

## CSE 143 Java

### Introduction to Graphical Interfaces in Java: AWT and Swing

Reading: Sec. 17.1-17.3, 17.7

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## Overview

- Roadmap
  - Today: introduction to Java Windows and graphical output
  - Future: event-driven programs and user interaction
- Topics
  - A bit of history: AWT and Swing
  - Some basic Swing components: JFrame and JPanel
  - Java graphics
- Reading:
  - Textbook: Ch. 19
  - Online: Sun Java Swing tutorial (particularly good for picking up details of particular parts of Swing/AWT as needed); Swing API javadoc web pages <http://java.sun.com/docs/books/tutorial/uiswing/index.html>

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## Graphical User Interfaces

- GUIs are a hallmark of modern software
- Hardly existed outside research labs until Mac's came along
  - Picked up by PC's later
- User sees and interacts with "controls" or "components" (sometimes called "widgets")
  - menus
  - scrollbars
  - text boxes
  - check boxes
  - buttons
  - radio button groups
  - graphics panels
  - etc. etc.

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## Opposing Styles of Interaction

- "Algorithm-Driven"
  - When *program* needs information from user, it asks for it
  - Program is in control
  - Typical in non-GUI environments (examples: payroll, batch simulations)
- "Event Driven"
  - When *user* wants to do something, he/she signals to the program
    - Moves or clicks mouse, types, etc.
  - These signals come to the program as "events"
  - Program is interrupted to deal with the events
  - User has more control
  - Typical in GUI environments

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## A Bit of Java History

- Java 1.0: AWT (Abstract Windowing Toolkit)
- Java 1.1: AWT with new event handling model
- Java 1.2 (aka Java 2): Swing
  - Greatly enhanced user interface toolkit built on top of AWT
  - Same basic event handling model as in Java 1.1 AWT
- Java 1.3, 1.4, 1.5
  - Bug fixes and significant performance improvements; no major revolution
- Naming
  - Most Swing components start with J.
  - No such standard for AWT components

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## Bit o' Advice

- Use Swing whenever you can
- Use AWT whenever you have to
  - (mostly to support older windows browsers that don't have or work with the current Sun Java plugin – not an issue unless you need to support applets in really old Windows or Mac OS 9 or earlier web browsers)



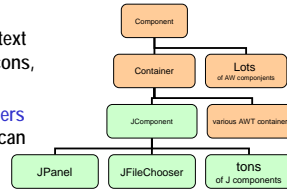
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## Components & Containers

- Every GUI-related component descends from **Component**, which contains dozens of basic methods and fields common to all AWT/Swing component
- "Atomic" components: labels, text fields, buttons, check boxes, icons, menu items, ...
- Some components are **Containers** – components like panels that can contain other nested subcomponents



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## Types of Containers

- **Top-level containers:** JFrame, JDialog, JApplet
  - Often correspond to OS Windows
- **Mid-level containers:** panels, scroll panes, tool bars, ...
  - can contain certain other components
  - JPanel is best for general use
  - An Applet is a special kind of container that lives in a web page – we won't cover this
- **Specialized containers:** menus, list boxes, combo boxes...
- **Technically, all J components are containers**

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## JFrame – A Top-Level Window

- **Top-level application window**

```
JFrame win = new JFrame("Optional Window Title");
```

- **Some common methods**

```
setBackground(Color c); // background color
pack(); // lay out components
setVisible(true); // make visible
repaint(); // request repaint after content change
dispose(); // get rid of the window when done
```

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## JPanel – A General Purpose Container

- **Commonly added to a window to provide a space for graphics, or collections of buttons, labels, etc.**
- **JPanels can be nested to any depth**
- **Many methods in common with JFrame (since both are ultimately instances of Component)**

```
setBackground(Color c);
repaint();
```

**and some that are new**

```
setPreferredSize(Dimension d); // default size for window; also can set min
// and max sizes
```

- **Advice: Can't find the method you're looking for? Check the superclass.**

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## Adding Components to Containers

- **Top-level swing containers have a "content pane" that manages the components in that container**  
(Differs from original AWT containers, which managed their components directly)
- **To add a component to a top-level container, get the content pane, and use its add method**

```
JFrame jf = new JFrame();
JPanel panel = new JPanel();
jf.getContentPane().add(panel);
or
Container cp = jf.getContentPane();
cp.add(panel);
```

