Lecture 3: Java Graphics & Events

CS 62

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Text Input

- **Scanner** class
  - Constructor: `myScanner = new Scanner(System.in);`
    - can use file instead of `System.in`
      - `new Scanner(new File("filename"))`
    - Can use delimeters other than whitespaces
      - `useDelimeter(String pattern)`
  - Read values:
    - `myScanner.nextInt()` -- returns an `int`
    - `myScanner.nextDouble()` -- returns a `double`
    - `myScanner.nextLine()` -- returns `String` -- to end of line
    - see documentation for more

For more details

- See document on course web page associated with lecture.
- See GUI cheat sheet in documentation and handouts section.

Overview

- Graphical User Interfaces (GUI)
  - Components, e.g., **`JButton`**, **`JTextField`**, **`JSlider`**, **`JChooser`**, …
  - Containers, e.g., **`JFrame`** (window), **`JPanel`** (grouping)
  - Layout managers, e.g., `FlowLayout` and `BorderLayout`,
- Graphics
  - Drawing items on the screen
- Events
  - Generated by mouse actions, button clicks etc.
  - Use **`MouseListener`**, **`MouseMotionListener`**, **`ActionListener`**, etc. to respond

Graphical User Interfaces (GUIs)

- **AWT** - The Abstract Windowing Toolkit is found in the package `java.awt`.
  - Heavyweight components.
  - Implemented with native native code written for that particular computer.
  - The AWT library was written in six weeks!

- **Swing** – Java 1.2 extended AWT with the `javax.swing` package.
  - Lightweight components
  - Written in Java

JFrame

- **javax.swing.JFrame** inherits from **java.awt.Frame**
- The outermost container in an application.
- To display a window in Java:
  - create a class that extends **JFrame**
  - set the size
  - set the location
  - set it visible

```
import javax.swing.JFrame;
public class MyFirstGUI extends JFrame{
        public MyFirstGUI() {
                super("First Frame");
                setSize(500, 300);
                setLocation(100, 100);
                setVisible(true);
        }
        public static void main(String[] args) {
                MyFirstGUI mfgui = new MyFirstGUI();
        }
}
```

Closing a GUI

- The default operation of the quit button is to set the visibility to false
  - The program does not terminate!

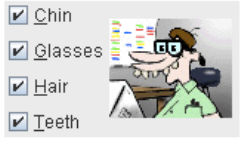
- **`setDefaultCloseOperation`** can be used to control this behavior.

- **`mfgui.setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE)`**;
  - Exits the application using **`System.exit(0)`**

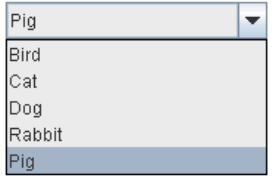
- More options (hide, do nothing, etc).

