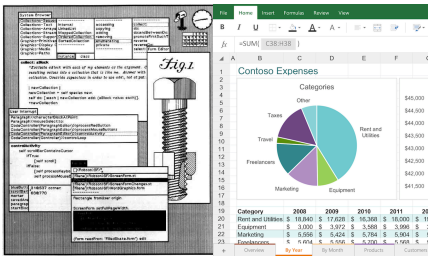
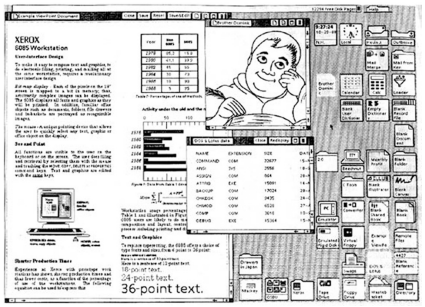
Graphical User Interfaces



CS 2110 Spring 2015

Ivan Sutherland: "Sketchpad", https://youtu.be/57wj8diYpgY

The Xerox Star GUI, 1981



Xerox and Apple

"Steve was working on a new secret project… and [we] were asked to go over to Xerox PARC and take a look at a new computer. We weren't told why."

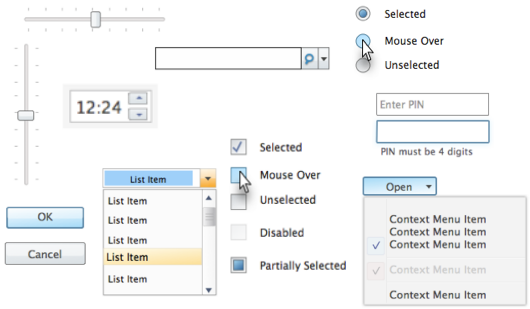
"We got a demonstration of the Star, which had a graphical user interface, a laser printer, and a mouse."

"Xerox had done research to find out what the best input system for a computer was… After ten PhD-years of research they had concluded that the mouse was the best input device."

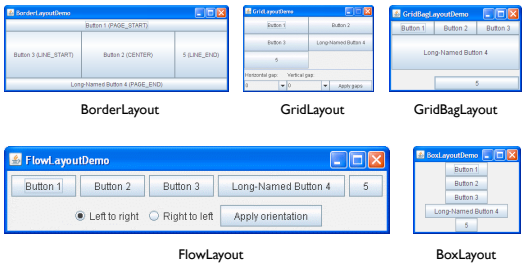
Jim Sachs on Apple Lisa, the first commercial computer with a GUI ($10k in 1982)

Microsoft Research: "Room Alive", https://youtu.be/ILb5ExBzHqw

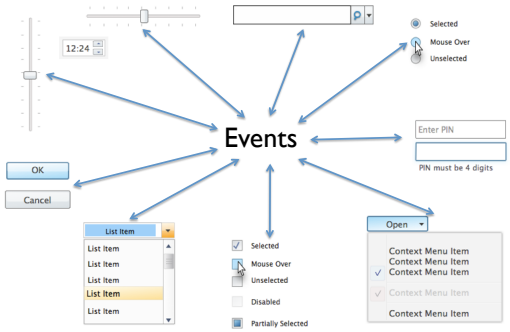
GUIs consist of Components/Widgets



Components are arranged in Layouts



Components communicate via Events



GUI

- Provides a friendly interface between user and program
- Allows event-driven or reactive programming: The program reacts to events such as button clicks, mouse movement, keyboard input
- Often is multi-threaded: Different threads of execution can be going on simultaneously

GUI

- Java provides two standard packages for making GUIs
  - **AWT** (Abstract or Awful Window Toolkit) – original one `(import java.awt.*)`
  - **Swing** – newer one, which builds on AWT as much as possible `(import javax.swing.*)`
- Two aspects to making a GUI:
  - Placing components (buttons, text…) TODAY
  - Listening/responding to events Next Lecture

Class JFrame

JFrame object: associated with a window on your monitor.

