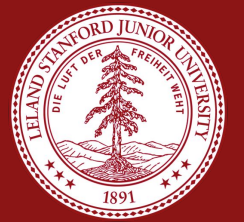
More Methods and Graphics

Lecture 8

CS106A, Summer 2019
Sarai Gould && Laura Cruz-Albrecht

With inspiration from slides created by Keith Schwarz, Mehran Sahami, Eric Roberts, Stuart Reges, Chris Piech and others.



Announcements

- Hope you had a great 4th!
- Assignment 2 due Wednesday July 10th, at 10AM

Plan for Today

- Review: Nested Loops, Infinite Loops, Intro to Graphics
- Returning to Returns
- More Graphics!
- Stoplights

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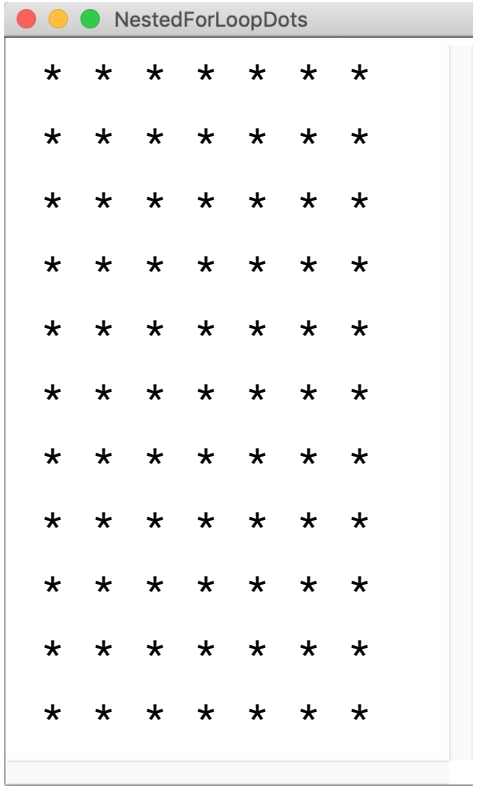
Review: Nested For Loops

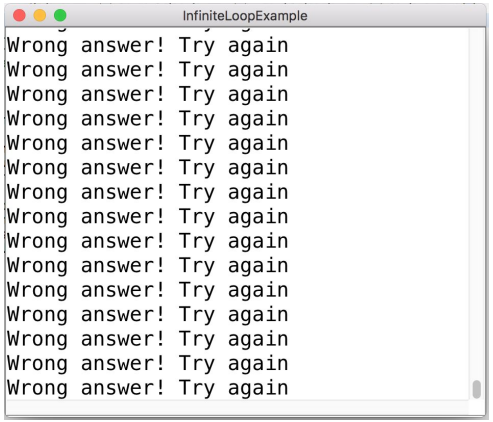



```
for (int i = 0; i < NUM_ROWS; i++) {
    for (int j = 0; j < NUM_COLS; j++) {
        print("*");
    }
    println();
}
```

Review: Infinite Loops

```
int answer = readInt("What is 1 + 1?");

while (answer != 2){
     println("Wrong answer! Try again");
}
```



Review: Infinite Loops

```
int answer = readInt("What is 1 + 1?");

while (answer != 2){
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```
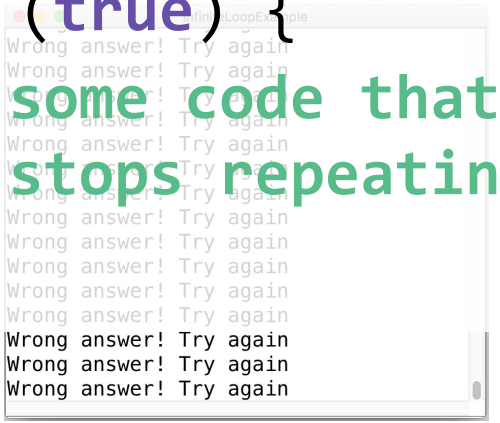
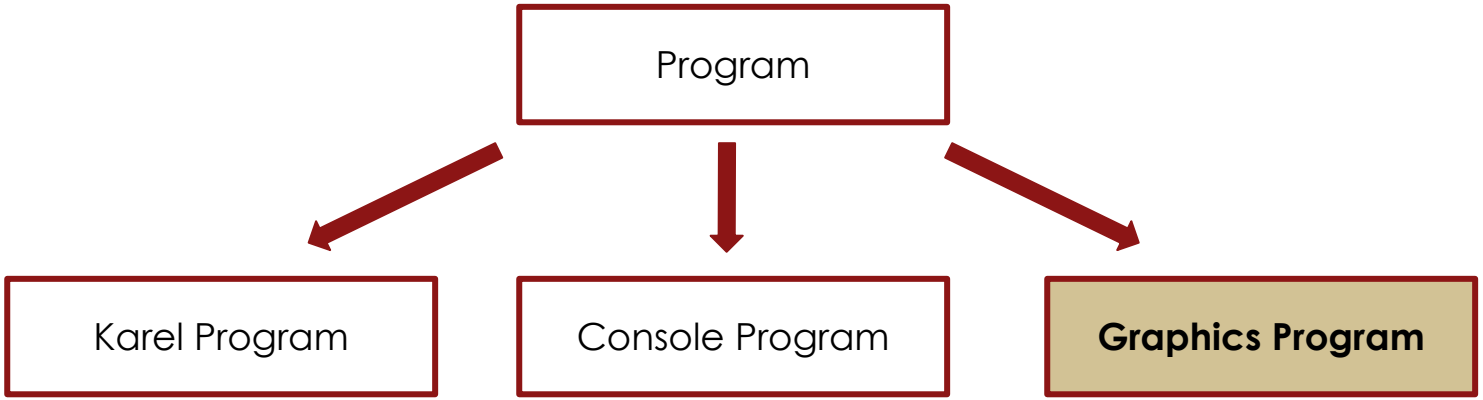

```
while (true) {
    // some code that never
    // stops repeating ...
}
```



Review: Intro to Graphics Programs



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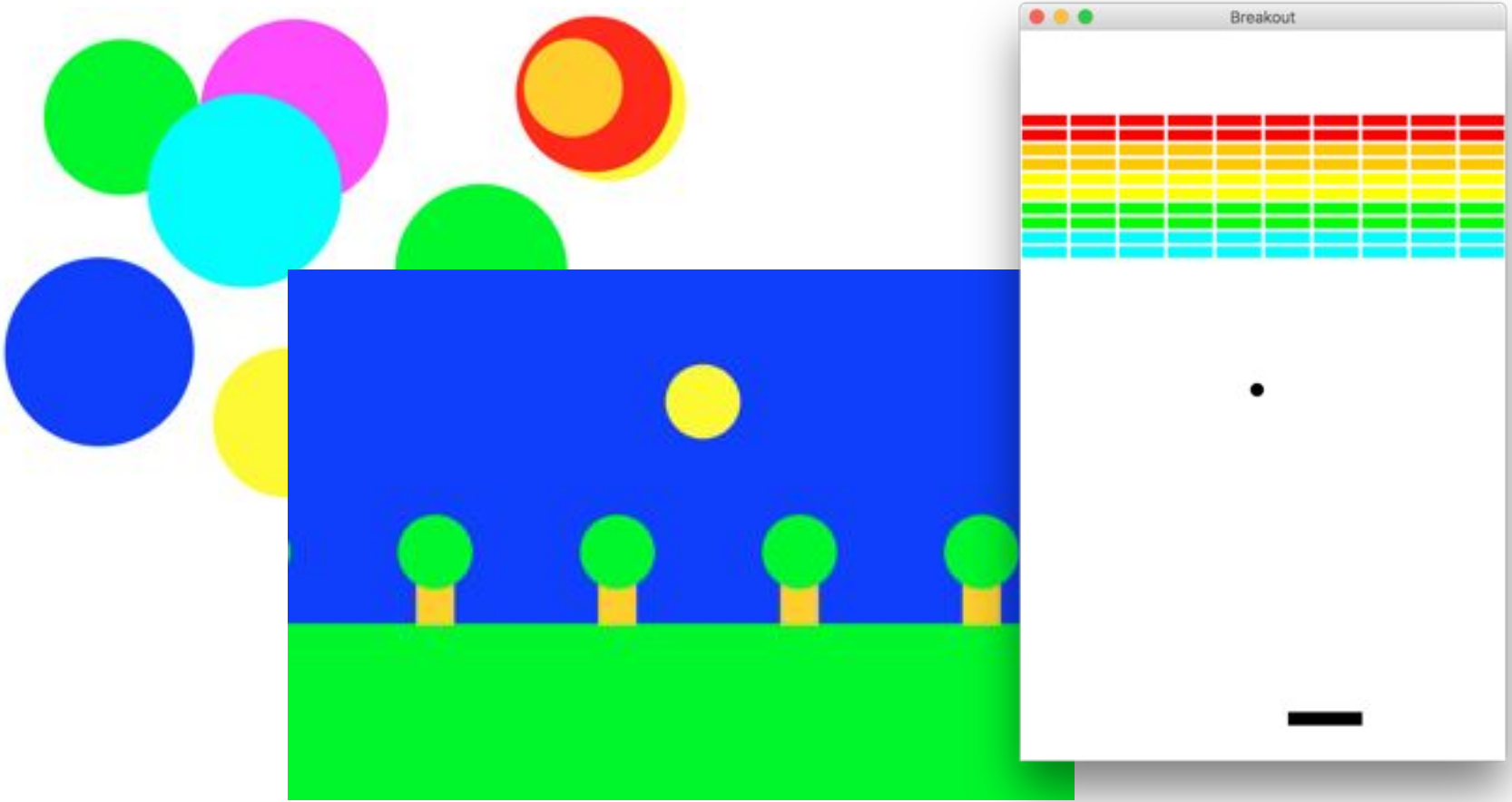
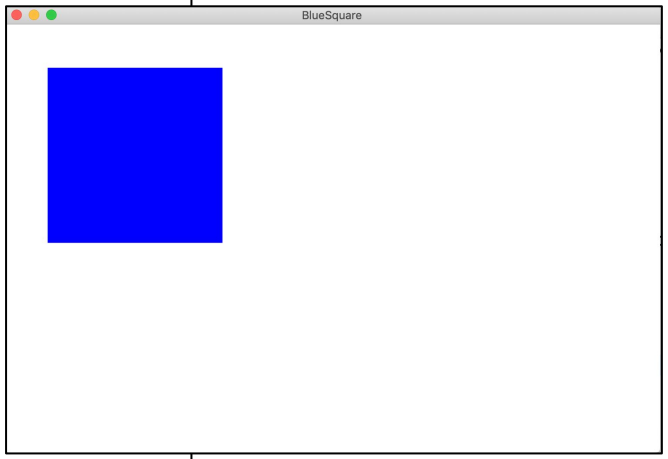


Review: Our First Graphics Program

```
import acm.program.*;
import acm.graphics.*; // Stanford graphical objects
import java.awt.*;     // Java graphical objects

public class BlueSquare extends GraphicsProgram {
     public void run(){
          drawBlueSquare();
     }

