

Variables

Chris Piech
CS106A, Stanford University

Challenge Carbon Dating



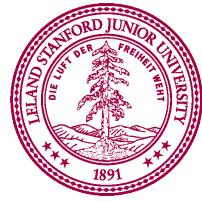
Write a program that can turn a measurement of C14 into an estimate of age.

```
CarbonDating
Radioactive molecule = C14
Halflife = 5730 years
C14 in living organisms = 13.6 dpm
-----
What is the amount of C14 remaining in your sample: 10.2
Your sample is 2378.0 years old.
```

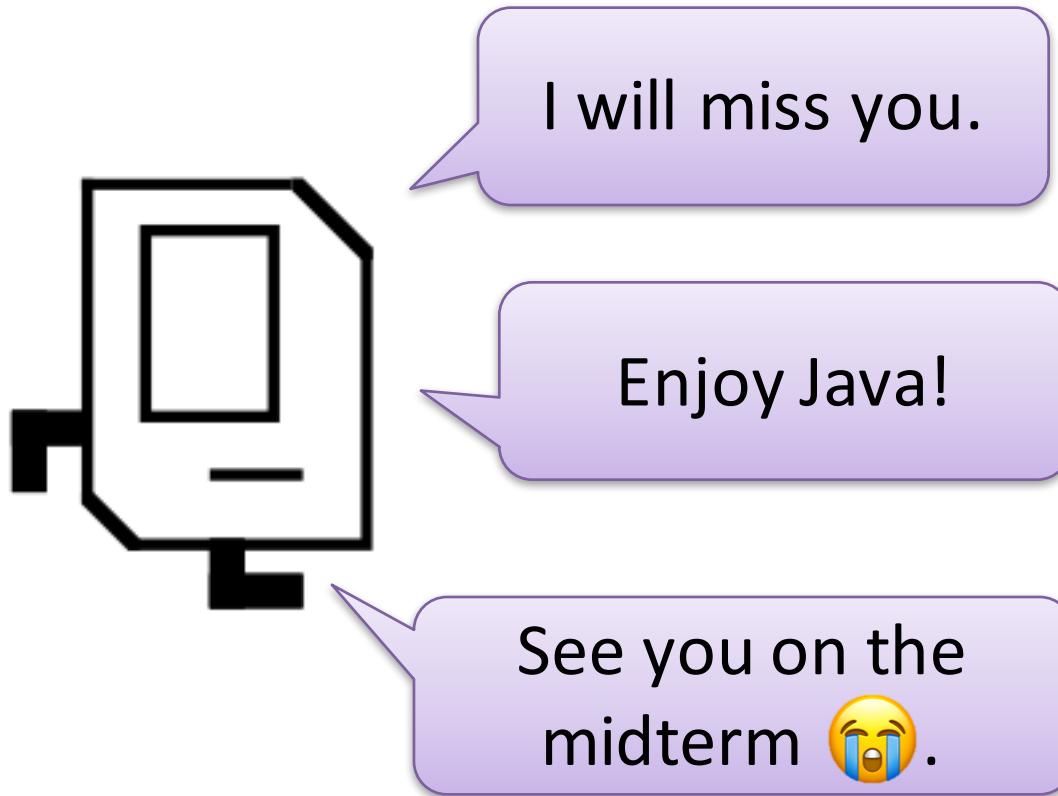


Review: Decomposition

1. Each method solves one “problem”
2. Methods should have good names
3. Comment each of your methods
4. Length of methods should be < 15 lines
5. Methods should ideally be generalizable



See You Later!



Java

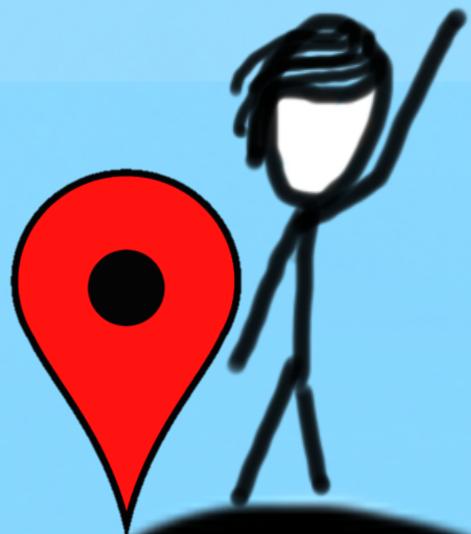


Piech, CS106A, Stanford University

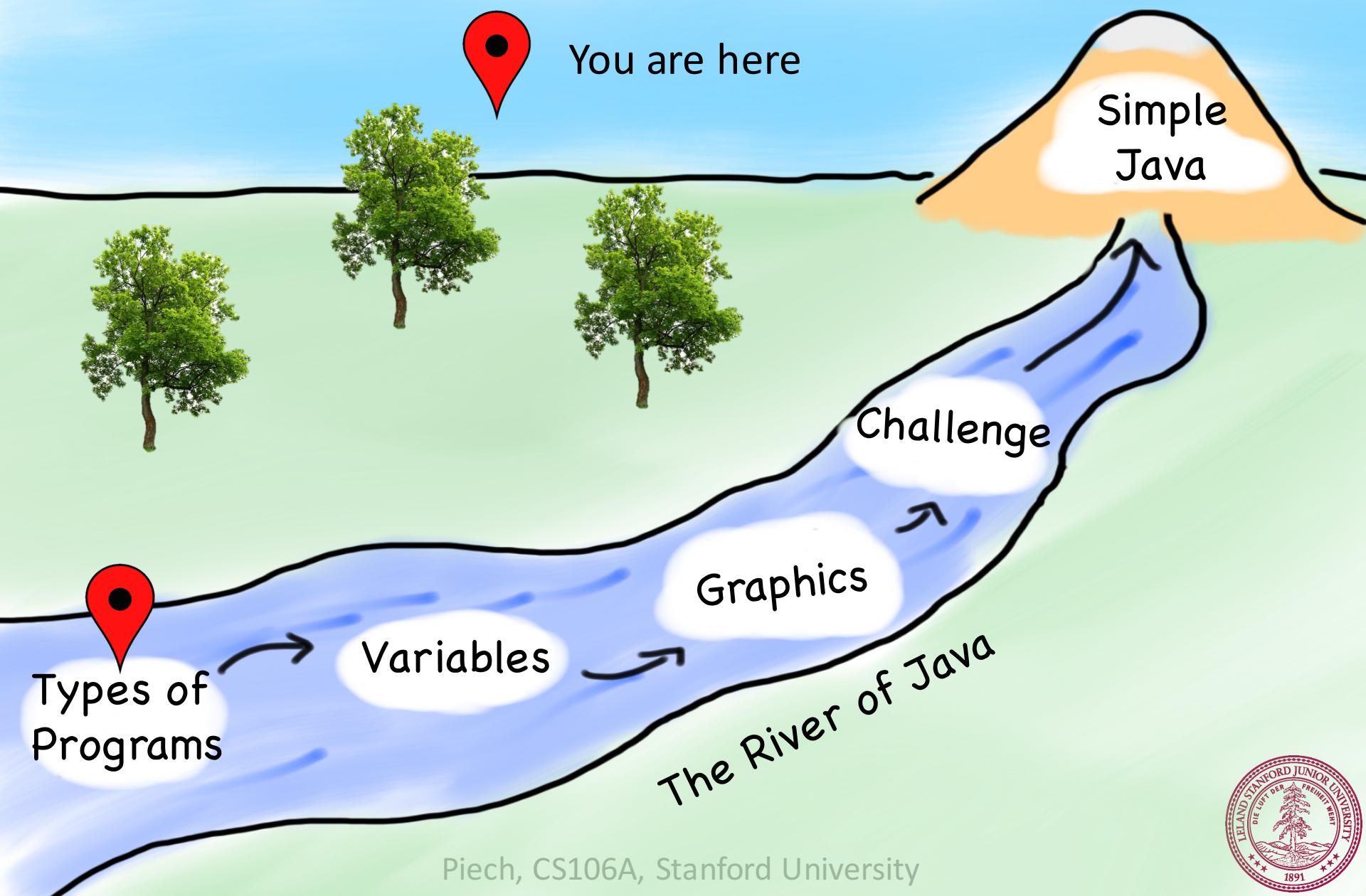


Today's Goal

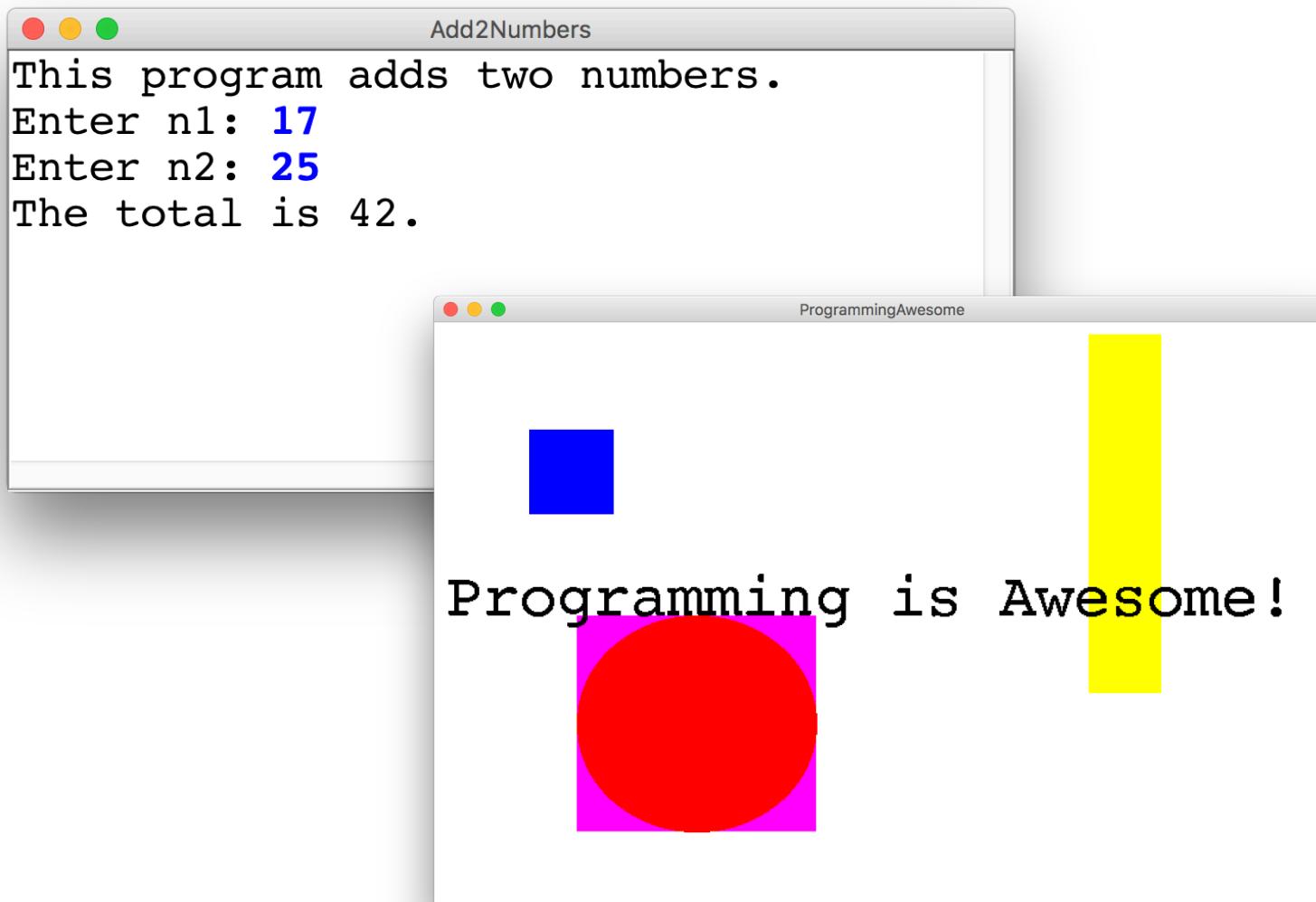
1. What are variables and how do I use them?
2. What are graphical objects and how do I use them?



