Graphical Structures

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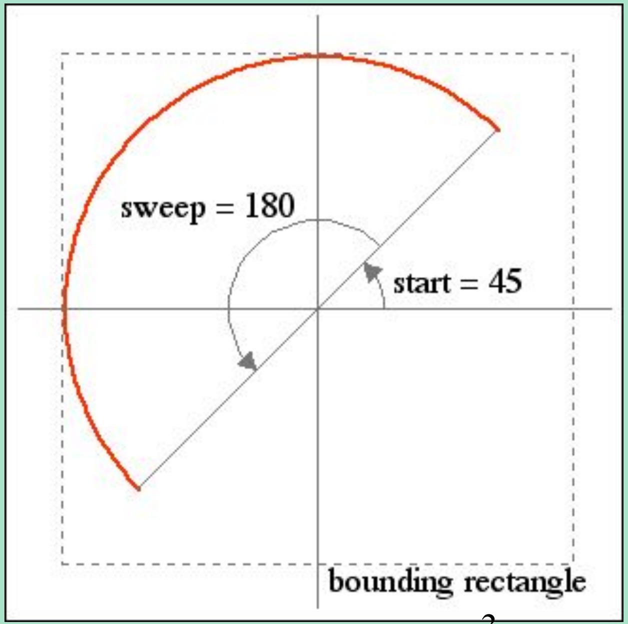
Graphical Structures

The **`GArc`** Class

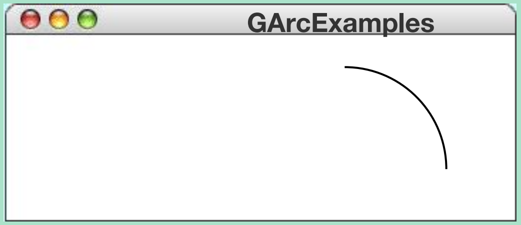
- The **`GArc`** class represents an arc formed by taking a section from the perimeter of an oval.
- Conceptually, the steps necessary to define an arc are:
  - Specify the coordinates and size of the bounding rectangle.
  - Specify the ***start angle***, which is the angle at which the arc begins.
  - Specify the ***sweep angle***, which indicates how far the arc extends.
- The geometry used by the **`GArc`** class is shown in the diagram on the right.
- In keeping with the graphics model, angles are 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.



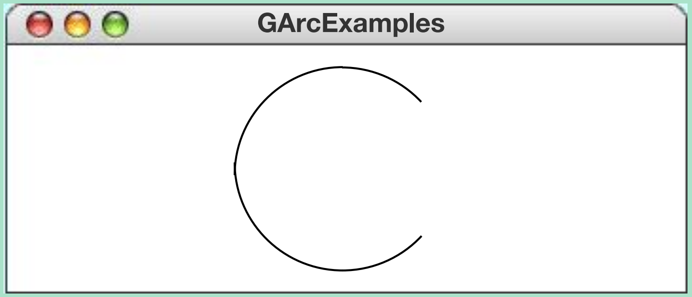
Exercise: `GArc` Geometry

Suppose that the variables **`cx`** and **`cy`** contain the coordinates of the center of the window and that the variable **`d`** is 0.8 times the screen height. Sketch the arcs that result from each of the following code sequences:

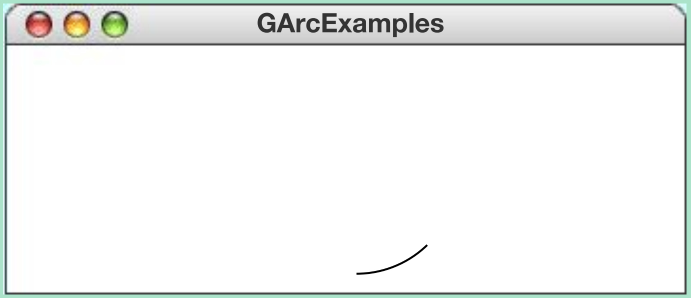
```
var a1 = GArc(d, d, 0, 90);
gw.add(a1, cx - d / 2, cy - d / 2);
```



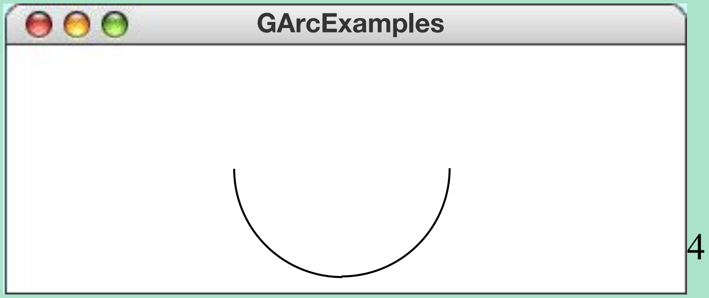
```
var a2 = GArc(d, d, 45, 270);
gw.add(a2, cx - d / 2, cy - d / 2);
```