Generally, a GUI is a JFrame object with various components placed in it

Some methods in a JFrame object

```
hide()    show()    setVisible(boolean)
getX()    getY()    (coordinates of top-left point)
getWidth()          getHeight()      setLocation(int, int)
getTitle()          setTitle(String)
getLocation()       setLocation(int, int)
```

Over 100 methods in a JFrame object!

Class JFrame is in package javax.swing

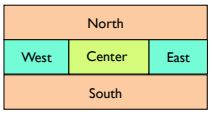
Placing components in a JFrame

Layout manager: Instance controls placement of components.

JFrame layout manager default: BorderLayout.

BorderLayout layout manager: Can place 5 components:

```
public class C extends JFrame {
   public C() {
      Container cp= getContentPane();
      JButton jb= new JButton("Click here");
      JLabel jl= new JLabel("label 2");
      cp.add(jb, BorderLayout.EAST);
      cp.add(jl, BorderLayout.WEST);
      pack();
      setVisible(true);
   }
```



JFrameDemo.java

Placing components in a JFrame

```
import java.awt.*;   import javax.swing.*;
/** Demonstrate placement of components in a JFrame.
    Places five components in 5 possible areas:
      (1) a JButton in the east,          (2) a JLabel in the west,
      (3) a JLabel in the south,          (4) a JTextField in the north
      (5) a JTextArea in the center.  */

public class ComponentExample extends JFrame {
   /** Constructor: a window with title t and 5 components */
   public ComponentExample(String t) {
      super(t);
      Container cp=  getContentPane();
      cp.add(new JButton("click me"), BorderLayout.EAST);
      cp.add(new JTextField("type here", 22), BorderLayout.NORTH);
      cp.add(new JCheckBox("I got up today"), BorderLayout.SOUTH);
      cp.add(new JLabel("still winter"), BorderLayout.WEST);
      cp.add(new JTextArea("type\nhere", 4, 10), BorderLayout.CENTER);
      pack();
   }
```

Add components to its contentPane

ComponentExample.java

Packages – Components

Packages that contain classes that deal with GUIs:
java.awt: Old package. **javax.swing: New package.**

javax.swing has a better way of listening to buttons, text fields, etc. Components are more flexible.

Jxxxx: in Swing, with xxxx in awt

Component: Something that can be placed in a GUI window. They are instances of certain classes, e.g.

JButton, Button:	Clickable button
JLabel, Label:	Line of text
JTextField, TextField:	Field into which the user can type
JTextArea, TextArea:	Many-row field into which user can type
JPanel, Panel:	Used for graphics; to contain other components
JCheckBox:	Checkable box with a title
JComboBox:	Menu of items, one of which can be checked
JRadioButton:	Similar functionality as JCheckBox
Container:	Can contain other components
Box:	Can contain other components

Hierarchy of Basic Components

```
Component
    Button, Canvas
    Checkbox,  Choice
    Label,  List,  Scrollbar
    TextComponent
        TextField, TextArea
    Container
        JComponent
        AbstractButton
            JButton
            JToggleButton
                JCheckBox
                RadioButton
        JLabel,  JList
        JOptionPane,  JPanel
        JPopupMenu,  JScrollBar,  JSlider
        JTextComponent
        JTextField,  JTextArea
```

Component: Something that can be placed in a GUI window. These are the basic ones used in Java GUIs

Note the use of subclasses to provide structure and efficiency. For example, there are two kinds of JToggleButtons, so that class has two subclasses.

Components that can contain other components

```
Component
    Box
    Container
        JComponent
        JPanel
        Panel
            Applet
    Window
        Frame
            JFrame
        JWindow
```

java.awt is the old GUI package.

javax.swing is the new GUI package. When they wanted to use an old name, they put **J** in front of it.

(e.g. Frame and JFrame)

When constructing javax.swing, the attempt was made to rely on the old package as much as possible.

