CSE 331
Software Design & Implementation

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Java GUIs

(Based on slides by Mike Ernst, Dan Grossman, David Notkin, Hal Perkins, Zach Tatlock)

Review

- Event-driven program is one whose main loop waits for an event and then processes it (over and over until quit time)
  - this sort of loop is called an event loop

- Examples of event-driven programs:
  - (web) servers
  - GUIs

- Technicalities:
  - OSes only let you wait for certain types of events at once
  - work around it by having another thread list for other types
    - (but be careful about what work is done on which thread)

Java AWT / Swing

References on Java AWT / Swing

Very useful start: Sun/Oracle Java tutorials

- http://docs.oracle.com/javase/tutorial/uiswing/index.html

Mike Hoton's slides/sample code from CSE 331 Sp12 (lectures 23, 24 with more extensive widget examples)

- http://courses.cs.washington.edu/courses/cse331/12sp/lectures/lect23-GUI.pdf
- http://courses.cs.washington.edu/courses/cse331/12sp/lectures/lect24-Graphics.pdf
- http://courses.cs.washington.edu/courses/cse331/12sp/lectures/lect23-GUI-code.zip
- http://courses.cs.washington.edu/courses/cse331/12sp/lectures/lect24-Graphics-code.zip

Good book that covers this (and much more):
Core Java vol. I by Horstmann & Cornell

- there are other decent Java books out there too

What not to do…

- Don’t try to learn the whole library: there’s way **too much**
- Don’t memorize – look things up as you need them
- Don’t miss the main ideas & fundamental concepts
- Don’t get bogged down implementing eye candy
  - (unless you finish everything else)

A very short history (1)

Java's standard libraries have supported GUIs from the beginning

Original Java GUI: AWT (Abstract Window Toolkit)

- mapped Java UI to host system UI widgets
- limited set of user interface elements (widgets)
    - lowest common denominator

Advantage: looks native

Disadvantage: "write once, debug everywhere"

A very short history (2)

Swing: new*er* GUI library, introduced with Java 2 (1998)

Basic idea: underlying system provides only a blank window

- Swing draws all UI components directly
- doesn’t use underlying system widgets
- (built on top of parts of AWT)

Advantage: **should** work the same on all platforms

- (be skeptical of that claim)

Disadvantage: doesn’t look like a native GUI for that OS

A very short history (3)

SWT: improved version of AWT approach (2004?)

- tries to expose all the functionality of native GUIs
- Eclipse is built using SWT
- not part of the standard Java library

Two choices:

1. Use Swing to make a GUI that looks / works consistently
2. Use SWT to make a native-looking GUI on each platform

Option 1 is less work.
Option 2 usually makes users happier.

We’ll cover Swing since it’s standard Java...

Main topics to learn

Using AWT/Swing components (a.k.a. widgets):

- different types of components
- how to lay them out in a window
- how to handle widget events

Writing your own components (Thursday section):

- how to draw your own UI
- how to handle lower level events

GUI terminology

window: A first-class citizen of the graphical desktop

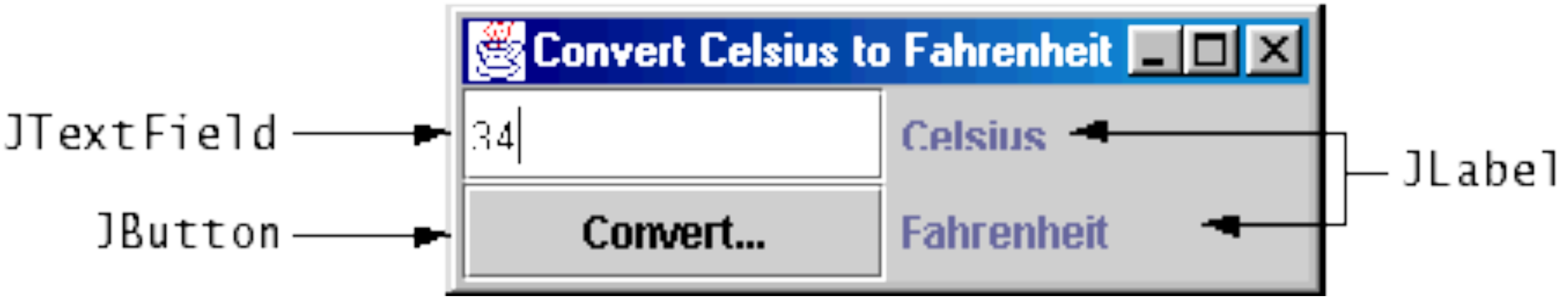
- also called a *top-level container*
- Examples: *frame* (window), dialog box

