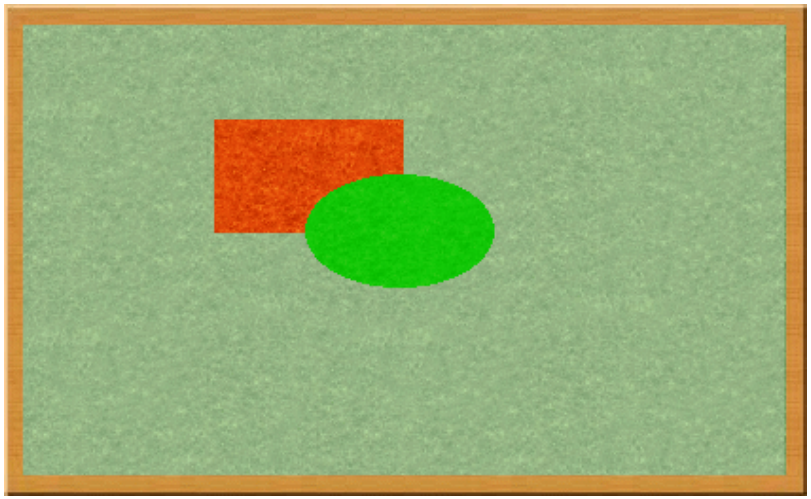
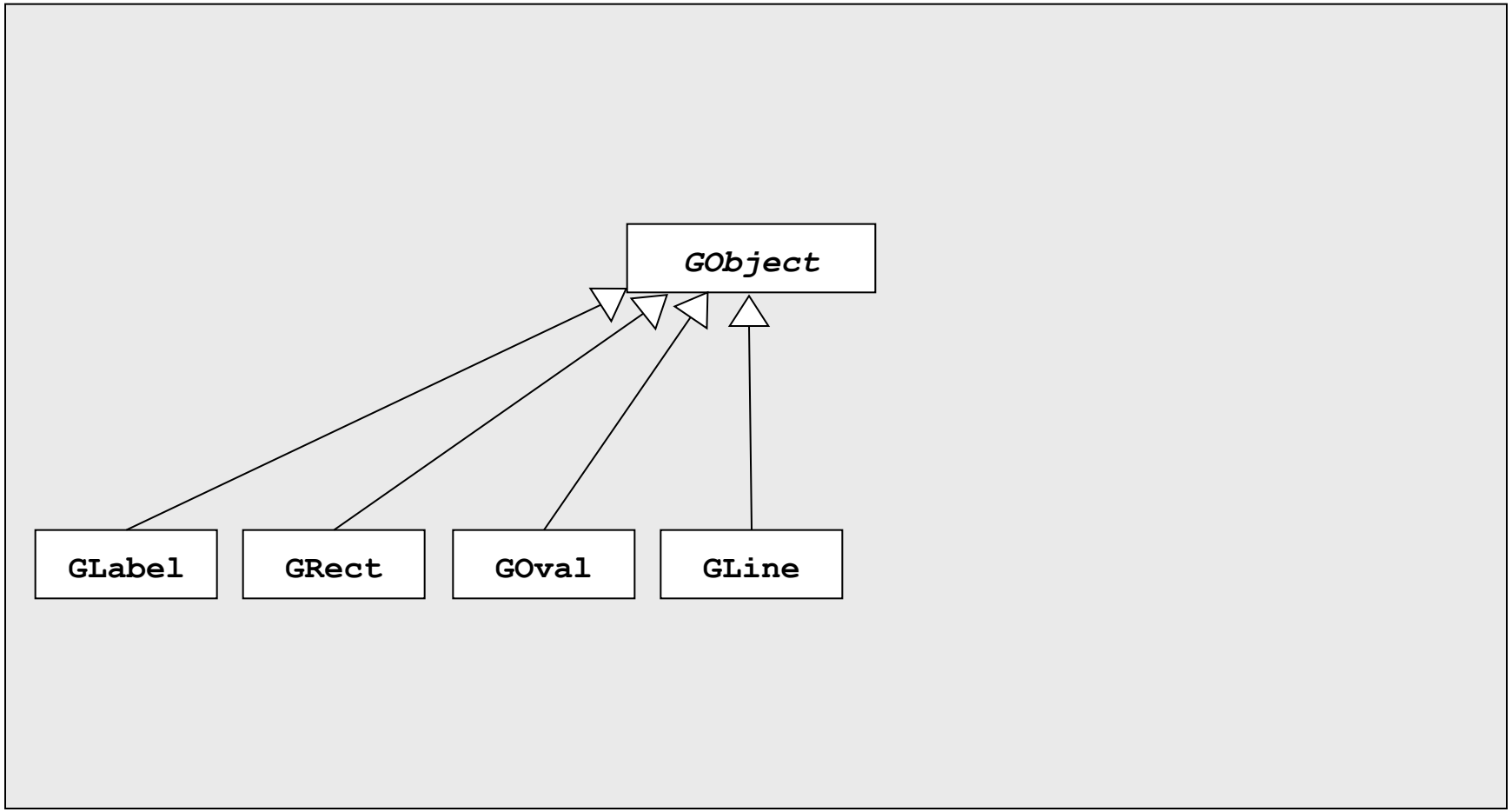
Revisiting `acm.graphics`

- **collage** model
  - create image by adding objects to a canvas



- Newer objects obscure those added earlier
- Layering is called the **stacking order** (or *z*-order)