     private void drawBlueSquare(){
          GRect rect = new GRect(200, 200);
          rect.setFilled(true);
          rect.setColor(Color.BLUE);
          add(rect, 50, 50);
     }
}
```



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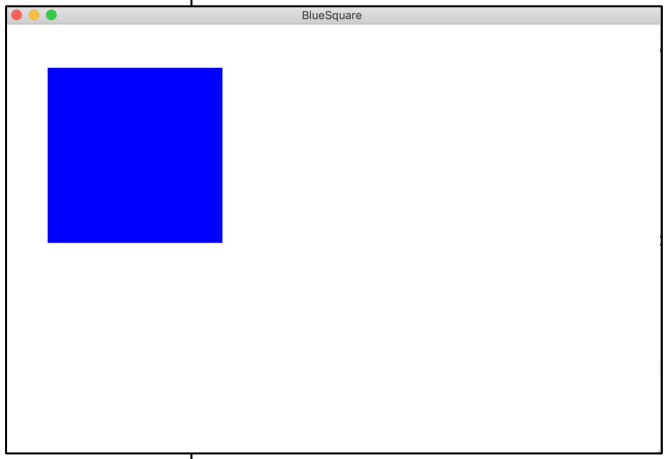
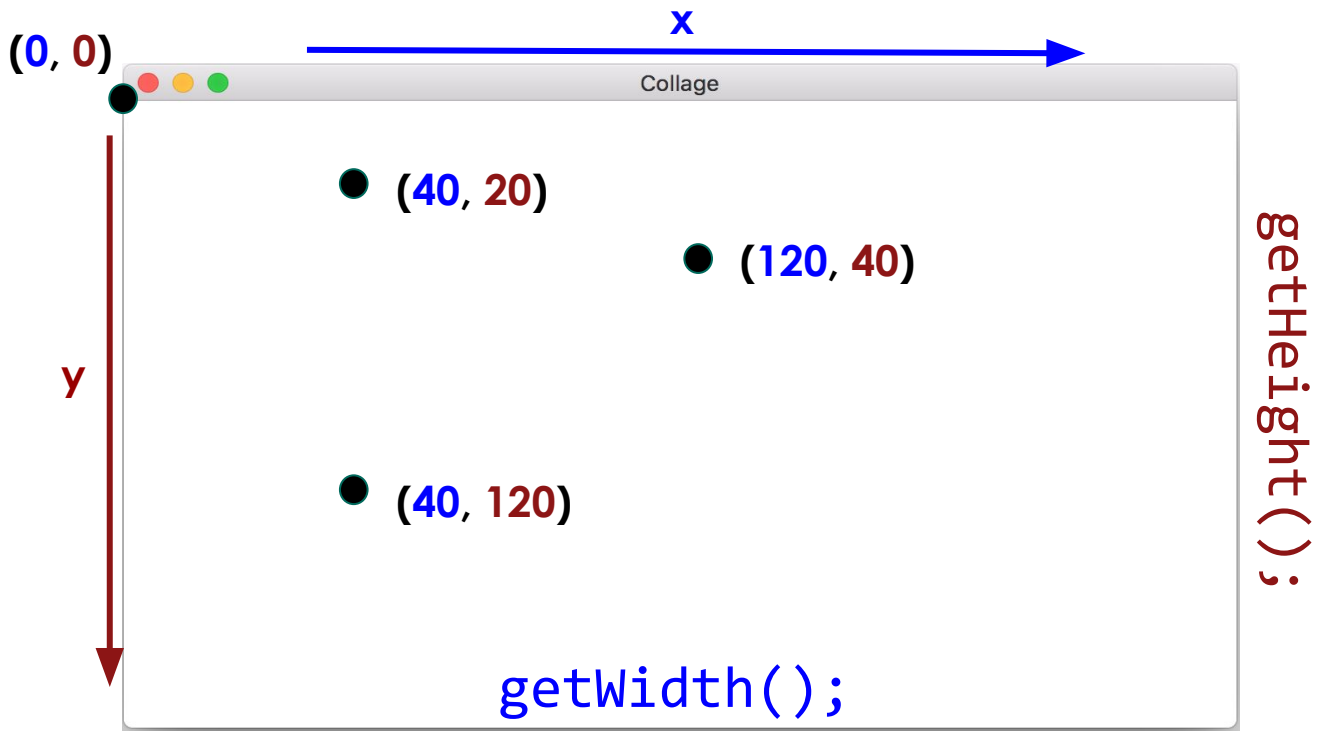
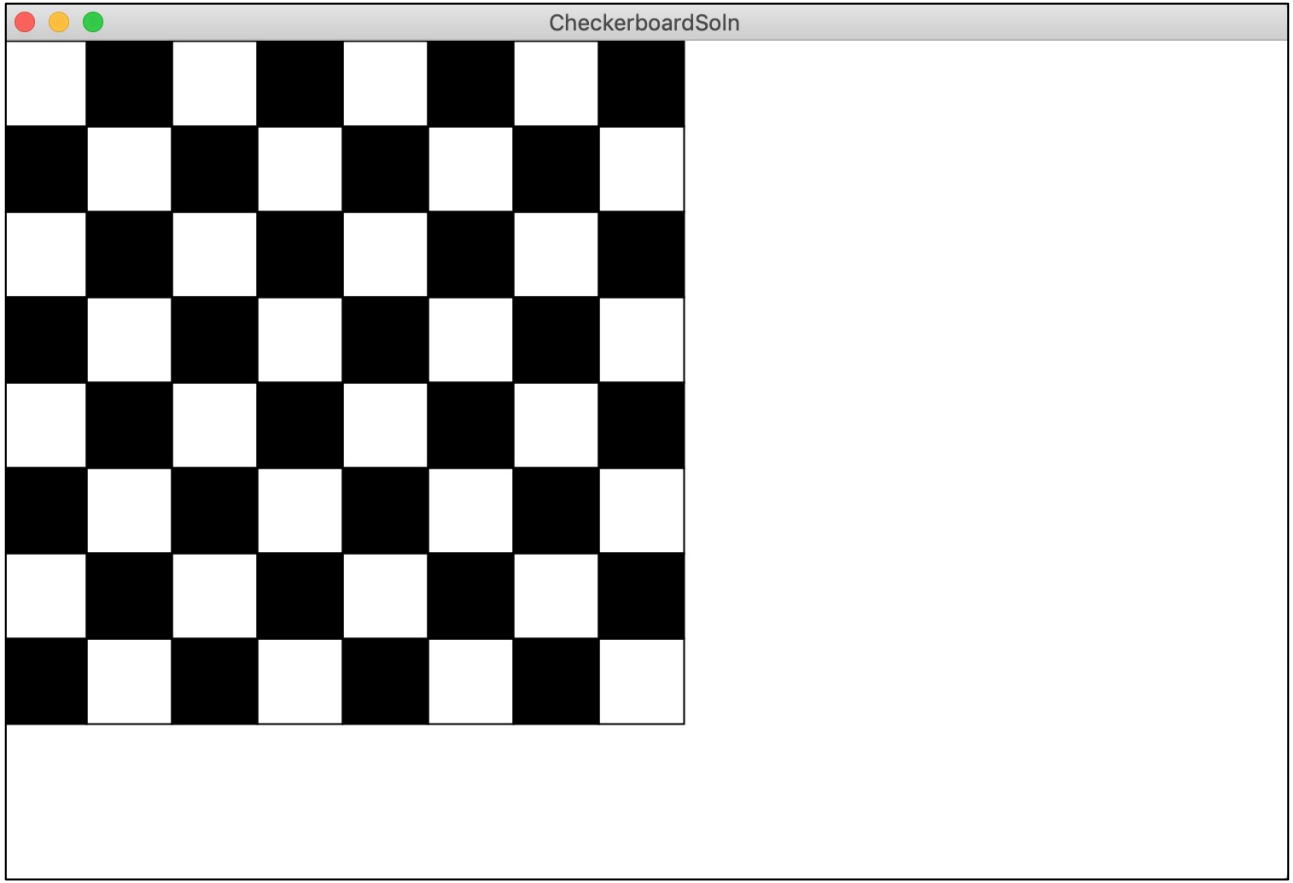


Review: The Graphics Canvas



* Note: The y coordinate gets *bigger* as we go *down*. This is opposite of how it acts in most math classes!

Review: Checkerboard



Plan for Today

- Review: Nested Loops, Infinite Loops, Intro to Graphics
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- More Graphics!
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Returning to Returns

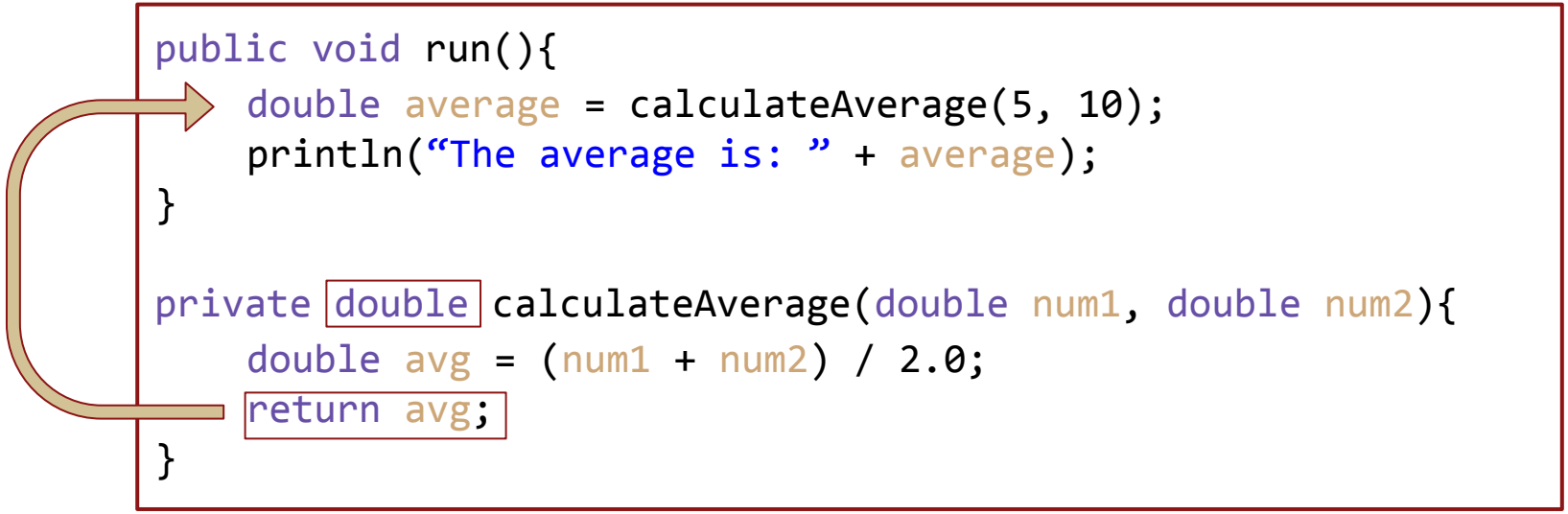
- Recall that methods can `return` data

```
public void run(){
    double average = calculateAverage(5, 10);
    println("The average is: " + average);
}

private double calculateAverage(double num1, double num2){
    double avg = (num1 + num2) / 2.0;
    return avg;
}
```

Returning to Returns

- Recall that methods can `return` data



Returning to Returns

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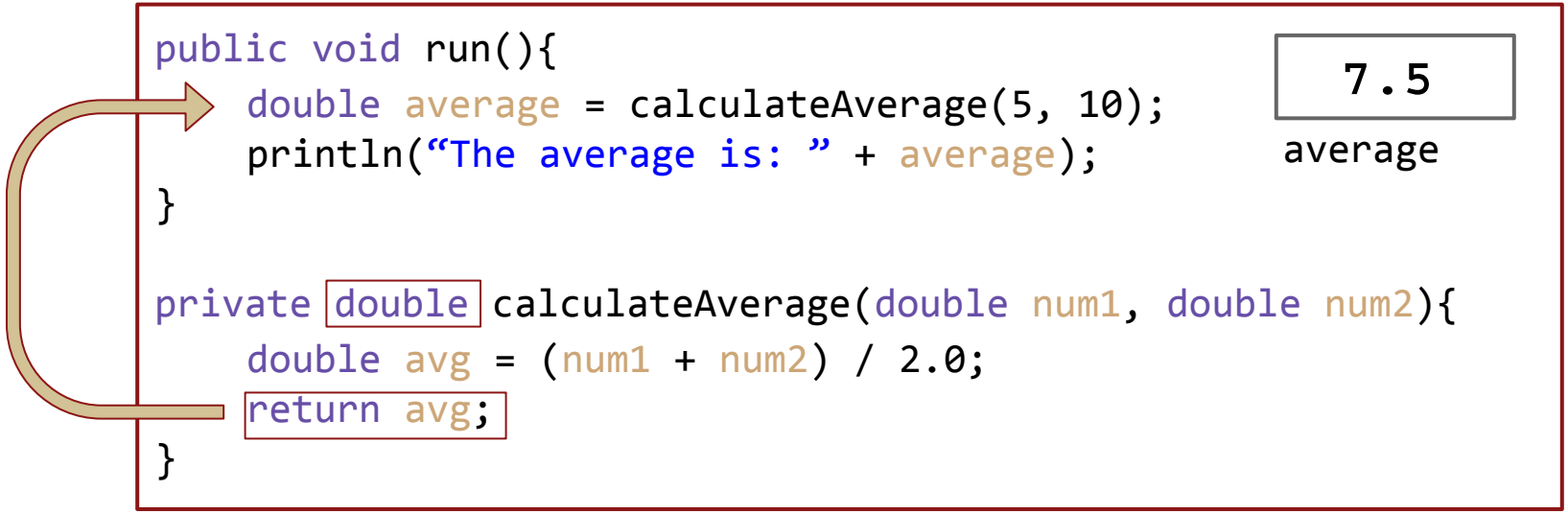

Multiple Return Statements

- You can have multiple return statements in a method

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```
private int max(int num1, int num2) {
    if (num1 >= num2) {
        return num1;
    }
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}
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Multiple Return Statements

```
public void run() {
    int larger = max(5, 1);
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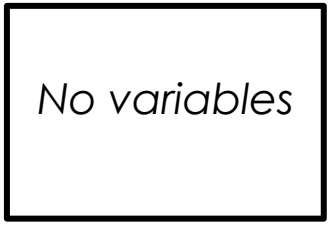
run memory



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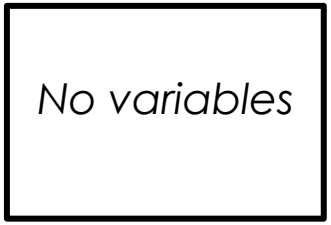

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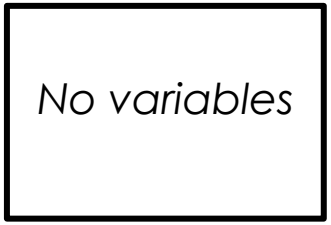

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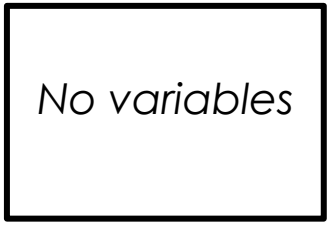

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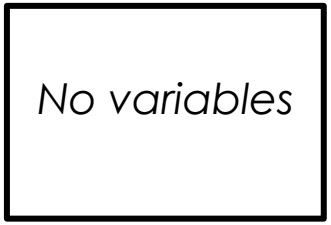
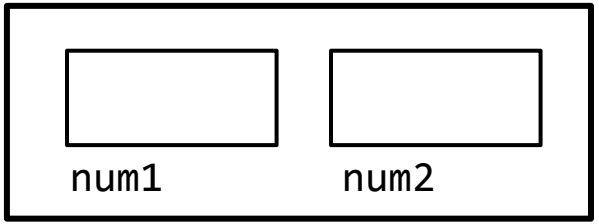


max memory



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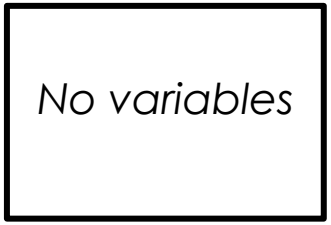

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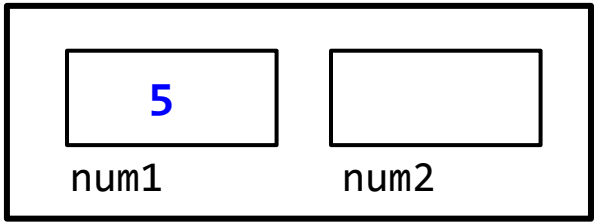