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



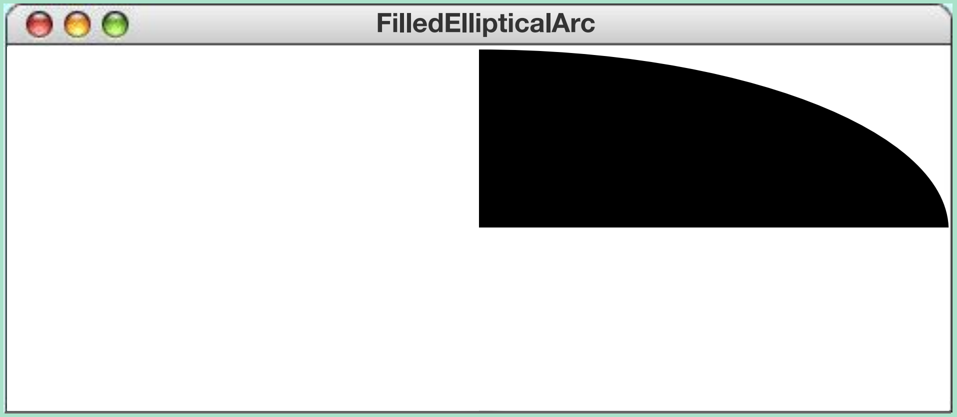
```
var a4 = GArc(d, d, 0, -180);
gw.add(a4, cx - d / 2, cy - d / 2);
```



Filled Arcs

- The **`GArc`** class implements the functions **`setFilled`** and **`setFilledColor`**.
- A filled **`GArc`** is displayed as the pie-shaped wedge formed by the center and the endpoints of the arc, as follows:

```
function FilledEllipticalArc() {
   var gw = GWindow(GWINDOW_WIDTH, GWINDOW_HEIGHT);
   var arc = GArc(0, 0, gw.getWidth(), gw.getHeight(),
                       0, 90);
   arc.setFilled(true);
   gw.add(arc);
}
```



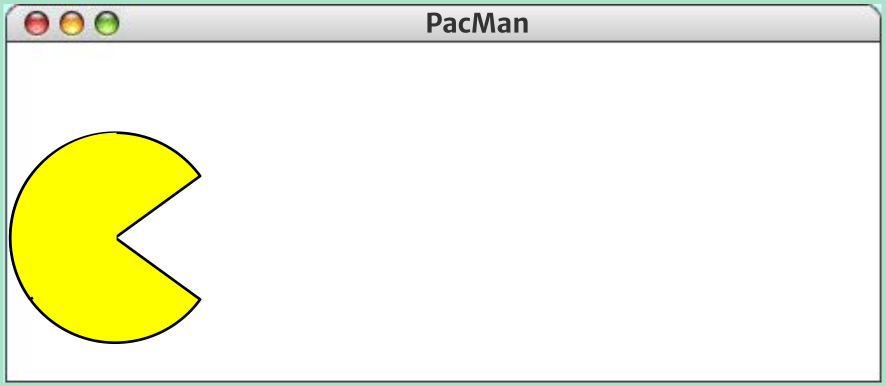
Additional Methods for **`GArc`**

`setStartAngle(`*start***`)`**	Sets the start angle for the arc
`getSweepAngle()`	Returns the start angle for the arc
`setSweepAngle(`*sweep***`)`**	Sets the sweep angle for the arc
`getSweepAngle()`	Returns the sweep angle
`setFrameRectangle(`*x, y, width, height***`)`**	Resets the bounds for the frame

- These methods allow you to animate the appearance of an arc.
- The **`setStartAngle`** and **`setSweepAngle`** methods make it possible to change the starting position and the extent of the arc dynamically.
- The **`setFrameRectangle`** method changes the bounds of the rectangle circumscribing the oval from which the arc is taken.

Exercise: PacMan

- Write a program that uses the GArc class to display a PacMan figure at the left edge of the graphics window.
- Add the necessary timer animation so that PacMan moves to the right edge of the window. As it moves, your program should change the start and sweep angles of the arc so that the mouth appears to open and close.