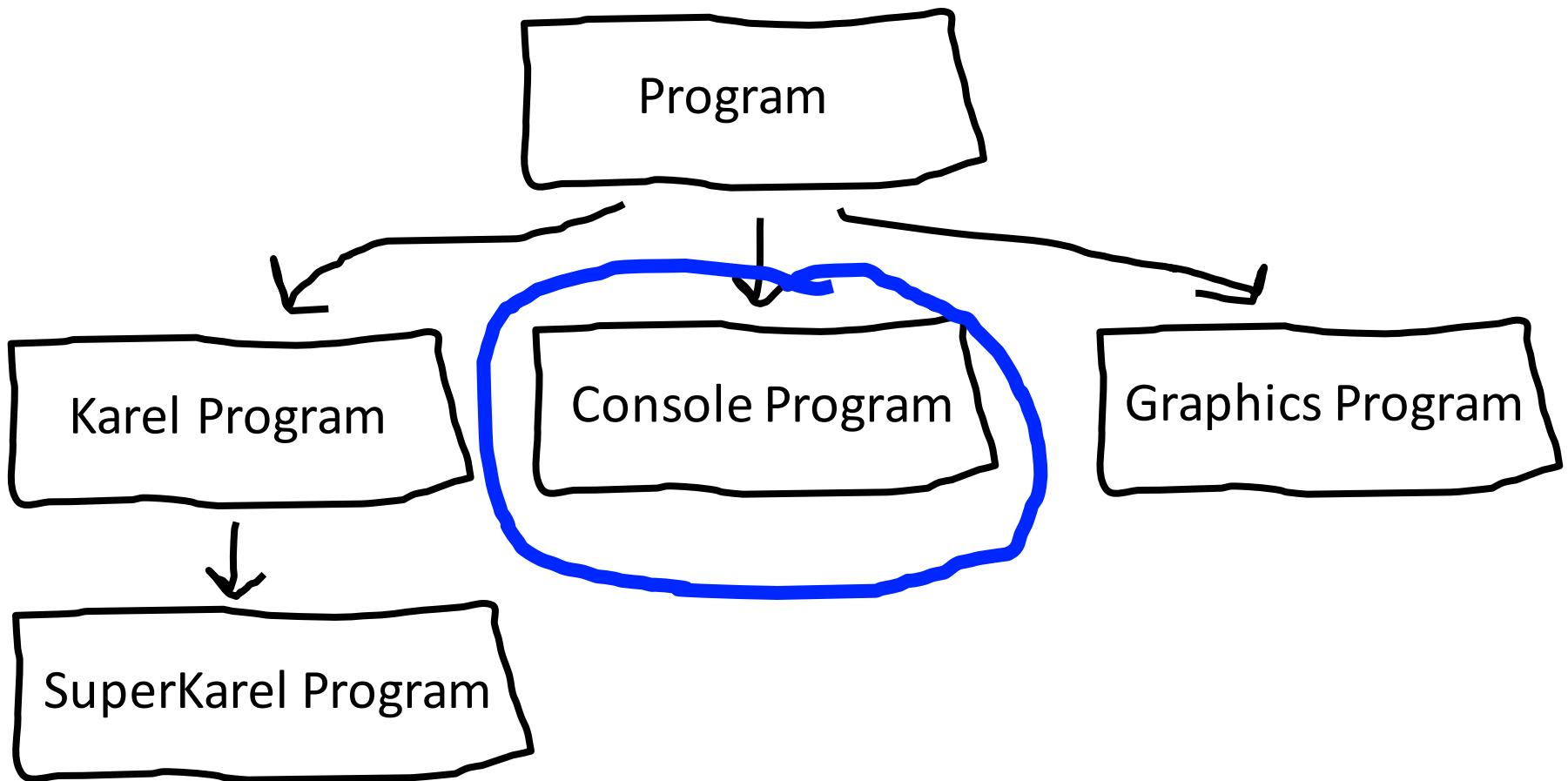
Today's Route



Two Example Programs



Types of Programs



First Console Program: Hello World

```
import acm.program.*;

public class HelloProgram extends ConsoleProgram {

    public void run() {
        println("hello, world");
    }
}
```



In Pop Culture



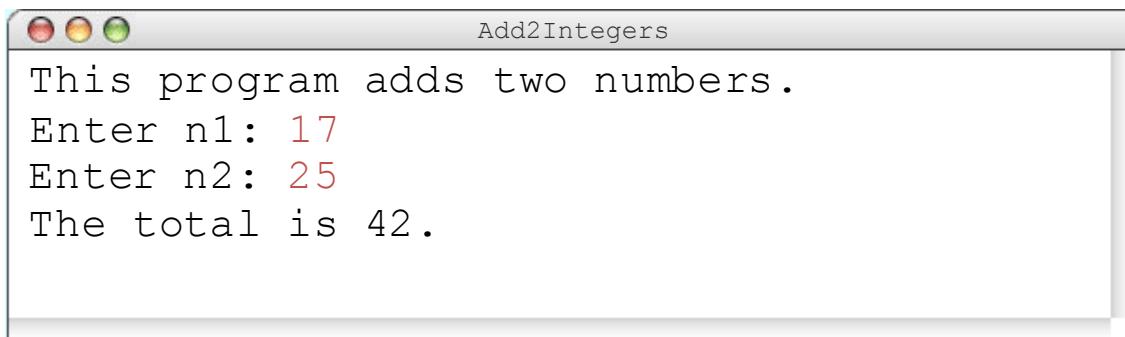
You had me at
"Hello, world"



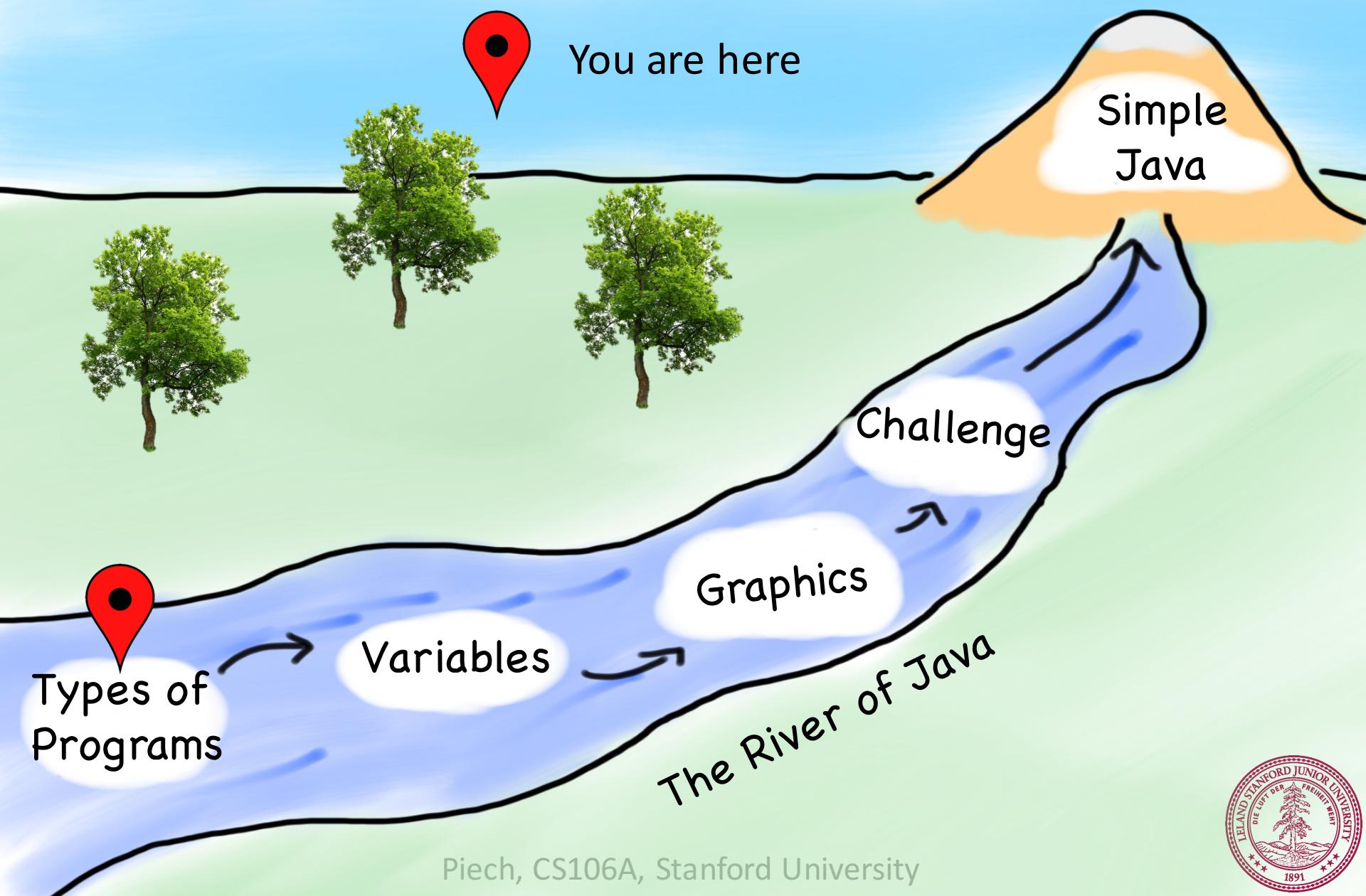
Add2Integers

```
class Add2Integers extends ConsoleProgram {  
    public void run() {  
        println("This program adds two numbers.");  
        int n1 = readInt("Enter n1: ");  
        int n2 = readInt("Enter n2: ");  
        int total = n1 + n2;  
        println("The total is " + total + ".");  
    }  
}
```