Structure of **`acm.graphics`** Package



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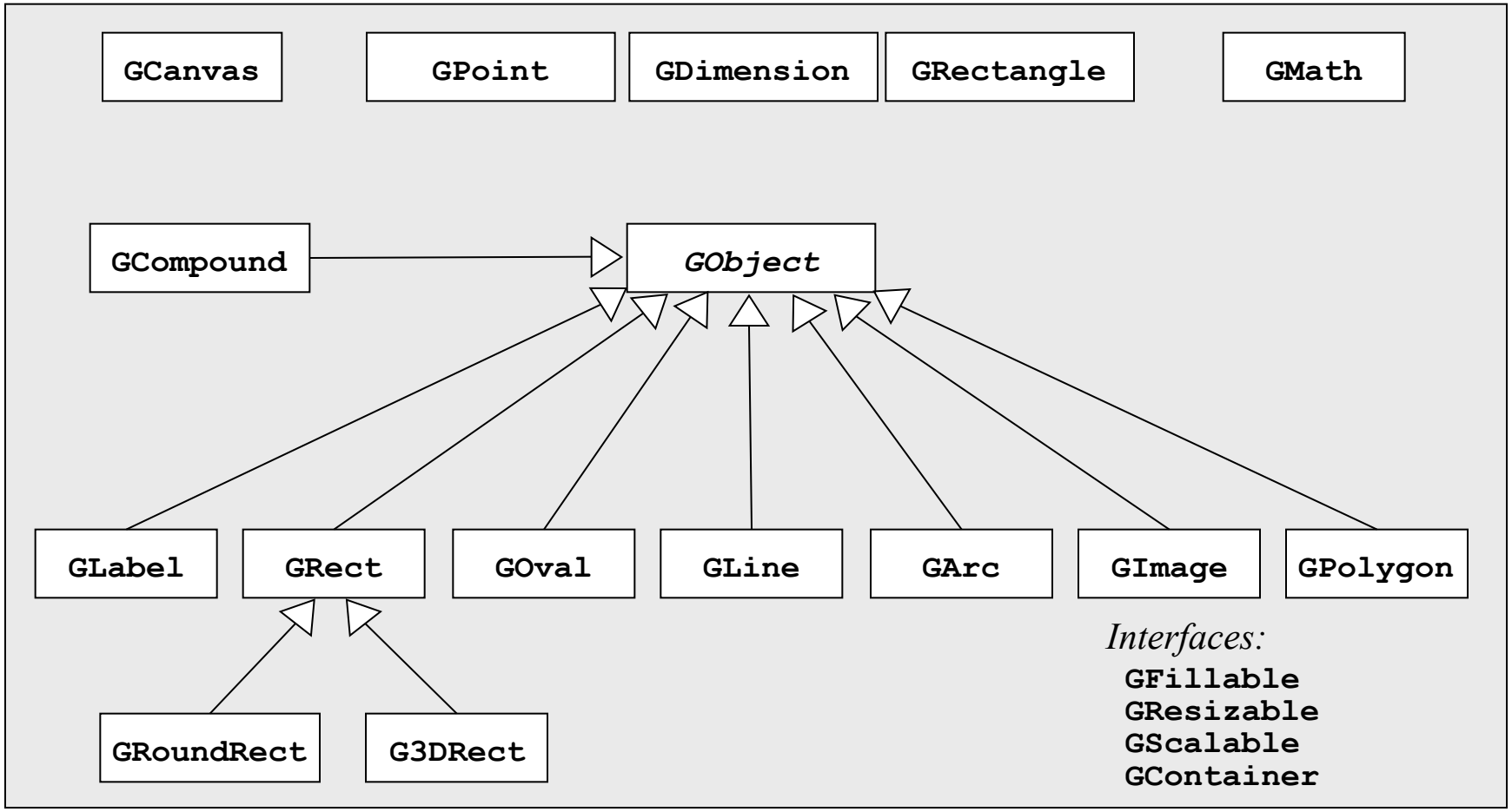
Structure of **acm.graphics** Package



