CSE 331 Software Design and Implementation

Section 9 ***Java Swing***

Contents:

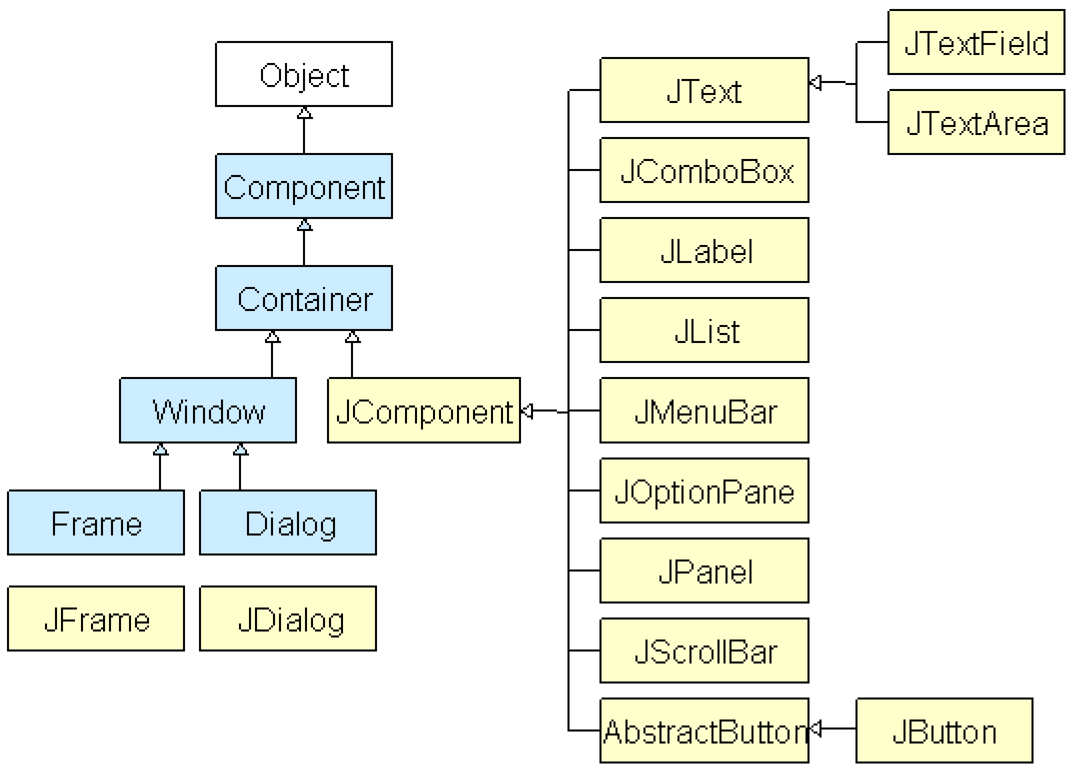
Introduction

`Swing` is a platform independent graphical toolset for Java applications. It contains a set of customizable components for building user interfaces, like buttons and text fields, as well as an API for creating 2D graphics. Applications built in Swing look roughly the same on all platforms.

Creating a Graphical User Interface (GUI) involves significant design. For this section, we will focus on the design and implementation of layouts, event handling and drawing. First, we'll go over how to make basic components, like a windows and text labels and then we'll show you how to put together a simple GUI application that checks the weather for a City.

Swing Hierarchy

The Swing library is built on top of the Java Abstract Widget Toolkit (AWT), an older, platform dependent GUI toolkit. All components in Swing are `JComponent`s, which can be added to windows like `JFrame`s or `JDialog`s.



Most of Swing's classes are AWT `Container`s -- technically, you can `add` any component to any other component. In practice, however, many components have this inheritance as a vestigial property, and don't actually expect to have anything added to them. User interfaces can be created by adding components to a window's *pane*, or to a nested series of *panels* which then get added to the pane.

Each component arranges its children based on a *layout manager*. We'll talk more about these later.

