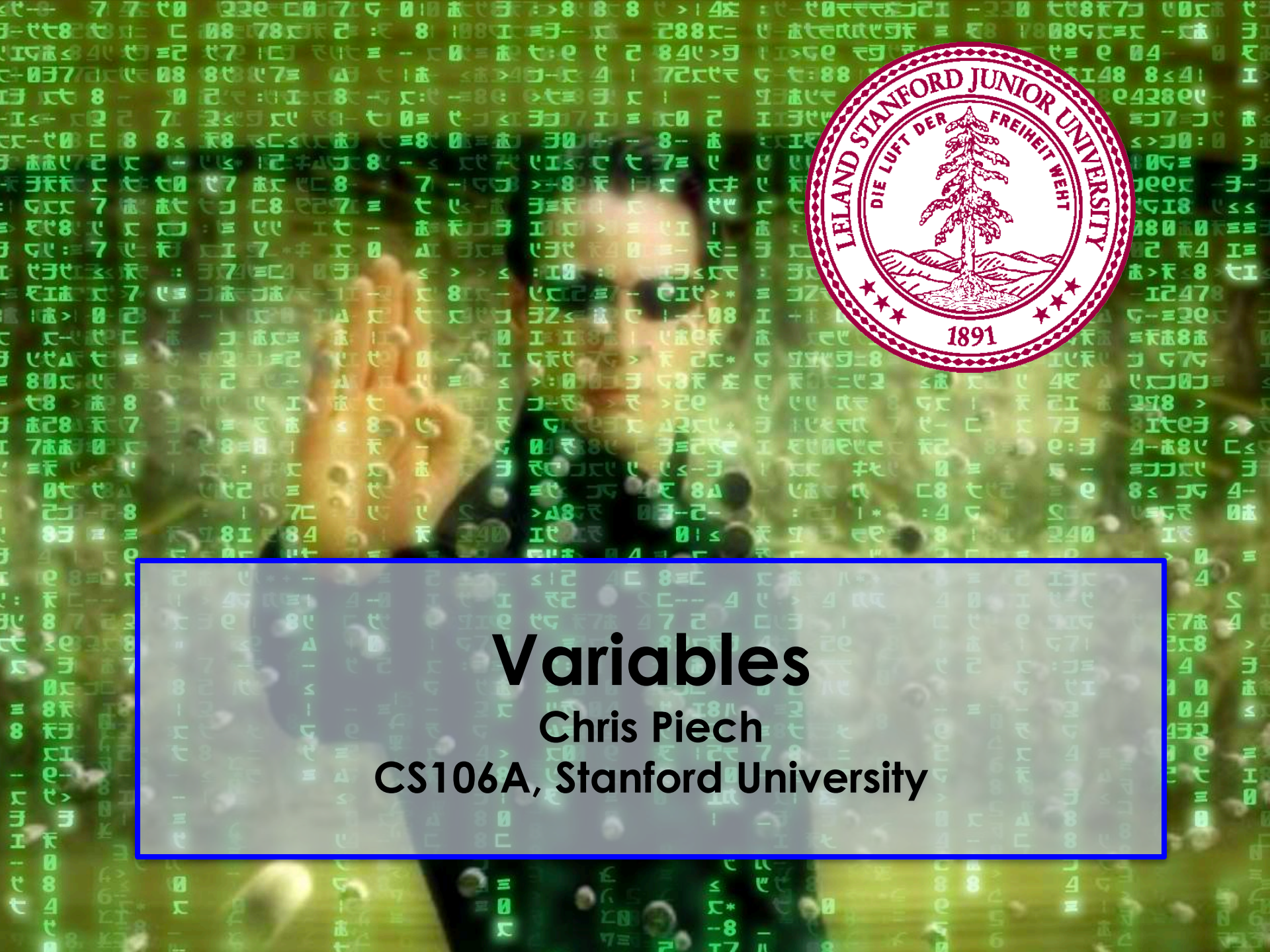


Variables

Chris Piech
CS106A, Stanford University

New Ability