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## Non-Component Classes

- **Not all AWT/Swing classes are components**
- **AWT**
  - Color, Dimension, Font, layout managers
  - Shape and subclasses like Rectangle, Point, etc.
  - Graphics
- **Swing**
  - Borders
  - Further geometric classes
  - Graphics2D
- **Neither AWT nor Swing**
  - Images, Icons

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## Layout Managers

- What happens if we add several components to a container?
  - What are their relative positions?
- Answer: each container has a layout manager. Some kinds:
  - FlowLayout (left to right, top to bottom)
  - BorderLayout("center", "north", "south", "east", "west")
  - GridLayout (2-D grid)
  - GridBagLayout (makes HTML tables look simple); others
- Default LayoutManager for JFrame is BorderLayout
- Default for JPanel is FlowLayout

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## pack and validate

- Container state is "valid" or "invalid" depending on whether layout manager has arranged components since last change
- When a container is altered, either by adding components or changes to components (resized, contents change, etc.), the layout needs to be updated (i.e., the container state needs to be set to valid)
  - Swing does this automatically more often than AWT, but not always
- Common methods after changing layout
  - validate() – redo the layout to take into account new or changed components
  - pack() – redo the layout using the preferred size of each component

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## Layout Example

- Create a JFrame with a label at the bottom and a panel in the center

```
JFrame frame = new JFrame("Trivial Window"); //default layout: Border
JPanel panel = new JPanel();
panel.setPreferredSize(new Dimension(300,250));
JLabel label = new JLabel("Smile!");
label.setHorizontalAlignment(SwingConstants.CENTER);
Container cp = frame.getContentPane();
cp.add(panel, BorderLayout.CENTER);
cp.add(label, BorderLayout.SOUTH);
```

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## Graphics and Drawing

- Simple things like labels know how to paint (draw) themselves
- For more complex graphics, extend a suitable class and override the inherited method *paintComponent* to draw its contents
  - (Different from AWT, where you override *paint* – don't do that in swing!)

```
public class Drawing extends JPanel {
    ...
    /** Repaint this Drawing whenever requested by the system */
    public void paintComponent(Graphics g) {
        super.paintComponent(g);
        g.setColor(Color.green);
        g.drawOval(40,30,100,100);
        g.setColor(Color.red);
        g.fillRect(60, 50, 60, 60);
    }
}
```

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## paintComponent

- Method *paintComponent* is called by the underlying system *whenever it needs the window to be repainted*
  - Triggered by window being move, resized, uncovered, expanded from icon, etc.
  - Can happen anytime – you don't control when
- If your code does something that requires repainting, call method *repaint()*
  - Requests that *paintComponent* be called sometime in the future, when convenient for underlying system window manager

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## Painter's Rules



- *Always* override *paintComponent()* of any component you will be drawing on
  - But not necessary if you make simple changes, like changing background color, title, etc. that don't require a graphics object
- *Always* call *super.paintComponent(g)* to paint the background
- *Never* call *paint()* or *paintComponent()*. Never means never!
  - This might be a hard rule to understand. Follow it anyway.
- *Always* paint the entire picture, from scratch
- Don't create a Graphics object to draw with
  - only use the one given to you as a parameter of *paintComponent()*
  - and, don't save that object to reuse later!
  - This rule is bent in advanced graphics applications

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## Classes Graphics and Graphics2D

- The parameter to *paintComponent* or *paint* is a graphics context where the drawing should be done
  - In Swing components, the parameter has static type `Graphics`, but dynamic type `Graphics2D`, a subclass of `Graphics`
    - Cast it to `Graphics2D` if you want to use the newer, more sophisticated graphics operations like image rotation

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## Graphics 2D

- In the Graphics 2D package, many graphical objects implement the `Shape` interface
  - When possible, chose a `Shape` rather than a non-`Shape`
- Lots of methods available to draw various kinds of outline and solid shapes and control colors and fonts

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## Learning Graphics2D

- In reading and experimenting, focus on these classes:
  - `JPanel` (and ancestors)
  - (interface) `Shape`
  - `Line2D`
  - `Polygon`
  - `Graphics2D`, especially these methods:
    - `draw(Shape)`
    - `draw(String, int, int)`
    - `fill(Shape)`
    - `setColor(Color)`
    - Avoid methods like `drawLine`, `drawPolygon`, etc.
- (But you can use the older AWT graphics unless you want to try this)

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## Roadmap

- Future: Events
  - User interaction
  - GUI components
- What to do
  - Start reading textbook chs. 17 and 18
  - Browse the Swing tutorial and Java Swing/AWT documentation from Sun to start to feel your way around

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