Basic Components

JButton

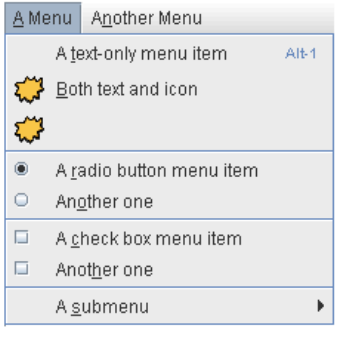


JCheckBox

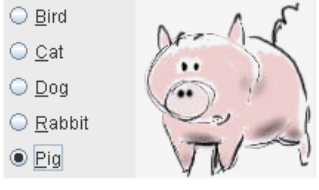


JComboBox

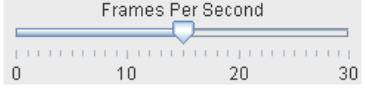
JList



JMenu



JRadioButton



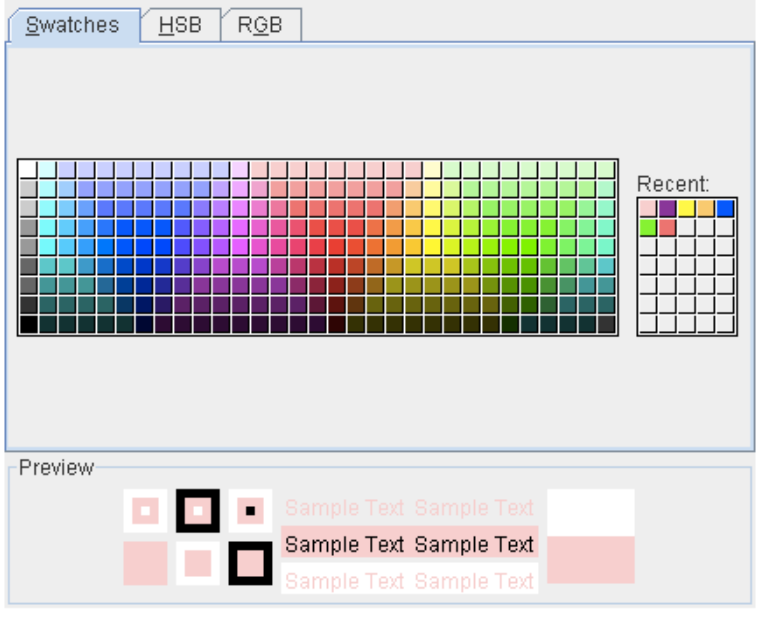
JSlider

JSpinner

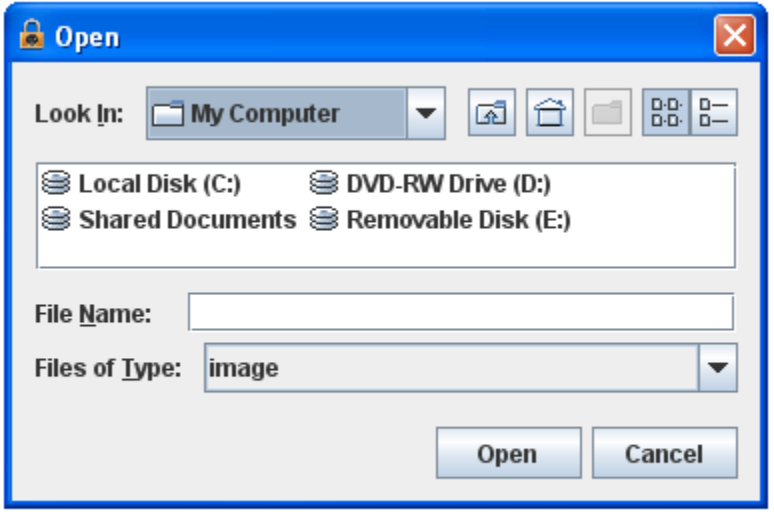
JTextField

JPasswordField

Interactive Displays



JColorChooser



JFileChooser

Adding JComponents to JFrame

```
public class Demo extends JFrame{
    public Demo() {
        Container cp = getContentPane();
        cp.setLayout(new FlowLayout());
        cp.add(new JLabel("Demo"));
        cp.add(new JButton("Button"));
        //...
    }
}
```

```
public class Demo extends JFrame{
    public Demo() {
        JPanel mainPanel = new
                JPanel(new FlowLayout());
        myPanel.add(new JLabel("Demo"));
        myPanel.add(new JButton("Button"));
        setContentPane(myPanel);
        //...
    }
}
```

Graphics

- Create objects you want to draw:
  - **`Rectangle2D.Double`**, **`Line.Double`**, etc.
  - Constructors take x,y coords and dimensions, but don't actually draw items.

- All drawing takes place in **`paint`** method using a "graphics context"

- Triggered implicitly by uncovering window or explicitly by calling **`repaint`** method.
  - Adds repaint event to event queue – eventually draws it

Graphics context

- All drawing is done in `paint` method of component
- `public void paint(Graphics g)`
  - `g` is a Graphics context provided by system
  - "pen" that does the drawing
  - Programmer calls repaint(), not paint!!
- Need to import classes from **`java.awt.*`**, **`java.geom.*`**, **`javax.swing.*`**
- See **`MyGraphicsDemo`**

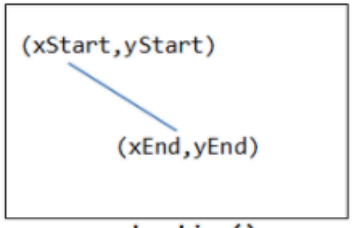
General Graphics Applications

- Create an extension of component (either `JPanel`, `JFrame`, or `JApplet`) and implement `paint` method in the subclass.
  - See main method of demo to get window to show
  - At start of paint method cast `g` to `Graphics2D` to get access to new methods