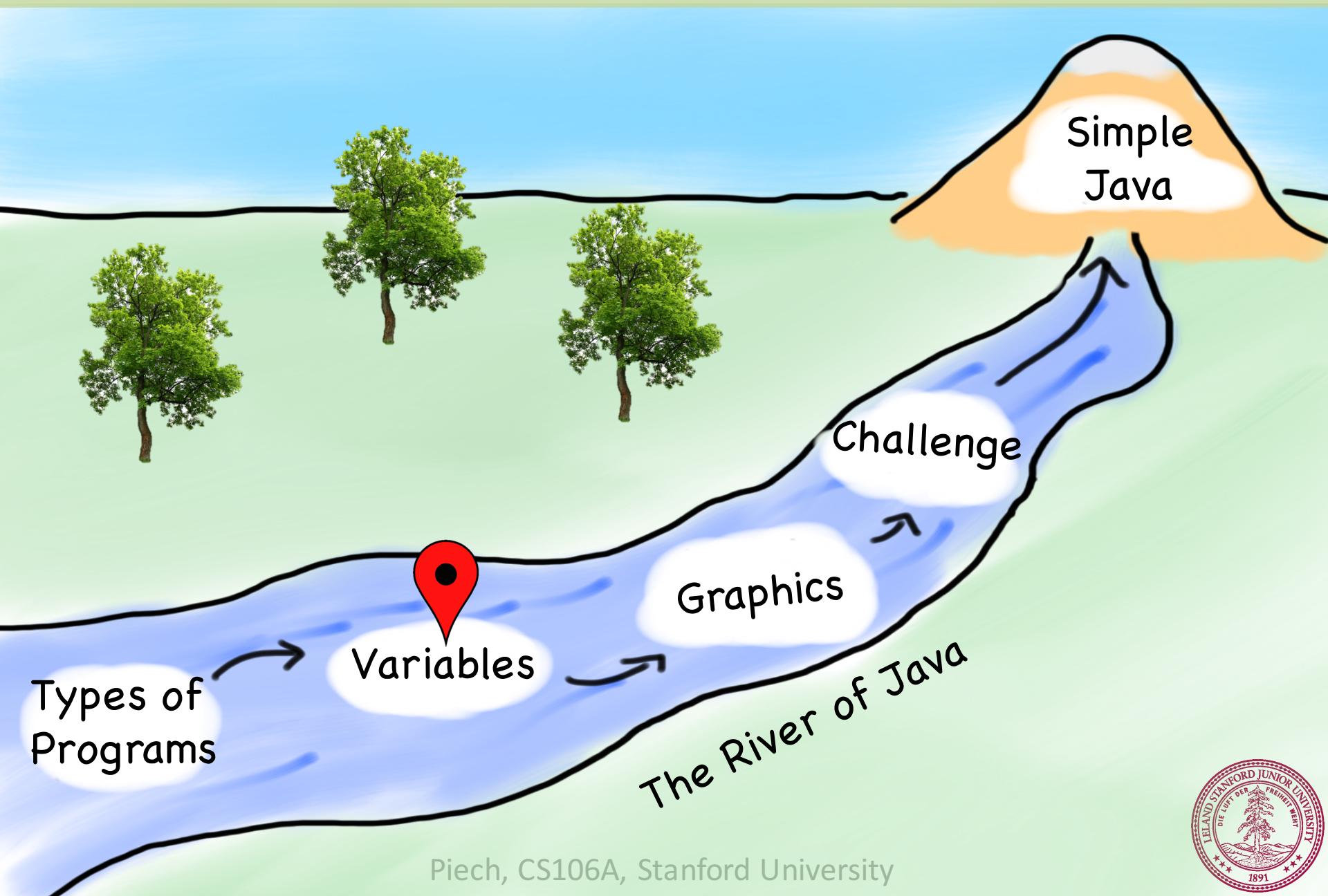
n1	n2	total
17	25	42



Today's Route



Today's Route



Programs are *control flow* and *variables*

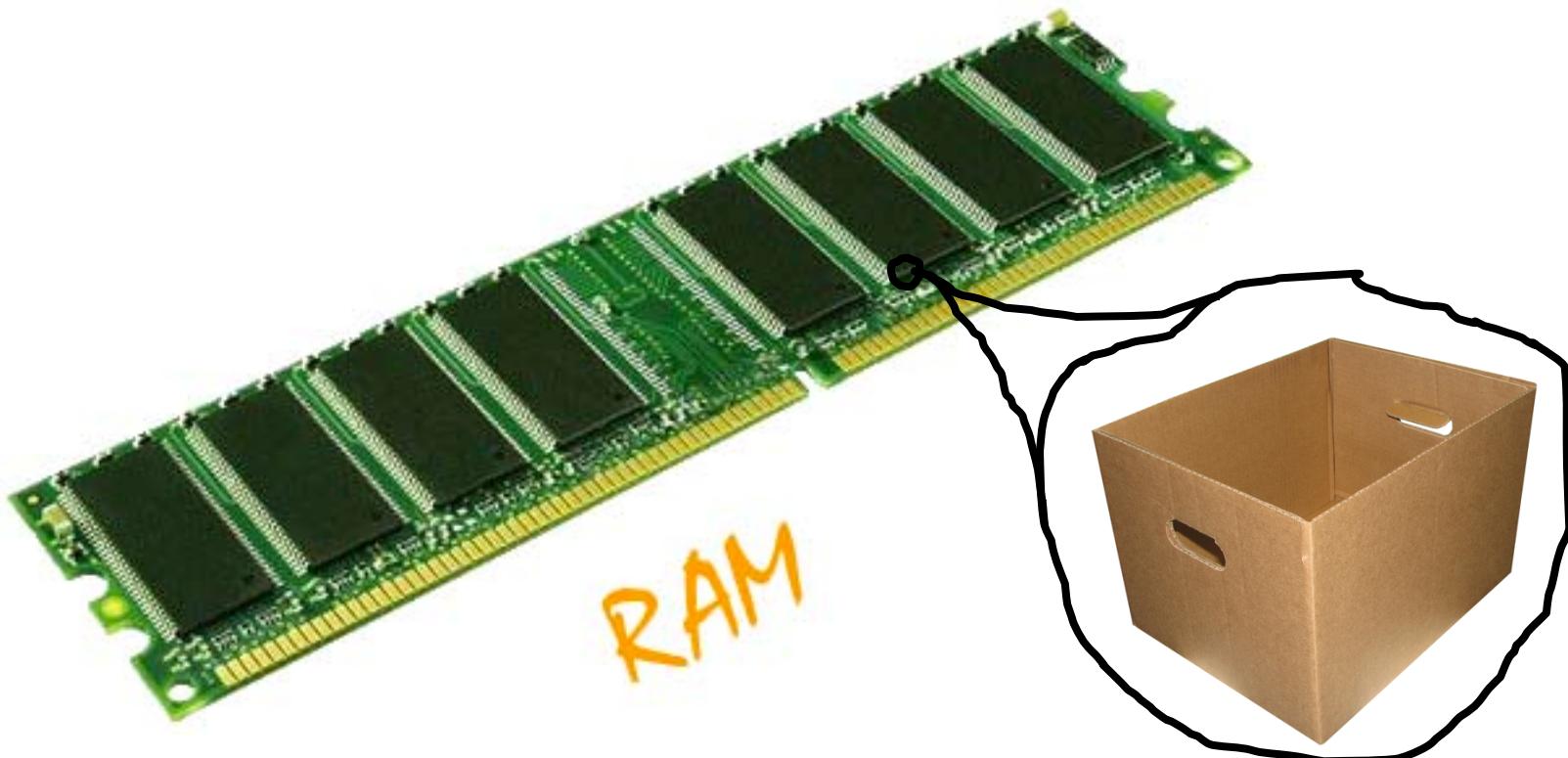
What is a variable?

[suspense]

Variables are Like Boxes

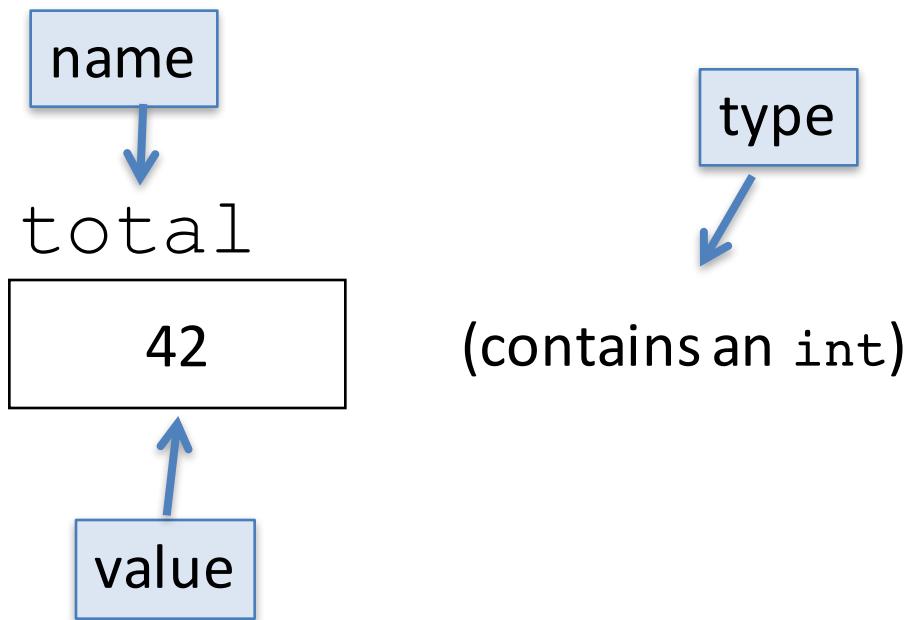


Teeny Tiny Boxes



My computer has space for about 2 billion boxes

Three Properties



Types

```
// integer values  
int num = 5;
```

```
// real values  
double fraction = 0.2;
```

```
// letters  
char letter = 'c';
```

```
// true or false  
boolean isLove = true;
```

* Why is it called a double? /



Double: How Much Do I Weigh?



* Answers could be real valued numbers



Int: How Many Children Do I Have?



