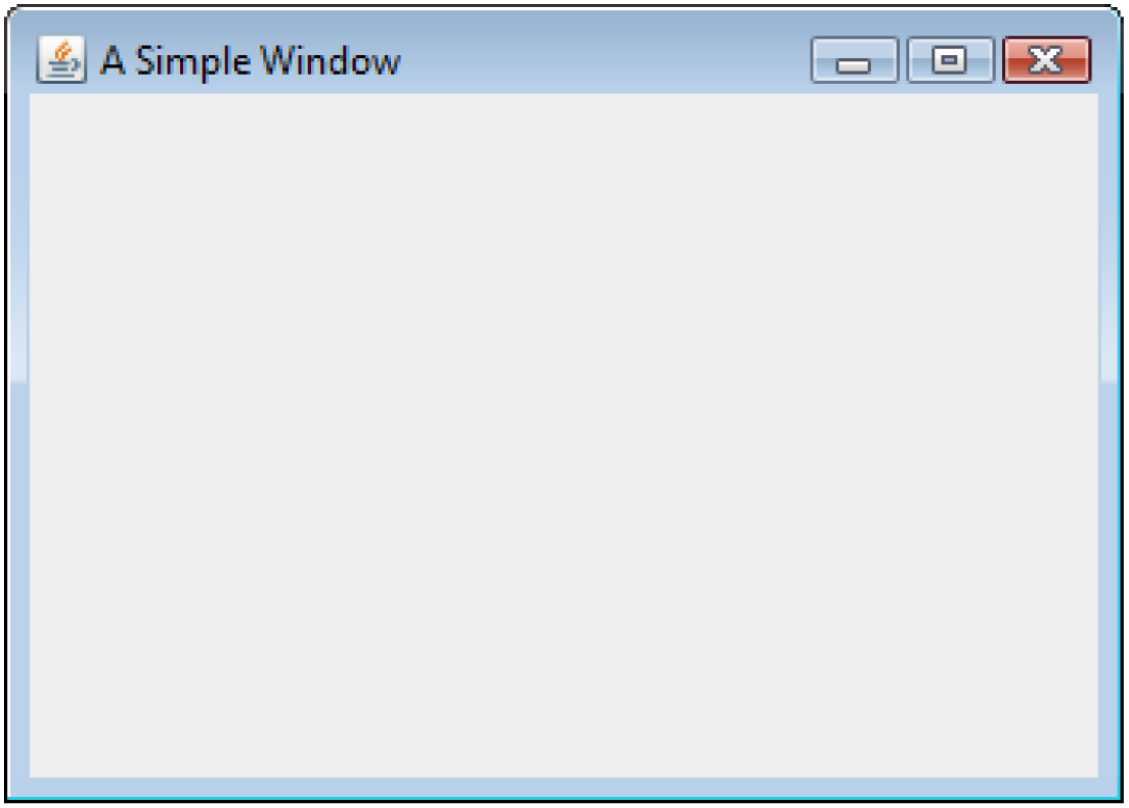
- Often, applications need one or more windows with various components.
- A window is a *container*, which is simply a component that holds other components.
- A container that can be displayed as a window is a *frame*.
- In a Swing application, you create a frame from the `JFrame` class.

Creating Windows

- A frame is a basic window that has:
  - a border around it,
  - a title bar, and
  - a set of buttons for:
    - minimizing,
    - maximizing, and
    - closing the window.
- These standard features are sometimes referred to as window *decorations*.

Creating Windows

- See example: ShowWindow.java



Creating Windows

- The following `import` statement is needed to use the swing components:

```
import javax.swing.*;
```

- In the `main` method, two constants are declared:

```
final int WINDOW_WIDTH = 350;
final int WINDOW_HEIGHT = 250;
```

- We use these constants later in the program to set the size of the window.
- The window's size is measured in pixels.
- A *pixel (picture element)* is one of the small dots that make up a screen display.

Creating Windows

- An instance of the `JFrame` class needs to be created:

```
JFrame window = new JFrame();
```

- This statement:
  - creates a `JFrame` object in memory and
  - assigns its address to the window variable.

- The string that is passed to the `setTitle` method will appear in the window's title bar when it is displayed.

```
window.setTitle("A Simple Window");
```

- A `JFrame` is initially invisible.

