Administration

- Department web server down since Thursday
- Lab 9 due tomorrow
- Lab 10 posted today
- Final project posted tomorrow
- Projected grades posted by tomorrow

Agenda

- What are applets?
- Running applets
- Writing applets
- Using graphics
- Using events and listeners
- Using components

Applets

- Applications
  - What we've been writing
  - Only one type of Java program
- Applets
  - Small applications
  - Accessed via the web
  - Code structured differently than an application

Running Applets

- Applets are embedded in web pages
  - HTML documents
- Running an applet:
  - User accesses web page that includes applet
  - Applet is downloaded automatically
  - Web browser uses JVM to run the applet

Running Applets [2]

- Java is an ideal language for programs distributed over the web
  - Can’t redistribute .exe files
    - Macs, UNIX won’t run them
  - .class files can be run by any machine
- Java programs become just another media that can be exchanged over the web
  - Text, graphics, and sound
A Simple Applet

import java.applet.*;
import java.awt.*;

public class SimpleApplet extends Applet {
    public void paint(Graphics g) {
        g.drawString("Hello, world!", 20, 20);
    }
}

Simple Applet [1]

- Note that it doesn't have a main method
  - Applet execution does not begin with main
  - Usually, applets don't have a main method
  - Applets begin execution when the name of the class is passed to a browser
- Also doesn't have System.out or Console method calls
  - Applets don't use console input/output

Simple Applet [2]

- import java.applet.*;
  - Imports the applet package, which contains the Applet class.
- import java.awt.*;
  - Imports the Abstract Window Toolkit (AWT).
  - Applets interact with the user using the AWT
  - Large, sophisticated package with support for a windows-based, graphical interface

Simple Applet [3]

- public class SimpleApplet extends Applet
  - All applets must extend Applet
  - Applet classes must be public because they must be visible to another program (the web browser)

Simple Applet [4]

- public void paint(Graphics g)
  - Method defined by AWT
  - Usually overridden by applets
  - Called whenever applet must paint itself
  - Graphics parameter represents graphical context in which applet is running
    - Class defined by AWT

Simple Applet [5]

- g.drawString("Hello, world!", 20, 20);
  - drawString is a member of the Graphics class
  - Outputs a string at the specified (x, y) coordinates on the window
    - Upper-left corner is (0, 0)
Applet Coordinates

Compiling/Executing

- Compiling an applet
  - Same as compiling an application
  - Produces .class file
- Executing applet
  - Requires Java-enabled browser
    - Netscape
    - Internet Explorer
  - Or use JDK tool: appletviewer

HTML File

- Need an HTML file that contains a tag for loading the applet:
  ```html
  <!-- probably in SimpleApplet.html-->
  <applet
code="SimpleApplet"
width="320"
height="200"
></applet>
  ```

Executing Applet

- Either:
  - Open SimpleApplet.html file with browser
  - Run the command (Metrowerks):
    ```
    appletviewer SimpleApplet.html
    ```

Executing Applets [2]

Applet Architecture

- Event driven
  - Applet waits for events to occur
    - Events: mouse movements, key presses, etc.
  - AWT notifies applet of event by calling event handler
  - Applet takes appropriate action and quickly returns control to AWT
- User initiates interaction with applet
  - In a non-windowed application, the program initiates interaction (e.g., Console.readString())
  - In applet, user interacts as s/he wants, when s/he wants
Initialization/Termination

- When an applet begins running, the AWT calls these methods, in order:
  - init()
  - start()
  - paint()

- When an applet is terminated, AWT calls:
  - stop()
  - destroy()

Initialization

- init()
  - First method in your code to be called
  - Initialize variables here (instead of constructor)
  - Only called once during applet lifetime

- start()
  - Restarts an applet after it stops
  - Including first time started
  - Called every time web page is redisplayed by browser (uncovered, reloaded, etc.)