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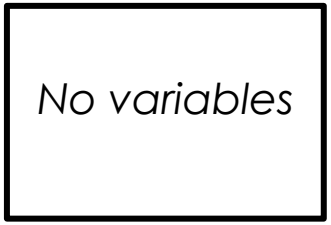

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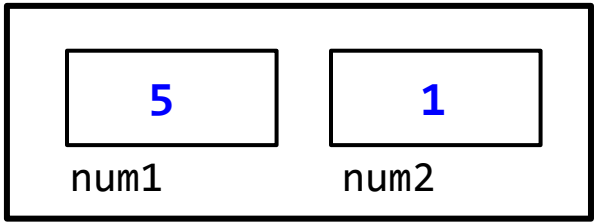

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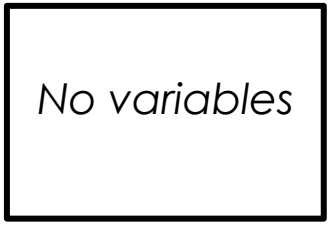

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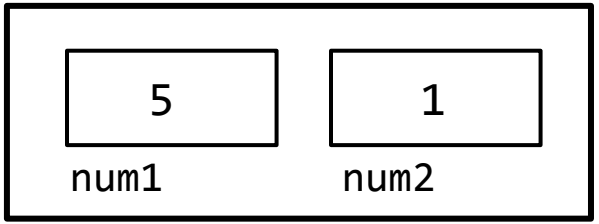

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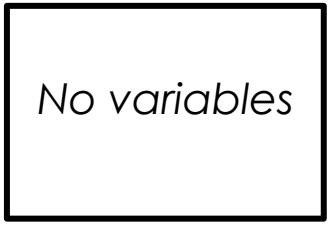
5

run memory



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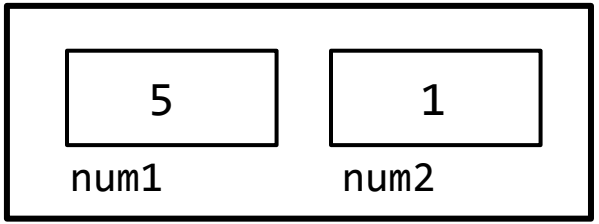

Multiple Return Statements

```
public void run() {
    int larger = max(5, 1); 5
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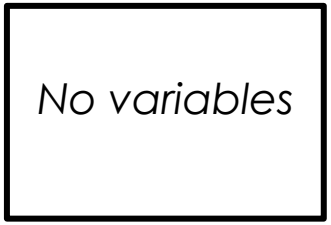

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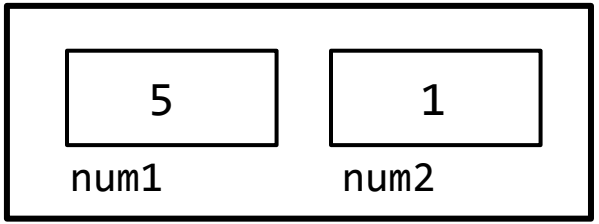

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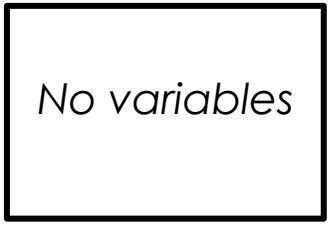

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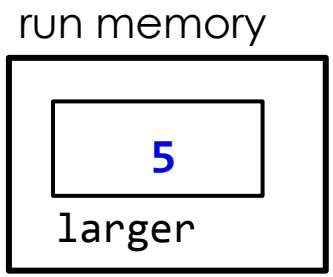

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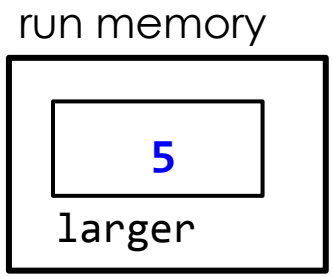

Returning to our scheduled programming

```
private topic getTopic() {
    if (isMonday()) {
        return moreGraphics;
    } else if (isTues()) {
        return animation;
    } else {
        return randomExcitingTopic;
    }
}
```

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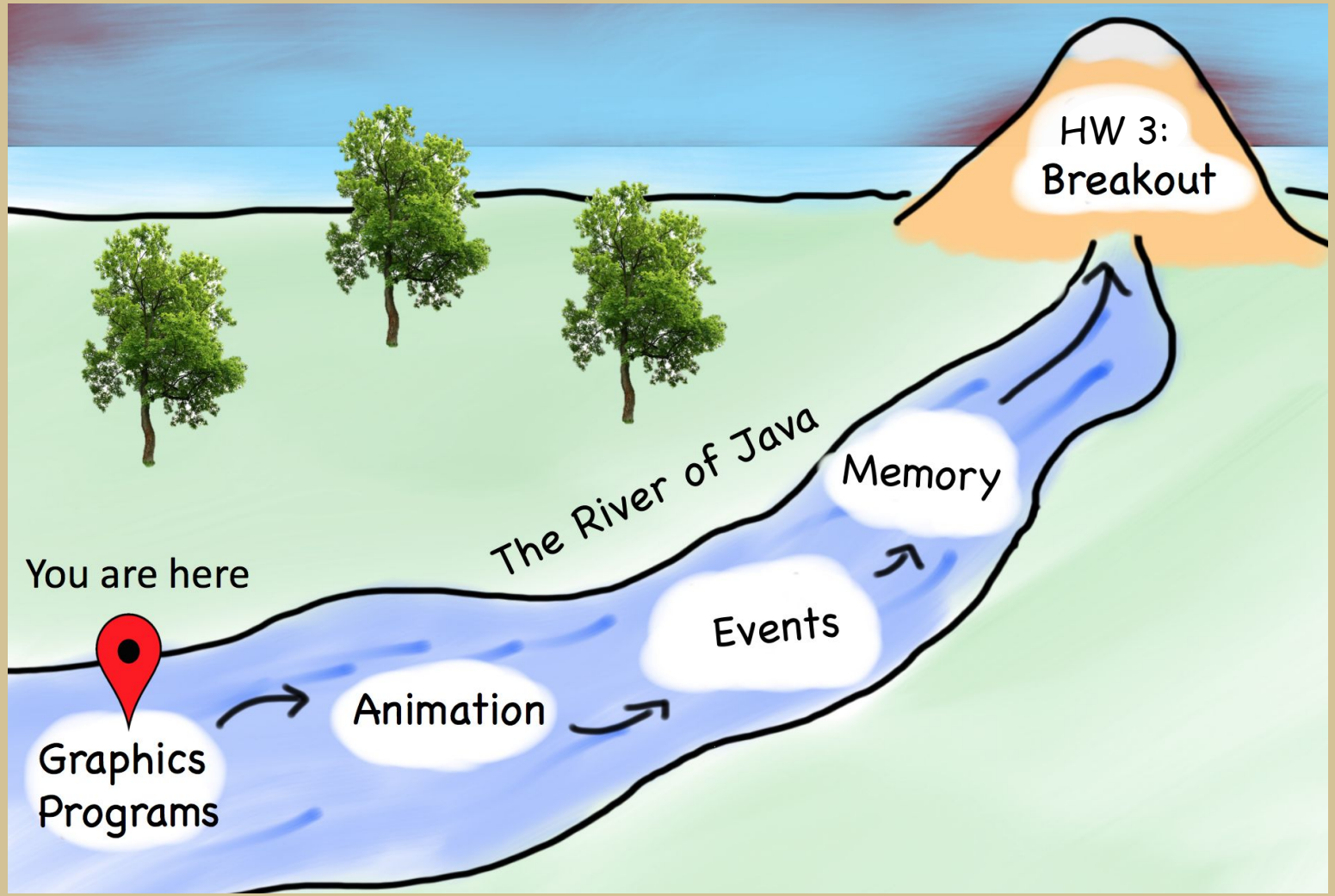
HW 3:
Breakout
The River of Java
Memory
You are here
Events
Animation
Graphics
Programs

Working with Graphics

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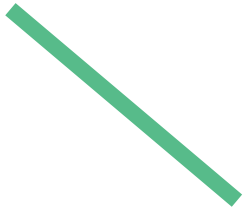
Graphical Objects

GRect

GOval

GLine



GLabel

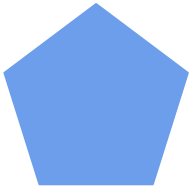
Hello

GImage

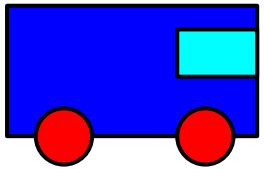
GRoundRect

GArc

GPolygon



GCompound



and more ...

Graphical Objects

GRect

GOval

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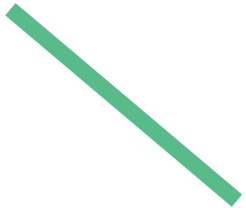

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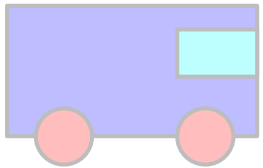
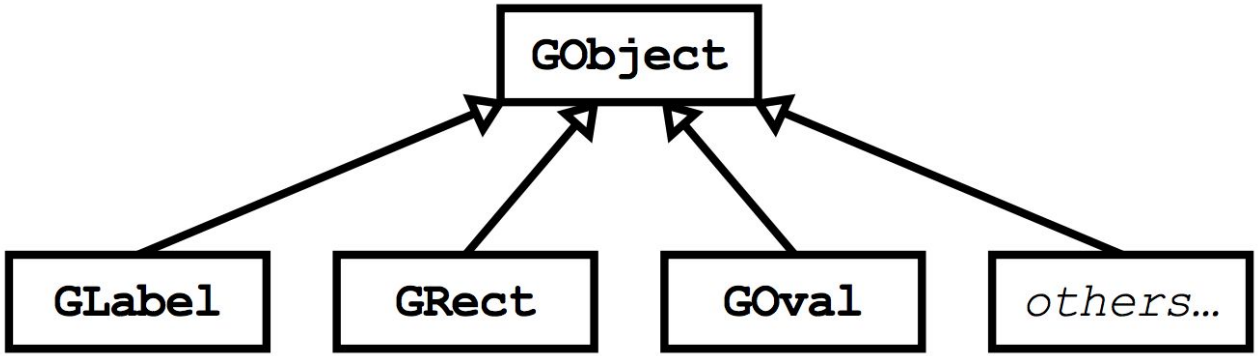


and more ...

Graphical Objects



Working with Graphics

We make graphics programs by ***creating*** *graphics objects* and *manipulating their properties*.

Creating Graphics Objects

- To create a graphics object, we need to:
  - declare a variable to hold that object, and
  - actually create the object using the **new** keyword.

- Initialization syntax:

```
type name = new type(...);
```

- Example:

```
GRect rect = new GRect(100, 200);
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This is called a "constructor"

Primitives vs. Objects

Primitive Variable Types

```
int
double
char
boolean
```

Object Variable Types

```
GRect
GOval
GLine
...
```

Primitives vs. Objects

Primitive Variable Types	Object Variable Types
`int`	`GRect`
`double`	`GOval`
`char`	`GLine`
`boolean`	`...`

Object variables:

Primitives vs. Objects

Primitive Variable Types	Object Variable Types
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Object variables:

1. Have UpperCamelCase types

Primitives vs. Objects

Primitive Variable Types	Object Variable Types
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Object variables:

1. Have UpperCamelCase types
2. Are constructed using `new`

Primitives vs. Objects

Primitive Variable Types	Object Variable Types
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Object variables:

1. Have UpperCamelCase types
2. Are constructed using `new`
3. You can call methods on them

Working with Graphics

We make graphics programs by *creating graphics objects* and ***manipulating their properties***.

Methods on Graphics Objects

- You can manipulate graphics objects by calling methods on those objects
- To call a method on an object, use the syntax:

```
object.method(parameters);
```

- Example:

```
rect.setColor(Color.BLUE);
```

Methods on Graphics Objects

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receiver — message

- Example:

```
rect.setColor(Color.BLUE);
```

Methods on Graphics Objects

- You can manipulate graphics objects by calling methods on those objects
- To call a method on an object, use the syntax:

```
object.method(parameters);
```

- Example:

```
rect.setColor(Color.BLUE);
```

who?

Methods on Graphics Objects

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who? what?

Methods on Graphics Objects

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- To call a method on an object, use the syntax:

```
object.method(parameters);
```

- Example:

```
rect.setColor(Color.BLUE);
```

who? what? what specifically?