* It is weird to say something like 1.7

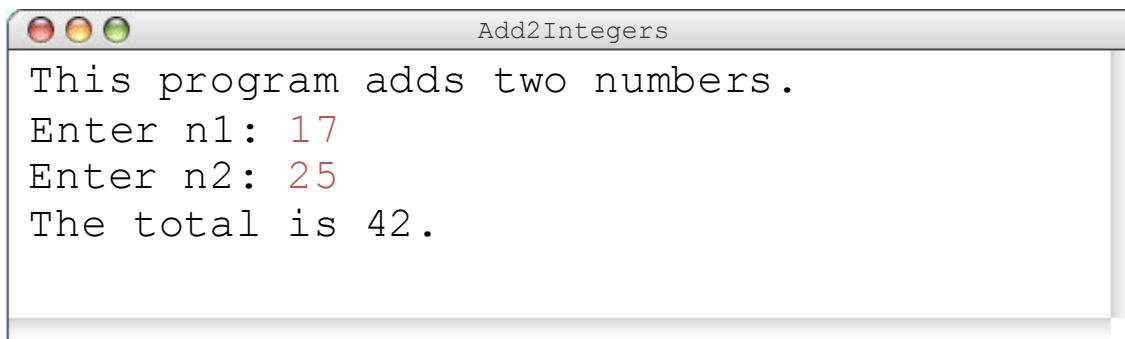


Assignment

Add2Integers

```
class Add2Integers extends ConsoleProgram {  
    public void run() {  
        println("This program adds two numbers.");  
        int n1 = readInt("Enter n1: ");  
        int n2 = readInt("Enter n2: ");  
        int total = n1 + n2;  
        println("The total is " + total + ".");  
    }  
}
```

n1	n2	total
17	25	42



User Input

```
int a = readInt("msg");  
  
double b = readDouble("msg");
```



Binary Operators

+ Addition

- Subtraction

* Multiplication

/ Division

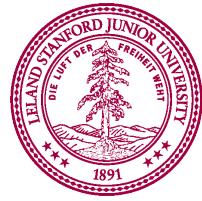
% Remainder

See you another day, tio.



What do you think this does?

```
println(1 / 2);
```



AHHHHHHHH!!!!!!

```
println(1 / 2);
```



Resulting Type

int + int results in an **int**

double + double results in a **double**

int + double results in a **double**

* The general rule is: operations always return the most expressive type



Operation Examples

Pitfalls of Integer Division

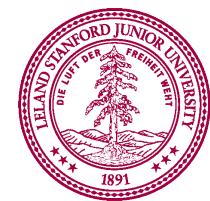
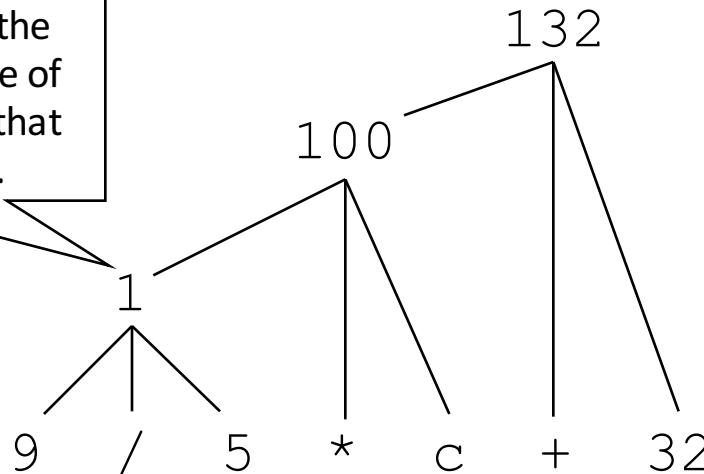
Convert 100° Celsius temperature to its Fahrenheit equivalent:

```
double c = 100;  
double f = 9 / 5 * c + 32;
```



The computation consists of evaluating the following expression:

The problem arises from the fact that both 9 and 5 are of type `int`, which means that the result is also an `int`.

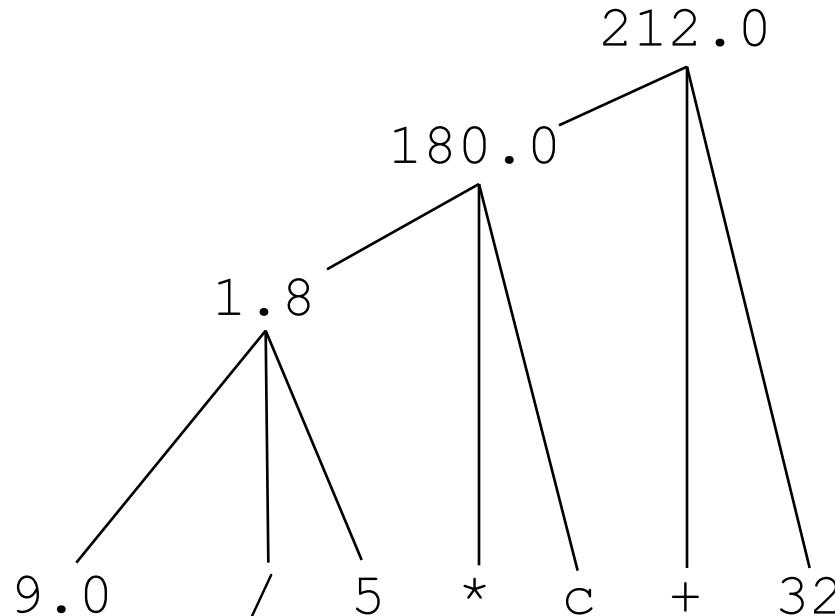


Pitfalls of Integer Division

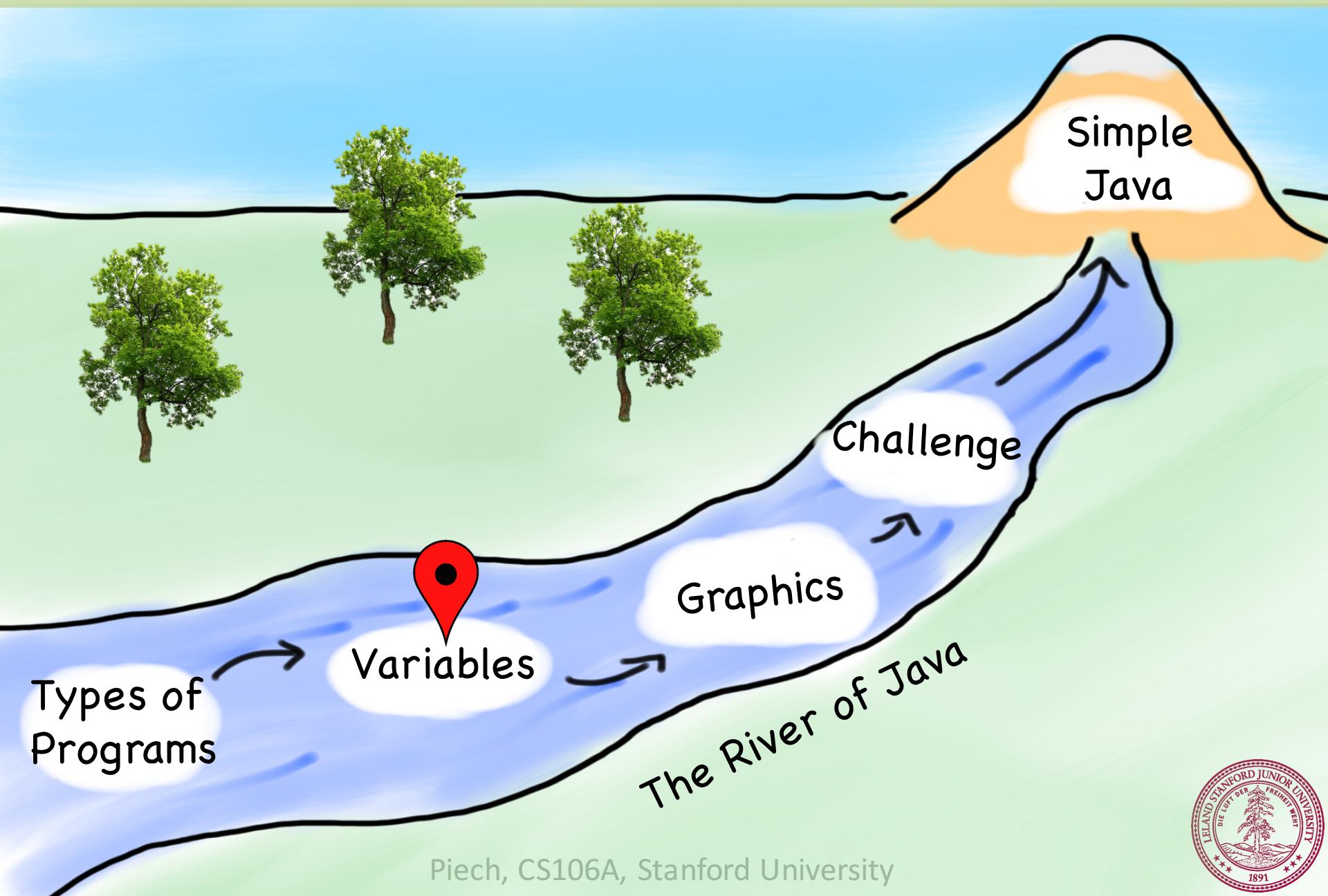
You can fix this problem by converting the fraction to a double, either by inserting decimal points or by using a type cast:

```
double c = 100;  
double f = 9.0 / 5 * c + 32;
```