Creating Windows

- To set the size of the window:

```
window.setSize(WINDOW_WIDTH, WINDOW_HEIGHT);
```

- To specify the action to take place when the user clicks on the close button.

```
window.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
```

- The `setDefaultCloseOperation` method takes an `int` argument which specifies the action.
  - `JFrame.HIDE_ON_CLOSE` - causes the window to be hidden from view, but the application does not end.
  - The default action is `JFrame.HIDE_ON_CLOSE`.

Creating Windows

- The following code displays the window:

```
window.setVisible(true);
```

- The `setVisible` method takes a `boolean` argument.
  - `true` - display the window.
  - `false` - hide the window.

Extending `JFrame`

- We usually use inheritance to create a new class that extends the `JFrame` class.
- When a new class extends an existing class, it inherits many of the existing class's members just as if they were part of the new class.
- These members act just as if they were written into the new class declaration.
- New fields and methods can be declared in the new class declaration.
- This allows specialized methods and fields to be added to your window.
- Examples: SimpleWindow.java, SimpleWindowDemo.java

Equipping GUI Classes with a `main` Method

- Java applications always starts execution with a method named `main`.
- The previous example used two separate files:
  - `SimpleWindow.java` -- the class that defines the GUI window
  - `SimpleWindowDemo.java` – containins the `main` method that creates an instance of the `SimpleWindow` class.
- Applications can also be written with the `main` method directly written into the GUI class.
- See example: EmbeddedMain.java

Adding Components

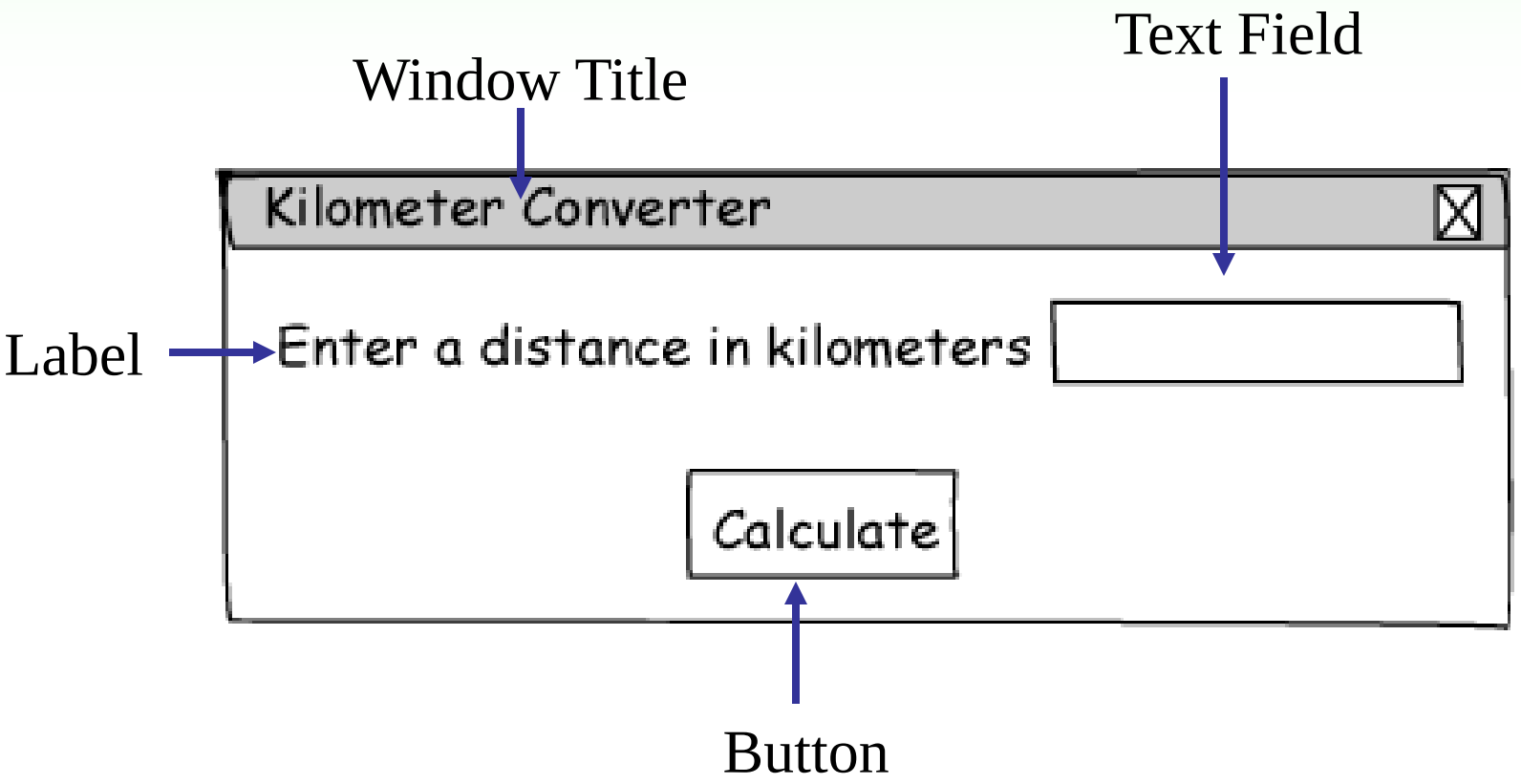
- Swing provides numerous components that can be added to a window.
- Three fundamental components are:

`JLabel` : An area that can display text.

`JTextField` : An area in which the user may type a single line of input from the keyboard.

`JButton` : A button that can cause an action to occur when it is clicked.

Sketch of Kilometer Converter Graphical User Interface



Adding Components

```
private JLabel message;
private JTextField kilometers;
private JButton calcButton;
…
message = new JLabel(
          "Enter a distance in kilometers");
kilometers = new JTextField(10);
calcButton = new JButton("Calculate");
```

- This code declares and instantiates three Swing components.

Adding Components

- A *content pane* is a container that is part of every `JFrame` object.
- Every component added to a `JFrame` must be added to its content pane. You do this with the `JFrame` class's `add` method.
- The content pane is not visible and it does not have a border.
- A *panel* is also a container that can hold GUI components.

Adding Components

- Panels cannot be displayed by themselves.
- Panels are commonly used to hold and organize collections of related components.
- Create panels with the `JPanel` class.

```
private JPanel panel;
…
panel = new JPanel();
panel.add(message);
panel.add(kilometers);
panel.add(calcButton);
```

Adding Components

- Components are typically placed on a panel and then the panel is added to the `JFrame`'s content pane.

```
add(panel);
```

- Examples: KiloConverter.java

Handling Action Events

- An *event* is an action that takes place within a program, such as the clicking of a button.
- When an event takes place, the component that is responsible for the event creates an *event object* in memory.
- The event object contains information about the event.
- The component that generated the event object is know as the *event source*.
- It is possible that the source component is connected to one or more event listeners.

Handling Action Events

- An *event listener* is an object that responds to events.
- The source component *fires* an event which is passed to a method in the event listener.
- Event listener classes are specific to each application.
- Event listener classes are commonly written as private inner classes in an application.

Writing Event Listener Classes as Private Inner Classes

A class that is defined inside of another class is known as an inner class

```
public class Outer
{
   Fields and methods of the Outer class appear here.

   private class Inner
   {
        Fields and methods of the Inner class appear here.
   }
}
```

Event Listeners Must Implement an Interface

- All event listener classes must *implement an interface*.
- An interface is something like a class containing one or more method headers.
- When you write a class that implements an interface, you are agreeing that the class will have all of the methods that are specified in the interface.