GObject Methods

The following operations apply to all `GObjects`:

object`.setColor(`*color*`)` Sets the color of the object to the specified color constant.
object`.setLocation(`*x*`,` *y*`)` Changes the location of the object to the point (*x*, *y*).
object`.move(`*dx*`,` *dy*`)` Moves the object on the screen by adding *dx* and *dy* to its current coordinates.
object`.getWidth()` Returns the width of the object
object`.getHeight()` Returns the height of the object
and more…

Graphic courtesy of Eric Roberts

Colors

- Specified as predefined `Color` constants:

  `Color.NAME`, where `NAME` is one of:

BLACK	BLUE	CYAN	DARK_GRAY	GRAY
GREEN	LIGHT_GRAY	MAGENTA	ORANGE	PINK
RED	WHITE	YELLOW		

```
rect.setColor(Color.MAGENTA);
```

Colors

- Specified as predefined `Color` constants:

  `Color.NAME`, where `NAME` is one of:

BLACK	BLUE	CYAN	DARK_GRAY	GRAY
GREEN	LIGHT_GRAY	MAGENTA	ORANGE	PINK
RED	WHITE	YELLOW		

```
rect.setColor(Color.MAGENTA);
```

- Or, create one using Red-Green-Blue (RGB) values of 0-255

```
new Color(red, green, blue);
```

ex:

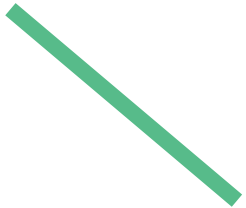
```
rect.setColor(new Color(218, 165, 32)); // goldenrold
```

Graphical Objects

GRect

GOval

GLine



GLabel

Hello

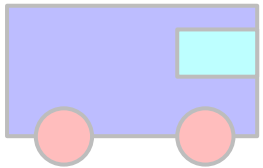
GImage

GRoundRect

GArc

GPolygon

GCompound

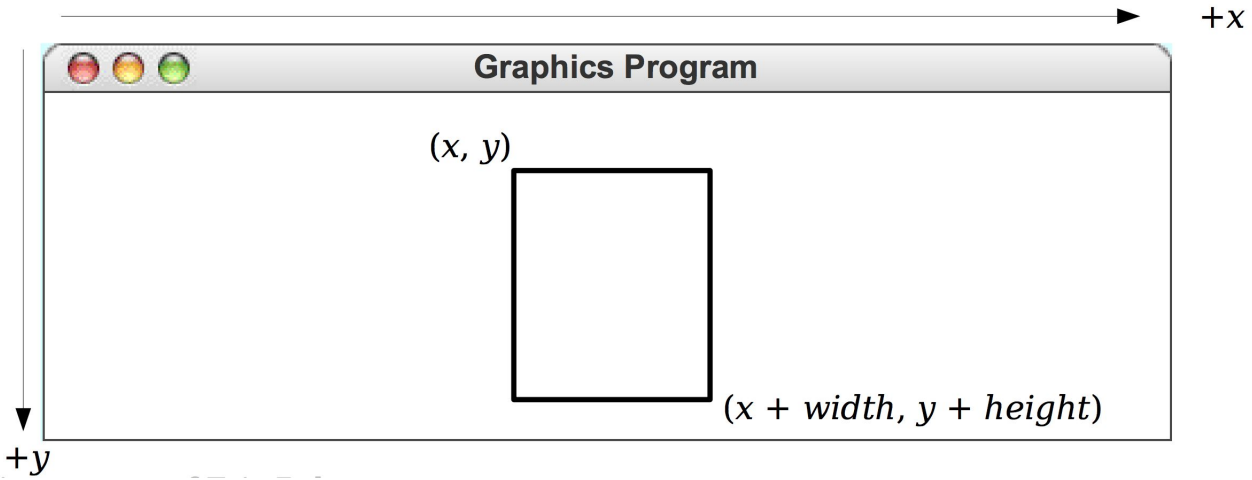


and more ...

GRect

```
new GRect(x, y, width, height);
```
Creates a rectangle with the given width and height, whose upper-left corner is at (x, y).

```
new GRect(width, height);
```
Same as above, but defaults (x, y) to (0, 0).



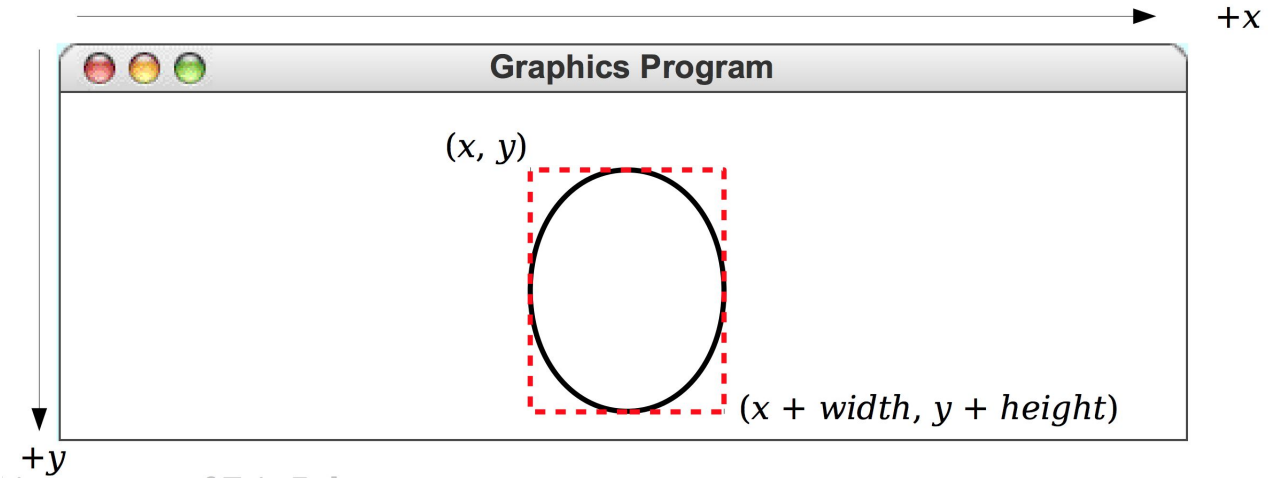
GOval

```
new GOval(x, y, width, height);
```

Creates an oval that fits within a rectangle with the given width and height, whose upper-left corner is at (x, y).

```
new GOval(width, height);
```

Same as above, but defaults (x, y) to (0, 0).



GRect & GOval

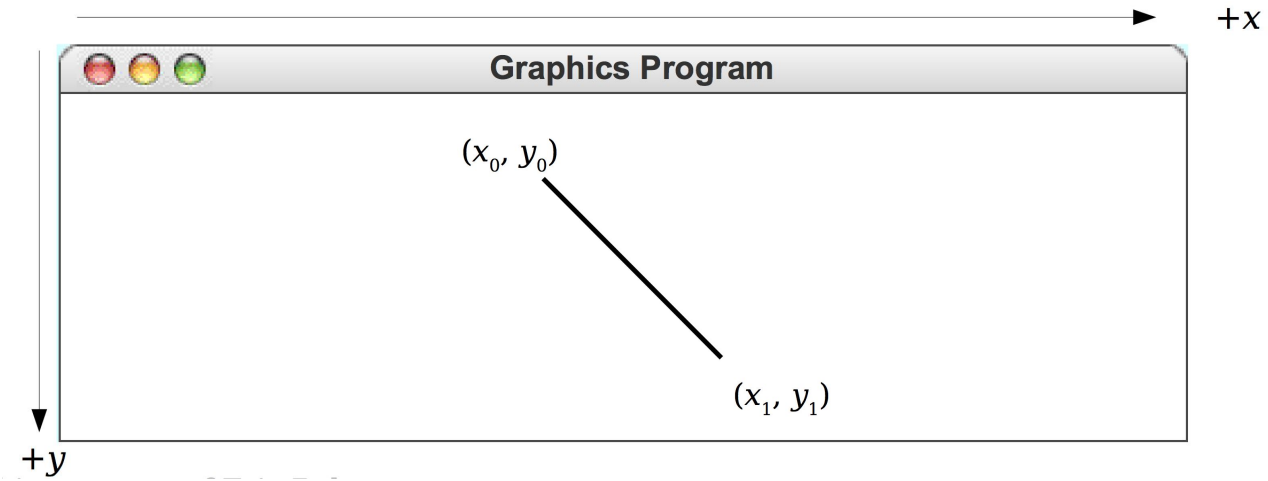
Methods shared by the `GRect` and `GOval` classes:

***object*`.setFilled(`*`fill`*`);`** If *fill* is `true`, fills in the interior of the object; if `false`, shows only the outline.
***object*`.setFillColor(`*`color`*`);`** Sets the color used to fill the interior, which can be different from the border.
***object*`.setSize(`*`width, height`*`);`** Sets the object's size to be the given width and height.

GLine

```
new GLine(x0, y0, x1, y1);
```

Creates a line extending from (x0, y0) to (x1, y1).



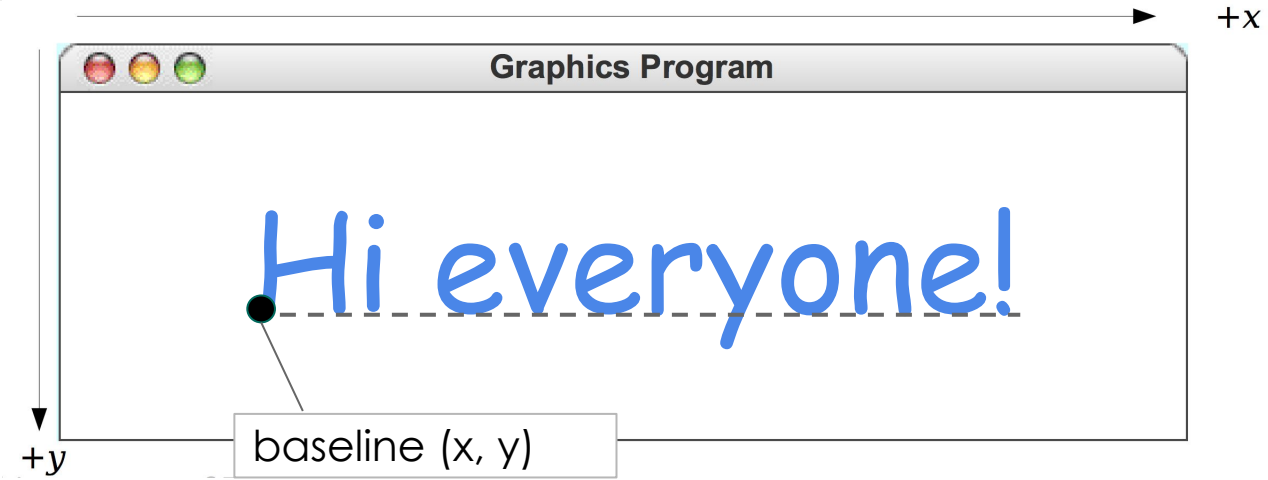
GLabel

`new GLabel("your text here", x, y);`

Creates a label with the given text, whose ***baseline*** starts at (x, y). Not positioned according to the top-left corner!

`new GLabel("your text here");`

Same as above, but defaults (x, y) to (0, 0).



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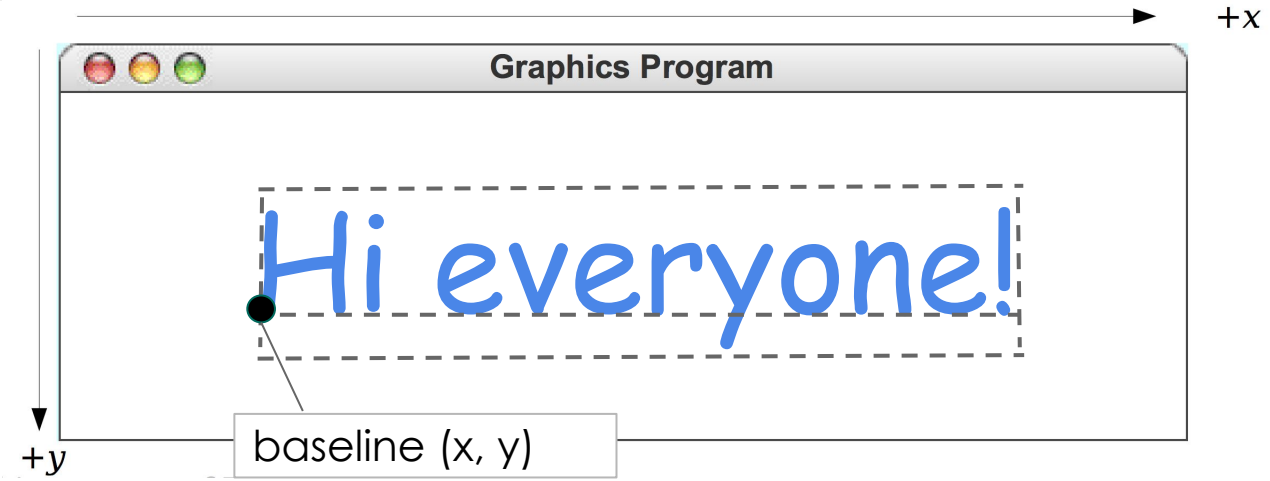

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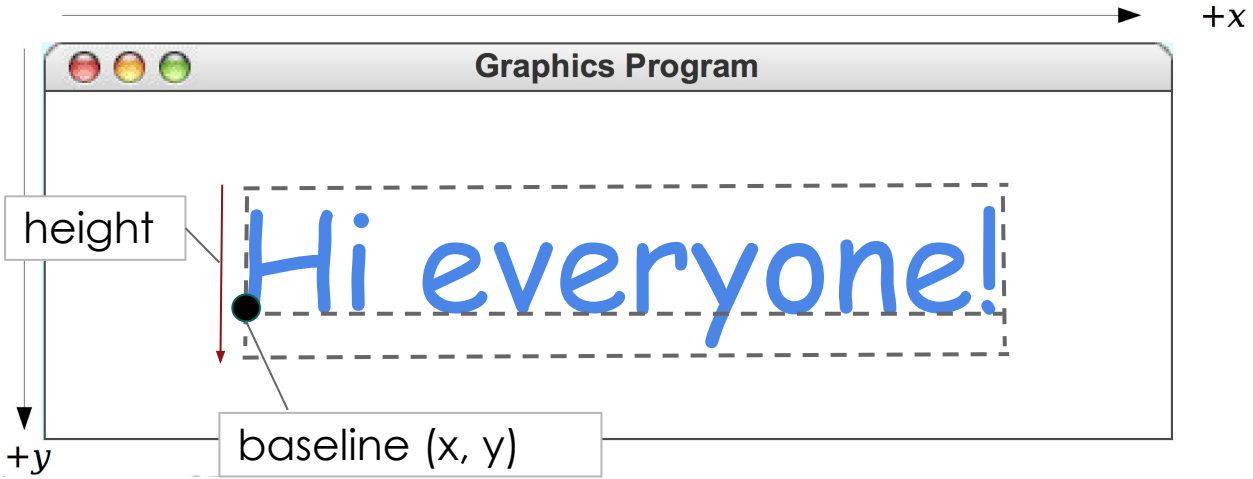