You will often need to import both `Swing` and `awt` classes in your code. You can import all of them if you wish, using:

```
import javax.swing.*;
import java.awt.*;
```

Please be warned however that this section provides only a very brief introduction and overview of Swing. We provide you with some sample code and appendix of commonly used Swing classes. To learn more about Swing, you should check out Oracle's Swing Tutorial.

Building a Weather Report Application

In this section, you will get some hands-on experience with Swing by putting the finishing touches on a simple GUI application that reports the weather for a chosen city.

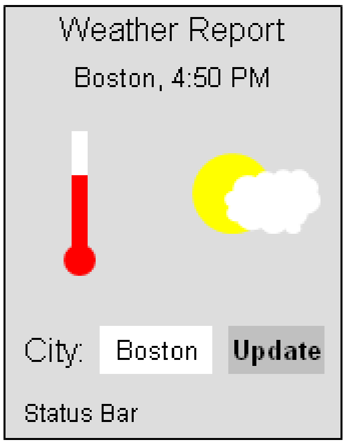
Designing using Layout Managers

The first step in GUI creation is design. After you've drawn a picture of what you want your user interface to look like, you'll need to figure out how to layout its components using the Swing `LayoutManager`s.

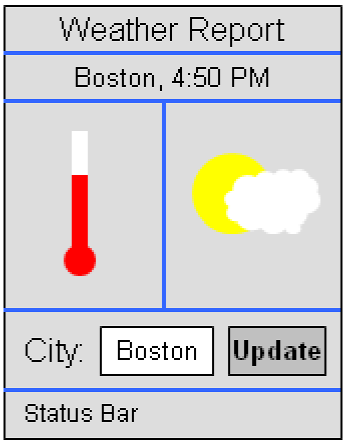
You should begin by dividing the application into regions. Recursively divide the rest of the regions until you have either a single component, or a simple panel of components.

In this section, we'll use `BoxLayout` and `GridLayout`. There are other useful layouts such as `BorderLayout`, `FlowLayout` and `GridBagLayout`, and you can find out how to use them in Oracle's Tutorial on Layout Managers. Oracle also has a Visual Guide to Layout Managers that can be very helpful when selecting layouts.

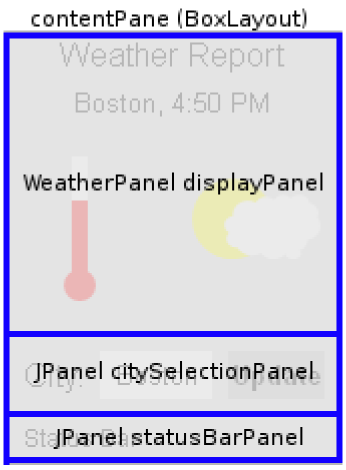
Drawing the GUI. Make a simple sketch of how we would like the GUI to appear.



First, divide the drawing into regions. Decide on which layout managers to use. `BoxLayout` and `GridLayout` will work.

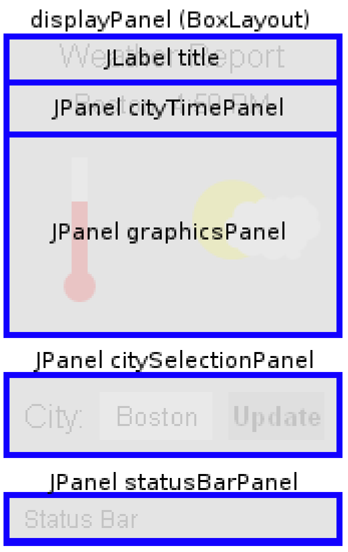


The contentPane is the area of the `JFrame` one can modify. Access it using the `getContentPane()` method of a `JFrame` object. `BoxLayout` lets you stack one component on top of another (or arrange them side by side, in rows). Here, three boxes have been created and stacked vertically. The top box will be a `WeatherPanel` which is a subclass of `JPanel` that has been defined. Below it, two more `JPanel`s will be stacked. Each `JPanel` will have its own layout, which will be described next.