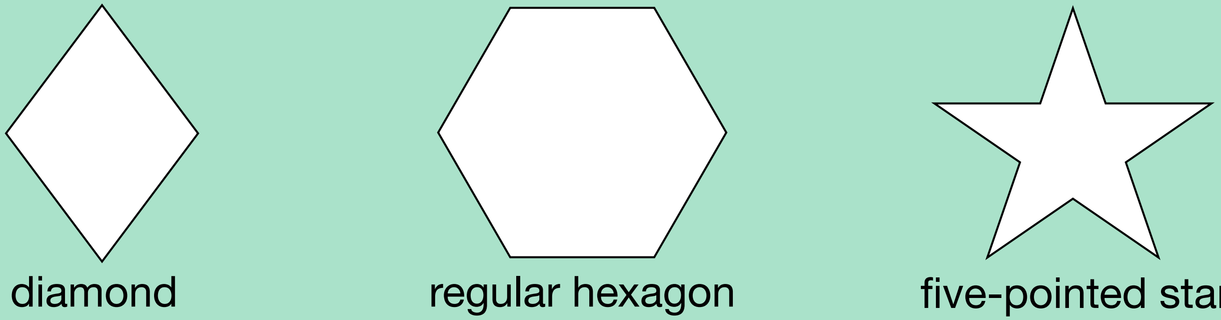
Questions about the PacMan Problem

- We're going to divide into four groups and spend the next five minutes discussing important questions you would need to answer while solving the PacMan problem. Each group will discuss <u>one</u> of the following four questions:

1. How would you create the initial PacMan object at the left of the window?
2. What needs to happen on each time step?
3. How do you get the program to stop?
4. How would you design milestones that would allow you to test the program in pieces?

The `GPolygon` Class

- The `GPolygon` class is used to represent graphical objects bound by line segments. In mathematics, such figures are called ***polygons*** and consist of a set of ***vertices*** connected by ***edges***. The following figures are examples of polygons:



- Unlike the other shape classes, that location of a polygon is not fixed at the upper left corner. What you do instead is pick a ***reference point*** that is convenient for that particular shape and then position the vertices relative to that reference point.
- The most convenient reference point is usually the geometric center of the object.

Constructing a `GPolygon` Object

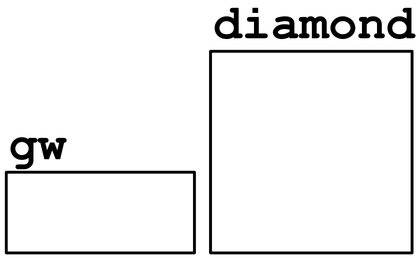
- The **`GPolygon`** function creates an empty polygon. Once you have the empty polygon, you then add each vertex to the polygon, one at a time, until the entire polygon is complete.
- The most straightforward way to create a **`GPolygon`** is to call the method **`addVertex(`***x*, *y***`)`**, which adds a new vertex to the polygon. The *x* and *y* values are measured relative to the reference point for the polygon rather than the origin.
- When you start to build up the polygon, it always makes sense to use **`addVertex(`***x*, *y***`)`** to add the first vertex. Once you have added the first vertex, you can call any of the following methods to add the remaining ones:
  - **`addVertex(`***x*, *y***`)`** adds a new vertex relative to the reference point
  - **`addEdge(`***dx*, *dy***`)`** adds a new vertex relative to the preceding one
  - **`addPolarEdge(`***r*, *theta***`)`** adds a new vertex using polar coordinates

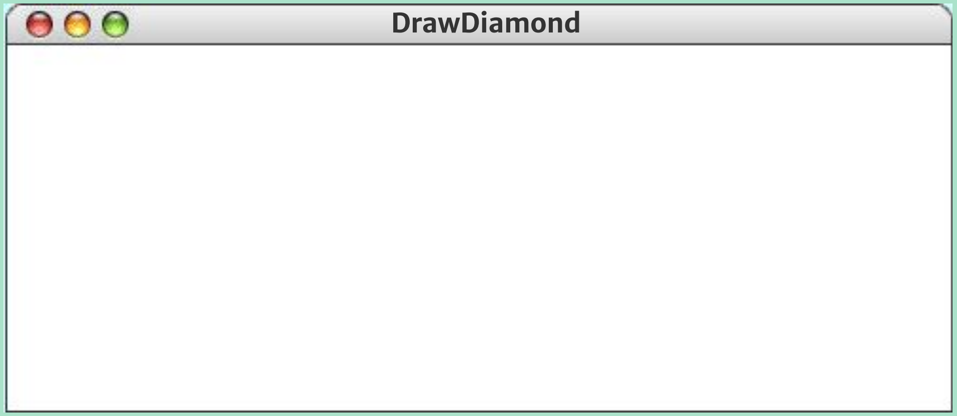
Using **`addVertex`** and **`addEdge`**

- The **`addVertex`** and **`addEdge`** methods each add one new vertex to a **`GPolygon`** object. The only difference is in how you specify the coordinates. The **`addVertex`** method uses coordinates relative to the reference point, while the **`addEdge`** method indicates displacements from the previous vertex.
- Your decision about which of these methods to use is based on what information you have readily at hand. If you can easily calculate the coordinates of the vertices, **`addVertex`** is probably the right choice. If, however, it is easier to describe each edge, **`addEdge`** is probably a better strategy.
- No matter which of these methods you use, the **`GPolygon`** class closes the polygon before displaying it by adding an edge from the last vertex back to the first one, if necessary.