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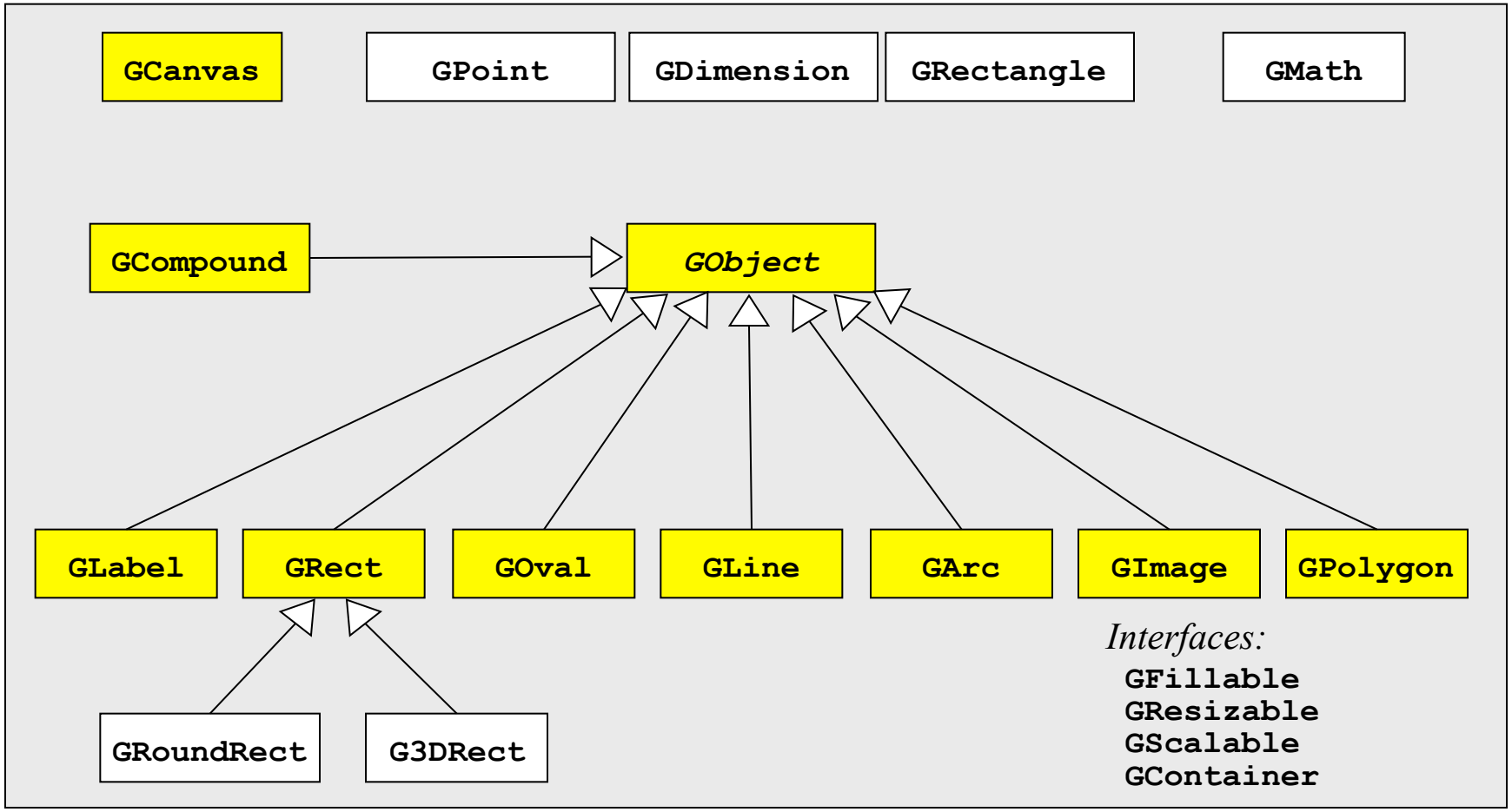
Structure of **acm.graphics** Package



Using portions of slides by Eric Roberts

`GCanvas`

- Used to represent background canvas of collage
- **`GraphicsProgram`** automatically creates **`GCanvas`** that fills the entire program window
- When you call **`add(…)`** in **`GraphicsProgram`**, it is *forwarding* your call to the **`GCanvas`**
  - Forwarding is just when receiver of message then calls some other object with that same message

Using portions of slides by Eric Roberts

Methods in **`GCanvas`** and **`GraphicsProgram`**

The following methods are available in both the **`GCanvas`** and **`GraphicsProgram`** classes:

`add(`*object*`)`**	Adds the object to the canvas at the front of the stack
`add(`*object*`, `*x*`, `*y*`)`**	Moves the object to (*x*, *y*) and then adds it to the canvas
`remove(`*object*`)`**	Removes the object from the canvas
`removeAll()`	Removes all objects from the canvas
`getElementAt(`*x*`, `*y*`)`**	Returns the frontmost GObject at (*x*, *y*), or **`null`** if none
`getWidth()`	Returns the width in pixels of the entire canvas
`getHeight()`	Returns the height in pixels of the entire canvas
`setBackground(`*c*`)`**	Sets the background color of the canvas to *c*.

The following methods are available in **`GraphicsProgram`** only:

`pause(`*milliseconds*`)`**	Pauses the program for the specified time in milliseconds
`waitForClick()`	Suspends the program until the user clicks the mouse