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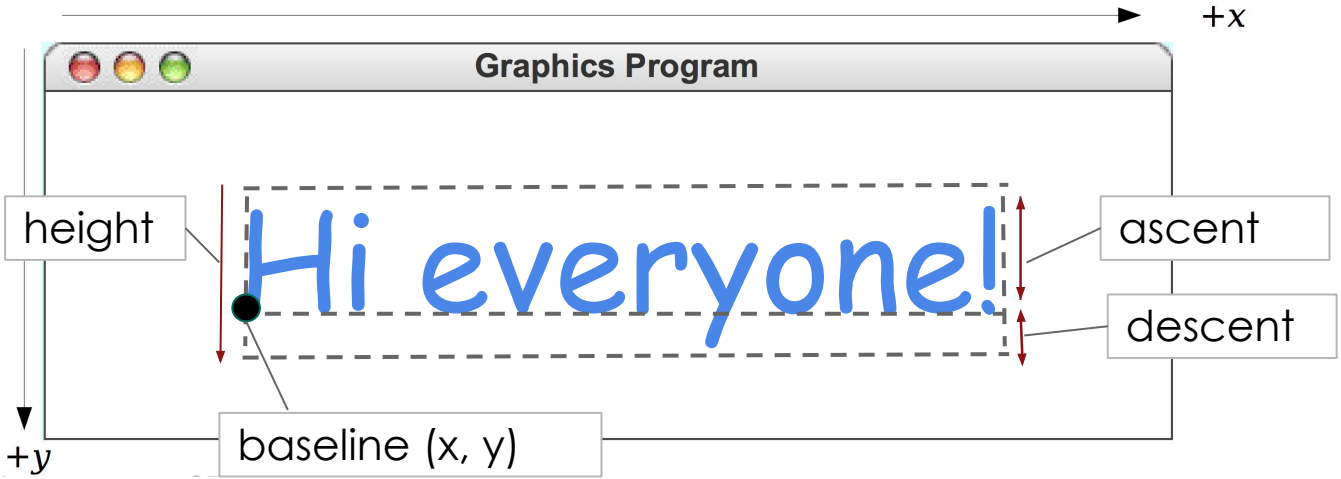


GLabel Methods

Methods specific to the `GLabel` class:

***label*`.getDescent();`** Returns the height of the label below its baseline.
***label*`.getAscent();`** Returns the height of the label above its baseline.
***label*`.setFont(`*`font`*`);`** Sets the font used to display the label as specified by the font string.

The font is typically specified as a string in the form:

"family-style-size"

family: is the name of a font family

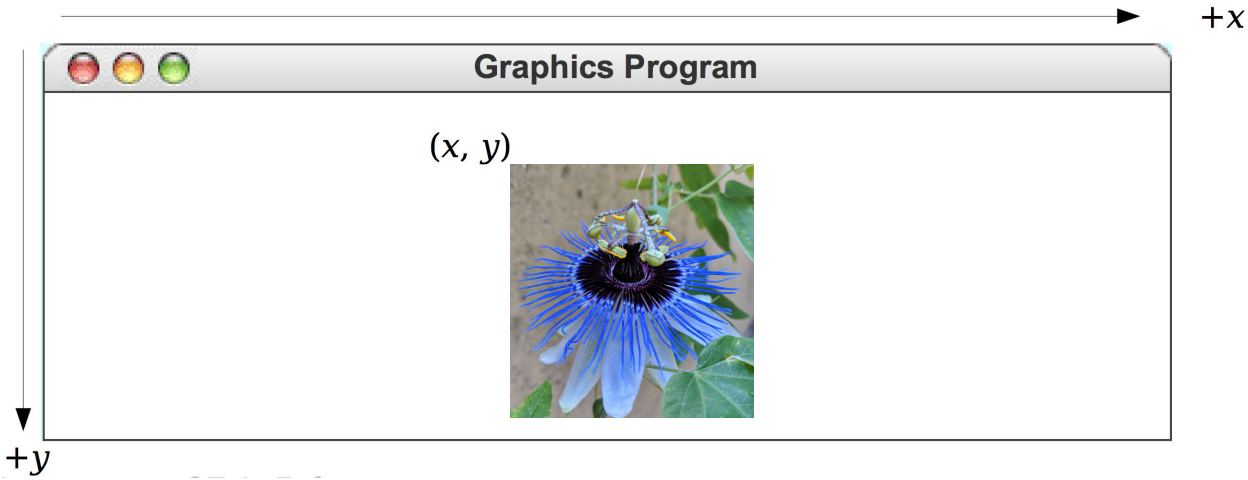
style: is either `PLAIN`, `BOLD`, `ITALIC`, or `BOLDITALIC`

size: is an integer indicating the point size

GImage

```
new GImage("filename", x, y);
```
Creates an image displaying the given file, whose upper-left corner is at (x, y).

```
new GImage("filename");
```
Same as above, but defaults (x, y) to (0, 0).



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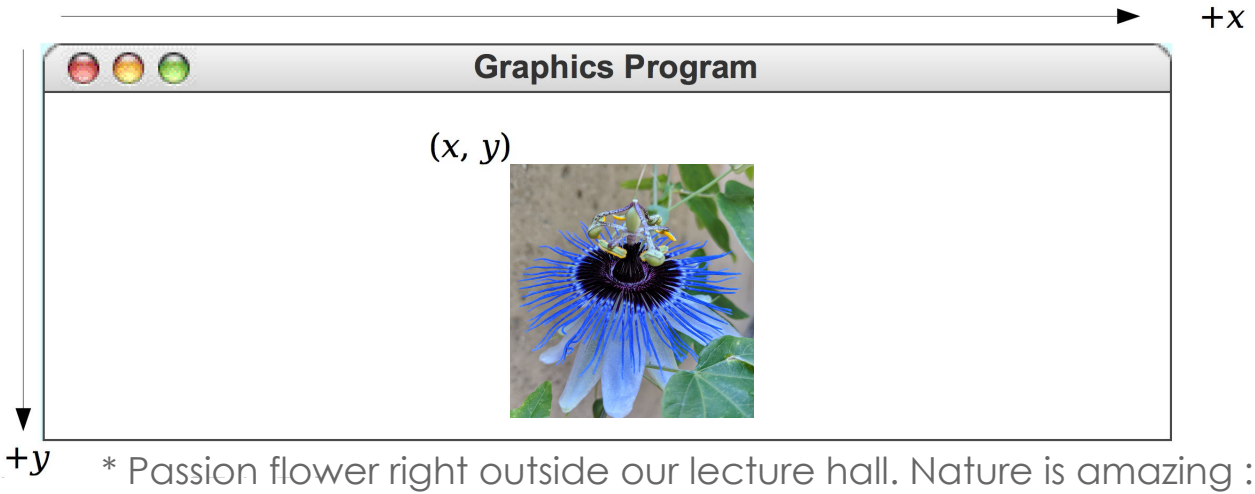


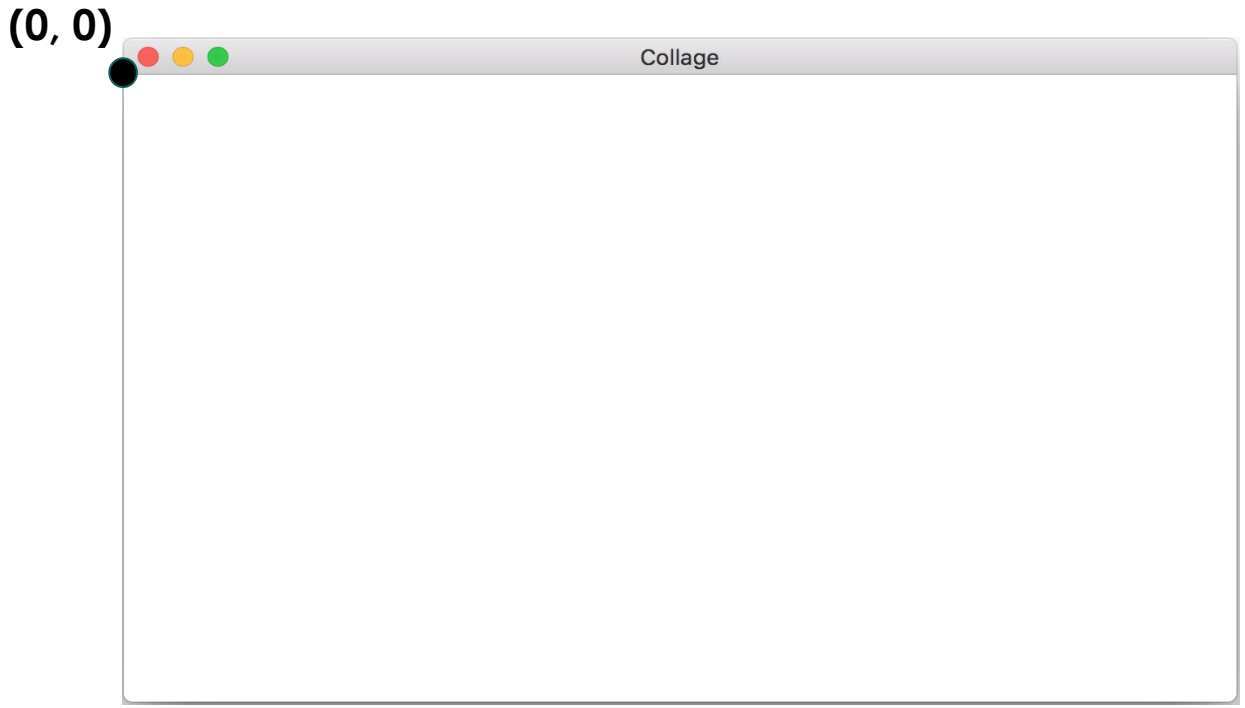
* Passion flower right outside our lecture hall. Nature is amazing :)

GImage Methods

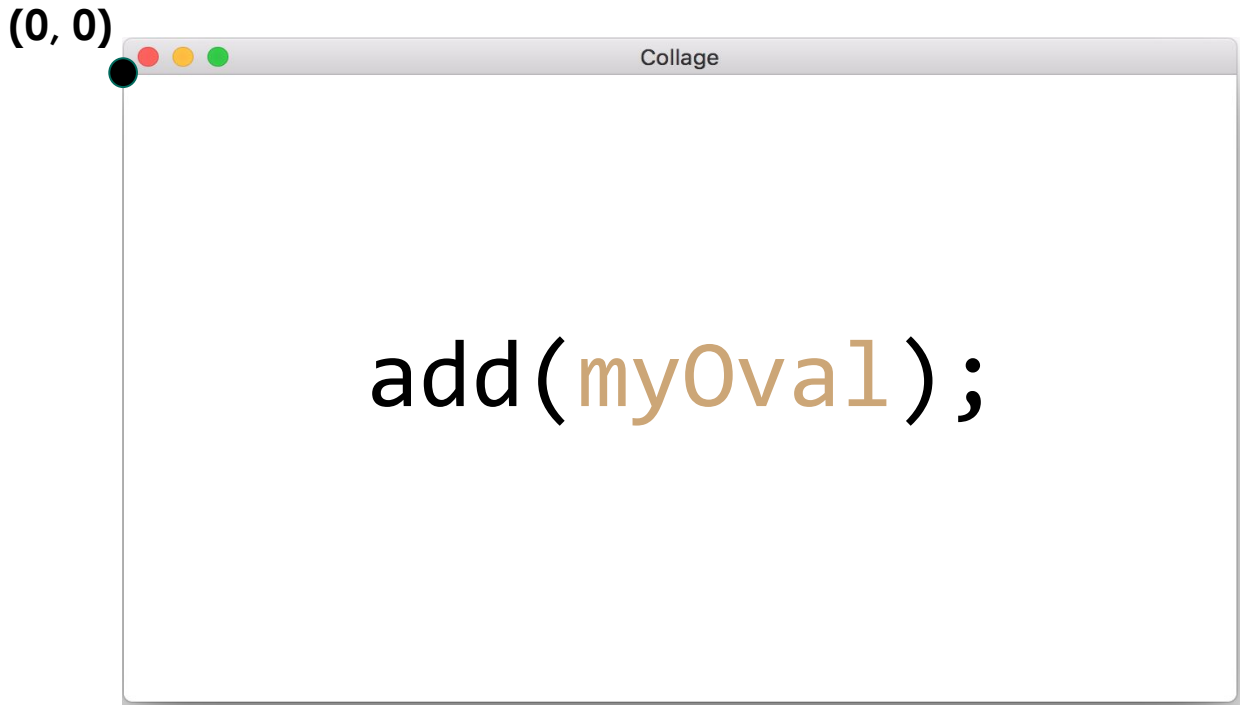
object.**setSize**(*width*, *height*);

Sets the object's size to be the given width and height.

