From Using to Programming GUIs

- Extend model of "keep it simple" in code to GUI
  - Bells and whistles ok, but easy to use and hide
- We're talking about software design
  - Not HCI or user-interface design or human factors…
  - However, compare winamp to iTunes
- How do we design GUIs
  - Programming, drag-and-drop, …
  - How do we program/connect GUIs?

javax.swing, events, and GUIs

- GUI programming requires processing events
  - There's no visible loop in the program
  - Wire up/connect widgets
    - Menu, button, text area, spinner, combobox, …
    - some generate events, some process events
- Pressing this button causes the following to happen
  - We want to do practice "safe wiring", meaning?
  - Open-closed principle

Building GUIs

- We need to put widgets together, what makes a good user-interface? What makes a bad user-interface?
  - How do we lay widgets out, by hand? Using a GUI-builder? Using a layout manager?
  - How do we cope with widget complexity?
- Use the Sun Java Tutorial
  - See other online sources

JComponent/Container/Component

- The java.awt package was the original widget package, it persists as parent package/classes of javax.swing widgets
  - Most widgets are JComponents (subclasses), to be used they must be placed in a Container
  - The former is a swing widget, the latter awt, why?
- Container is a component, but contains a collection of components (similar to what design pattern?)
  - Composite Design Pattern

Composite, Container (continued)

- A Container is also a Component, but not all Containers are JComponents (what?)
  - JFrame is often the "big container" that holds all the GUI widgets, we'll use this and JApplet (awt counterparts are Frame and Applet)
- A JPanel is a JComponent that is also a Container
  - Holds JComponents, for example and is holdable as well

What do Containers do?

- A Container is a Component, so it's possible for a Container to "hold itself"? Where have we seen this?

"You want to represent part-whole hierarchies of objects. You want clients to be able to ignore the difference between compositions of objects and individual objects. Clients will treat all objects in the composite structure uniformly".

- Composite pattern solves the problem. Think tree, linked list: leaf, composite, component

Parents and Children

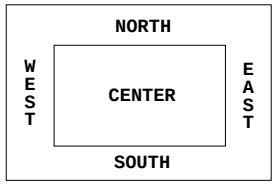
- What about parent references?
  - Does child need to know who contains it?
- What about child references?
  - Does parent need to know who it contains?
- In Java/Swing, a parent is responsible for painting its children
  - For "paint" think draw, arrange, manage, …

Widget layout

- A Layout Manager "decides" how widgets are arranged in a Container
  - In a JFrame, we use the ContentPane for holding widgets/components, not the JFrame itself
- Strategy pattern: *"related classes only differ in behavior, configure a class with different behaviors… you need variants of an algorithm reflecting different constraints…context forwards requests to strategy, clients create strategy for the context"*
  - Context == JFrame/container, Strategy == Layout
- Layouts: Border, Flow, Grid, GridBag, Spring, …
  - I'll use Border, Flow, Grid in my code

BorderLayout (see code)

- Default for the JFrame contentpane
- Provides four areas, center is "main area" for resizing
- Recursively nest for building complex (yet simple) GUIs
- `BorderLayout.CENTER` for adding components
  - Some code uses "center", bad idea (bugs?)



Action and other events

- Widgets generate events, these events are processed by event listeners
  - Different types of events for different scenarios: press button, release button, drag mouse, press mouse button, release mouse button, edit text in field, check radio button, …
  - Some widgets "fire" events, some widgets "listen" for events
- To process events, add a listener to the widget, when the widget changes, or fires, its listeners are automatically notified.
  - Observer/Observable (related to MVC) pattern

Adding Listeners

- In lots of code you'll see that the Container widget is the listener, so pressing a button or selecting a menu is processed by the Container/Frame's actionPerformed method
  - All ActionListeners have an actionPerformed method, is this interface/implements or inheritance/extends?
  - Here's some "typical" code, why is this bad?

```
void actionPerformed(ActionEvent e)
{
    if (e.getSource() == thisButton) …
    else if (e.getSource() == thatMenu)…
}
```


A GUI object can be its own client

- Occasionally a GUI will be a listener of events it generates
  - Simple, but not extendable
  - Inner classes can be the listeners, arguably the GUI is still listening to itself, but …
    - Encapsulating the listeners in separate classes is better
- Client (nonGUI) objects cannot access GUI components
  - Properly encapsulated JTextField, for example, responds to aGui.displayText(), textfield not accessible to clients
  - If the GUI is its own client, it shouldn't access textfield
    - Tension: simplicity vs. generality
- Don't wire widgets together directly or via controller that manipulates widgets directly
  - Eventual trouble when GUI changes

Using inner/anonymous classes

- For each action/event that must be processed, create an object to do the processing
  - Command pattern: parameterize object by an action to perform, queue up requests to be executed at different times, support undo
  - There is a javax.swing Event Queue for processing events, this is the hidden while loop in event processing GUI programs

Anonymous classes

- The inner class can be named, or it can be created "anonymously"
  - For reuse in other contexts, sometimes naming helpful
  - Anonymous classes created close to use, easy to read (arguable to some)

Listeners

- Events propagate in a Java GUI as part of the event thread
  - Don't manipulate GUI components directly, use the event thread
  - Listeners/widgets register themselves as interested in particular events
    - Events go only to registered listeners, can be forwarded/consumed

More on Listeners

- `ActionListener`, `KeyListener`, `ItemListener`, `MouseListener`, `MouseMotionListener`, ..., see java.awt.event.*
  - Isolate listeners as separate classes, mediators between GUI, Controller, Application
  - Anonymous classes can help here too

Listeners and Adapters

- MouseListener has five methods, KeyListener has three
  - What if we're only interested in one, e.g., key pressed or mouse pressed?
  - As interface, we must implement all methods as no-ops
  - As adapter we need only implement what we want

Adapters and Interfaces

- Single inheritance can be an annoyance in this situation
  - Can only extend one class, be one adapter, …
- What about click/key modifiers, e.g., shift/control/left/both
  - Platform independent, what about Mac?