component: A GUI *widget* that resides in a window

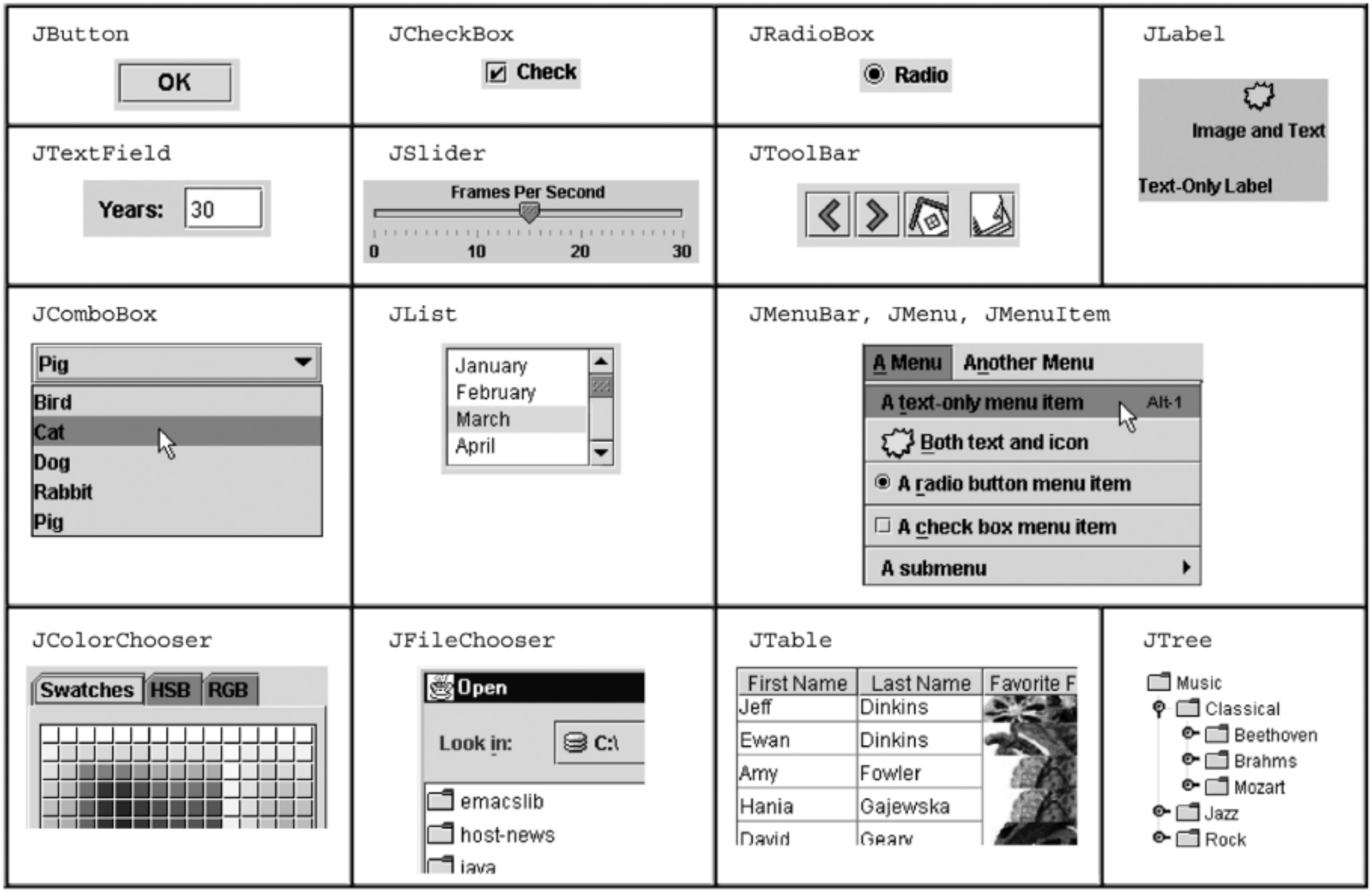
- called *controls* in many other languages
- Examples: button, text box, label