Painting

- paint()
  - Called by AWT whenever applet must paint itself
    - Window covered by another window, then uncovered
    - Minimized, then restored
    - Applet first started

- repaint()
  - Method that you can call to tell applet to repaint itself

Termination

- stop()
  - Called whenever web page is left

- destroy()
  - Called whenever applet needs to be removed from memory (e.g., web browser closed)

Graphics

- Graphics class contains many methods for producing graphical output:
  - drawString
  - drawLine
  - drawRect, fillRect
  - drawRoundRect, fillRoundRect
  - drawOval, fillOval
  - drawArc, fillArc
  - drawPolygon, fillPolygon
  - drawPolyline

- See LL 2.10, 6.6

Colors

- Color class is used to manage colors
- Every graphics context has a foreground and background color
  - setColor(Color c) // foreground
  - setBackground(Color c)
- Color defines several constants for making it easy to use colors
  - Color.red, Color.blue, etc.
  - See LL 2.10
Fonts

- Represented by Font class (see LL Appendix M)
- To change fonts:
  - Save the old font:
    ```java
    Font oldFont = g.getFont();
    ```
  - Create a new Font object:
    ```java
    Font f = new Font(name, style, size);
    ```
    - `name` is a String, e.g., "Courier"
    - Style is a constant: Font.PLAIN, Font.BOLD, Font.ITALIC
    - `size` is an integer point size, e.g., 12
  - Set the font:
    ```java
    g.setFont(f);
    ```
  - Eventually, restore the original font:
    ```java
    g.setFont(oldFont);
    ```

Events and Listeners

- An event is an object that represents some occurrence in which an applet might be interested
  - e.g., user pressing mouse button, typing a key, pushing a button, moving a scroll bar, etc.
  - Has methods to determine information about event
- A listener is an object that waits for events to occur and then responds to them
  - Has methods that are called when event occurs

Mouse-related Events

- Mouse events:
  - mouse pressed
  - mouse released
  - mouse clicked
  - mouse entered
  - mouse exited
- Mouse motion events:
  - mouse moved
  - mouse dragged

Listening for Mouse Events

- To listen, an object must implement the MouseListener interface
- The object must also register itself with the applet as a listener
  - Easy way: make the applet itself the listener

Trivial Listener

```java
import java.applet.*;
import java.awt.*;
import java.awt.event.*;

public class TrivialMouseListenerApplet extends Applet
    implements MouseListener {
    public void init() {
        addMouseListener(this);
    }
    public void mousePressed(MouseEvent event) {
    }
    public void mouseReleased(MouseEvent event) {
    }
    public void mouseClicked(MouseEvent event) {
    }
    public void mouseEntered(MouseEvent event) {
    }
    public void mouseExited(MouseEvent event) {
    }
}
```

Implementing Listeners

- To make listener less trivial, we can react to the event.
- The MouseEvent object can tell us where mouse was clicked:
  - `int getX()`
  - `int getY()`
  - `Point getPoint()`
- See LL 5.5
Implementing Listeners

private Point clickPoint = null;
public void mouseClicked(MouseEvent event) {
    clickPoint = event.getPoint();
    repaint();
}

Components

- A component is a visual entity that allows the user to interact with a program or displays information
- Examples:
  - buttons
  - text fields
  - labels
  - scroll bars
  - checkboxes
  - lists

Components [2]

- An applet itself is a component
  - Also a container - component that contains components
- Components must be added to a container in order to be displayed
  - Added using add method of the container
  - Can't specify exactly where to add without advanced usage of LayoutManagers

Components [3]

- Components generate events
  - Buttons and text fields generate ActionEvents
- The component must have a listener added to it in order to process these events
- Again, the applet itself can be that listener

Component Example

public class GolfStrokesApplet extends Applet
    implements ActionListener {
    private int numStrokes = 0;
    private Label strokes;
    private Button inc, dec;
    ...
}

Component Example [2]
Component Example [3]

```java
public void init() {
    strokes = new Label("0");
    inc = new Button("+1");
    dec = new Button("-1");
    add(strokes);
    add(inc);
    add(dec);
    inc.addActionListener(this);
    dec.addActionListener(this);
}
```

Component Example [4]

```java
public void actionPerformed(ActionEvent event) {
    String button = event.getActionCommand();
    Object source = event.getSource();
    if (source == inc) {
        numStrokes++;
    } else if (source == dec) {
        numStrokes--;
    }
    strokes.setText("" + numStrokes);
}
```

For Lab Tomorrow

- Read the lab handout in advance
  - First program requires some creativity
  - You’ll want to have an idea before you arrive