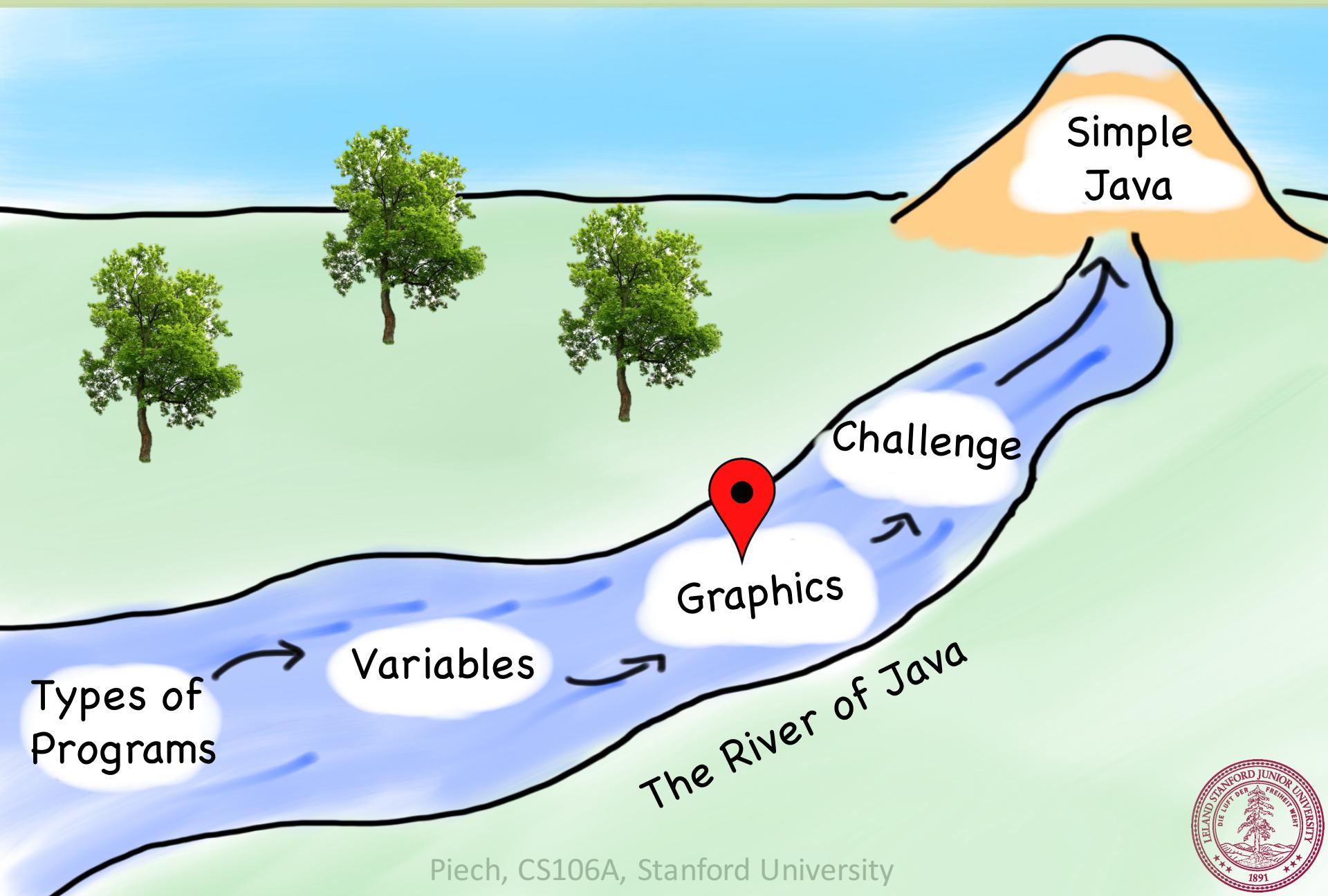
The computation now looks like this:



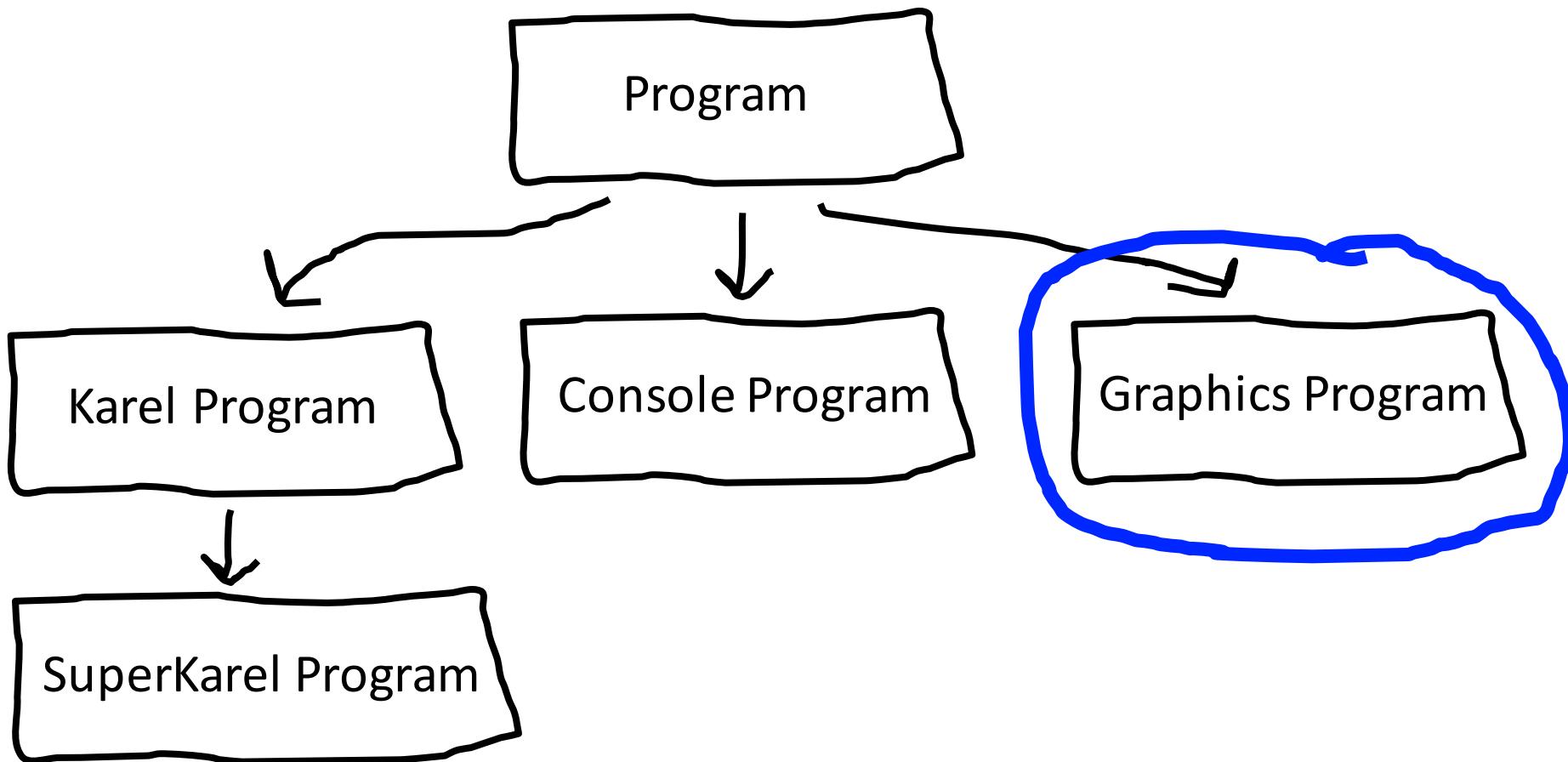
Today's Route



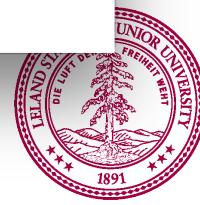
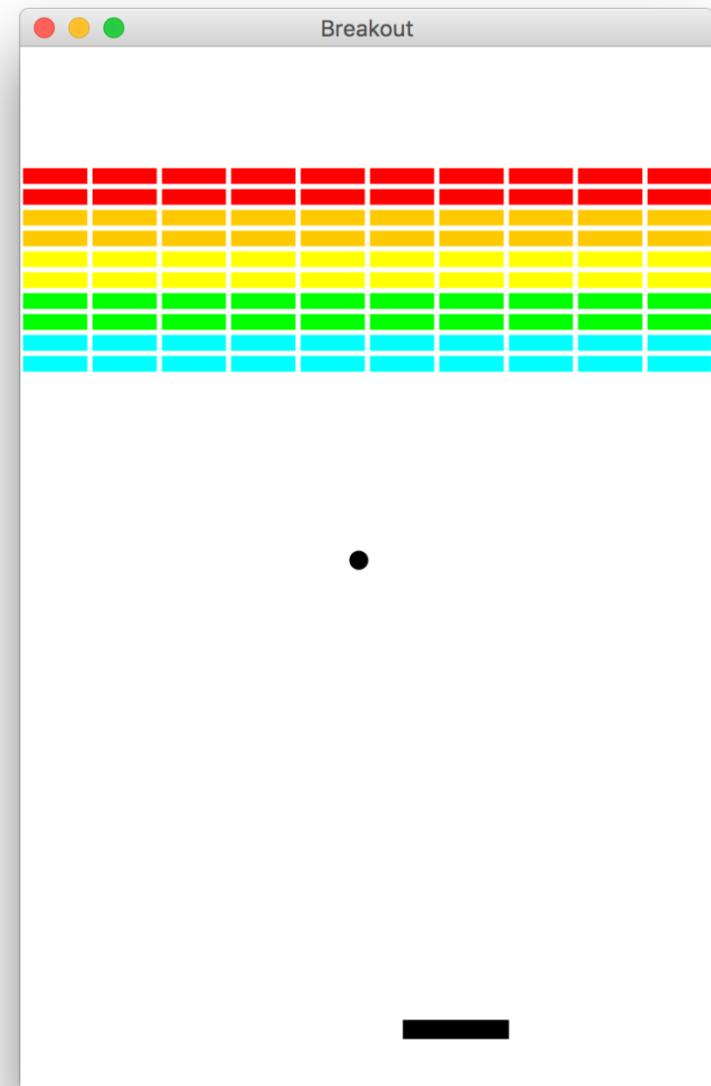
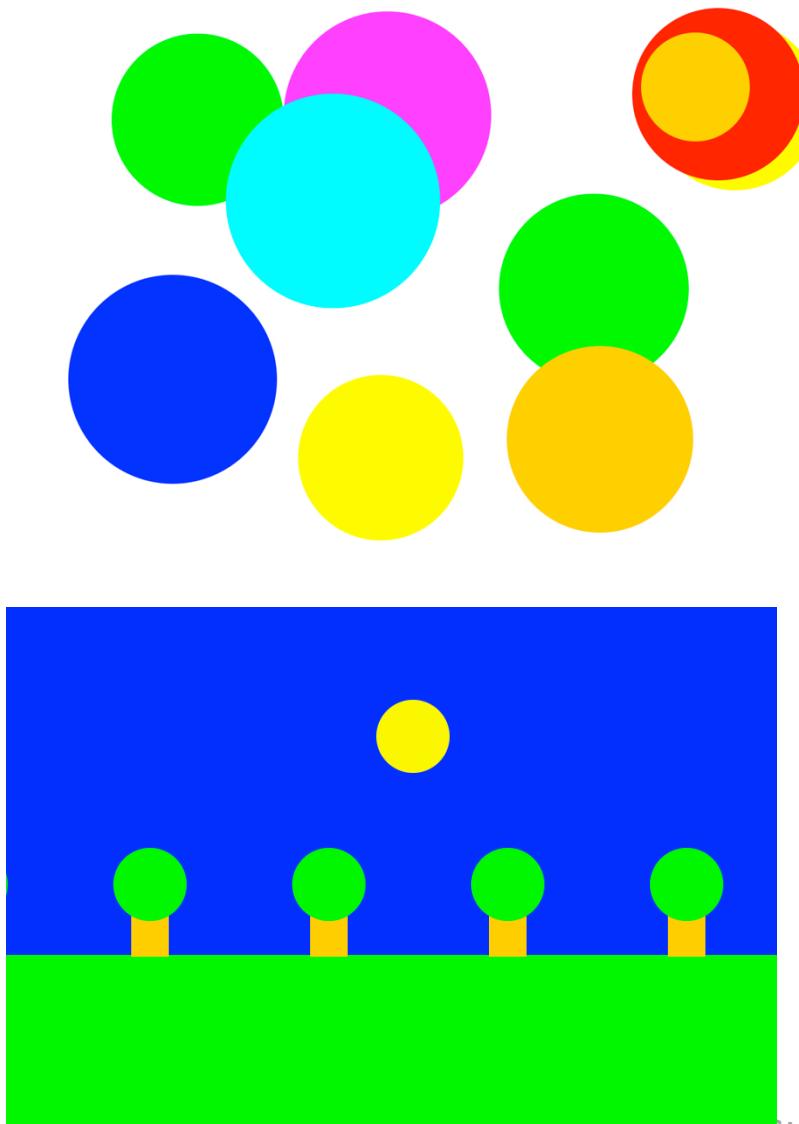
Today's Route