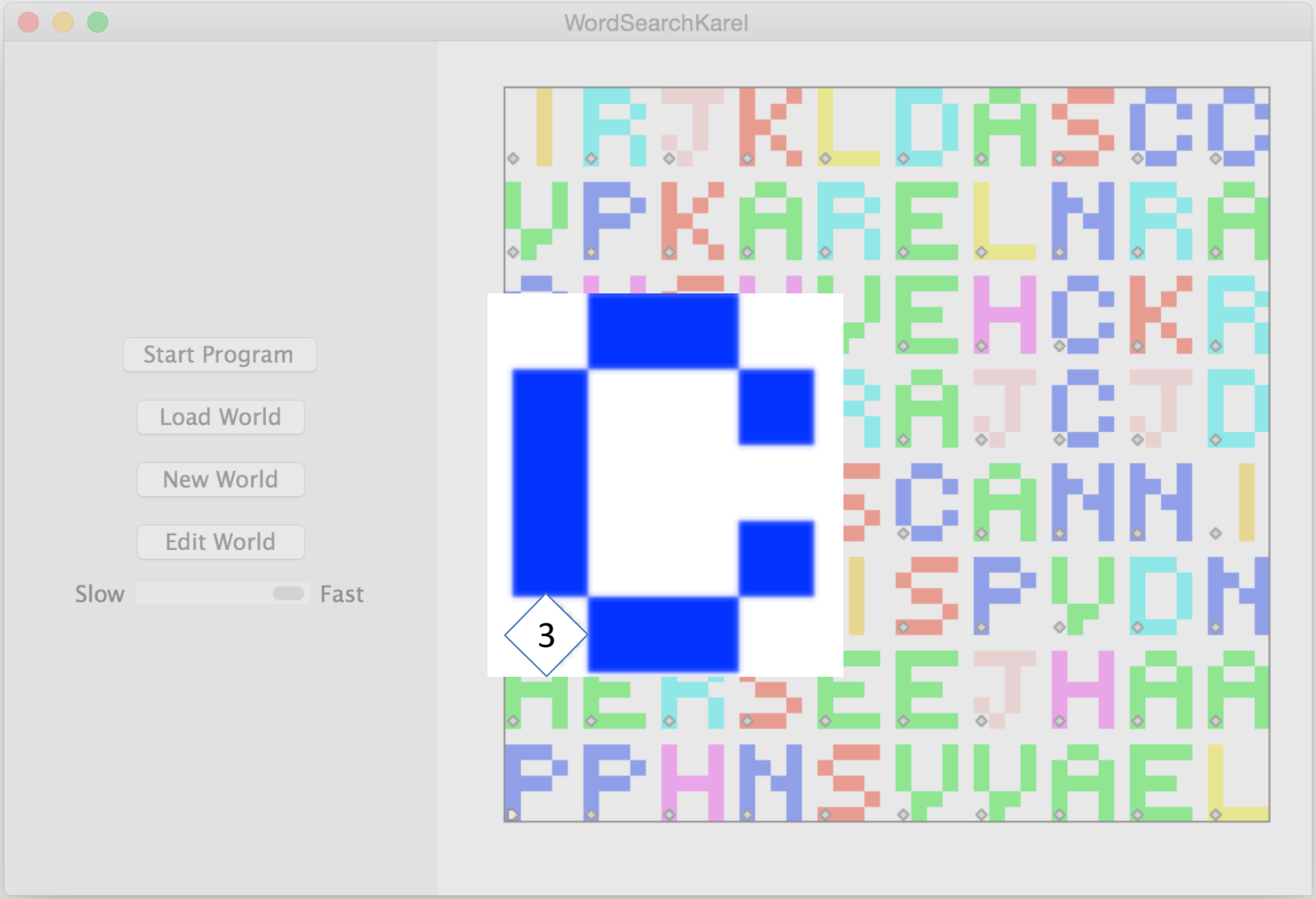
Write a program that can turn a measurement of C14 into an estimate of age.