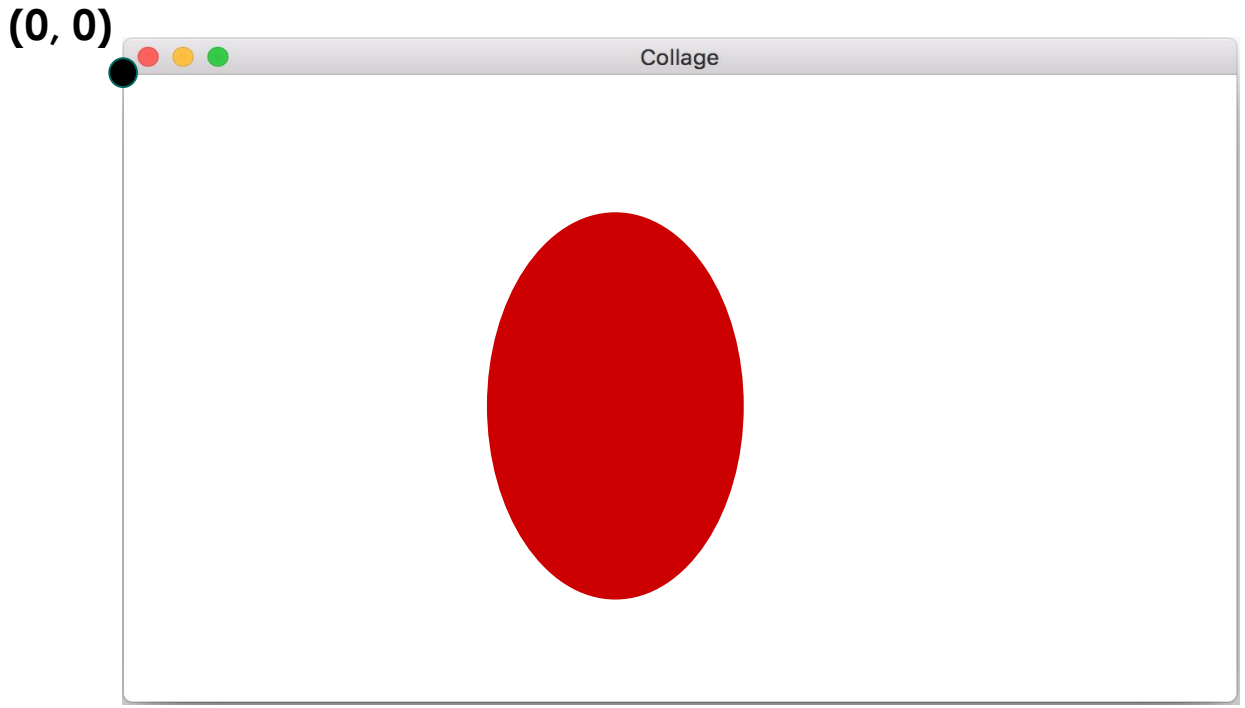
The Collage Model



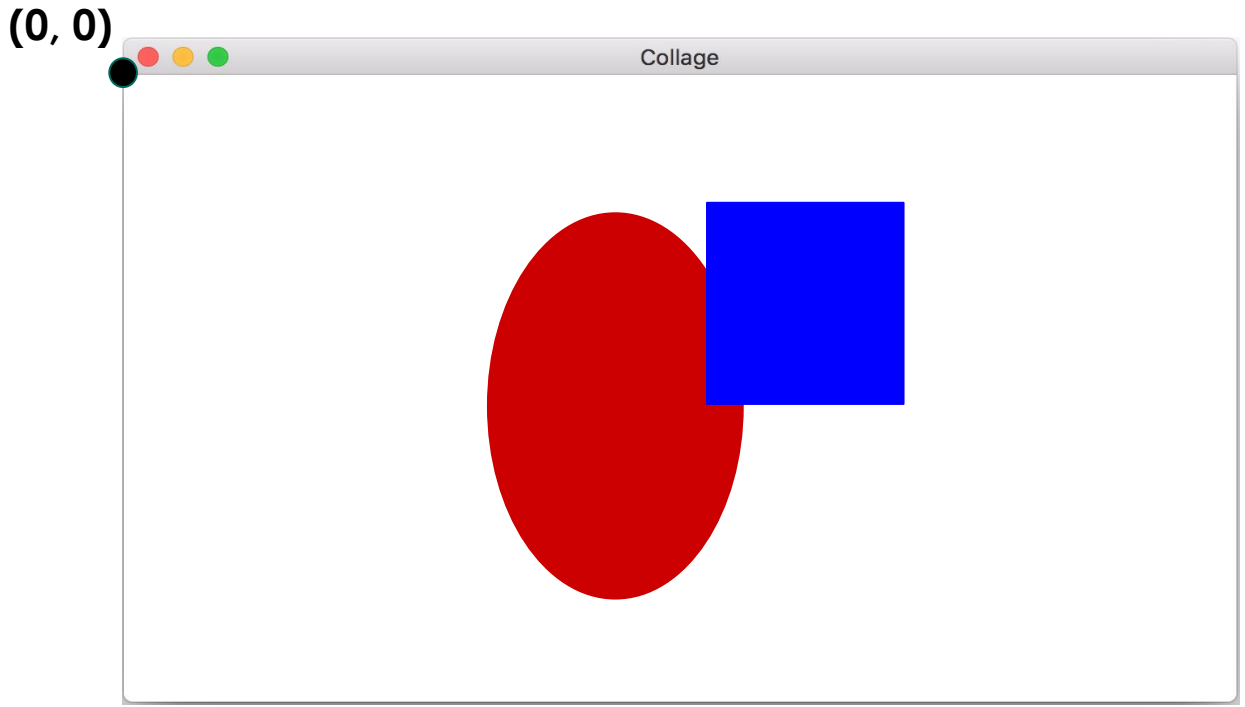
The Collage Model



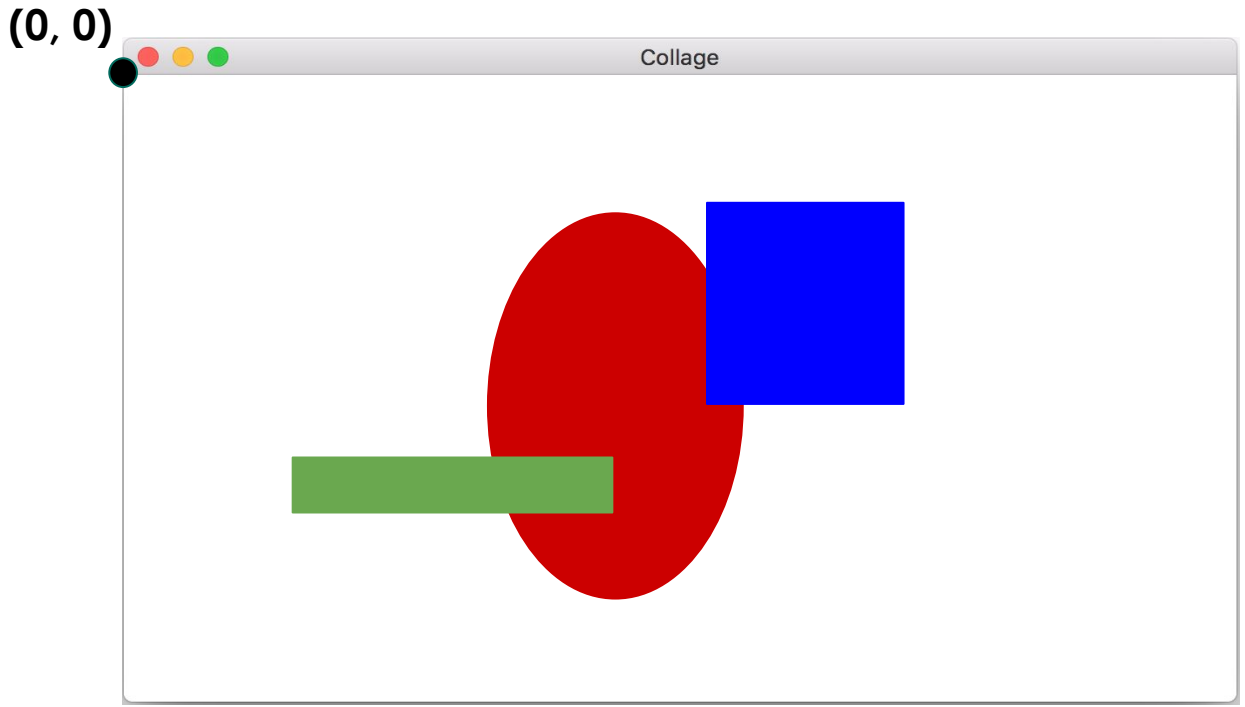
The Collage Model



The Collage Model



The Collage Model



GraphicsProgram Methods

`GraphicsProgram` contains these useful methods:

Method	Description
`add(gobj);` `add(gobj, x, y);`	adds a graphical object to the window
`getElementAt(x, y)`	return the object at the given (x,y) position(s)
`getElementCount()`	return number of graphical objects onscreen
`getWidth(), getHeight()`	return dimensions of window
`remove(gobj);`	removes a graphical object from the window
`removeAll();`	remove all graphical objects from window
`setCanvasSize(w, h);`	set size of drawing area
`setBackground(color);`	set window's background color

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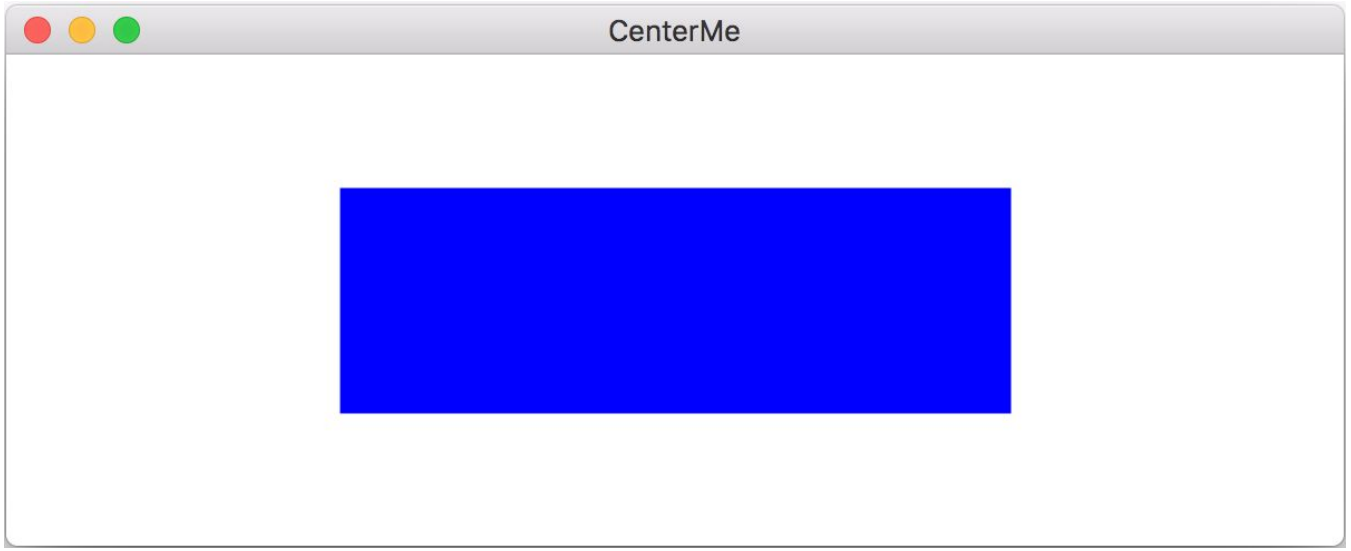
`setBackground(color);`	set window's background color

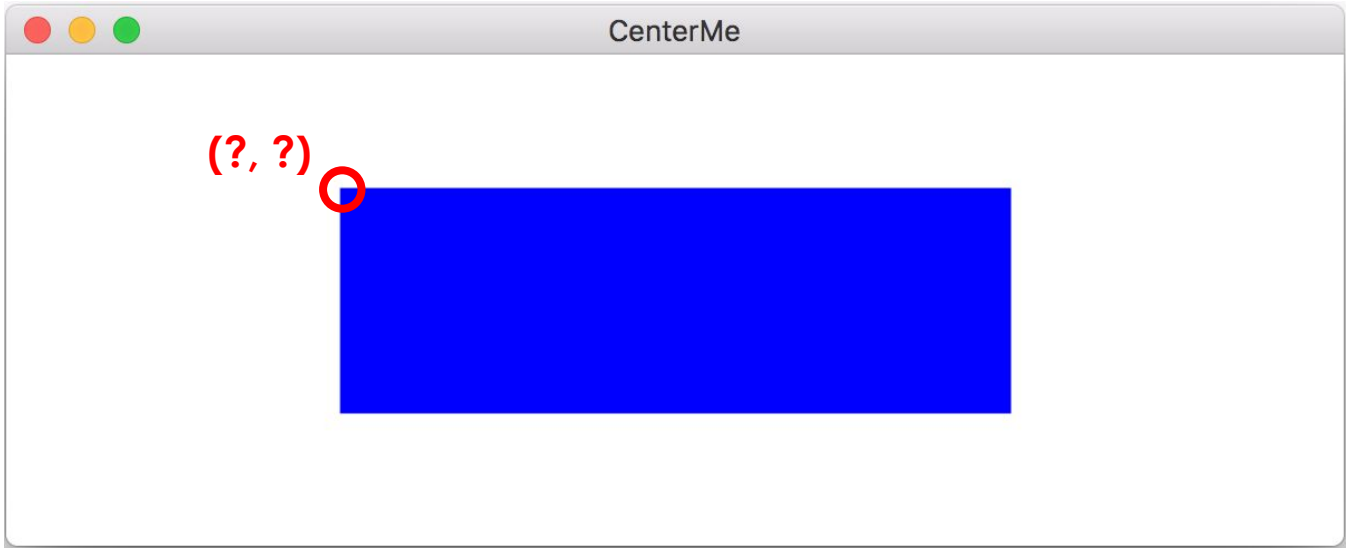
Practice: Centering

How can we nicely center an object on our canvas?