Types of Programs



Graphics Programs

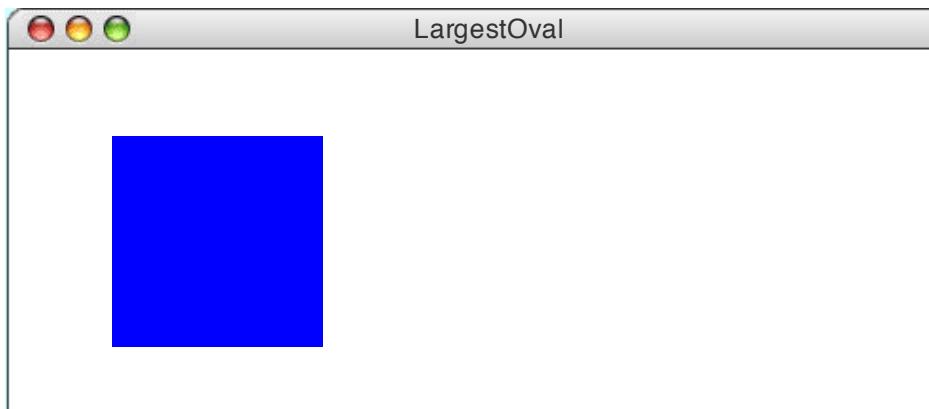


GRect

GRect is a variable type that stores a rectangle.

As an example, the following **run** method displays a blue square

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



Graphics Coordinates

0,0

x 40,20

x 120,40

x 40,120

getWidth();

getHeight();

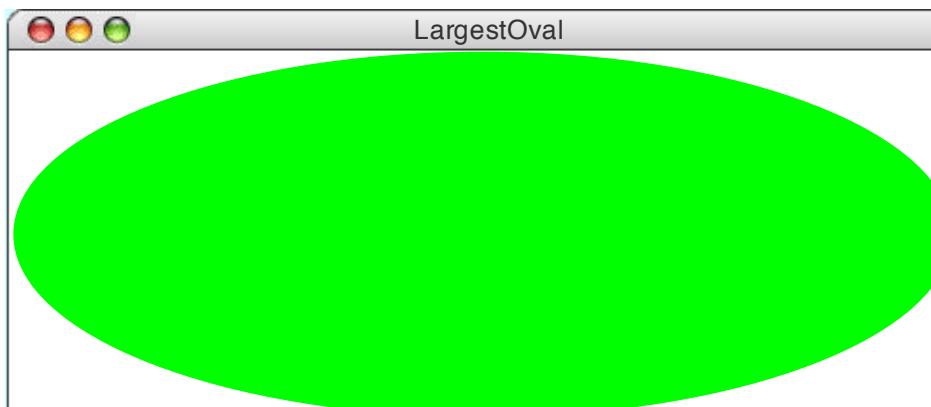


GOval

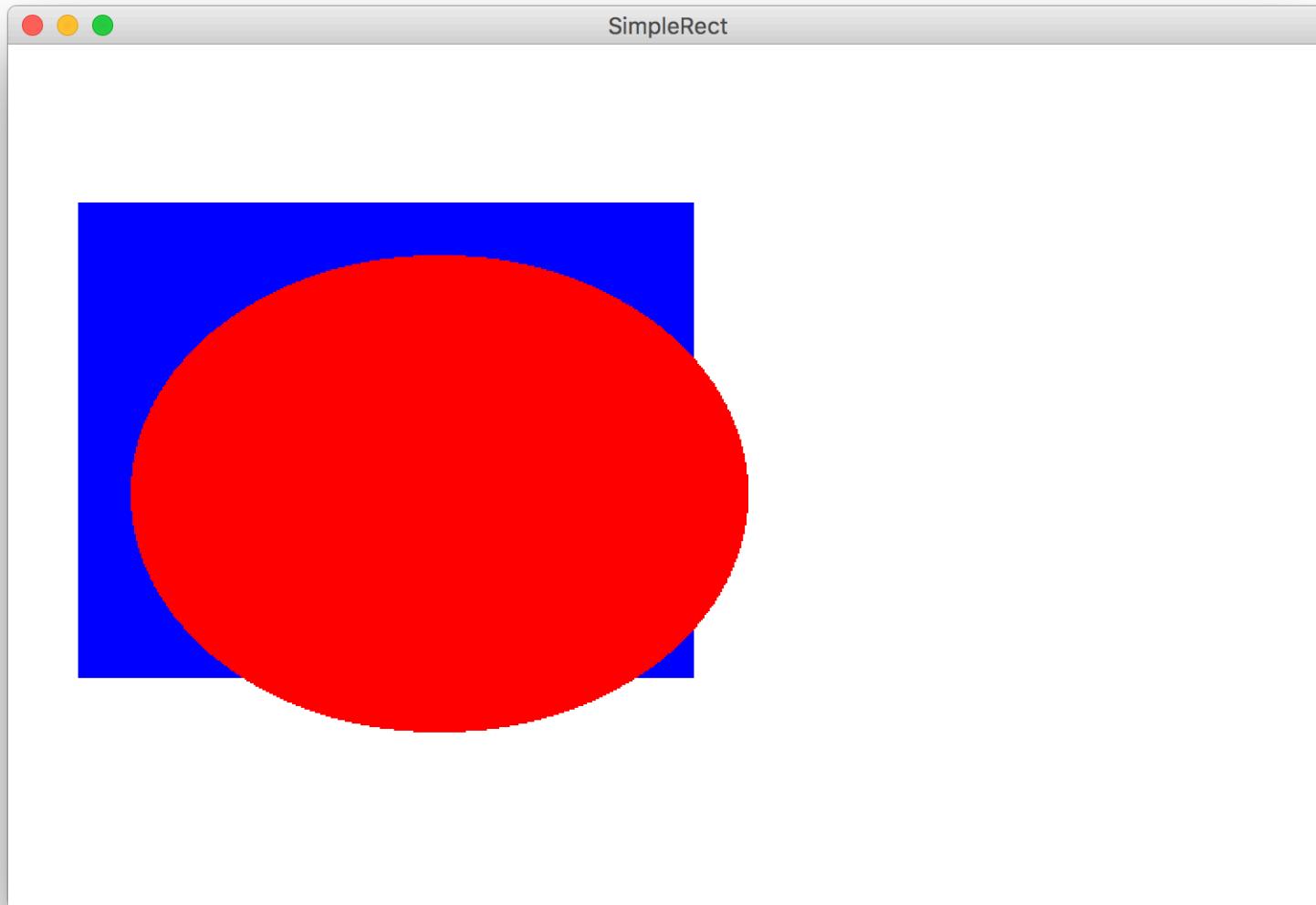
The `GOval` class represents an elliptical shape defined by the boundaries of its enclosing rectangle.

As an example, the following `run` method creates the largest oval that fits within the canvas:

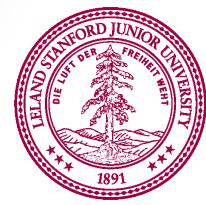
```
public void run() {  
    GOval oval = new GOval(getWidth(), getHeight());  
    oval.setFilled(true);  
    oval.setColor(Color.GREEN);  
    add(oval, 0, 0);  
}
```



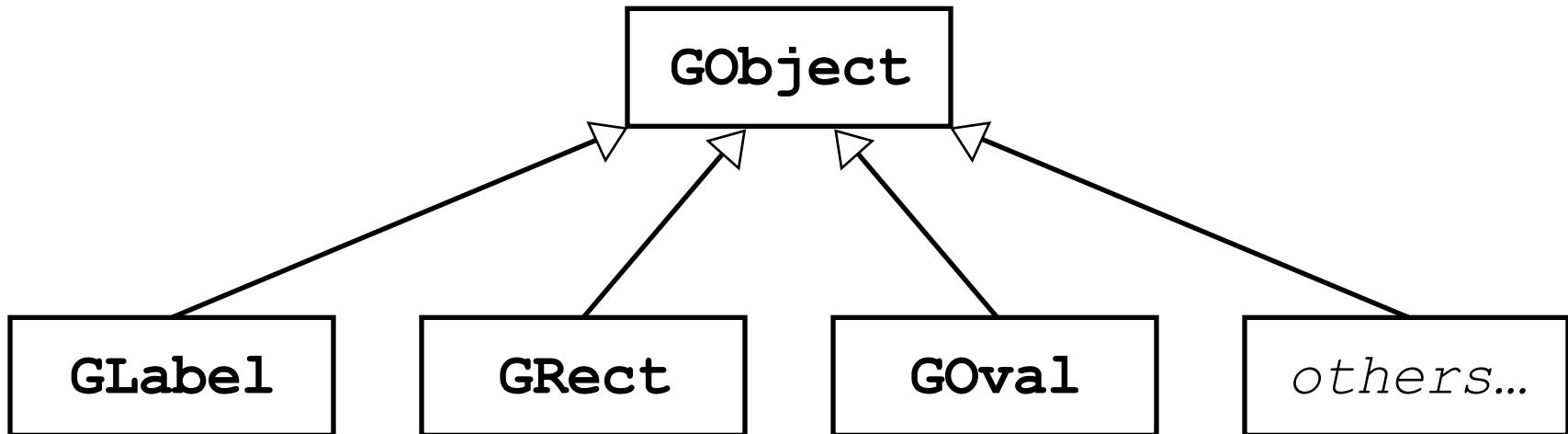
Learn By Example



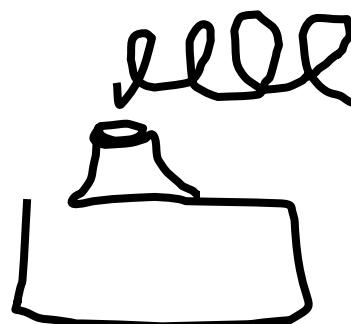
Piech, CS106A, Stanford University



Graphics Variable Types



```
GRect myRect = new GRect(350, 270);
```



Primitives vs Classes

Primitive Variable Types

int
double
char
boolean

Class Variable Types

GRect
GOval
GLine
...