The *displayPanel* has been divided into to three regions. The top part contains a JLabel and underneath it is JPanel that contains information about the city and local time. Below that is a JPanel, which is called graphicsPanel, will use a FlowLayout to arrange the Therometer and WeatherIcon side by side in a row. Therometer and WeatherIcon extend JComponent.

The other two JPanels that we subdivided in the first step will also have FlowLayout.



Events

Now you can put all sorts of widgets in a window. That's very nice, but how do you make them do anything? Swing uses the observer design pattern to handle input and do the appropriate thing. In Swing, many observer objects are called Listeners.

When a JComboBox's selection changes or a JButton is clicked, the ActionListeners registered with it are triggered. We've written an ActionListener for changing the city when the Update button is pushed. Take a look at UpdateActionListener (an inner class in WeatherReportGUI), and understand what it does.

Whenever a button is pressed, JButton calls the actionPerformed method on all ActionListeners registered with the button. The updating functionality of the WeatherPanel has been registered the with the update button, so it will do what we want.

Other types of listeners can be registered. Look for methods of the form addFooListener if you want to deal with the user doing foo to your object. Examples are addSelectionListener, addMouseListener, addKeyboardListener, and more. Some of these types of listeners are more complicated to write than others; look in the API for details.

Drawing Graphics and Images

Drawing Graphics

A good technique for drawing on the screen is extending JComponent (which is an empty component) and overriding the public void paintComponent(Graphics) method. This technique allows us to customize the graphics for a single component without having to customize the paint method for the entire container (e.g. JPanel or JFrame). In short, if you want to create a frame that at some point draws something like a circle or a thermometer, don't change your frame's paintComponent() method. It's better to extend JComponent, change its own paintComponent() method and add an instance of your class to the frame.

You should not, however, call the paintComponent() method yourself. In general, the Swing library takes care of figuring out when components should be painted. However, if a component needs to be redrawn at a particular time (say, if the component is notified of a model change and would like to update its appearance), you can use the `repaint()` method to let Swing know to schedule that component for redisplay.

That's exactly what we have done here. `Thermometer` and `WeatherIcon` extend `JComponent`, and their `paintComponent()` methods are overridden. The method takes a `Graphics` object as an argument, which is simply what we will be drawing on. Some of the methods for drawing simple graphics in Java, found in the `Graphics` class and are summarized here:

- `drawRect(int x, int y, int width, int height)` Draws an empty box with the top-left point at (x,y) and with width and height as defined in the arguments.
- `drawOval(int x, int y, int width, int height)` Draws an empty oval whose surrounding box is the one defined by the arguments.
- `fillRect(x,y,width,height)` Draws a filled rectangle.
- `fillOval(x,y,width,height)` Draws a filled oval.

There are also methods for drawing other shapes, such as `drawString`, `drawImage` and `drawPolygon`.

Drawing Images

Drawing images from files in Java is also fairly easy. First, we need to load the image from the file. One way to access external image files is to use the `ImageIO` API:

```
BufferedImage img = null;
try {
    img = ImageIO.read(new File("path/to/file.png"));
} catch (IOException e) {
    // TODO: You may wish to put a more robust error handling system here
    e.printStackTrace();
}
```

The Java Tutorial on drawing images has more information on manipulating image files.

ImageObserver

When loading an image, we might want to monitor the progress of the this process, which might be useful for example if we are downloading a picture from the web, or even from a local resource. The `ImageObserver` class is a `Swing` class that exists for this purpose, and it is used as an argument to many methods such as `Graphics.drawImage(...)`. For our purposes, you can pass `null` as an argument to methods that require an `ImageObserver`.

An Example

The starter code for this section, as well as a sample solution, can be found in this zip archive. The archive is an Eclipse workspace containing the projects WeatherReportStarter and WeatherReportSolution. You can either load this workspace into Eclipse, or import the individual projects into another workspace of your choosing.