Drawing a Diamond (**`addVertex`**)

```
function DrawDiamond() {
   var gw = GWindow(GWINDOW_WIDTH, GWINDOW_HEIGHT);
   var diamond = createDiamond(60, 100);
   diamond.setFilled(true);
   diamond.setFillColor("Magenta");
   gw.add(diamond, gw.getWidth() / 2, gw.getHeight() / 2);
}
```

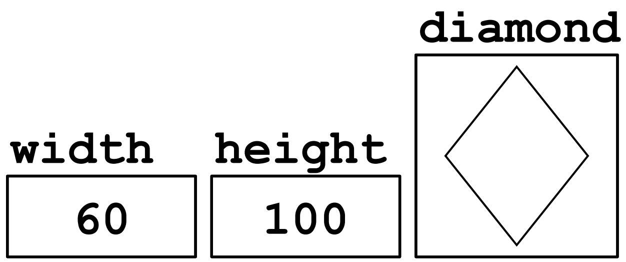


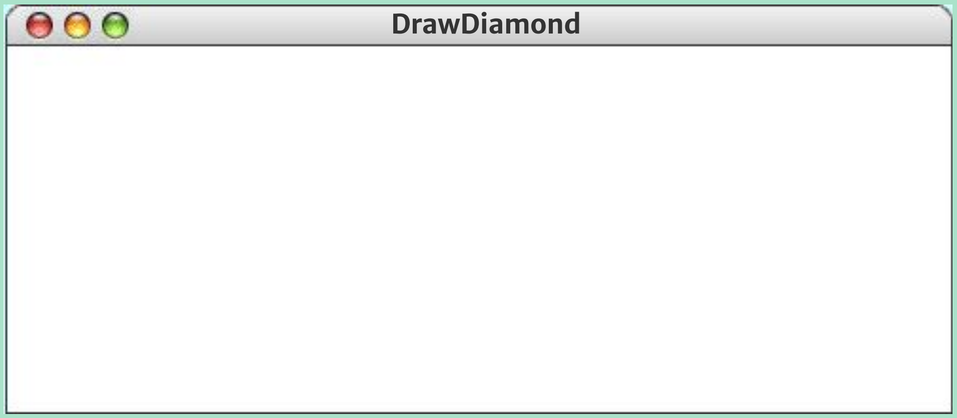


Drawing a Diamond (**`addVertex`**)

```
function DrawDiamond() {
```

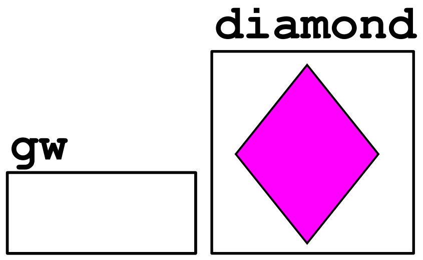
```
function createDiamond(width, height) {
   var diamond = GPolygon();
   diamond.addVertex(-width / 2, 0);
   diamond.addVertex(0, height / 2);
   diamond.addVertex(width / 2, 0);
   diamond.addVertex(0, -height / 2);
   return diamond;
}
```