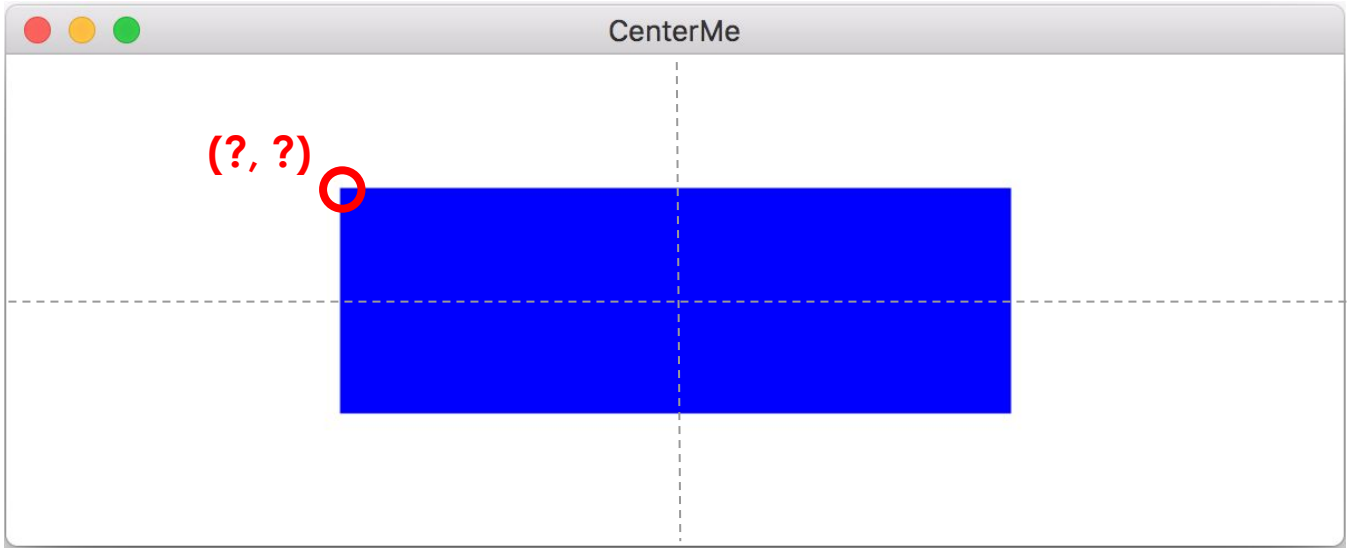
Practice: Centering



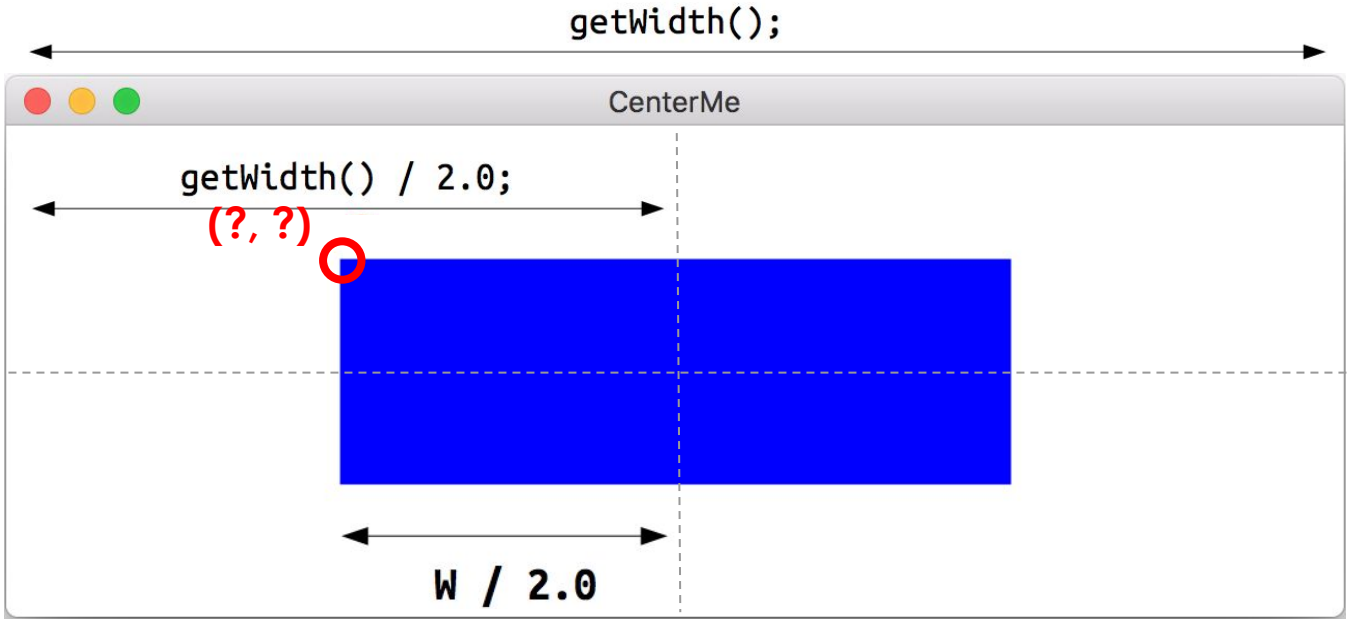
Practice: Centering



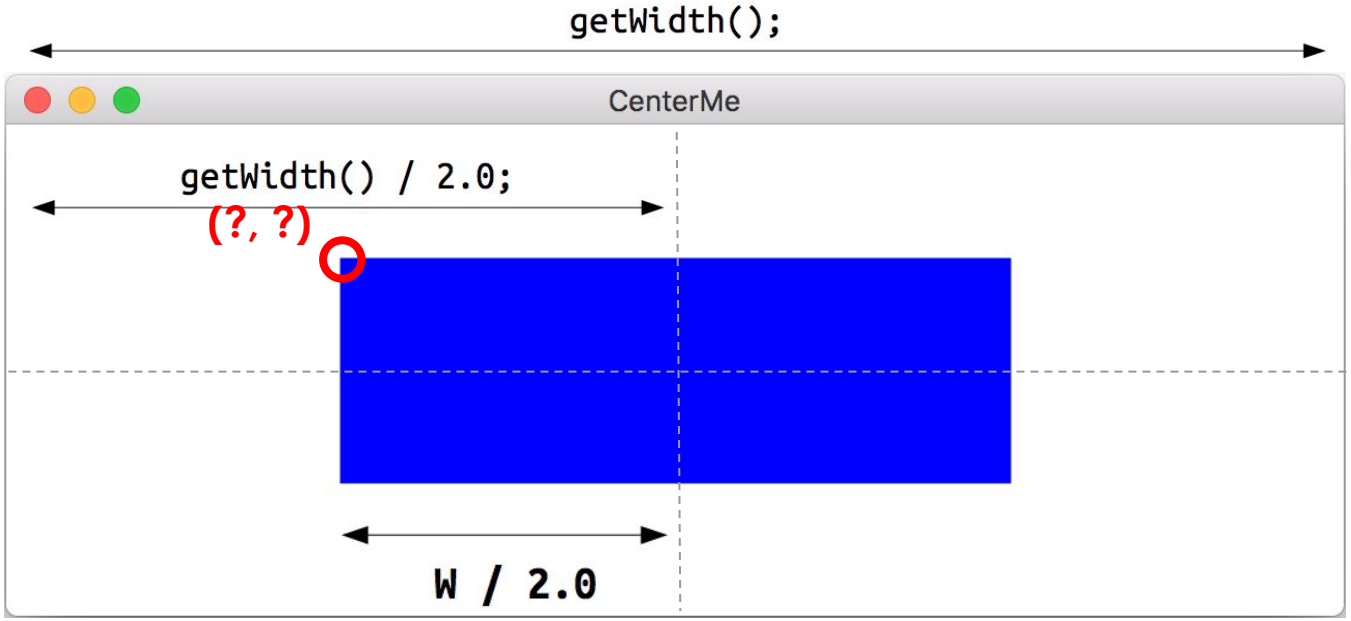
Practice: Centering



Practice: Centering

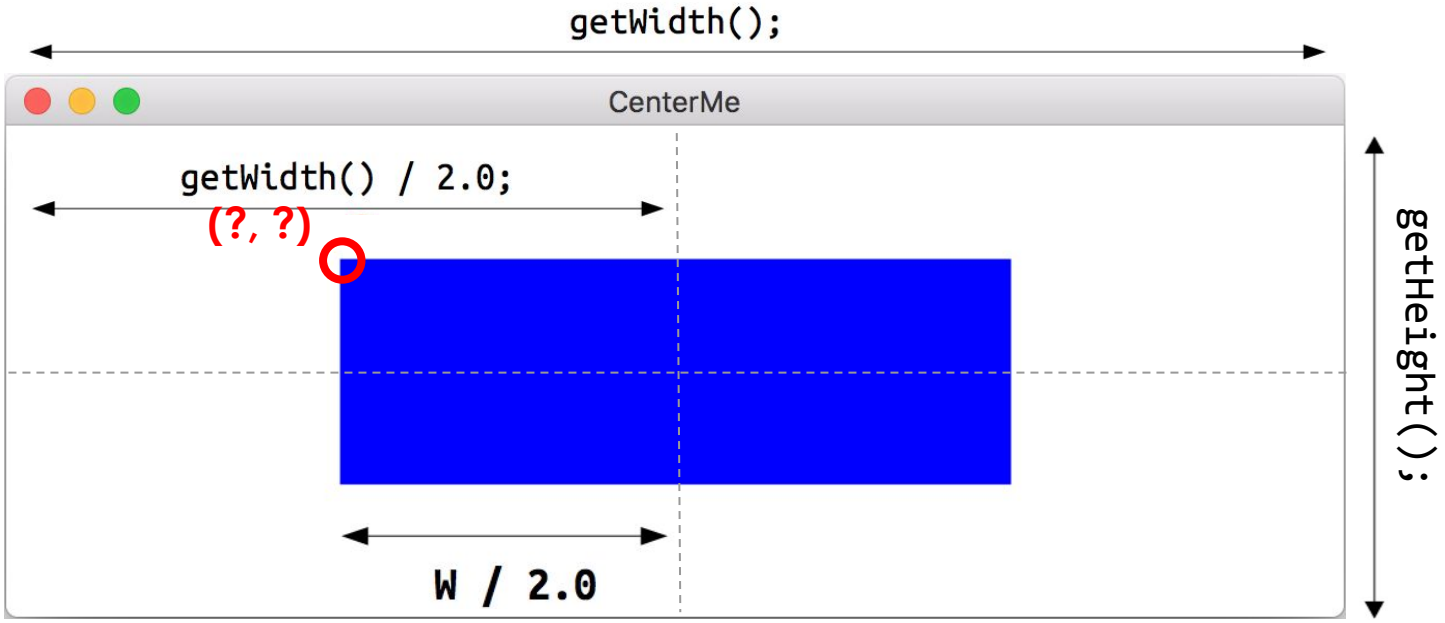


Practice: Centering



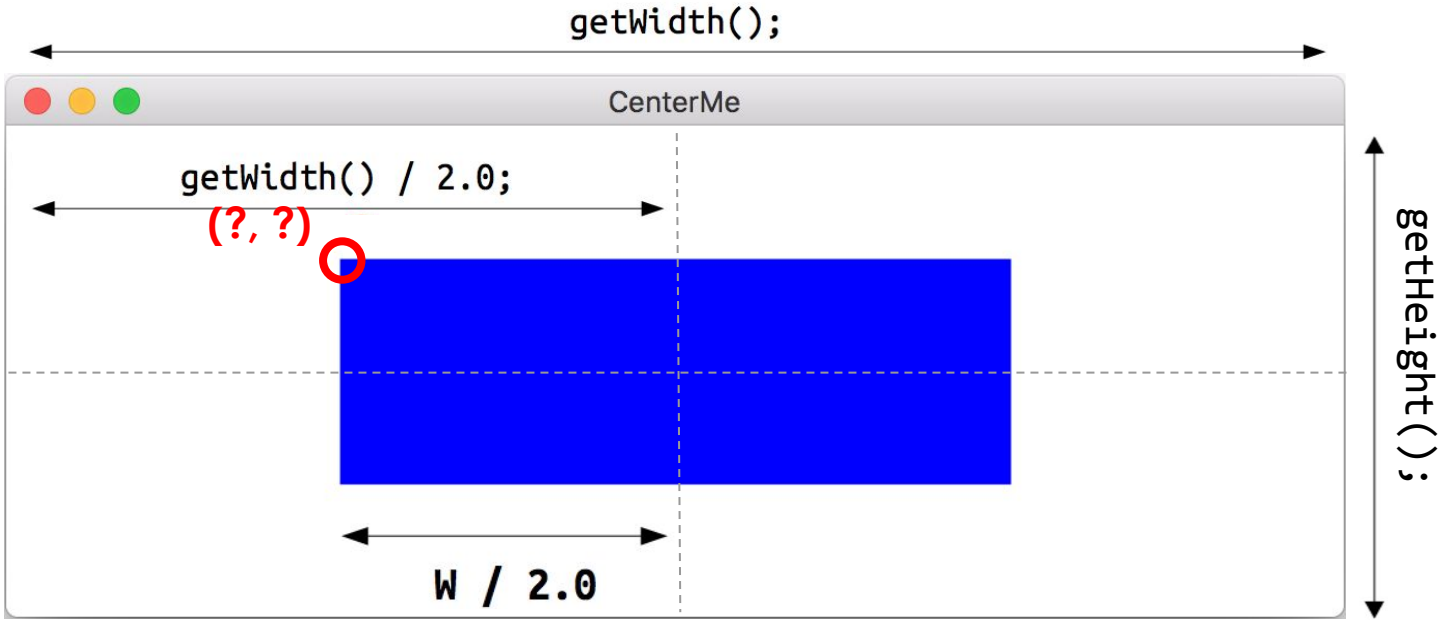

```
double x = getWidth() / 2.0 - W / 2.0;
```

