Applets and GUIs

COMS W1007
Introduction to Computer Science

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19 June 2003
GUIs in Java

There are at least three separate methods for doing GUIs in Java:

- Abstract Window Toolkit (AWT) 1.0 (1995)
- AWT 1.1 (1997)
- Swing (1999)

Many people still use AWT 1.0 for maximum compatibility. We will use Swing, because that’s what’s in the book.
GUIs in Java: 2

The long evolution of Java’s GUI tools means we have to dig through a lot of packages to find what we need.

- **java.awt** - Swing is built on top of AWT. All of the top-level classes and many of the utility classes come from the AWT package.

- **java.awt.event** - the Java event model (more later) has been consistent since AWT 1.1.

- **javax.swing** - all of the Swing-specific classes are here, including all the actual GUI components.
GUI Components: A Taxonomy

The Java GUI toolkits provide the full assortment of GUI components that you find on every platform. Types of components include:

- Buttons, Check Boxes and Radio Buttons
- Combo/List Boxes
- Text Areas and Fields
- Scroll Bars
Buttons

Buttons are simple components with one basic capability: you can click on them. The Swing button classes are:

```
AbstractButton
  \-- JButton
  \-- JToggleButton
    \-- JCheckBox
    \-- JRadioButton
```

Toggle Buttons

A regular button has no state. It is just a portion of the screen you can click on.

A toggle button has a “checked” and “unchecked” state.

- A *check box* is a button you can check and uncheck.
- A *radio button* is part of a group of buttons, only one of which can be checked at the same time.
Combo Boxes

A combo box or list box is a drop-down list of items, only one of which may be selected.

The Swing combo box class is JComboBox.
Text Components

Text components are areas for entering and displaying text. The Swing text component classes are:

- `JTextComponent`
- `JTextArea`
- `JTextField`
- `JPasswordField`
Text Components: 2

- A *text field* allows the input of a single line of text.
- A *text area* allows the input of multiple lines of text.
- A *password field* is a text field that masks the input (usually with ‘*’).

Text components can be editable (the user can type in it) or non-editable (only the programmer can put text in it).
Scroll Bars

Scroll bars allow a component to contain more data than can be displayed on screen at once. The Swing class that handles scrolling is JScrollPane.

JScrollPane is a container: it is a component into which you place other components. The components inside the scroll pane handle their own behavior and data, and the scroll pane provides a viewport onto the components, which can be controlled using the scroll bars.
Panels

Another type of container is a panel. A panel doesn’t have any behavior of its own; it just provides a place to put other components. We often use panels when we layout control. The Swing panel class is `JPanel`.

The parent class of all GUI containers is `java.awt.Container`. `Container` has a method `add(Component c)` that adds a component to the container.
Layout Managers

The placement of components inside a container is controlled by the layout manager. The `java.awt` package has an interface `LayoutManager` which is implemented by:

- **FlowLayout** - components are placed from left to right and wrap when there’s no more room, like text in a paragraph.

- **GridLayout** - components are placed in a rigid $m \times n$ grid.
Layout Managers, cont’d

- **BorderLayout** - each component is specified as at the top, bottom, left, right or center of the container.

- **GridBagLayout** - the programmer specifies in great detail exactly where every component should go.

`GridBagLayout` is by far the most flexible, and the most complicated. If you want to know more about layout managers, read the book.

`Container` has a method `add(Component c, Object constraints)` that specifies constraints to the layout manager. The type of `constraints` is defined by the implementation of `LayoutManager`. 
Applets

An *applet* is a Java program that can run inside a web browser. To write a Swing applet, you create a class that extends `javax.swing.JApplet`. If your applet doesn’t use Swing (unlikely), you can extend `java.applet.Applet` instead. `Applet` is the parent of `JApplet`.

When you run a Java program from the command line, the JVM looks for a *main* method to execute. When you run an applet in a web browser, the JVM looks for methods inherited from `Applet: init, start, stop` and `destroy`. 
Applet Methods

- **init** - this method is called when the applet is loaded (i.e., brought into memory).
- **start** - this method is called when the applet starts. If a user leaves the applet’s web page and comes back, the applet will load once and start twice.
- **stop** - this method is called when the applet stops (e.g., when the user leaves the applet’s web page).
- **destroy** - this method is called when the applet is unloaded.
Applet Methods: 2

If the applet were a videotape, these events would correspond to:

- **init** - putting the tape in the VCR
- **start** - pressing play
- **stop** - pressing stop
- **destroy** - ejecting the tape
Applet Methods: 3

We don’t have to override all of these methods; in fact, we usually don’t.

`init` plays the same role as a constructor. If the applet has GUI components (and it usually does), we can create them and lay them out in `init`.

`start` and `stop` are useful if the applet has a real-time component (e.g., an animation).

We almost never override `destroy`. 
The Applet Container

Every applet has an associated GUI container.