So, JFrame is a subclass of Frame.

But they couldn't do this with JPanel.

```
import java.awt.*;   import javax.swing.*;
/** Instance has labels in east /west, JPanel with four buttons in center.  */
public class PanelDemo extends JFrame {
   JPanel p= new JPanel();
   /** Constructor: a frame with title "Panel demo", labels in east/west,
       blank label in south, JPanel of 4 buttons in the center */
   public PanelDemo() {
      super("Panel demo");
      p.add(new JButton("0"));   p.add(new JButton("1"));
      p.add(new JButton("2"));   p.add(new JButton("3"));
      Container cp= getContentPane();
      cp.add(new JLabel("east"), BorderLayout.EAST);
      cp.add(new JLabel("west"), BorderLayout.WEST);
      cp.add(new JLabel("    "), BorderLayout.SOUTH);
      cp.add(p, BorderLayout.CENTER);
      pack();
   }
}
```

JPanel: a container

JPanel layout manager default: FlowLayout.

FlowLayout layout manager: Place any number of components. They appear in the order added, taking as many rows as necessary.

```
import javax.swing.*;  import java.awt.*;
/** Demo class Box. Comment on constructor says how frame is laid out. */
public class BoxDemo extends JFrame {
   /** Constructor: frame with title "Box demo", labels in the east/west,
       blank label in south, horizontal Box with 4 buttons in center. */
   public BoxDemo() {
      super("Box demo");
      Box b= new Box(BoxLayout.X_AXIS);
      b.add(new JButton("0"));     b.add(new JButton("1"));
      b.add(new JButton("2"));     b.add(new JButton("3"));
      Container cp= getContentPane();
      cp.add(new JLabel("east"),  BorderLayout.EAST);
      cp.add(new JLabel("west"), BorderLayout.WEST);
      cp.add(new JLabel(" "),       BorderLayout.SOUTH);
      cp.add(b,                        BorderLayout.CENTER);
      pack();
   }
}
```

Box: a container

Box layout manager default: BoxLayout.

BoxLayout layout manager: Place any number of components. They appear in the order added, taking only one row.

```
public class BoxDemo2 extends JFrame {
  /** Constructor: frame with title t and 3 columns with n, n+1, and n+2 buttons. */
  public BoxDemo2(String t, int n) {
     super(t);
     // Create Box b1 with n buttons.
     Box b1= new Box(BoxLayout.Y_AXIS);
     for (int i= 0; i != n; i= i+1)
          b1.add(new JButton("i " + i));
     // Create Box b2 with n+1 buttons.
     Box b2= …
     // Create Box b3 with n+2 buttons.
     Box b3= …
     // Create horizontal box b containing b1, b2, b3
     Box b= new Box(BoxLayout.X_AXIS);
     b.add(b1);
     b.add(b2);
     b.add(b3);
     Container cp= getContentPane();
     cp.add(b, BorderLayout.CENTER);
     pack();  show();
  }
}
```

Boxes within a Box

3 vertical boxes, each a column of buttons, are placed in a horizontal box

BoxLayout layout manager: Place any number of components. They appear in the order added, taking only one row.

Simulate BoxLayout Manager in a JFrame

To simulate using a BoxLayout manager for a JFrame, create a Box and place it as the sole component of the Jframe:

```
JFrame jf= new JFrame( "title" );
Box b= new Box(BoxLayout.X_AXIS);
Add components to b;
jf.add(b, BorderLayout.CENTER);
```

1. **Start developing a GUI by changing an already existing one.** A lot of details. Hard to get all details right when one starts from scratch and has little idea about the Java GUI package
2. Showed how to place components in a GUI. Next time: how to "listen" to things like button clicks in a GUI
3. There are usually 5 different ways to achieve the same thing. Some are more elegant/efficient than others
4. To debug layouts, add borders to containers:
   c.setBorder(BorderFactory.createLineBorder(Color.black));