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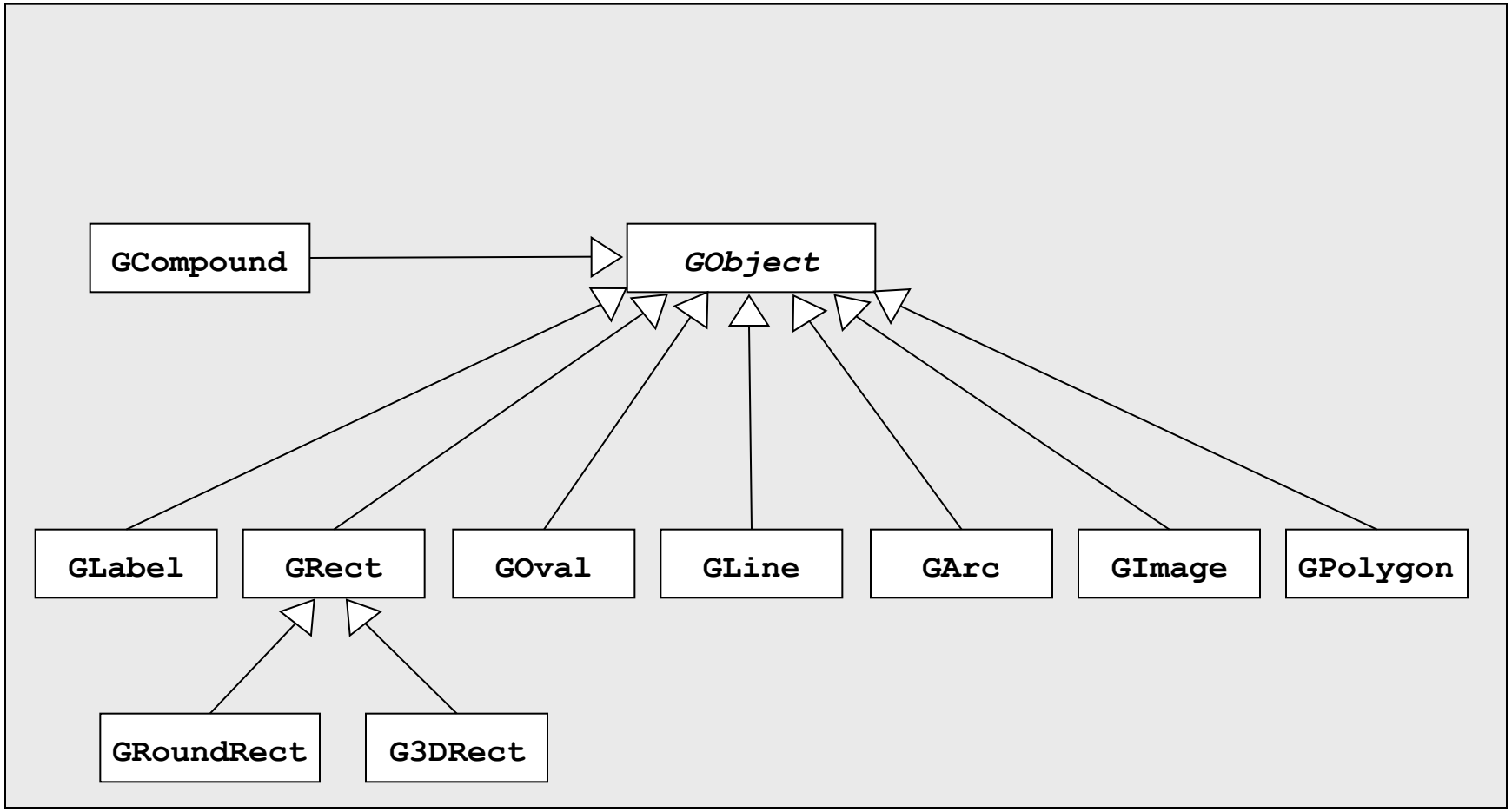
Class hierarchy of **GObject**



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Methods Common to All `GObject`s

`setLocation(`*x*`,` *y*`)`**	Resets the location of the object to the specified point
`move(`*dx*`,` *dy*`)`**	Moves the object *dx* and *dy* pixels from its current position
`getX()`	Returns the *x* coordinate of the object
`getY()`	Returns the *y* coordinate of the object
`getWidth()`	Returns the horizontal width of the object in pixels
`getHeight()`	Returns the vertical height of the object in pixels
`contains(`*x*`,` *y*`)`**	Returns **`true`** if the object contains the specified point
`setColor(`*c*`)`**	Sets the color of the object to the **`Color`** *c*
`getColor()`	Returns the color currently assigned to the object
`setVisible(`*flag*`)`**	Sets the visibility flag (**`false`**=invisible, **`true`**=visible)
`isVisible()`	Returns **`true`** if the object is visible
`sendToFront()`	Sends the object to the front of the stacking order
`sendToBack()`	Sends the object to the back of the stacking order
`sendForward()`	Sends the object forward one position in the stacking order
`sendBackward()`	Sends the object backward one position in the stacking order

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Methods Defined by Interfaces

`GFillable` (`GRect`, `GOval`, `GArc`, `GPolygon`)

`setFilled(`*flag*`)`	Sets the fill state for the object (`false`=outlined, `true`=filled)
`isFilled()`	Returns the fill state for the object
`setFillColor(`*c*`)`	Sets the color used to fill the interior of the object to *c*
`getFillColor()`	Returns the fill color

`GResizable` (`GOval`, `GRect`, `GImage`)

`setSize(`*width*`,` *height*`)`	Sets the dimensions of the object as specified
`setBounds(`*x*`,` *y*`,` *width*`,` *height*`)`	Sets the location and dimensions together

`GScalable` (`GLine`, `GOval`, `GRect`, `GArc`, `GCompound`, `GImage`, `GPolygon`,)

`scale(`*sf*`)`	Scales both dimensions of the object by *sf*
`scale(`*sx*`,` *sy*`)`	Scales the object by *sx* horizontally and *sy* vertically

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A little animation demo: `BouncingBall.java`

Event-driven Programs

- When users interact with computer they generate events (e.g., moving/clicking the mouse, typing, etc.)
- Can respond to events by having **listener** for events

```
addMouseListeners();
addKeyListerners();
```

- Use Java library the deals with events:

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

- Methods of a listener get called *asynchronously* when events occur

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Responding to Mouse Events

General steps:

1. **`init`** or **`run`** method should call **`addMouseListeners()`**
2. Write definitions of any listener methods needed

`mouseClicked(`*e***`)`**	Called when the user clicks the mouse
`mousePressed(`*e***`)`**	Called when the mouse button is pressed
`mouseReleased(`*e***`)`**	Called when the mouse button is released
`mouseMoved(`*e***`)`**	Called when the user moves the mouse
`mouseDragged(`*e***`)`**	Called when the mouse is dragged with the button down

The parameter *e* is **`MouseEvent`** object, which provides more data about event, such as the location of mouse.

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MouseTracker Example

Responding to Keyboard Events

General steps:

1. **`init`** or **`run`** method should call **`addKeyListeners()`**
2. Write definitions of any listener methods needed

`keyPressed(`*e***`)`**	Called when the user presses a key
`keyReleased(`*e***`)`**	Called when the key comes back up
`keyTyped(`*e***`)`**	Called when the user types (presses and releases) a key

The parameter *e* is a **`KeyEvent`** object, which indicates which key is involved.