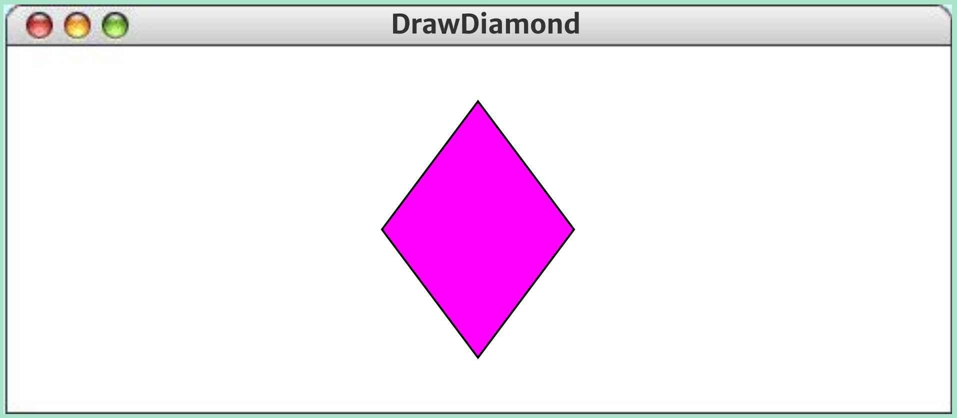




Drawing a Diamond (**addVertex**)

```
function DrawDiamond() {
   var gw = GWindow(GWINDOW_WIDTH, GWINDOW_HEIGHT);
   var diamond = createDiamond(60, 100);
   diamond.setFilled(true);
   diamond.setFillColor("Magenta");
   gw.add(diamond, gw.getWidth() / 2, gw.getHeight() / 2);
}
```

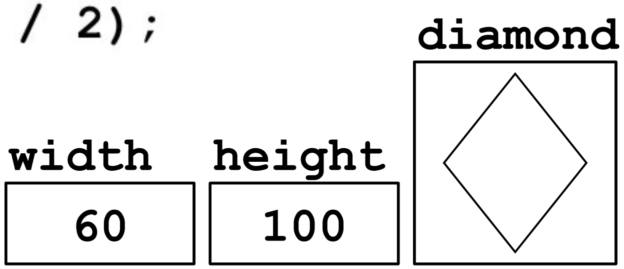


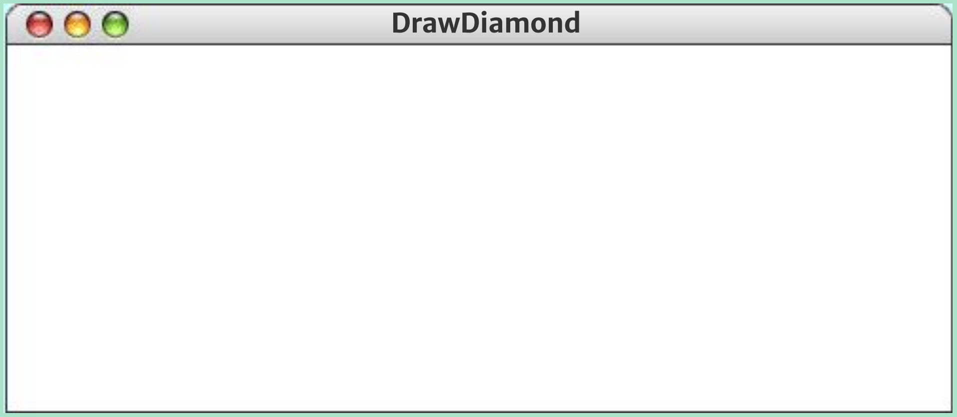


Drawing a Diamond (**`addEdge`**)

```
function DrawDiamond() {
```

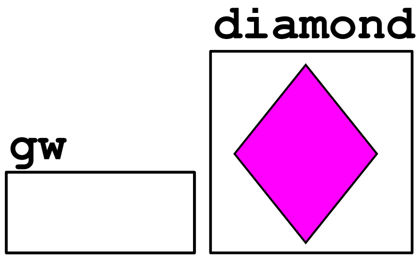
```
function createDiamond(width, height) {
   var diamond = GPolygon();
   diamond.addVertex(-width / 2, 0);
   diamond.addEdge(width / 2, -height / 2);
   diamond.addEdge(width / 2, height / 2);
   diamond.addEdge(-width / 2, height / 2);
   diamond.addEdge(-width / 2, -height / 2);
   return diamond;
}
```

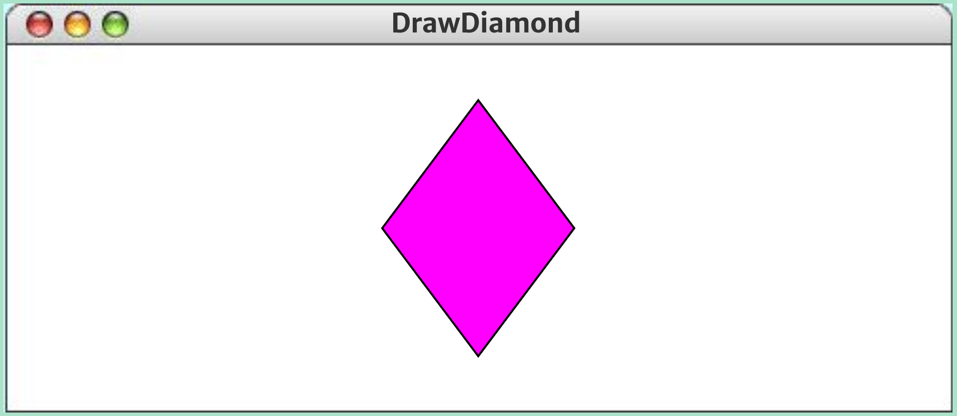




Drawing a Diamond (**addEdge**)