Handling Action Events

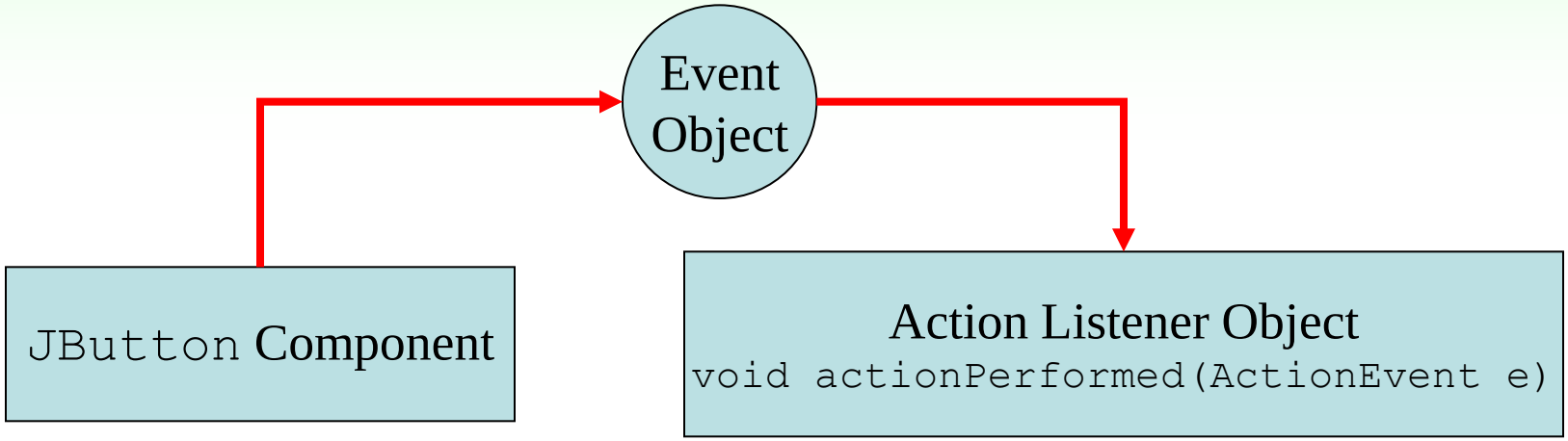
- `JButton` components generate *action events*, which require an *action listener* class.

- Action listener classes must meet the following requirements:
  - It must implement the `ActionListener` interface.
  - It must have a method named `actionPerformed`.

- The `actionPerformed` method takes an argument of the `ActionEvent` type.

```
public void actionPerformed(ActionEvent e)
{
   Code to be executed when button is pressed goes here .
}
```

Handling Action Events



When the button is pressed …

The `JButton` component generates an event object and passes it to the action listener object's `actionPerformed` method.

Example:

KiloConverter.java

Registering A Listener

- The process of connecting an event listener object to a component is called *registering* the event listener.
- `JButton` components have a method named `addActionListener`.

```
calcButton.addActionListener(
                new CalcButtonListener());
```

- When the user clicks on the source button, the action listener object's `actionPerformed` method will be executed.

Background and Foreground Colors

- Many of the Swing component classes have methods named `setBackground` and `setForeground`.
- `setBackground` is used to change the color of the component itself.
- `setForeground` is used to change the color of the text displayed on the component.
- Each method takes a color constant as an argument.

Color Constants

- There are predefined constants that you can use for colors.

```
Color.BLACK                Color.BLUE
Color.CYAN                 Color.DARK_GRAY
Color.GRAY                 Color.GREEN
Color.LIGHT_GRAY           Color.MAGENTA
Color.ORANGE               Color.PINK
Color.RED                  Color.WHITE
Color.YELLOW
```

- Examples: ColorWindow.java

The `ActionEvent` Object

- Event objects contain certain information about the event.
- This information can be obtained by calling one of the event object's methods.
- Two of these methods are:
  - `getSource` - returns a reference to the object that generated this event.
  - `getActionCommand` - returns the action command for this event as a `String`.
- Example:
  - EventObject.java

Layout Managers

- An important part of designing a GUI application is determining the layout of the components.
- The term *layout* refers to the positioning and sizing of components.
- In Java, you do not normally specify the exact location of a component within a window.
- A *layout manager* is an object that:
  - controls the positions and sizes of components, and
  - makes adjustments when necessary.

Layout Managers

- The layout manager object and the container work together.
- Java provides several layout managers:
  - `FlowLayout` - Arranges components in rows. This is the default for panels.
  - `BorderLayout` - Arranges components in five regions:
    - North, South, East, West, and Center.
    - This is the default layout manager for a `JFrame` object's content pane.
  - `GridLayout` - Arranges components in a grid with rows and columns.