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The `GLabel` Class

```
public class HelloProgram extends GraphicsProgram {
   public void run() {
      GLabel label = new GLabel("hello, world", 100, 75);
      label.setFont("SansSerif-36");
      label.setColor(Color.RED);
      add(label);
   }
}
```

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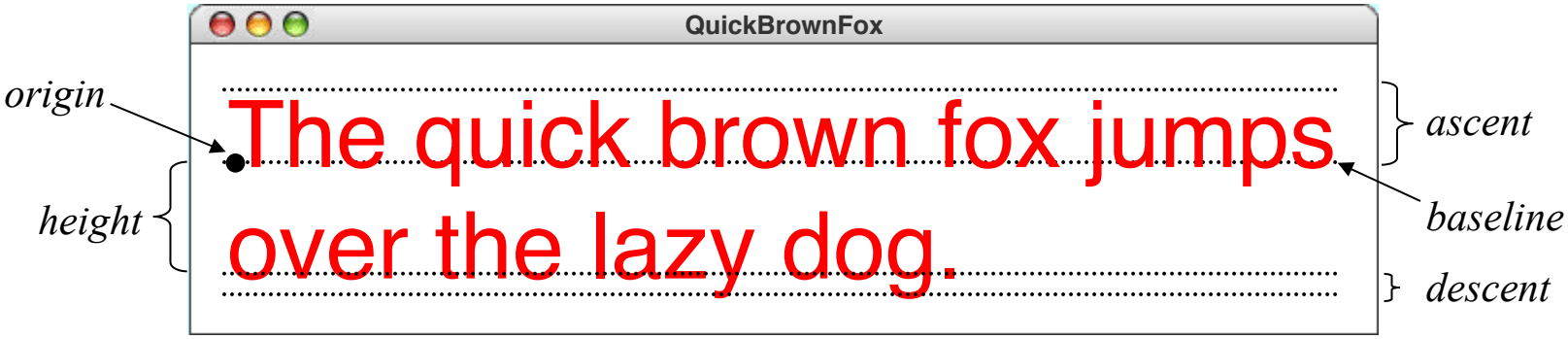
The Geometry of the `GLabel` Class

- The `GLabel` class typesetting concepts:
  - **baseline**: imaginary line on which the characters rest.
  - **origin**: point on the baseline at which the label begins.
  - **height** (of font): distance between successive baselines.
  - **ascent**: distance characters rise above the baseline.
  - **descent**: distance characters drop below the baseline.



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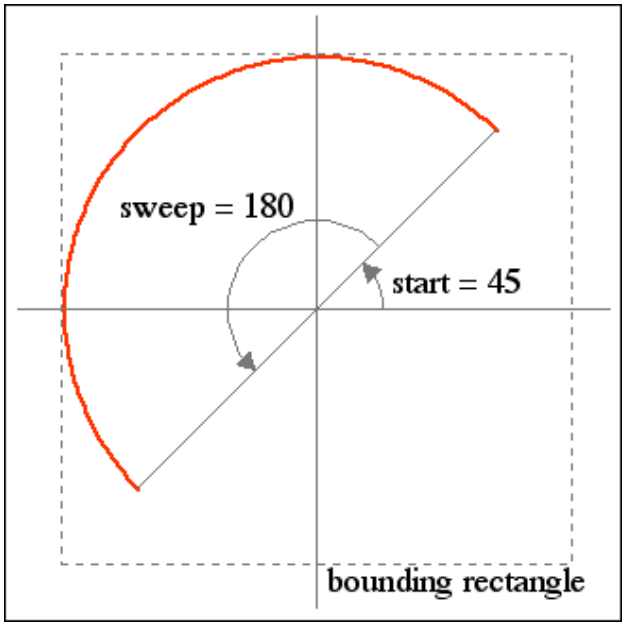
The `GArc` Class

- **`GArc`** – arc formed by taking section from perimeter of oval.
- Conceptually, steps necessary to define an arc are:
  - Specify the coordinates and size of the bounding rectangle
  - Specify **start angle** (angle at which the arc begins)
  - Specify **sweep angle** (how far the arc extends)

- Angles measured in degrees starting at the +*x* axis (the 3:00 o'clock position) and increasing **counterclockwise**.
- Negative values for the *start* and *sweep* angles signify a clockwise direction.



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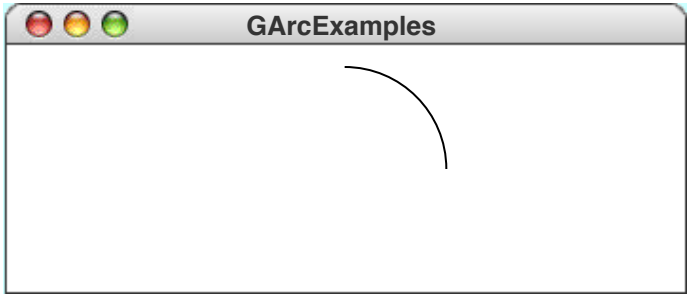
`GArc` Geometry

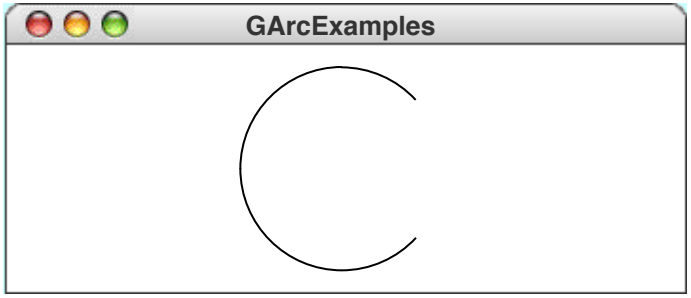
Assume: **`cx`** and **`cy`** are coordinates of window center

`d` (diameter) is 0.8 times the screen height.