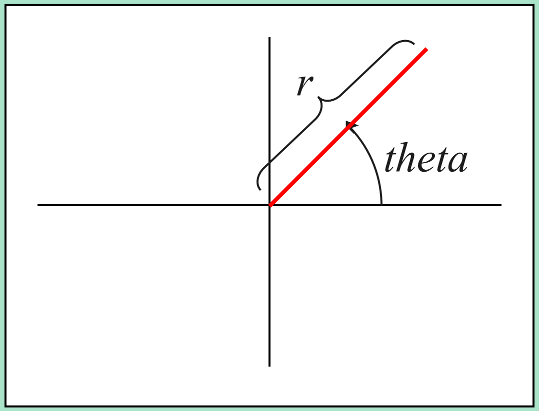
```
function DrawDiamond() {
   var gw = GWindow(GWINDOW_WIDTH, GWINDOW_HEIGHT);
   var diamond = createDiamond(60, 100);
   diamond.setFilled(true);
   diamond.setFillColor("Magenta");
   gw.add(diamond, gw.getWidth() / 2, gw.getHeight() / 2);
}
```





Using **`addPolarEdge`**

- In many cases, you can determine the length and direction of a polygon edge more easily than you can compute its *x* and *y* coordinates. In such situations, the best strategy for building up the polygon outline is to call **`addPolarEdge(`***r*, *theta***`)`**, which adds an edge of length *r* at an angle that extends *theta* degrees counterclockwise from the +*x* axis, as illustrated by the following diagram:



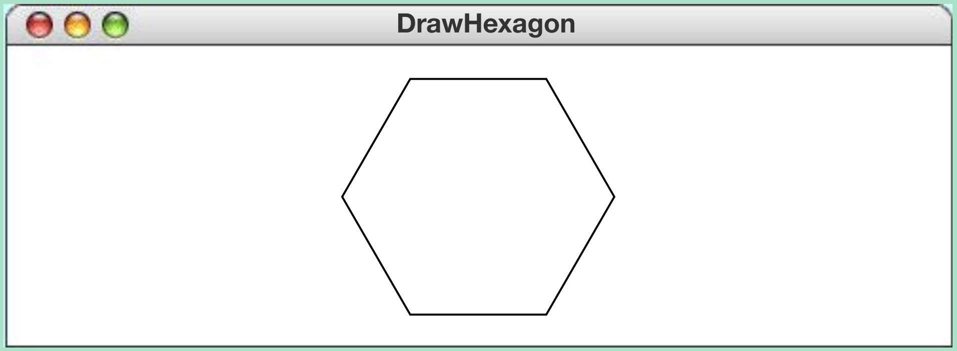
- The name of the method reflects the fact that **`addPolarEdge`** uses what mathematicians call ***polar coordinates***.

Drawing a Hexagon

```
function DrawHexagon() {
```

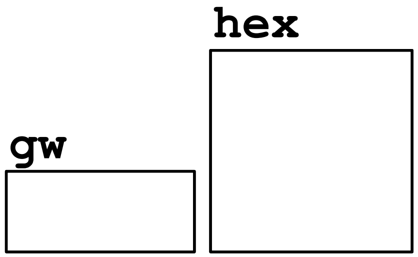
```
function createHexagon(side) {
   var hex = GPolygon();
   hex.addVertex(-side, 0);
   var angle = 60;
   for ( var i = 0 ; i < 6 ; i++ ) {
      hex.addPolarEdge(side, angle);
      angle -= 60;
   }
   return hex;
}
```

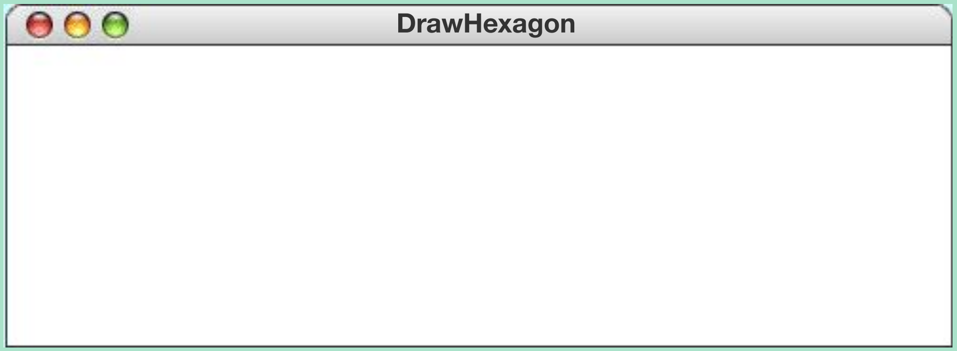
side
angle
i
hex



Drawing a Hexagon

```
function DrawHexagon() {
   var gw = GWindow(GWINDOW_WIDTH, GWINDOW_HEIGHT);
   var hex = createHexagon(60);
   gw.add(hex, gw.getWidth() / 2, gw.getHeight() / 2);
}
```