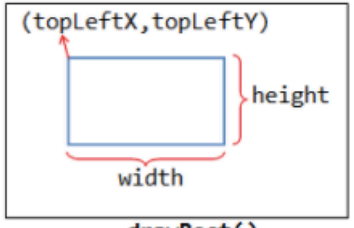
- Call `repaint()` on component every time you make a change.
  - Causes OS to schedule call of paint in event queue
  - Called automatically if window obscured and revealed

Geometric Objects

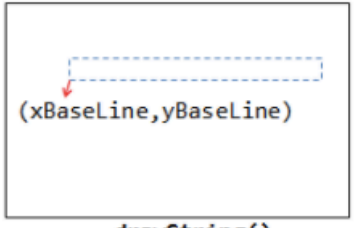
- Objects from classes **`Rectangle2D.Double`**, **`Line2D.Double`**, etc. from **`java.awt.geom`**
  - There are also float versions
  - Constructors take params x, y, width, height, but don't draw object
- **`Rectangle2D.Double`**
- **`RoundRectangle2D.Double`**
- **`Ellipse2D.Double`**
- **`Arc2D.Double`**
- **`Line2D.Double`**, …



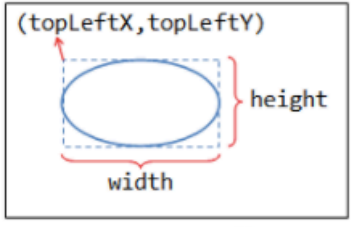
drawLine()



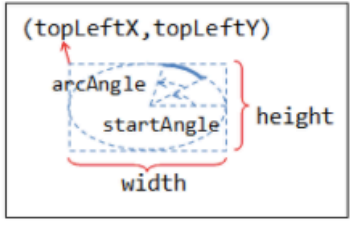
drawRect()



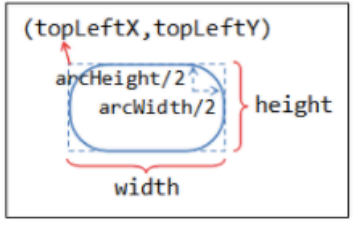
drawString()



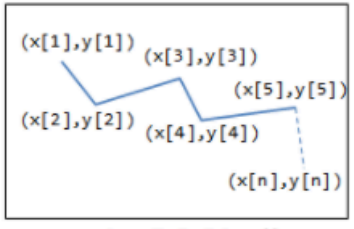
drawOval()



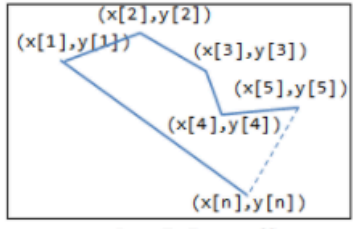
drawArc()



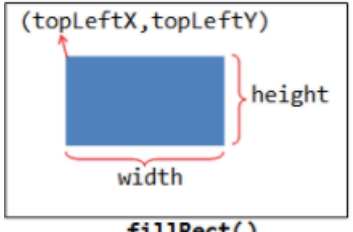
drawRoundRect()



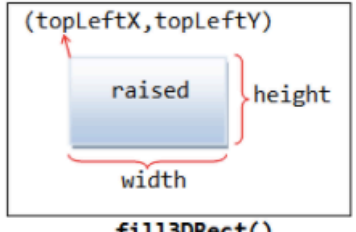
drawPolyline()



drawPolygon()



fillRect()



fill3DRect()