container: A component that hosts (holds) components

- Examples: frame, *panel*, box



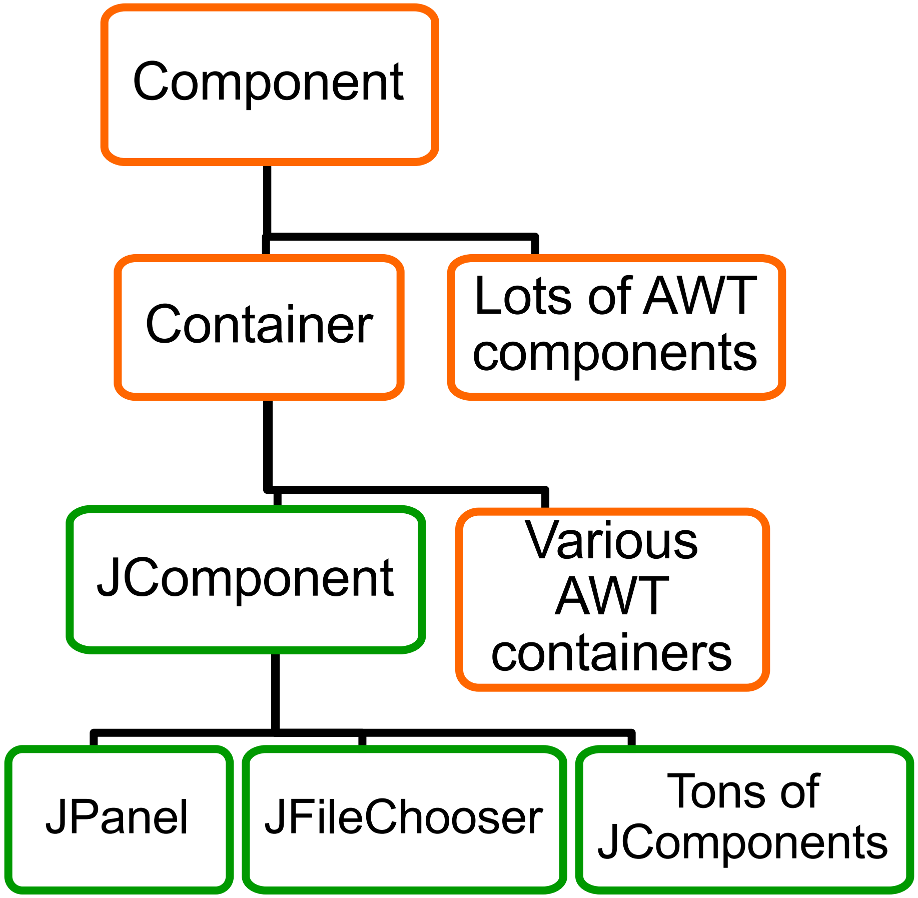
Some components…



First Name	Last Name	Favorite F
Jeff	Dinkins	
Ewan	Dinkins	
Amy	Fowler	
Hania	Gajewska	
David	Geary	

Component and container classes

- Every GUI-related class descends from Component, which contains dozens of basic methods and fields
  - Examples: **`getBounds`**, **`isVisible`**, **`setForeground`**, …
- "Atomic" components: labels, text fields, buttons, check boxes, icons, menu items…
- Many components are containers – things like panels (**`JPanel`**) that can hold nested subcomponents