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   var hex = GPolygon();
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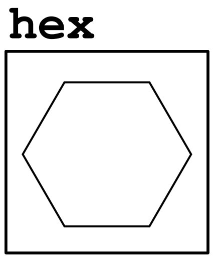
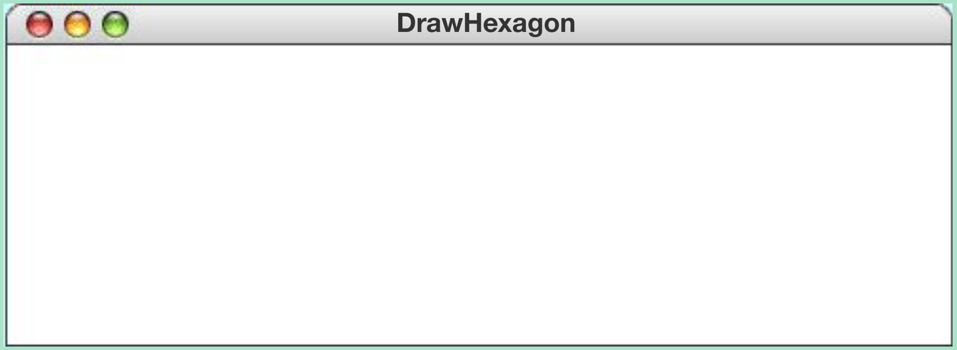
   var angle = 60;
   for ( var i = 0 ; i < 6 ; i++ ) {
      hex.addPolarEdge(side, angle);
      angle -= 60;
   }
   return hex;
}
```

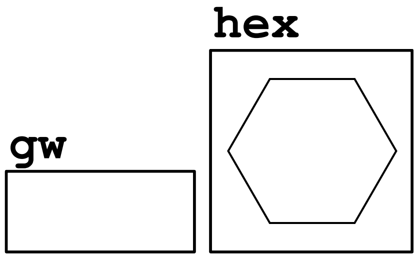
side	angle	i
60	-270	6

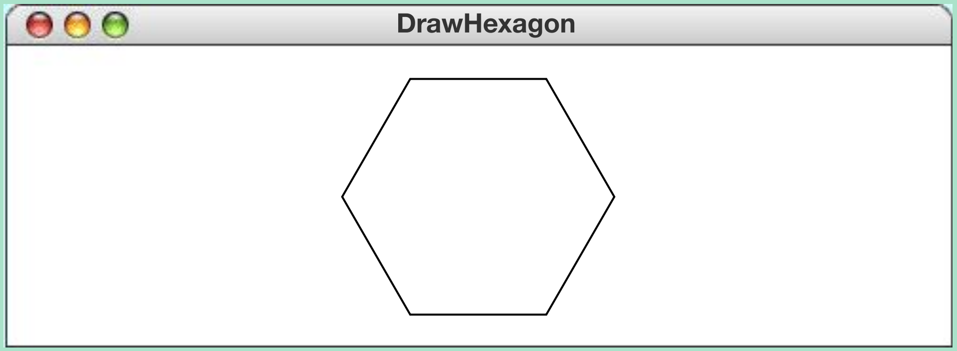




Drawing a Hexagon