Class variables:

1. Have upper camel case types
2. You can call methods on them
3. Are constructed using **new**
4. Are stored in a special way



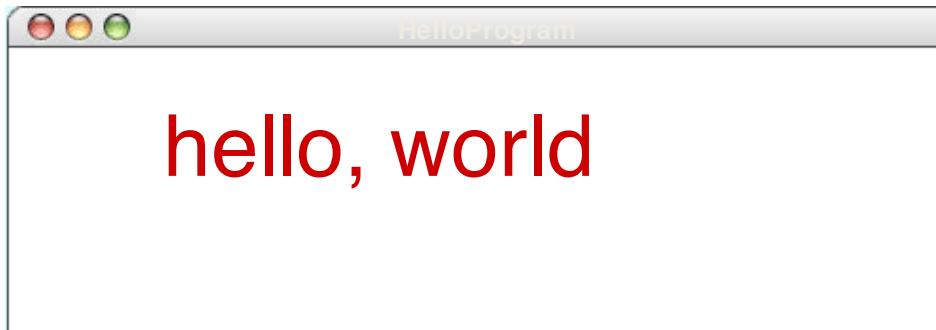
Graphics Trace

The following program illustrates sending a message to an object. Note that the label doesn't appear until it is added to the canvas.

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

label

hello, world



skip



Label Location

- Origin is upper left
- Everything measured in pixels (dots on the screen)
- x coordinates increase to the right
- y coordinates increase going down
- `GLabel` coordinates are baseline of first character



Operations on GRect

`object.setColor(color)`

Sets the color of the object to the specified color constant.

The standard color names are defined in the `java.awt` package:

`Color.BLACK`

`Color.DARK_GRAY`

`Color.GRAY`

`Color.LIGHT_GRAY`

`Color.WHITE`

`Color.RED`

`Color.YELLOW`

`Color.GREEN`

`Color.CYAN`

`Color.BLUE`

`Color.MAGENTA`

`Color.ORANGE`

`Color.PINK`



Operations on GRect

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 . 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 . getWidth ()

Returns the width of the rectangle.

object . getHeight ()

Returns the height of the rectangle.



Operations on GOval

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 . 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 . getWidth ()

Returns the width of the rectangle.

object . getHeight ()

Returns the height of the rectangle.



Operations on GLabel

Methods specific to the **GLabel** class

label.setFont(font)

Sets the font used to display the label as specified by the font string.

label.getAscent()

Returns the height of the label above its baseline.

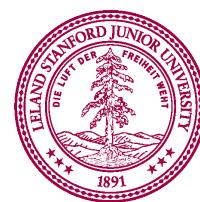
The font is typically specified as a string in the form

"*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



Construction

new GRect(width , height)

Creates a rectangle with dimensions width and height.

new GOval(width , height)

Creates an oval that fits inside the rectangle with the same dimensions.

new GRect(x , y , width , height)

Creates a rectangle whose upper left corner is at (x, y) of the specified size.

new GOval(x , y , width , height)

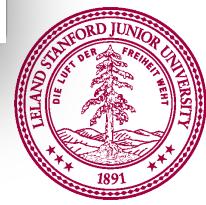
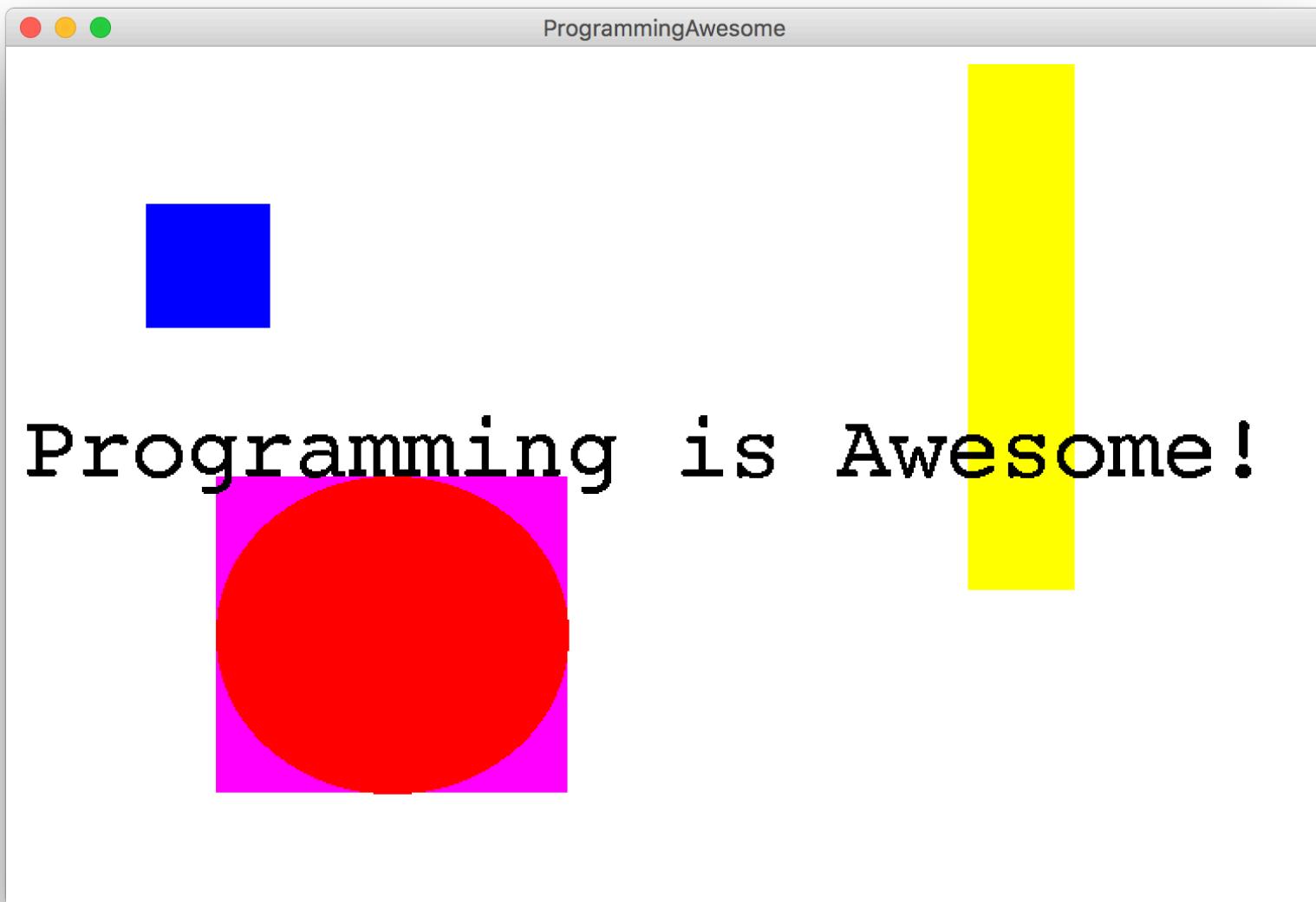
Creates an oval that fits inside the rectangle with the same dimensions.

new GLabel(text)

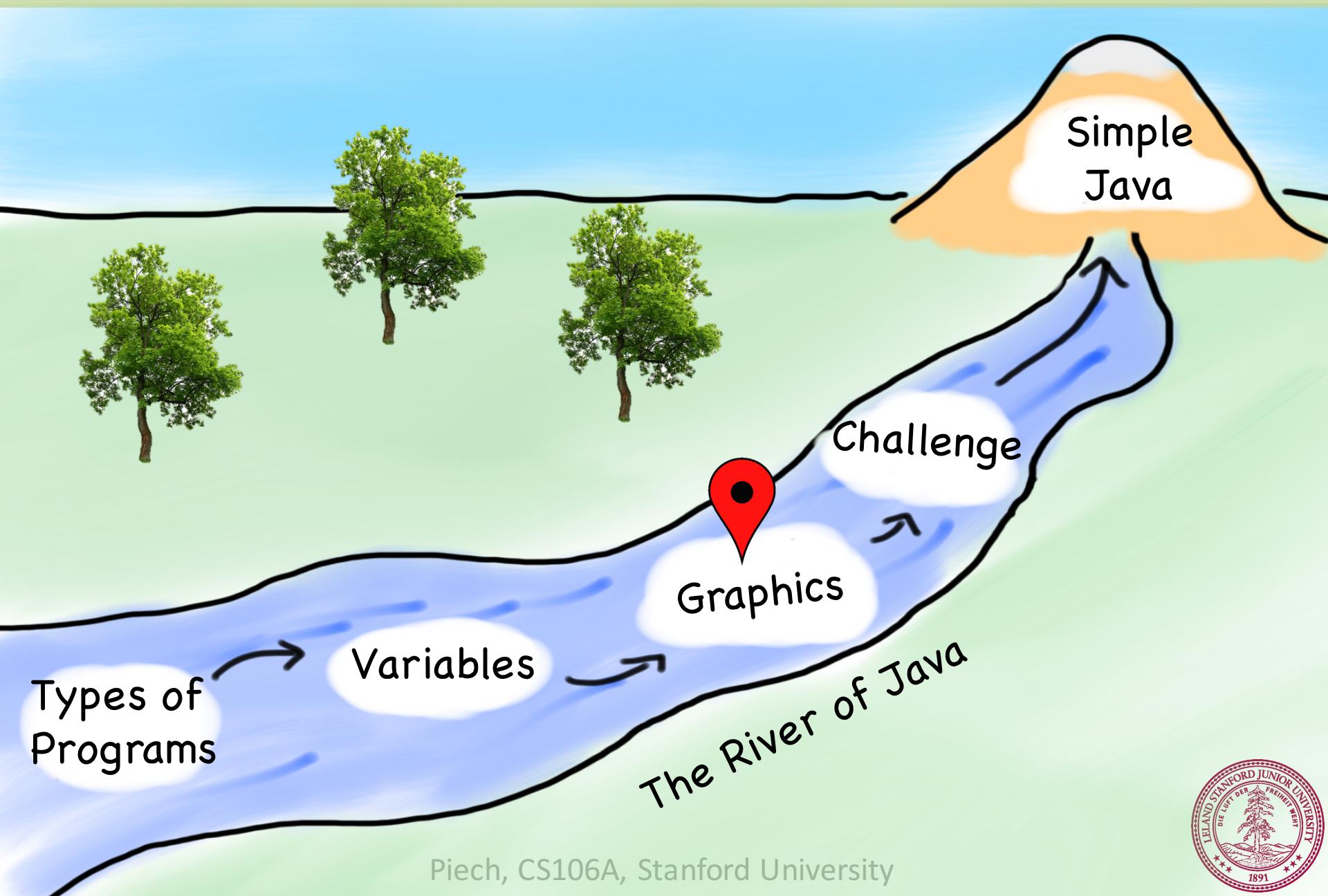
Creates a label with the given text.