Appendix: Common Swing classes

Survey of Useful Swing Classes

JFrame

Standalone windows are implemented as `JFrame`s in Swing. This code creates a `JFrame`:

```
JFrame myFrame = new JFrame("Title");
myFrame.setBounds(200,200,300,400); myFrame.setVisible(true);
```

You should not try to add anything directly to a `JFrame`. Instead, to make components appear in a `JFrame`, use `JFrame.getContentPane().add(yourComponent)`

JPanel

A `JPanel` is a simple, empty container meant to be used as a container for other components. Every JPanel has its own Layout, an object that describes how the components will be placed on it. Here is an example of how to create a JPanel whose Layout is initially a `FlowLayout` (by default), and then changes to a `BorderLayout`.

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

JLabel

A `JLabel` is used to create a single uneditable line of text. The user may not change this text. However, you can change it programatically with `JLabel.setText()`:

```
JLabel myLabel = new JLabel("This is a Label");
myPanel.add(myLabel);
```

JButton

A `JButton` is used to create a button:

```
JButton myButton = new JButton("Press me");
myPanel.add(myButton);
```

JTextField

A `JTextField` is used to create an area displaying a single line of editable text.

JTextArea

A `JTextArea` is used to create an area displaying some text. This area can be edit able by the user (`true` by default). Another useful property is the line wrapping, which is `false` by default.

```
JTextArea myArea = new JTextArea();
myArea.setEditable(false);
myArea.setLineWrap(true);
```

JScrollPane

A `JScrollPane` is a useful `JComponent` that allows us to surround an area (a `JTextArea` for example, or an image) with scroll bars. The constructor of `JScrollPane` takes the `JComponent` that we want to surround with the scroll bars, and two integers, that correspond to whether we want the vertical and horizontal scroll bars to be never, as needed or always visible.

```
JScrollPane myScrollPane = new JScrollPane(myArea,
    JScrollPane.VERTICAL_SCROLLBAR_ALWAYS,JScrollPane.HORIZONTAL_SCROLLBAR_NEVER);
myScrollPane.setPreferredSize(new Dimension(150, 200));
myPanel.add(myScrollPane);
```

`Timer`

A `Timer` is used to fire an `ActionEvent` after a specific delay. For information about `ActionEvent`s, see the Events section. Using a `Timer` we can implement, for example, an animation. In this example, the `Timer` is used to implement an automatic update of the weather every minute. This is the code used: (`UpdateListener` is an `ActionListener` we defined that will listen for `ActionEvent`s fired by `timer` and other `JComponent`s.

```
int delay = 1000*60; //1 minute
Timer timer = new Timer(delay, new UpdateListener());
timer.start();
```

WARNING: this section refers to `javax.swing.Timer`. `java.util.Timer` also exists, but is not designed for use with Swing user interfaces

Basic Swing Tips

- Most components have multiple constructors. You might omit the argument in the constructor of JFrame for example, and you might set the title later, using `myFrame.setTitle("Title")`
- The convention for the coordinate system in Java (and in most computer systems) is that the top-left of the screen is the origin. We measure in pixels, of course and the x-axis is horizontal from top-left going right. The y-axis starts from top-left going down vertically. For example, we use the `setBounds(int x, int y, int width, int height)` method to place the top-left corner of the window at the point (x,y) and its width and height to `width` and `height`
- The `setPreferredSize(Dimension d)` method can be used to set the preferred size of a `JComponent` to the `Dimension` we want. This will inform the relevant `LayoutManager`s to adjust their size accordingly.
- Unlike other Swing components, we have to specifically set a JFrame to visible.
- Closing the window (using the ``X'' button of the title bar for example) will hide the frame, but it will not terminate the program. `setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE)` will make the program terminate when the window is closed.
- For many reasons, one might want to extend JFrame or JPanel. One simple reason why this is good is that it abstracts away the details of the window's contents and implementation from the actual use of the window. Moreover, it's easy to create a similar, identical window if one wishes to.