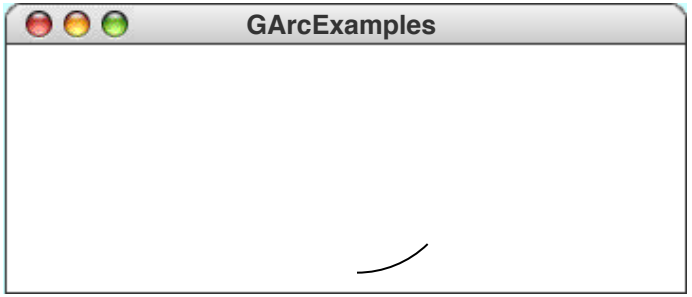
```
GArc a1 = new GArc(d, d, 0, 90);
add(a1, cx - d / 2, cy - d / 2);
```



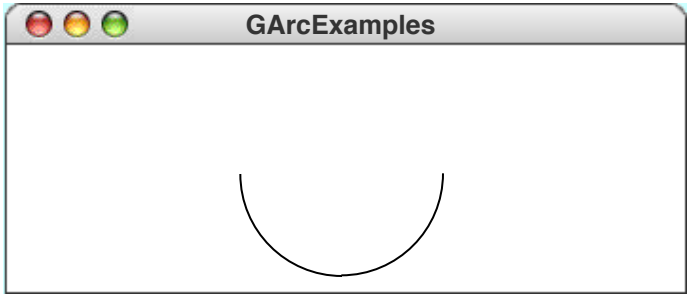

```
GArc a2 = new GArc(d, d, 45, 270);
add(a2, cx - d / 2, cy - d / 2);
```




```
GArc a3 = new GArc(d, d, -90, 45);
add(a3, cx - d / 2, cy - d / 2);
```




```
GArc a4 = new GArc(d, d, 0, -180);
add(a4, cx - d / 2, cy - d / 2);
```

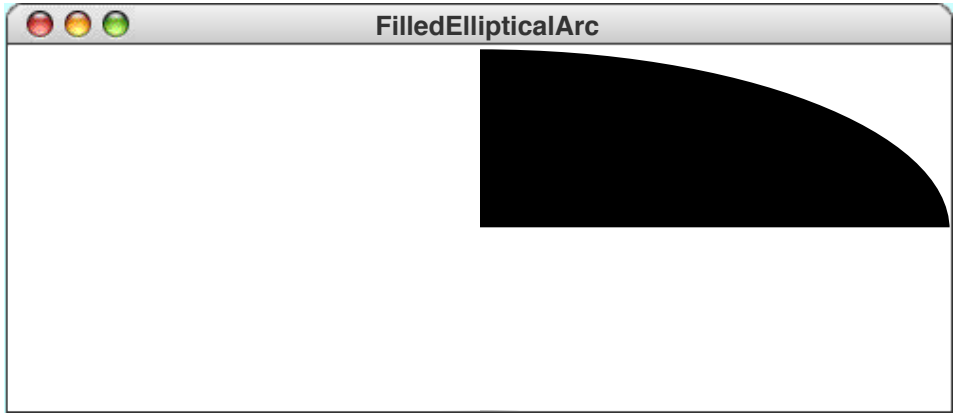


Filled Arcs

- **`GArc`** class implements **`GFillable`** interface

- Filled **`GArc`** is the pie-shaped wedge formed by the center and the endpoints of the arc

```
public void run() {
   GArc arc = new GArc(0, 0, getWidth(), getHeight(),
                       0, 90);
   arc.setFilled(true);
   add(arc);
}
```



The **`GImage`** Class

- **`GImage`** class is used to display an image from a file

`new GImage(`*image file*`,` *x*`,` *y*`)`**

image file: name of a file containing image

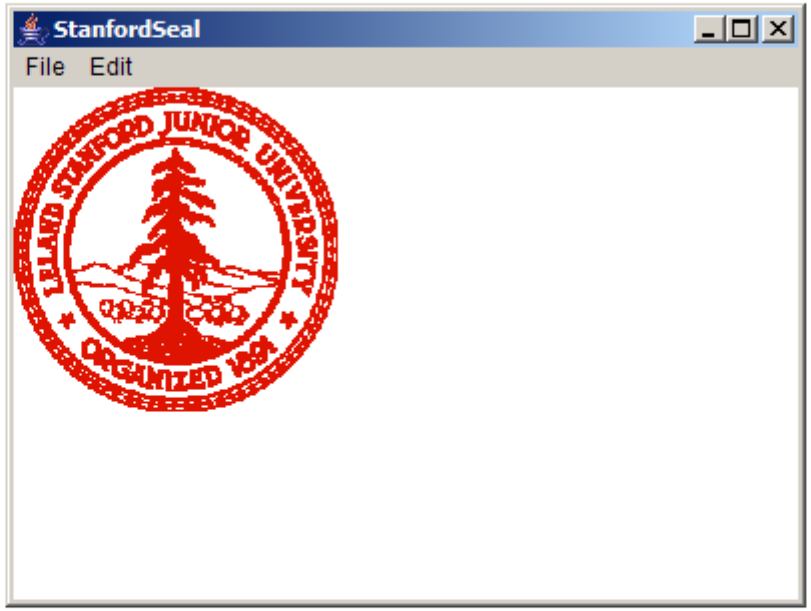
x and *y*: coordinates of upper left corner of image