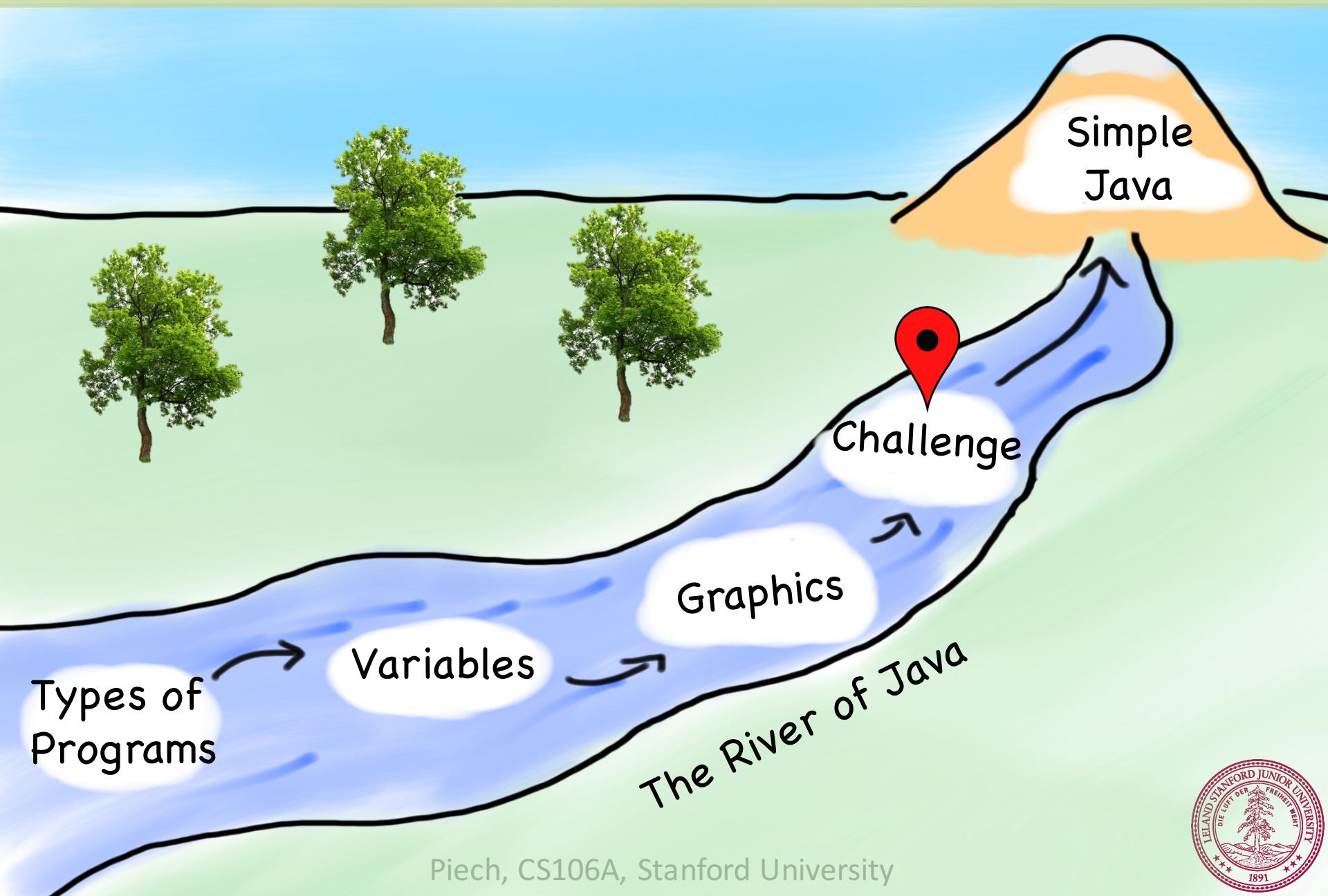
Another Example



Today's Route



Today's Route



Challenge Carbon Dating



Write a program that can turn a measurement of C14 into an estimate of age.

```
CarbonDating
Radioactive molecule = C14
Halflife = 5730 years
C14 in living organisms = 13.6 dpm
-----
What is the amount of C14 remaining in your sample: 10.2
Your sample is 2378.0 years old.
```



Example: Carbon Dating



C₁₄ = 1.2 dpm



C₁₄ = 13.6 dpm

Carbon Dating Equation

$$\text{age} = \frac{\log\left(\frac{c}{13.6}\right)}{\log\left(\frac{1}{2}\right)} \times 5730$$

Amount of C₁₄ in your sample

Amount of C₁₄ in a living sample

Half life of C₁₄

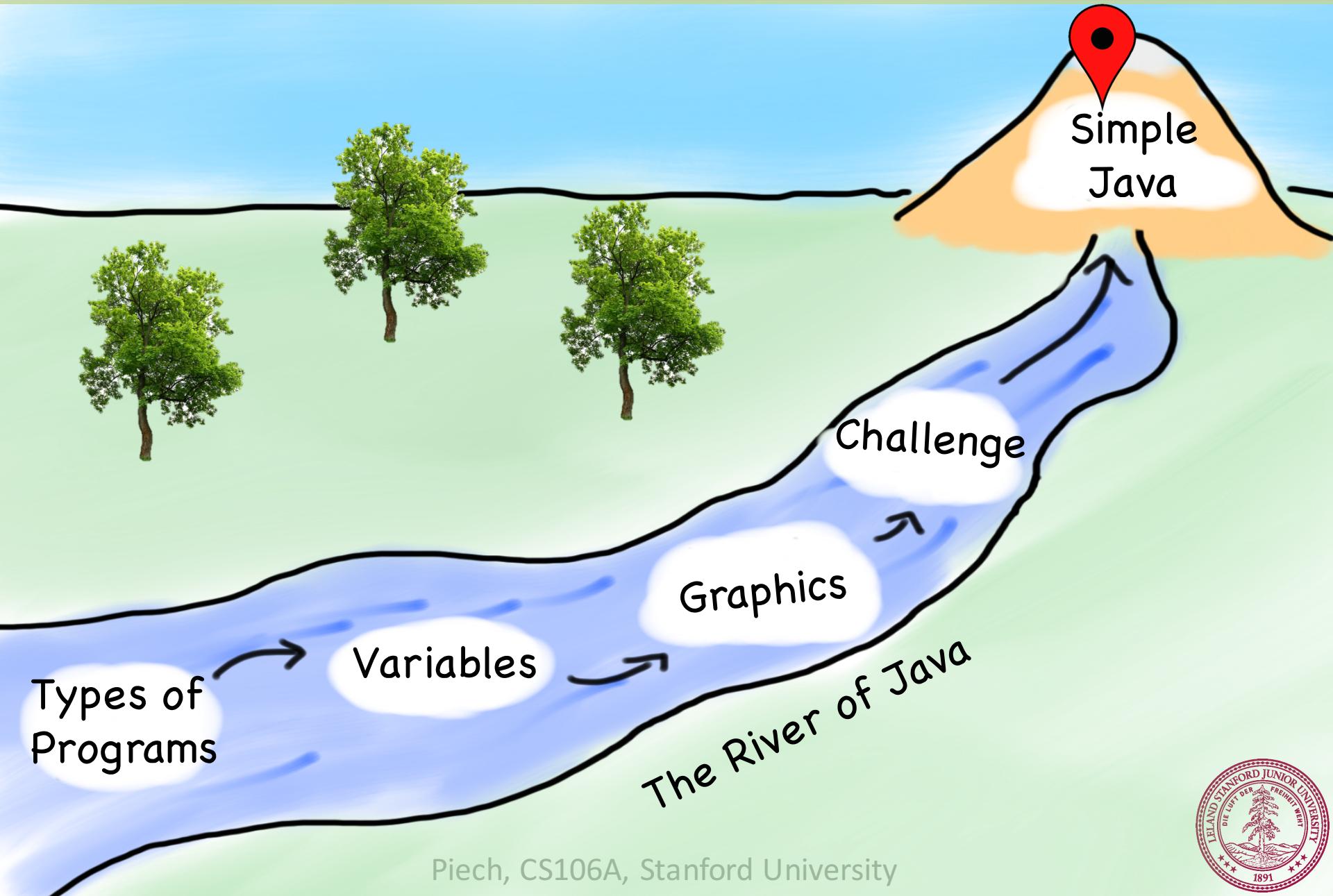
Age of the sample

½ because of half life convention

- * Some of these values are constants
- ** Use the function: Math.log(num)

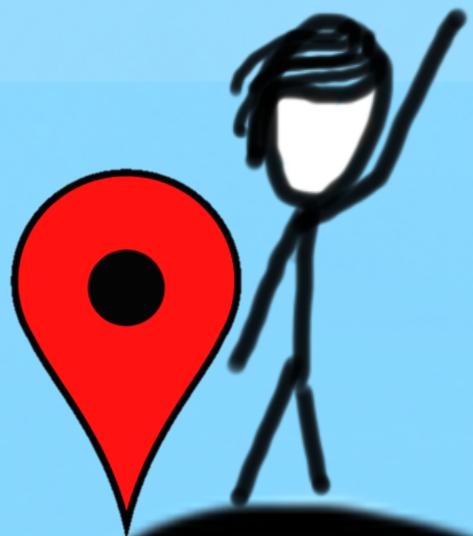


Today's Route



Today's Goal

1. What are variables and how do I use them?
2. What are graphical objects and how do I use them?



The End?