```
function DrawHexagon() {
   var gw = GWindow(GWINDOW_WIDTH, GWINDOW_HEIGHT);
   var hex = createHexagon(60);
   gw.add(hex, gw.getWidth() / 2, gw.getHeight() / 2);
}
```



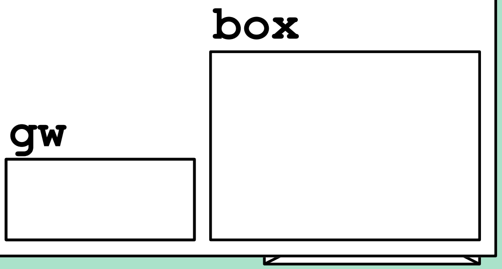


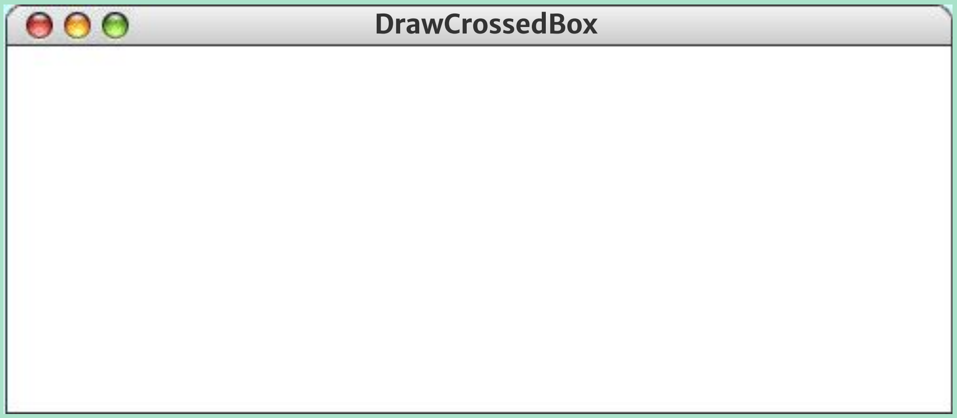
Creating Compound Objects

- The **`GCompound`** class in the graphics library makes it possible to combine several graphical objects so that the resulting structure behaves as a single **`GObject`**.
- The easiest way to think about the **`GCompound`** class is as a combination of a **`GWindow`** and a **`GObject`**. A **`GCompound`** is like a **`GWindow`** in that you can add objects to it, but it is also like a **`GObject`** in that you can add it to the graphics window.
- As was true in the case of the **`GPolygon`** class, a **`GCompound`** object has its own coordinate system that is expressed relative to a ***reference point***. When you add new objects to the **`GCompound`**, you use the local coordinate system based on the reference point. When you add the **`GCompound`** to the graphics window, all you have to do is set the location of the reference point; the individual components will automatically appear in the right locations relative to that point.

Using the **GCompound** Class

```
function DrawCrossedBox() {
   var gw = GWindow(GWINDOW_WIDTH, GWINDOW_HEIGHT);
   var box = createCrossedBox(200, 100);
   gw.add(box, gw.getWidth() / 2, gw.getHeight() / 2);
}
```

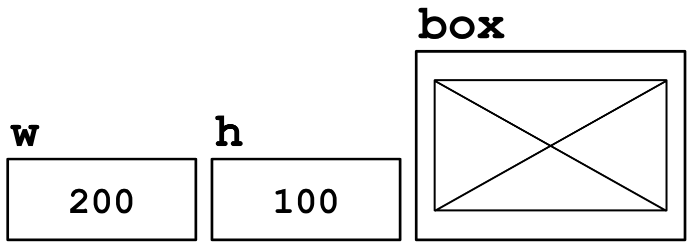


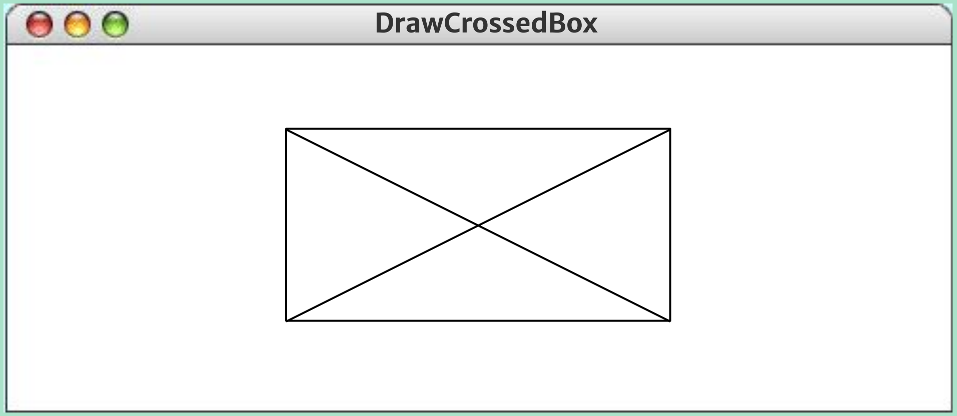


Using the **GCompound** Class

```
function DrawCrossedBox() {
```

```
function createCrossedBox(w, h) {
   var box = GCompound();
   box.add(GRect(-w / 2, -h / 2, w, h));
   box.add(GLine(-w / 2, -h / 2, w / 2, h / 2));
   box.add(GLine(-w / 2, h / 2, w / 2, -h / 2));
   return box;
}
```





The End