- Looks for file in current project directory and then in a subdirectory named **`images`**.
- GIF (**`.gif`**) and JPEG (**`.jpg`** or **`.jpeg`**) supported

Using portions of slides by Eric Roberts

Example of the `GImage` Class

```
public void run() {
   GImage image = new GImage("StanfordSeal.gif");
   add(image, 0, 0);
}
```



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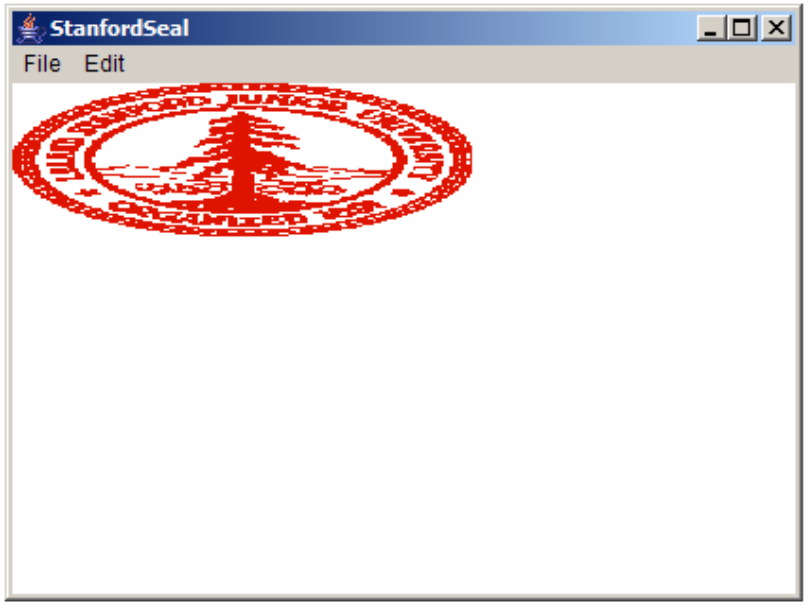
Resizing GImages

```
public void run() {
   GImage image = new GImage("StanfordSeal.gif");
   image.scale(1.5, 0.5);
   add(image, 0, 0);
}
```



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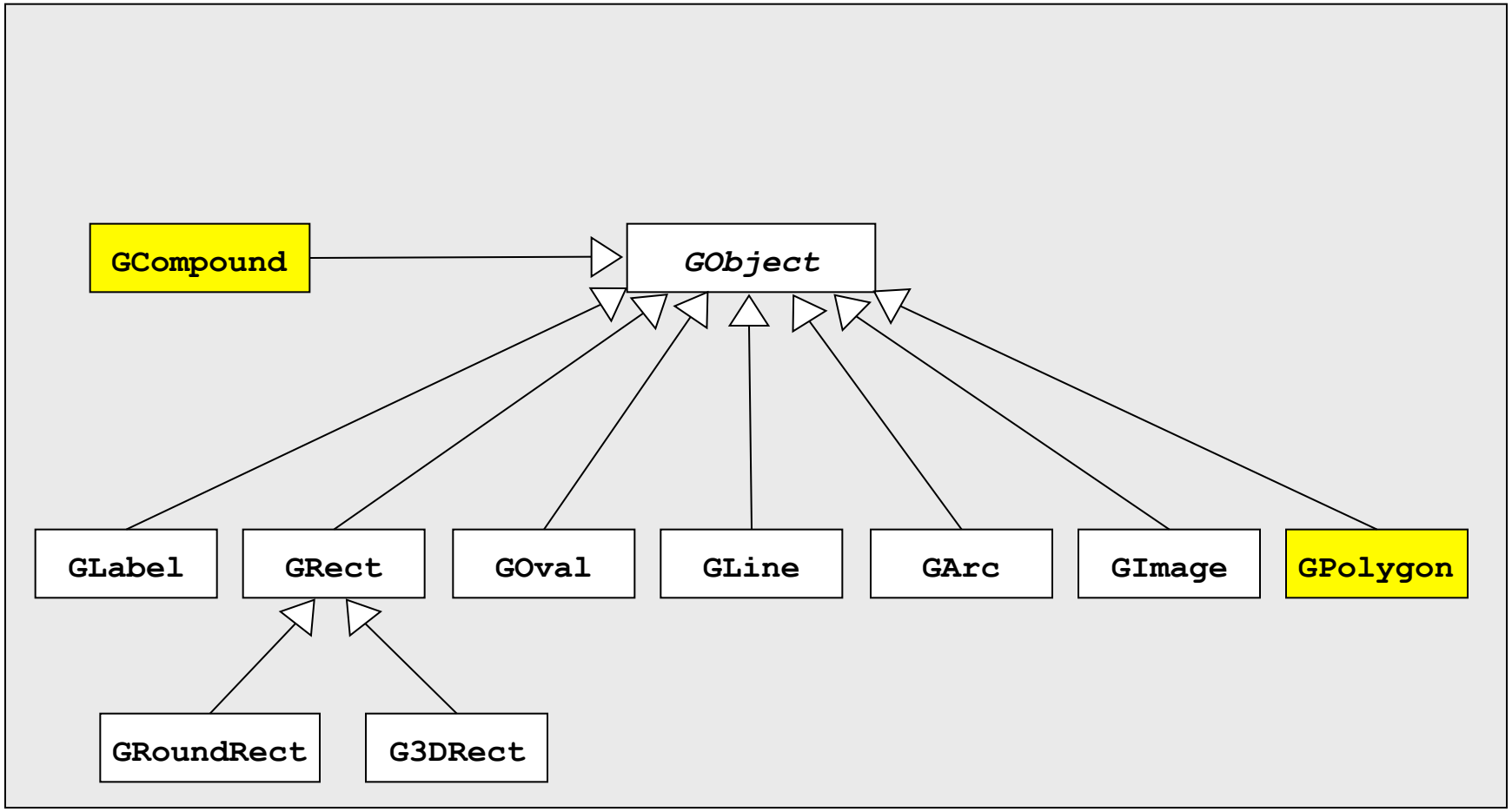
Class hierarchy of `GObject`