Layout Managers

- The `Container` class is one of the base classes that many components are derived from.
- Any component that is derived from the `Container` class can have a layout manager added to it.
- You add a layout manager to a container by calling the `setLayout` method.

```
JPanel panel = new JPanel();
panel.setLayout(new BorderLayout());
```

- In a `JFrame` constructor you might use:
  `setLayout(new FlowLayout());`

`FlowLayout` Manager

- `FlowLayout` is the default layout manager for `JPanel` objects.
- Components appear horizontally, from left to right, in the order that they were added. When there is no more room in a row, the next components "flow" to the next row.
- See example: FlowWindow.java

`FlowLayout` Manager

- The `FlowLayout` manager allows you to align components:
  - in the center of each row
  - along the left or right edges of each row.
- An overloaded constructor allows you to pass:
  - `FlowLayout.CENTER,`
  - `FlowLayout.LEFT, or`
  - `FlowLayout.RIGHT.`
- Example:

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

`FlowLayout` Manager

- `FlowLayout` inserts a gap of five pixels between components, horizontally and vertically.
- An overloaded `FlowLayout` constructor allows these to be adjusted.
- The constructor has the following format:

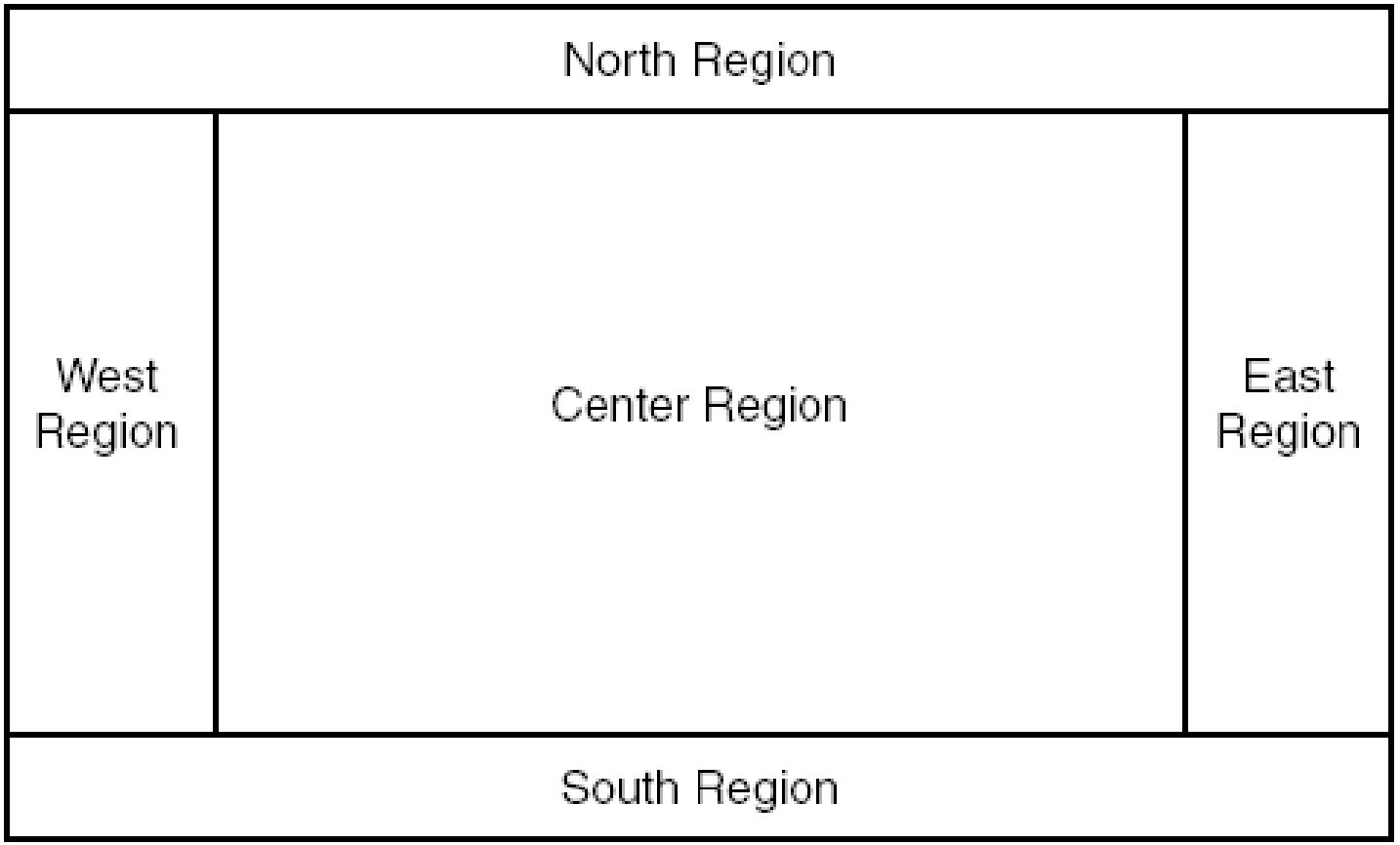
```
FlowLayout(int alignment,
           int horizontalGap,
           int verticalGap)
```

- Example:

```
setLayout(new FlowLayout(FlowLayout.LEFT, 10, 7));
```

`BorderLayout` Manager

`BorderLayout` manages five regions where components can be placed.