- **JApplet** has a method `getContentPane()` that returns a `Container`. You can add components to this container.

  ```java
  Container c = getContentPane() ;
  c.add( new JButton("Click Here!") ) ;
  ```

- **Applet** is *itself* a `Container`—it extends `java.awt.Panel`. Components are added to the applet itself.

  ```java
  this.add( new JButton("OK") ) ;
  ```
The `<applet>` Tag

An applet is embedded in a web page using the HTML `<applet>` tag. The tag has attributes to define the applet class and the dimensions of the applet area on the page:

```html
<applet code="MyApplet.class" width=240 height=120></applet>
```

Text that appears between start and end tags will only be displayed if the web browser doesn’t support applets.

```html
<applet code="MyApplet.class" width=240 height=120>
    You browser is ignoring the `<applet>` tag. Consider upgrading, or just go away.
</applet>
```
Applet Parameters

You can specify “command-line” arguments to an applet by using the `<param>` tag inside the `<applet>` tag. You can read the parameters in the applet using the `getParameter` method of the `Applet` class.

```html
<applet code="MyApplet.class" width=240 height=120>
   <param name="file" value="input.txt" />
</applet>
```

```java
String in = getParameter("file") ;
/* in="input.txt" */
```
The AWT Event Model

User input in a GUI environment is handled \textit{asynchronously}. We call a user action an \textit{event}.

Objects (\textit{event listeners}) register their interest in a certain type of event (clicking, pressing a key, moving the mouse) with the object that may generate the event (buttons, text fields, containers).

When an event occurs, the generating object invokes a method (an \textit{event handler}) on each registered listener.
The `EventListener` Interface

Event listeners implement a subinterface of `java.util.EventListener`. Some common listener interfaces are:

- **MouseListener** - reacts to mouse button events (button down, button up and click (down+up) are separate events).

- **MouseMotionListener** - reacts to mouse movement and dragging (motion with a button pressed).

- **KeyListener** - reacts to keyboard events (key down, key up and key typed (down+up)).
- **TextListener** - reacts to a change in the value of a text component.

- **ItemListener** - reacts in a change to the state of a component (e.g., the selection in a combo box changes).

- **ActionListener** - reacts to an “action” on a component (e.g., clicking a button). What an action is depends on the component.

- **FocusListener** - reacts to a change in focus (i.e., which component is currently active).

- **WindowListener** - reacts to a change in the state of a window (e.g., an attempt to close it).
Adapter Classes

Sometimes we only want to deal with one particular event, but the listener interface handles many related events. java.awt.event contains adapter classes that implement the listener interfaces with do-nothing methods. We can extend an adapter class and override just the methods that we are interested in.

Some adapter classes are:

- MouseAdapter
- MouseMotionAdapter
- KeyAdapter
- FocusAdapter
- WindowAdapter
public class Word extends JApplet
    implements ActionListener {
    JTextField textfield;

    public void init() {
        textfield = new JTextField();
        JButton button = new JButton("Add A Word");
        button.addActionListener( this );
        ...
    }

    public void actionPerformed(ActionEvent e) {
        if(e.getID()==ActionEvent.ACTION_PERFORMED)
            textfield.setText( textfield.getText() + "A Word" );
    }
}
Inner Classes

If your application has a lot of GUI components, the number of listener interfaces implemented becomes unwieldy and annoying. At the same time, defining a separate class for each listener is inconvenient.

An *inner class* is a class declared inside another class. If an inner class is a member of the *outer class*, it can access the other members of the class.

A *local inner class* is a class declared inside a code block, e.g., a method body. A local inner class can access variables inside the scope of the block, as long as they are declared *final*.
public class InnerWord extends JApplet {
    JTextField textfield;

    class ActionHandler implements ActionListener {
        public void actionPerformed(ActionEvent e) {
            if (e.getID() == ActionEvent.ACTION_PERFORMED)
                textfield.setText(textfield.getText() + "A Word");
        }
    }

    public void init() {
        textfield = new JTextField();
        JButton button = new JButton("Add A Word");
        button.addActionListener(new ActionHandler());
        ...
    }
}
public class LocalInnerWord extends JApplet {
    public void init() {
        final JTextField textfield = new JTextField();
        JButton button = new JButton("Add A Word") ;

        class ActionHandler implements ActionListener {
            public void actionPerformed(ActionEvent e) {
                if( e.getID()==ActionEvent.ACTION_PERFORMED )
                    textfield.setText(textfield.getText() + "A Word") ;
            }
        }
        button.addActionListener( new ActionHandler() ) ;
    }
    ...
}
Anonymous Inner Classes

If an inner class is only used once, giving it a name is a waste of time. An anonymous inner class can be created using the syntax:

```java
new AbstractClassName() {
    /* abstract method definitions */
}
```

or

```java
new InterfaceName() {
    /* interface method definitions */
}
```
public class AnonymousWord extends JApplet {
    public void init() {
        final JTextField textfield = new JTextField();
        JButton button = new JButton("Add A Word");

        button.addActionListener( new ActionListener() {
            public void actionPerformed(ActionEvent e) {
                if( e.getID()==ActionEvent.ACTION_PERFORMED )
                    textfield.setText( textfield.getText() + "A Word") ;
            }
        } ) ;
        ...
    }
}
The JComboBox component

The `JComboBox` component operates on a list of objects. Each item is displayed in the list using the object’s `toString` method.

The method `getSelectedItems` returns the `Object` in the list that is selected. If you know the type of the item (and you should), you can case the `Object` to its proper type and use it.

An `ItemListener` on a `JComboBox` will be called when the selection changes.