Practice: Centering




```
double x = getWidth() / 2.0 - W / 2.0;
```

Practice: Centering

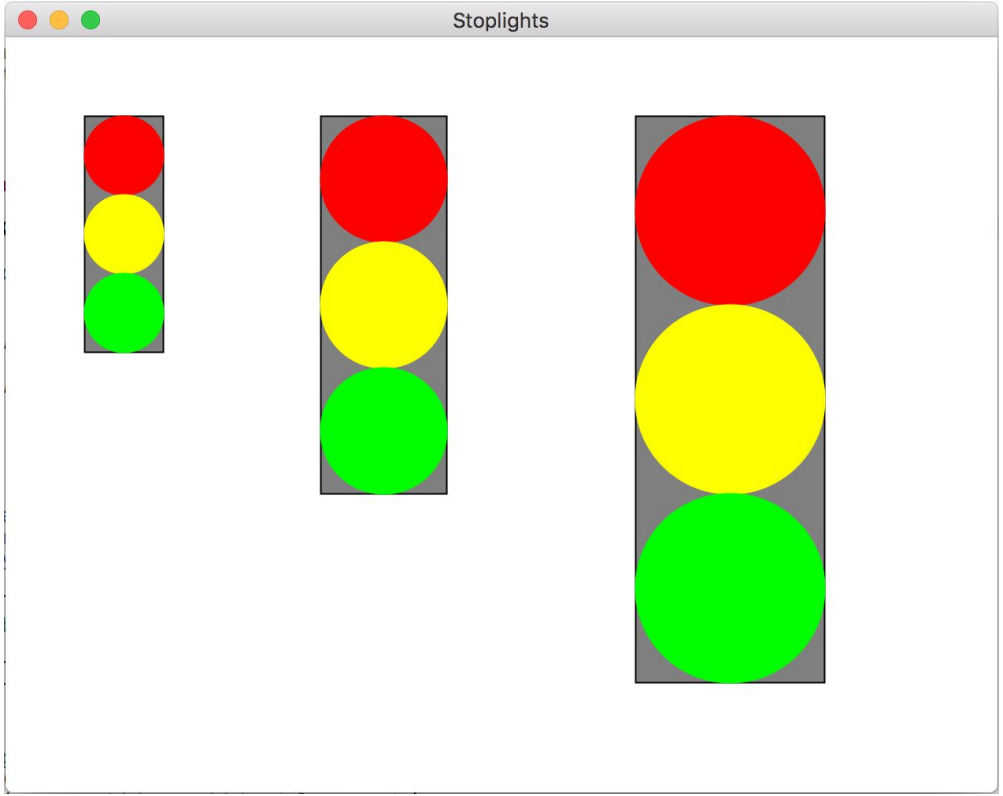



```
double x = getWidth() / 2.0 - W / 2.0;
double y = getHeight() / 2.0 - H / 2.0;
```

Plan for Today

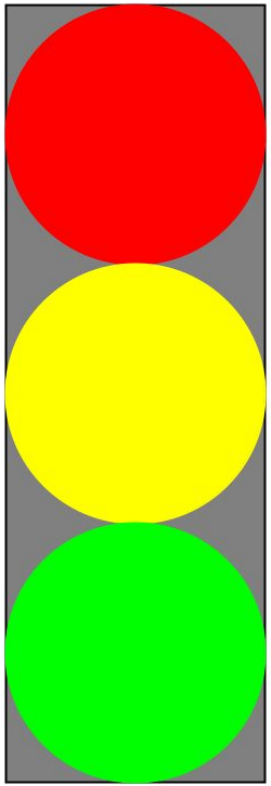
- Review: Nested Loops, Infinite Loops, Intro to Graphics
- Returning to Returns
- More Graphics!
- Stoplights

Practice: Stoplights



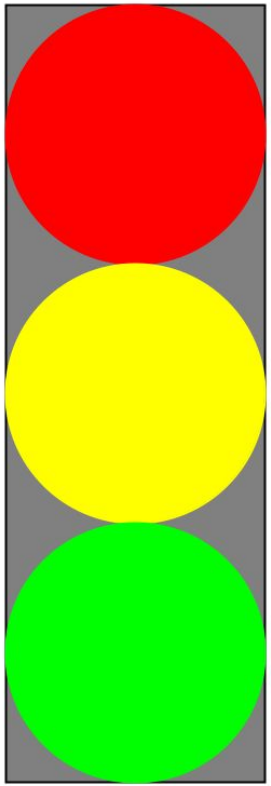
How would you make a **method** for drawing stoplights of different locations & sizes?

Practice: Stoplights



What information do we need in order to draw this?

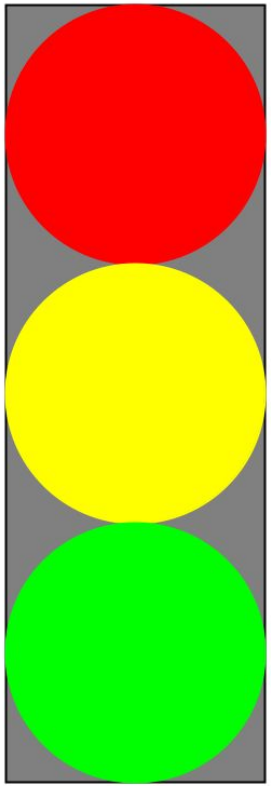
Practice: Stoplights



What's the Pseudocode?

Make stoplight (needs what info??):

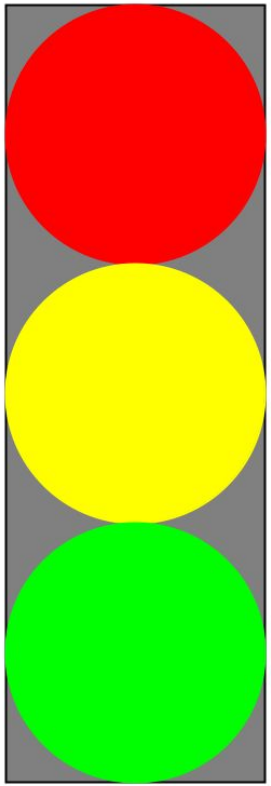
Practice: Stoplights



What's the Pseudocode?

Make stoplight (location, size):

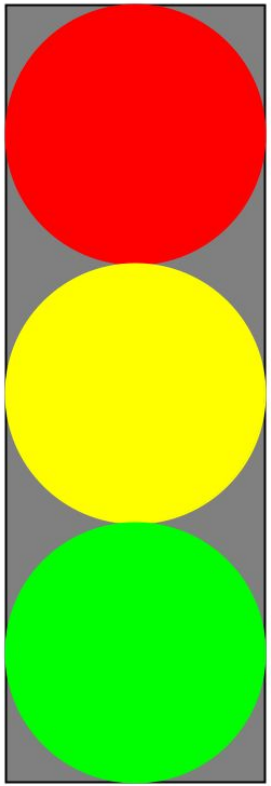
Practice: Stoplights



What's the Pseudocode?

Make stoplight (location, size):
    Make background
    Make red circle
    Make yellow circle
    Make green circle

Practice: Stoplights

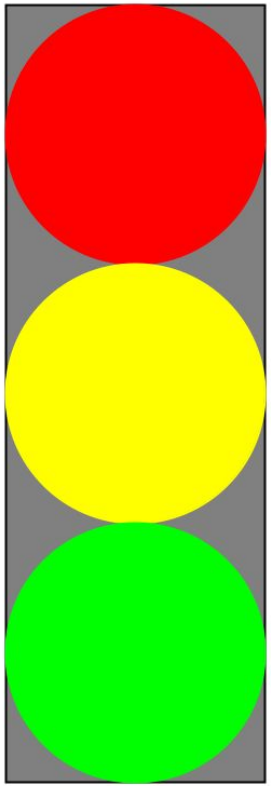


What's the Pseudocode?

Make stoplight (location, size):

- Make background
- **Make red circle**
- **Make yellow circle**
- **Make green circle**

Practice: Stoplights



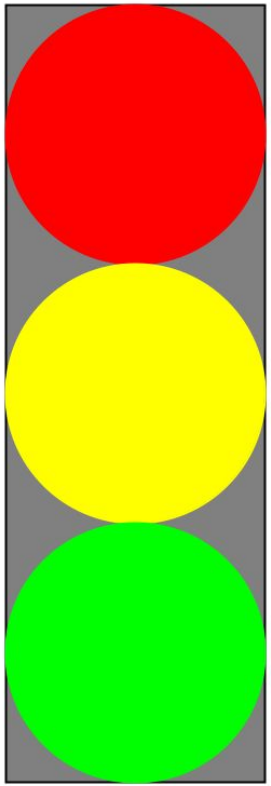
A helper method!

What's the Pseudocode?

Make stoplight (location, size):

- Make background
- **Make colored circle (red)**
- **Make colored circle (yellow)**
- **Make colored circle (green)**

Practice: Stoplights

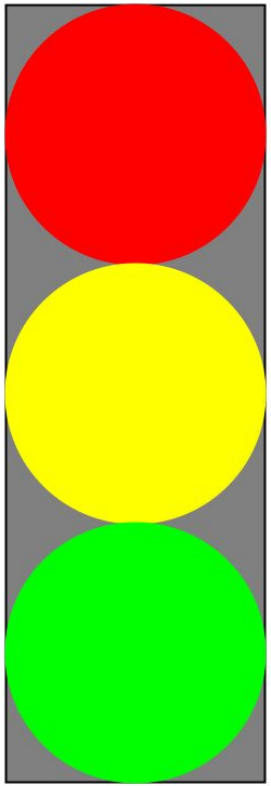


What's the Pseudocode?

Make stoplight (location, size):
    Make background
    Make colored circle (red)
    Make colored circle (yellow)
    Make colored circle (green)

Make colored circle (needs what info?):

Practice: Stoplights

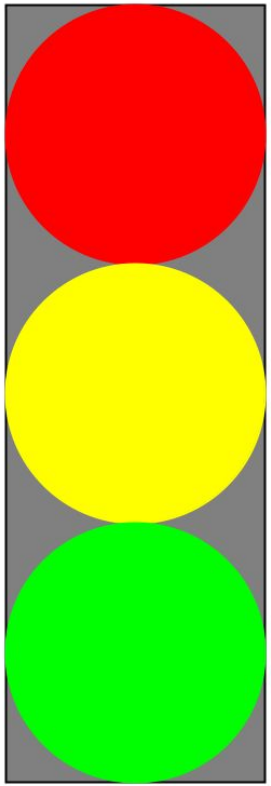


What's the Pseudocode?

Make stoplight (location, size):
    Make background
    Make colored circle (red)
    Make colored circle (yellow)
    Make colored circle (green)

Make colored circle (location, size, color):

Practice: Stoplights



What's the Pseudocode?

Make stoplight (location, size):
    Make background
    Make colored circle (red)
    Make colored circle (yellow)
    Make colored circle (green)

Make colored circle (location, size, color):
    Make circle of provided size and color
    and add it at the provided location

Let’s Code It!

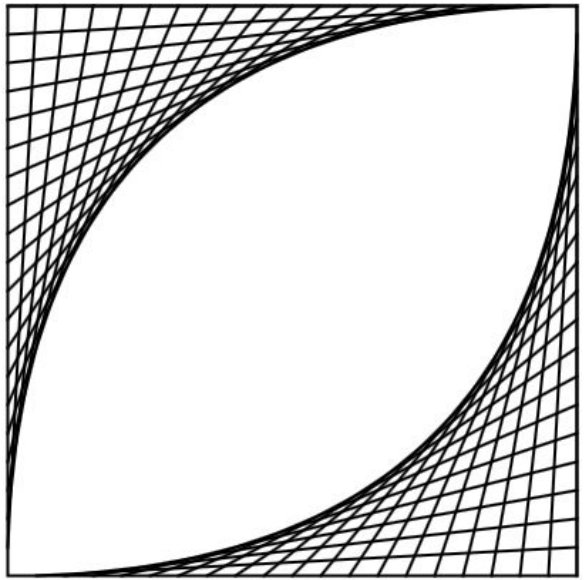
Extra Practice: Line Art

Write a graphical program LineArt that draws a series of lines (see lecture code for solution):

- Outer square is at (10, 30) and size 200x200
- Each line is 10px apart in each direction

coordinates of top-left lines:
- (210, 30) to (10, 30)
- (200, 30) to (10, 40)
- (190, 30) to (10, 50)
- ...
- (20, 30) to (10, 220)

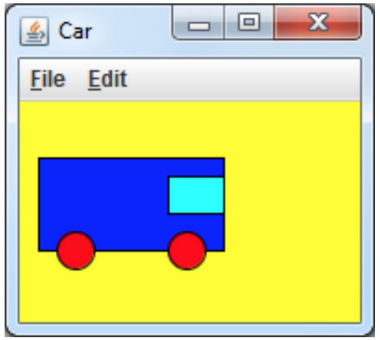
coordinates of bottom-right lines:
- (210, 30) to (210, 230)
- (210, 40) to (200, 230)
- ...
- (210, 220) to (20, 230)



Extra: GCompound

A `GCompound` contains other `GObject`s. It's useful when you want to do one operation on multiple `GObject`s at the same time (e.g., move all of them by the same amount).

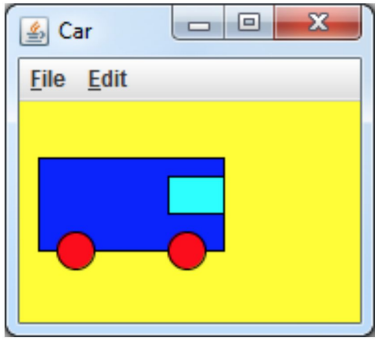
```
GCompound compound = new GCompound();
compound.add(shape);
compound.add(shape);
...
compound.add(shape);
add(compound);
```



Example: you can make a `GCompound` to represent a car.

Extra: GCompound

```
setBackground(Color.YELLOW);
GCompound car = new GCompound();

GRect body = new GRect(10, 30, 100, 50);
body.setFilled(true);
body.setFillColor(Color.BLUE);
car.add(body);

GOval wheel1 = new GOval(20, 70, 20, 20);
wheel1.setFilled(true);
wheel1.setFillColor(Color.RED);
car.add(wheel1);

GOval wheel2 = new GOval(80, 70, 20, 20);
wheel2.setFilled(true);
wheel2.setFillColor(Color.RED);
car.add(wheel2);

GRect windshield = new GRect(80, 40, 30, 20);
windshield.setFilled(true);
windshield.setFillColor(Color.CYAN);
car.add(windshield);

add(car);   // adds whole GCompound (like a "sub-canvas") to the canvas
```



Plan for Today

- Review: Nested Loops, Infinite Loops, Intro to Graphics
- Returning to Returns
- More Graphics!
- Stoplights

Extra: Line Art practice & GCompound

Next time: Animation!