`BorderLayout` Manager

- See example: BorderWindow.java
- A component placed into a container that is managed by a `BorderLayout` must be placed into one of five regions:
  - `BorderLayout.NORTH`
  - `BorderLayout.SOUTH`
  - `BorderLayout.EAST`
  - `BorderLayout.WEST`
  - `BorderLayout.CENTER`

`BorderLayout` Manager

- Each region can hold only one component at a time.
- When a component is added to a region, it is stretched so it fills up the entire region.
- `BorderLayout` is the default manager for `JFrame` objects.

```
add(button, BorderLayout.NORTH);
```

- If you do not pass a second argument to the add method, the component will be added to the center region.

`BorderLayout` Manager

- Normally the size of a button is just large enough to accommodate the text that it displays
- The buttons displayed in `BorderLayout` region will not retain their normal size.
- The components are stretched to fill all of the space in their regions.

`BorderLayout` Manager

- If the user resizes the window, the sizes of the components will be changed as well.
- `BorderLayout` manager resizes components:
  - placed in the north or south regions may be resized horizontally so it fills up the entire region,
  - placed in the east or west regions may be resized vertically so it fills up the entire region.
  - A component that is placed in the center region may be resized both horizontally and vertically so it fills up the entire region.

`BorderLayout` Manager

- By default there is no gap between the regions.
- An overloaded `BorderLayout` constructor allows horizontal and vertical gaps to be specified (in pixels).
- The constructor has the following format

```
BorderLayout(int horizontalGap, int verticalGap)
```

- Example:

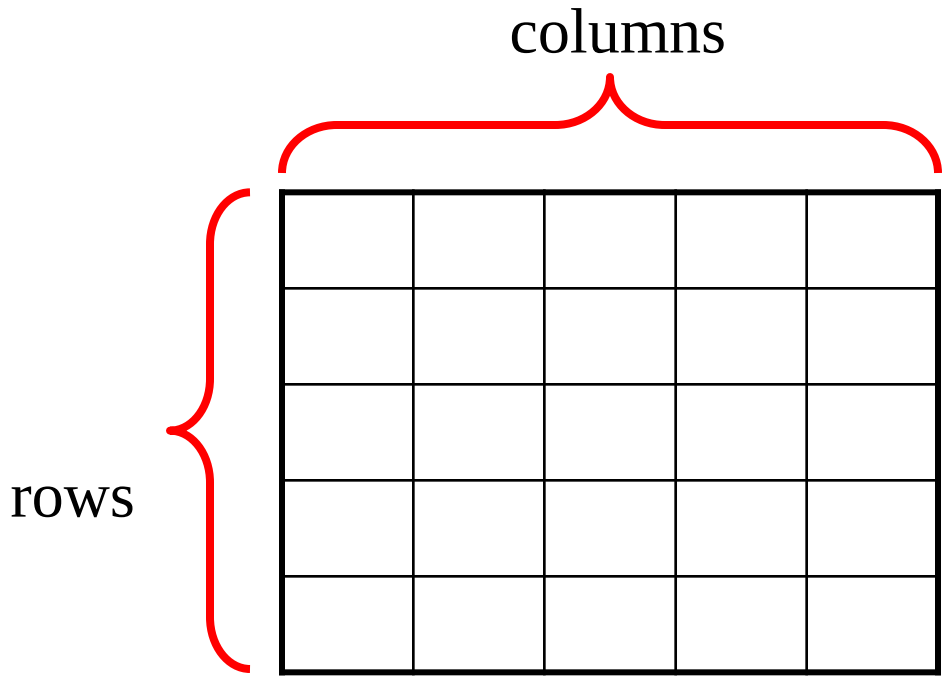
```
setLayout(new BorderLayout(5,10));
```

Nesting Components in a Layout

- Adding components to panels and then nesting the panels inside the regions can overcome the single component limitation of layout regions.
- By adding buttons to a `JPanel` and then adding the `JPanel` object to a region, sophisticated layouts can be achieved.
- See example:BorderPanelWindow.java

`GridLayout` Manager

`GridLayout` creates a grid with rows and columns, much like a spreadsheet. A container that is managed by a `GridLayout` object is divided into equally sized cells.