java.awt.Color

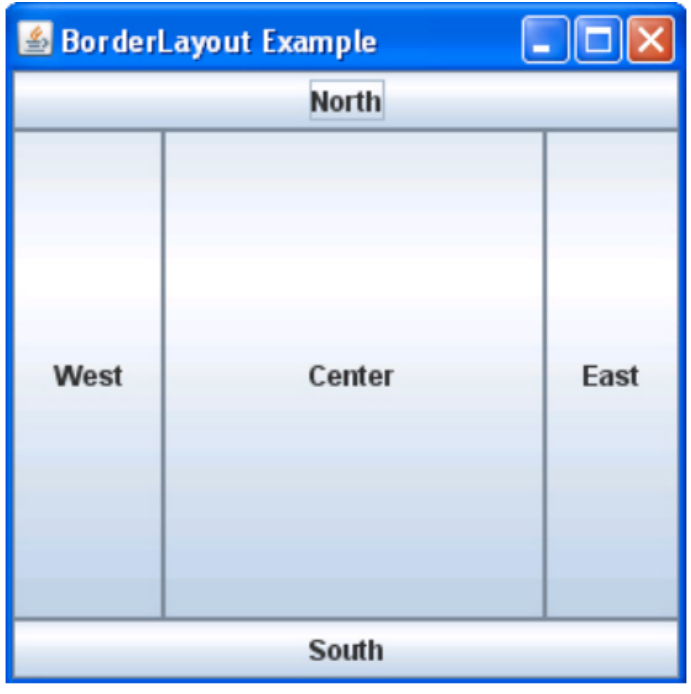
Methods

- `myObj.setFrame(x,y,width,height)` : can move object
- `g2.draw(myObj)` : gives outline
- `g2.fill(myObj)` : gives filled version
- `g2.drawString("a string",x,y)` : draws string

MyGraphicsDemo

- Class extends **`JFrame`**, which creates window.
- Constructor calls **`super`** with title of window.
- **`main`** method creates object, sets size, visibility, and enables go-away box.
- **`paint`** method creates and draws objects.

BorderLayout



PostItApplication

- More sophisticated.
- **JFrame** contains two **JPanels**.
- **JFrame** uses **BorderLayout**, so add controls to **JPanel** in **SOUTH**, drawing canvas in **CENTER** of the **JFrame**.
- **DrawingCanvas** extends **JPanel** -- contains paint method
  - Note use of **ArrayList** to hold **PostIts**.

PostIt

- Represents the rectangles being dragged:
  - Contains getter(accessor) and setter(mutator) methods to allow it to be manipulated by drawing program.
  - Could add features (title bar, go-away box) without affecting **PostItApplication** code.

PostItApplication

- **PostItApplication** class responsible for
  - setting up the GUI
  - Responding to button pressed and menu selections
  - Sets up **ArrayList** of items on canvas.
- Class has 3 inner classes
  - **DrawingCanvas**
  - **DrawingMouseListener**
  - **DrawingMouseMotionListener**
  - *Inner classes have access to private features of containing class*

Inner Classes

- **`DrawingCanvas`** extends **`JPanel`**
  - Associates listeners for mouse actions on the canvas
  - Responsible for repainting the screen
- **`DrawingMouseListener`** and **`DrawingMouseMotionListener`**
  - Responsible for responding to mouse actions by changing the items in the ArrayList.

Event-Driven Programming

Handling Mouse Events

- If you want program to react to mouse press, click, or release on a component
  - send **`addMouseListener(mlo)`** to component (usually in the constructor of the component)
  - See **`PostItApplication.java`**
  - For motion or drag, send **`addMouseMotionListener(mlo)`**
- When user presses mouse on a component
  - Computer looks for registered **`MouseListener`** for component or its containers.
  - If found, sends **`mousePressed(evt)`** to listener

Listener

- Object designated as mouse listener must
  - implement **`MouseListener`** (& implement **`mousePressed`**, **`mouseReleased`**, & **`mouseClicked`**) *or*
  - extend **`MouseAdapter`** (which has default implementations of all 3)
- Second is easier unless class already extends another. *Can only extend one class in Java*
- Similarly, for mouse motion listener
  - implement **`MouseMotionListener`** or
  - extend **`MouseMotionAdapter`**

Listeners in `PostItApplication`

- Main class (`this`) is listener for button and choice. Set up when GUI items constructed

- Special listener objects for mouse actions. Set up by **`DrawingCanvas`** since listening for actions on that object.

`List` Operations

- Review list operations from library interface **`List`** in Java 8 documentation.
  - Bailey's List is slightly different.
- Think about how to implement with array.
- **`size`**, **`isEmpty`**, **`get`**, **`set`** functions

ArrayList

- See Bailey's **ArrayIndexList**
  - Similar to Java 8's **ArrayList**
  - Instance variables:
    - **elts**: array instance variable,
    - **eltsFilled**: number of slots filled.
- Some operations very cheap:
  - **size**, **isEmpty**, **get**, **set** take constant time (no search)
- Others more expensive