Java Graphics
and
Applets

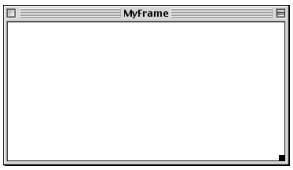
Java Graphics

- Two main Graphics libraries:
  - java.awt (Abstract Window Toolkit)
    - older
    - accepted by most web browsers
  - java.swing
    - newer
    - more portable (less sensitive to window system)
    - might not be support on your browser, without plugins

We will use awt

- relatively simple to use
- works on most browsers

class *Frame: Basic "window"*



Drawing on Objects

- In order to draw in a frame or other objects, an Object of class

  Graphics

  must first be obtained for the frame. This is referred to as a graphics **context**. This is done using the call

  `getGraphics()`

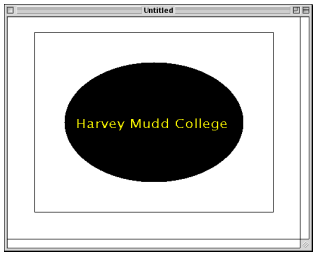
  which returns a Graphics object.

abstract class *Graphics*

- Think of a Graphics object as being like a **canvas** on which drawing takes place.
- The actual display of what is drawn is usually done behind the scenes, without giving an explicit command to display the Graphics object.
- Graphics objects have other uses too, e.g. printing.

A Simple Graphics Program

Desired Result




```
import java.awt.*;                        // to get awt

public class MyFrame1 extends Frame     // Customize Frame class
{

// test Program

public static void main(String[] arg)
  {
  new MyFrame1("My Frame", 50,  50);
  }


// construct frame with title and position

MyFrame1(String title, int x, int y)
  {
  setTitle(title);

  setBackground(Color.white);              // set the background color

  reshape(x, y, 500, 400);                 // set the location and size

  setVisible(true);                        // show the frame

  toFront();
  }
```

```
// draw items in Graphics in Frame; called by paint()

void drawStuff()
  {
  Graphics g = getGraphics();
  g.setColor(Color.black);                  // set the color for drawing
  g.drawRect(50, 50, 400, 300);             // draw a rectangle
  g.fillOval(100, 100, 300, 200);           // fill an oval

  g.setFont(new Font("Times", Font.BOLD, 20));
  g.setColor(Color.yellow);
  g.drawString("Harvey Mudd College", 120, 210);  // draw a string
  }


// paint(Graphics) will be called by the system to paint the Frame when
// necessary, e.g. when setVisible(true) is called.
// This call is done implicitly; we do not see it in the source.
// The Graphics of the frame will then be passed as an argument.

public void paint(Graphics g)
  {
  drawStuff();
  }
}
```

Typical awt Drawing Methods

- `void drawLine(int x1, int y1, int x2, int y2)`
- `void drawRect(int x, int y, int width, int height)`
- `void drawOval(int x, int y, int width, int height)`
- `void drawPolygon(int[] xPoints, int[] yPoints, int nPoints)`
- `void drawArc(int x, int y, int width, int height, int startAngle, int arcAngle)`
- `void drawString(String str, int x, int y)`
- `void drawImage(Image img, int x, int y, Color bgcolor, ImageObserver observer)`
- Blue bullets also have fill instead of draw.

Frame Buffering

This may be somewhat confusing.

Follow the lead of canned examples when in doubt, which may be most of the time.

This is a legacy from the Java designers.

paint() method

some **event** occurs, such as setting Frame visible, or `repaint()` called explicitly

The `update()` method can be over-ridden.

`update()` is called on Graphics of Frame, resulting in:

Frame being **cleared** with **background** color, then

`paint()` is called on Graphics of Frame

whatever is drawn in paint is displayed

Flicker Prevention 1

- Clearing the background in `update()` can create lots of **flicker** in the application.
- It is customary to **over-ride** `update()` in the customized frame as follows:

```
public void update(Graphics g)
  {
  paint(g);
  }
```

Flicker Prevention 2

- Instead of painting the background, then drawing on it, it is better to "paint" a complete image covering the visible area of the Frame.
- This image is known as an

  off-screen buffer

  because the buffer is not part of the Frame.
- The buffer is drawn on prior to `update()`.
- The buffer contents is then painted in `update()`.

```
public class MyFrame2 extends Frame    // Customize Frame class
{
Image buffer;

public void update(Graphics g)
  {
  paint(g);
  }

void drawStuff()
  {
  Graphics g = buffer.getGraphics();
  ... as before ...
  }

public void paint(Graphics g)
  {
  if( buffer == null )
    buffer = createImage(getWidth(), getHeight());
  drawStuff();
  g.drawImage(buffer, 0, 0, null);
  }
```

No Flicker 2: off-screen buffer

No Flicker 1: over-ride update()

draw on buffer Graphics, not on Frame Graphics

create buffer on demand

could also be done elsewhere

paint the buffer into the frame

Flicker Prevention Summary

some event occurs, such as setting Frame visible, or `repaint()`

`update()` is called on Graphics of Frame, resulting in:

`paint()` is called on Graphics of Frame

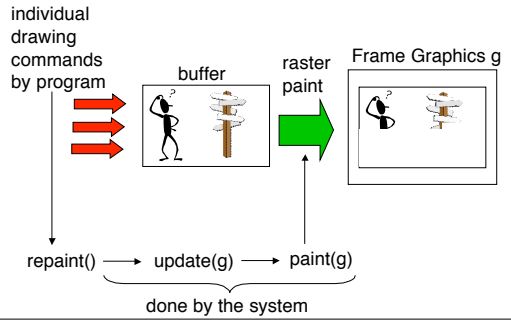
drawing is on **buffer** → **buffer** is painted on Graphics of Frame

`repaint()`

- When the programmer wants to force repainting of the Frame, she calls

  `repaint()`
- This causes the system to schedule a call to `update()`.
- `repaint()` has no arguments.
- The programmer normally does not call `paint()` directly, outside of `update()`.

repaint() -> paint()



Applets

- "Applet" means "small application"
- Run in one of two ways:
  - In a web browser
  - Using a program appletviewer
- Applet runs in a specialized Frame (type of window)
- No `main()`; instead: `init()`, `run()`.

Viewing Applets on the Web or using appletviewer

contents of MyApplet1.html:

```
<html>
<title>MyApplet1</title>
<head>
<!-- MyApplet1 applet-->
</head>
<body>

<applet code=MyApplet1.class width=500 height=400></applet>

</body>
</html>
```

HTML comment

run by:

```
appletviewer MyApplet1.html
```

Web Applet Restrictions

- Might not be able to load *files* on server or client
- Instead load content of URL's, but maybe only from the same server that contains the applet code

Examples

- appletGraphics example on our web pages
- and others

CS60 BaseApplet

- The class BaseApplet was created to provide functionality of a type useful in CS 60 assignments.
- It sets up the off-screen buffering.
- It provides a real-time loop:
  - Program over-rides step() to have her method called in the loop.
  - Programmer over-rides continue() to possibly terminate the loop.
- Programmer over-rides mouse methods to get mouse input.
- Examples of using menu inputs are provided.