`GridLayout` Manager

- `GridLayout` manager follows some simple rules:
  - Each cell can hold only one component.
  - All of the cells are the size of the largest component placed within the layout.
  - A component that is placed in a cell is automatically resized to fill up any extra space.
- You pass the number of rows and columns as arguments to the `GridLayout` constructor.

`GridLayout` Manager

- The general format of the constructor:

  `GridLayout(int` *`rows, int columns)`*

- Example

  `setLayout(new GridLayout(2, 3));`

- A zero (0) can be passed for one of the arguments but not both.
  - passing 0 for both arguments will cause an `IllegalArgumentException` to be thrown.

`GridLayout` Manager

- Components are added to a `GridLayout` in the following order (for a 5×5 grid):

1	2	3	4	5
6	7	8	9	10
11	12	13	14	15
16	17	18	19	20
21	22	23	24	25

Example:
GridWindow.java

`GridLayout` also accepts nested components:
Example:
GridPanelWindow.java

Radio Buttons

- *Radio buttons* allow the user to select one choice from several possible options.
- The `JRadioButton` class is used to create radio buttons.
- `JRadioButton` constructors:
  - `JRadioButton(String text)`
  - `JRadioButton(String text, boolean selected)`

Button appears already selected when true

- Example:

```
JRadioButton radio1 = new JRadioButton("Choice 1");
```

or

```
JRadioButton radio1 = new JRadioButton(
                                  "Choice 1", true);
```

Button Groups

- Radio buttons normally are grouped together.
- In a radio button group only one of the radio buttons in the group may be selected at any time.
- Clicking on a radio button selects it and automatically deselects any other radio button in the same group.
- An instance of the `ButtonGroup` class is a used to group radio buttons

Button Groups

- The `ButtonGroup` object creates the *mutually exclusive* relationship between the radio buttons that it contains.

```
JRadioButton radio1 = new JRadioButton("Choice 1",
                                       true);
JRadioButton radio2 = new JRadioButton("Choice 2");
JRadioButton radio3 = new JRadioButton("Choice 3");
ButtonGroup group = new ButtonGroup();
group.add(radio1);
group.add(radio2);
group.add(radio3);
```

Button Groups

- `ButtonGroup` objects are not containers like `JPanel` objects, or content frames.
- If you wish to add the radio buttons to a panel or a content frame, you must add them individually.

```
panel.add(radio1);
panel.add(radio2);
panel.add(radio3);
```

Radio Button Events

- `JRadioButton` objects generate an action event when they are clicked.
- To respond to an action event, you must write an action listener class, just like a `JButton` event handler.
- See example: MetricConverter.java

Determining Selected Radio Buttons

- The `JRadioButton` class's `isSelected` method returns a `boolean` value indicating if the radio button is selected.

```
if (radio.isSelected())
{
   // Code here executes if the radio
   // button is selected.
}
```

Selecting a Radio Button in Code

- It is also possible to select a radio button in code with the `JRadioButton` class's `doClick` method.
- When the method is called, the radio button is selected just as if the user had clicked on it.
- As a result, an action event is generated.

```
radio.doClick();
```

Check Boxes

- A *check box* appears as a small box with a label appearing next to it.
- Like radio buttons, check boxes may be selected or deselected at run time.
- When a check box is selected, a small check mark appears inside the box.
- Check boxes are often displayed in groups but they are not usually grouped in a `ButtonGroup`.

Check Boxes

- The user is allowed to select any or all of the check boxes that are displayed in a group.
- The `JCheckBox` class is used to create check boxes.
- Two `JCheckBox` constructors:

```
JCheckBox(String text)
JCheckBox(String text, boolean selected)
```

Check appears in box if true

- Example:

```
JCheckBox check1 = new JCheckBox("Macaroni");
```

or

```
JCheckBox check1 = new JCheckBox("Macaroni",
                                 true);
```

Check Box Events

- When a `JCheckBox` object is selected or deselected, it generates an *item event*.
- Handling item events is similar to handling action events.
- Write an *item listener* class, which must meet the following requirements:
  - It must implement the `ItemListener` interface.
  - It must have a method named `itemStateChanged`.
    - This method must take an argument of the `ItemEvent` type.