Swing/AWT inheritance hierarchy

```
Component   (AWT)
   Window
      Frame
         JFrame   (Swing)
         JDialog
   Container
      JComponent  (Swing)
         JButton        JColorChooser    JFileChooser
         JComboBox      JLabel           JList
         JMenuBar       JOptionPane      JPanel
         JPopupMenu     JProgressBar     JScrollbar
         JScrollPane    JSlider          JSpinner
         JSplitPane     JTabbedPane      JTable
         JToolbar       JTree            JTextArea
         JTextField     ...
```

Component properties

Zillions. Each has a **`get`** (or **`is`**) accessor and a **`set`** modifier.
Examples: **`getColor,setFont,isVisible`**, …

name	type	description
background	**`Color`**	background color behind component
border	**`Border`**	border line around component
enabled	**`boolean`**	whether it can be interacted with
focusable	**`boolean`**	whether key text can be typed on it
font	**`Font`**	font used for text in component
foreground	**`Color`**	foreground color of component
height, width	**`int`**	component's current size in pixels
visible	**`boolean`**	whether component can be seen
tooltip text	**`String`**	text shown when hovering mouse
size, minimum / maximum / preferred size	**`Dimension`**	various sizes, size limits, or desired sizes that the component may take

Types of containers

- Top-level containers: **`JFrame`**, **`JDialog`**, …
  - usually correspond to OS windows
  - a "host" for other components
  - live at top of UI hierarchy, not nested in anything else

- Mid-level containers: panels, scroll panes, tool bars
  - sometimes contain other containers, sometimes not
  - **`JPanel`** is a general-purpose component for drawing or hosting other UI elements (buttons, etc.)

- Specialized containers: menus, list boxes, …

`JFrame` – top-level window

- Graphical window on the screen
- Holds other components
- Common methods:
  - **`JFrame(String`** *title*) : constructor, title optional
  - **`setDefaultCloseOperation(int`** *what***)**
    - What to do on window close
    - **`JFrame.EXIT_ON_CLOSE`** terminates application
  - **`setSize(int`** *width*, **`int`** *height*) : set size
  - **`setVisible(boolean`** *b*) : make window visible or not

Example

`SimpleFrameMain.java`

`JFrame` – top-level window

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- Holds other components

- Common methods:
  - **`JFrame(String`** *title***`)`** : constructor, title optional
  - **`setDefaultCloseOperation(int`** *what***`)`**
    - What to do on window close
    - **`JFrame.EXIT_ON_CLOSE`** terminates application
  - **`setSize(int`** *width***`, int`** *height***`)`** : set size
  - **`setVisible(boolean`** *b***`)`** : make window visible or not
  - **`add(Component`** *c***`)`** : add component to window

Example

`SimpleButtonDemo.java`

Where is the event loop?

GUIs are event-driven programs, so where is the event loop?

- It is created automatically by Swing
  - presumably when we call `frame.setVisible(true)`
- The main method actually returns…
- Swing creates another thread to run the GUI event loop
  - this is called the UI thread
  - the Java VM does not quit the program until *all threads* exit

Example

`SimpleButtonDemo2.java`

`JPanel` – a general-purpose container

- Commonly used to hold a collection of button, labels, etc.
  - (also has another use you will learn about in section)

- Needs to be added to a window or other container:

  `frame.add(new JPanel(…))`

- **`JPanel`**s can be nested to any depth

- Many methods/fields in common with **`JFrame`** (since both inherit from **`Component`**)
  - Can't find a method/field? Check the superclasses.

A particularly useful method:

- **`setPreferredSize(Dimension`** *d***`)`**

Example

`SimpleButtonDemo3.java`

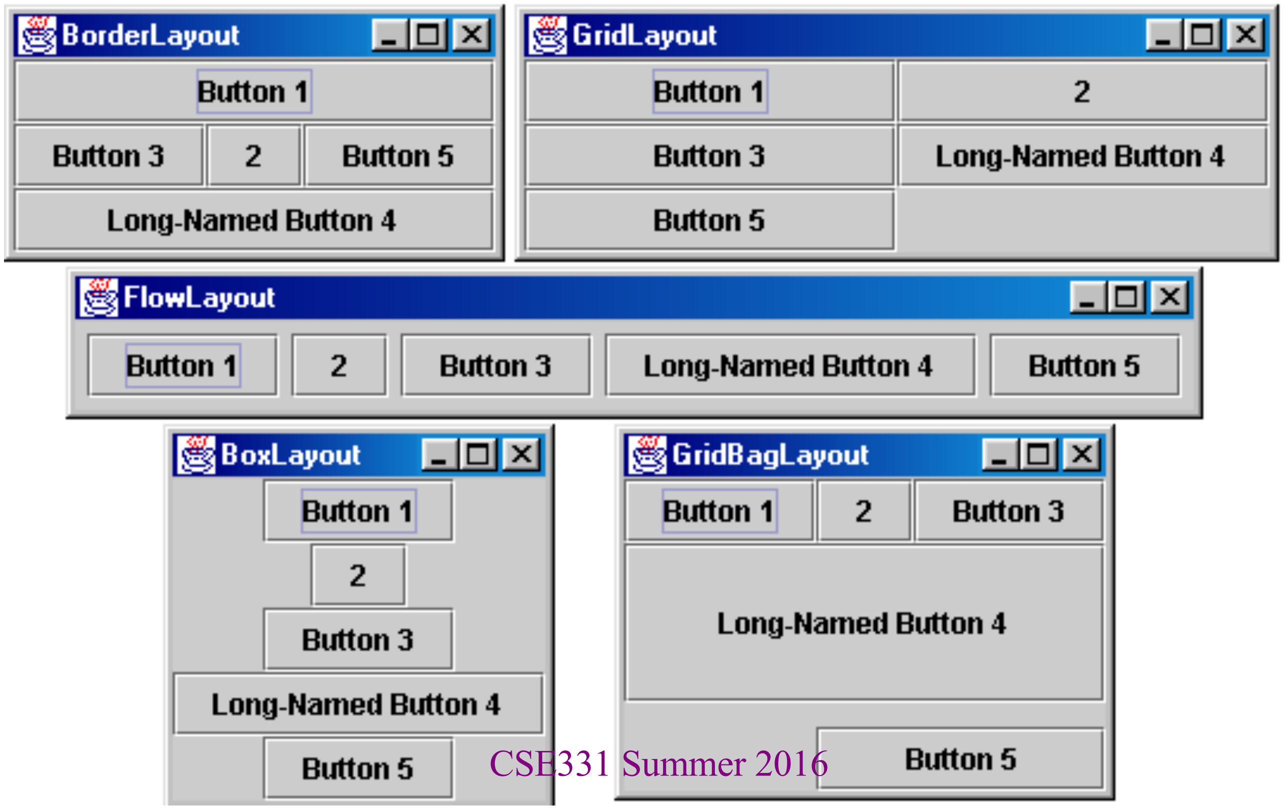
Example

`SimpleFieldDemo.java`

Containers and layout

- What if we add several components to a container?
  - How are they positioned relative to each other?

- Answer: each container has a *layout manger*



Layout managers

Kinds:

- **`FlowLayout`** (left to right [changeable], top to bottom)
  - Default for **`JPanel`**
  - Each row centered horizontally [changeable]
- **`BorderLayout`** (“center”, “north”, “south”, “east”, “west”)
  - Default for **`JFrame`**
  - No more than one component in each of 5 regions
  - (Of course, component can itself be a container)
- **`GridLayout`** (regular 2-D grid)
- Others... (Some are incredibly complex. None are perfect.)

Layout managers

You can change the layout manager on any **`JComponent c`**

- **`c.setLayout(new GridLayout())`**

`FlowLayout` and **`BorderLayout`** are likely good enough for now…

(There are similar issues creating UI in HTML…)

Example

`SimpleFieldDemo2.java`

Example

`SimpleFieldDemo3.java`

`pack()`

Instead of having the components lay out within the window size, you can instead size the window to fit the components:

```
      frame.pack();
```

`pack()` figures out the sizes of all components and calls the container’s layout manager to set locations in the container

- (recursively as needed)

Example

`SimpleFieldDemo4.java`