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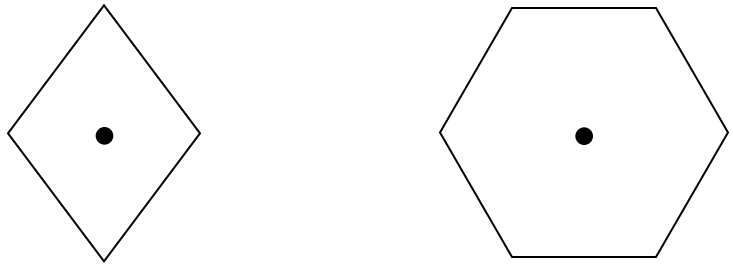
The `GPolygon` Class

- **`GPolygon`**: represent graphical objects bound by line segments.



- A **`GPolygon`** has a **reference point** that is convenient for that particular shape
- Position the vertices relative to that reference point.
- Convenient reference point is often center of object.

Using portions of slides by Eric Roberts

Constructing a `GPolygon` Object

- Create an empty polygon
- Add vertices one at a time using **`addVertex(`***x*`, `*y*`)`**
  - *x* and *y* relative to **reference point** of polygon
- After setting initial vertex using **`addVertex(`***x*`, `*y*`)`**, can add remaining ones using:
  - **`addVertex(`***x*`, `*y*`)`** adds a new vertex relative to the reference point
  - **`addEdge(`***dx*`, `*dy*`)`** adds a new vertex relative to the preceding one
- Polygon "closed" for you
  - automatically attaches first and last vertices

Using portions of slides by Eric Roberts

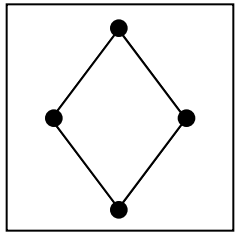
Drawing a Diamond (`addVertex`)

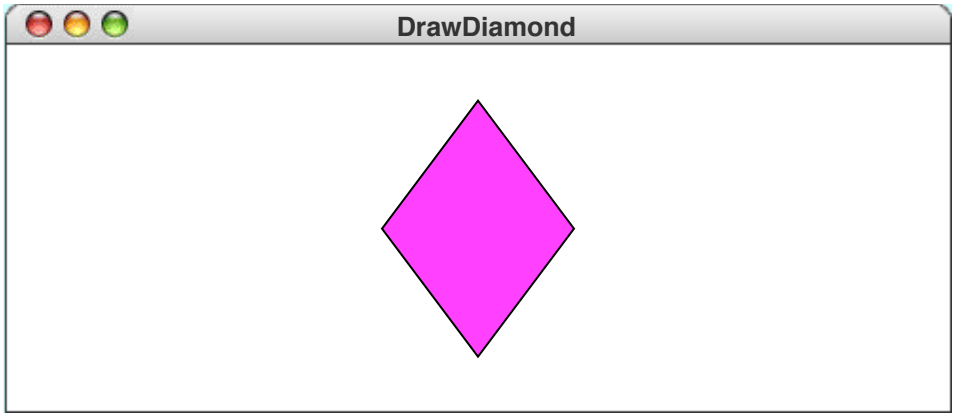
The following program draws a diamond using **`addVertex`**:

```
public void run() {
```

```
private GPolygon createDiamond(double width, double height) {
   GPolygon diamond = new GPolygon();
   diamond.addVertex(-width / 2, 0);
   diamond.addVertex(0, -height / 2);
   diamond.addVertex(width / 2, 0);
   diamond.addVertex(0, height / 2);
   return diamond;
}
```

diamond

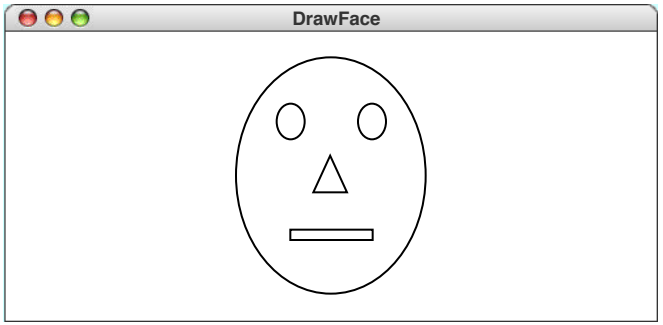




skip simulation

The `GCompound` Class

- **`GCompound`** allows for combining several graphics objects so they behave like one **`GObject`**
- Add objects to a **`GCompound`** (like it was a canvas)
- You can treat whole **`GCompound`** as one object
- Similar to **`GPolygon`**, a **`GCompound`** has a reference point that all objects are added with respect to
- When **`GCompound`** is added to canvas, it is placed relative to its reference point
- Let's draw a face:



Draw Face and Bouncing Face Examples