Check Box Events

- Create an object of the class
- Register the item listener object with the `JCheckBox` component.
- On an event, the `itemStateChanged` method of the item listener object is automatically run
  - The event object is passed in as an argument.

Determining Selected Check Boxes

- The `isSelected` method will determine whether a `JCheckBox` component is selected.
- The method returns a `boolean` value.

```
if (checkBox.isSelected())
{
   // Code here executes if the check
   // box is selected.
}
```

- See example: ColorCheckBoxWindow.java

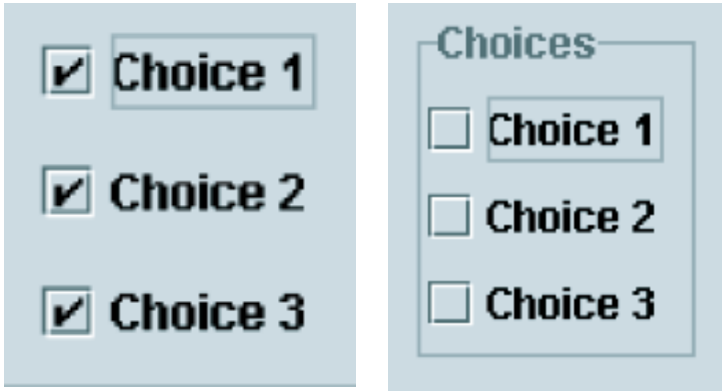
Selecting Check Boxes in Code

- It is possible to select check boxes in code with the `JCheckBox` class's `doClick` method.
- When the method is called, the check box is selected just as if the user had clicked on it.
- As a result, an item event is generated.

```
checkBox.doClick();
```

Borders

- Windows have a more organized look if related components are grouped inside borders.



- You can add a border to any component that is derived from the `JComponent` class.
  - Any component derived from `JComponent` inherits a method named `setBorder`

Borders

- The `setBorder` method is used to add a border to the component.
- The `setBorder` method accepts a `Border` object as its argument.
- A `Border` object contains detailed information describing the appearance of a border.
- The `BorderFactory` class, which is part of the `javax.swing` package, has static methods that return various types of borders.

Border	`BorderFactory` Method	Description
Compound border	`createCompoundBorder`	A border that has two parts: an inside edge and an outside edge. The inside and outside edges can be any of the other borders.
Empty border	`createEmptyBorder`	A border that contains only empty space.
Etched border	`createEtchedBorder`	A border with a 3D appearance that looks "etched" into the background.
Line border	`createLineBorder`	A border that appears as a line.
Lowered bevel border	`createLoweredBevelBorder`	A border that looks like beveled edges. It has a 3D appearance that gives the illusion of being sunken into the surrounding background.
Matte border	`createMatteBorder`	A line border that can have edges of different thicknesses.
Raised bevel border	`createRaisedBevelBorder`	A border that looks like beveled edges. It has a 3D appearance that gives the illusion of being raised above the surrounding background.
Titled border	`createTitledBorder`	An etched border with a title.

The Brandi's Bagel House Application

- A complex application that uses numeroous components can be constructed from several specialized panel components, each containing other components and related code such as event listeners.
- Examples:

  GreetingPanel.java, BagelPanel.java, ToppingPanel.java, CoffeePanel.java, OrderCalculatorGUI.java

Splash Screens

- A splash screen is a graphic image that is displayed while an application loads into memory and starts up.
- A splash screen keeps the user's attention while a large application loads and executes.
- Beginning with Java 6, you can display splash screens with your Java applications.

Splash Screens

- To display the splash screen you use the `java` command in the following way when you run the application:

```
java -splash:GraphicFileName ClassFileName
```

- *GraphicFileName* is the name of the file that contains the graphic image, and *ClassFileName* is the name of the *.class* fi le that you are running.
- The graphic file can be in the GIF, PNG, or JPEG formats.

Using Console Output to Debug a GUI

- Display variable values, etc. as your application executes to identify logic errors
  - Use `System.out.println()`

```
// For debugging, display the text entered, and
// its value converted to a double.
 System.out.println("Reading " + str +
    " from the text field.");
 System.out.println("Converted value: " +
     Double.parseDouble(str));
```

- See example: KiloConverter.java