CarbonDating

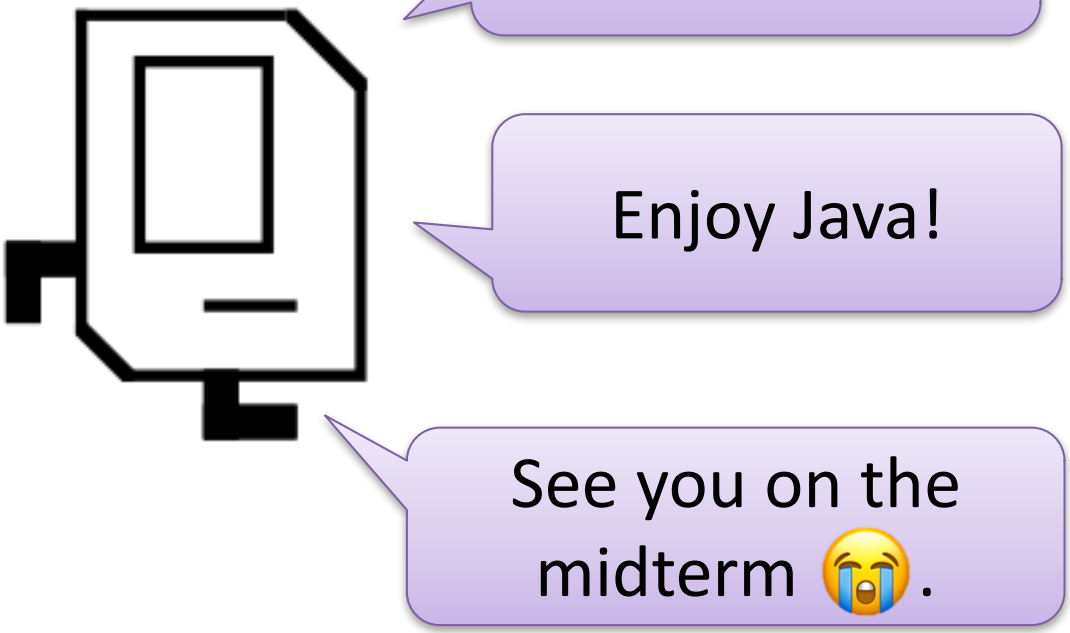
```
Radioactive molecule = C14
Halflife = 5730 years
C14 in living organisms = 13.6 dpm
-----

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


WordSearchKarel
Start Program
Load World
New World
Edit World
Slow
Fast
3

See You Later!

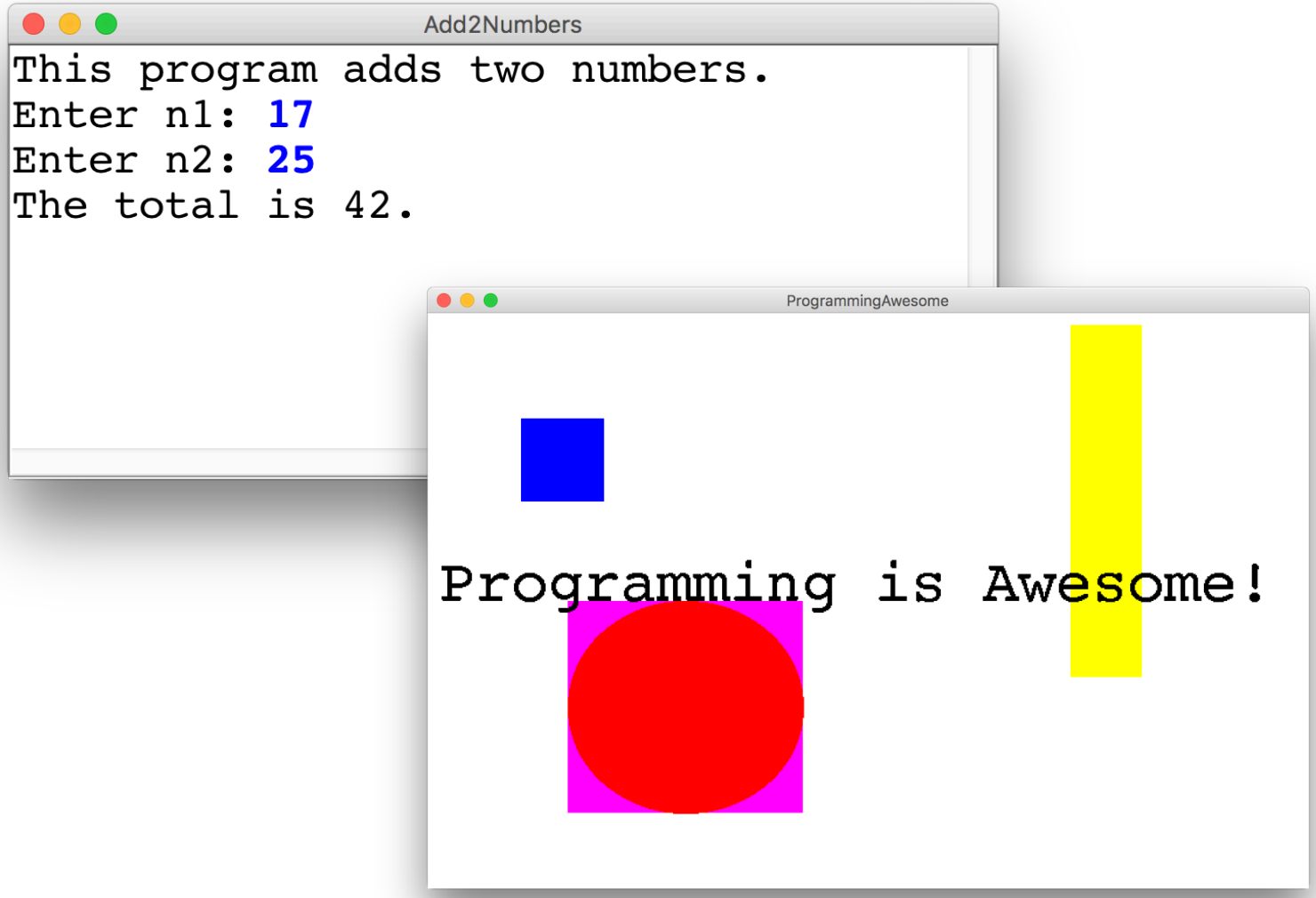


Java

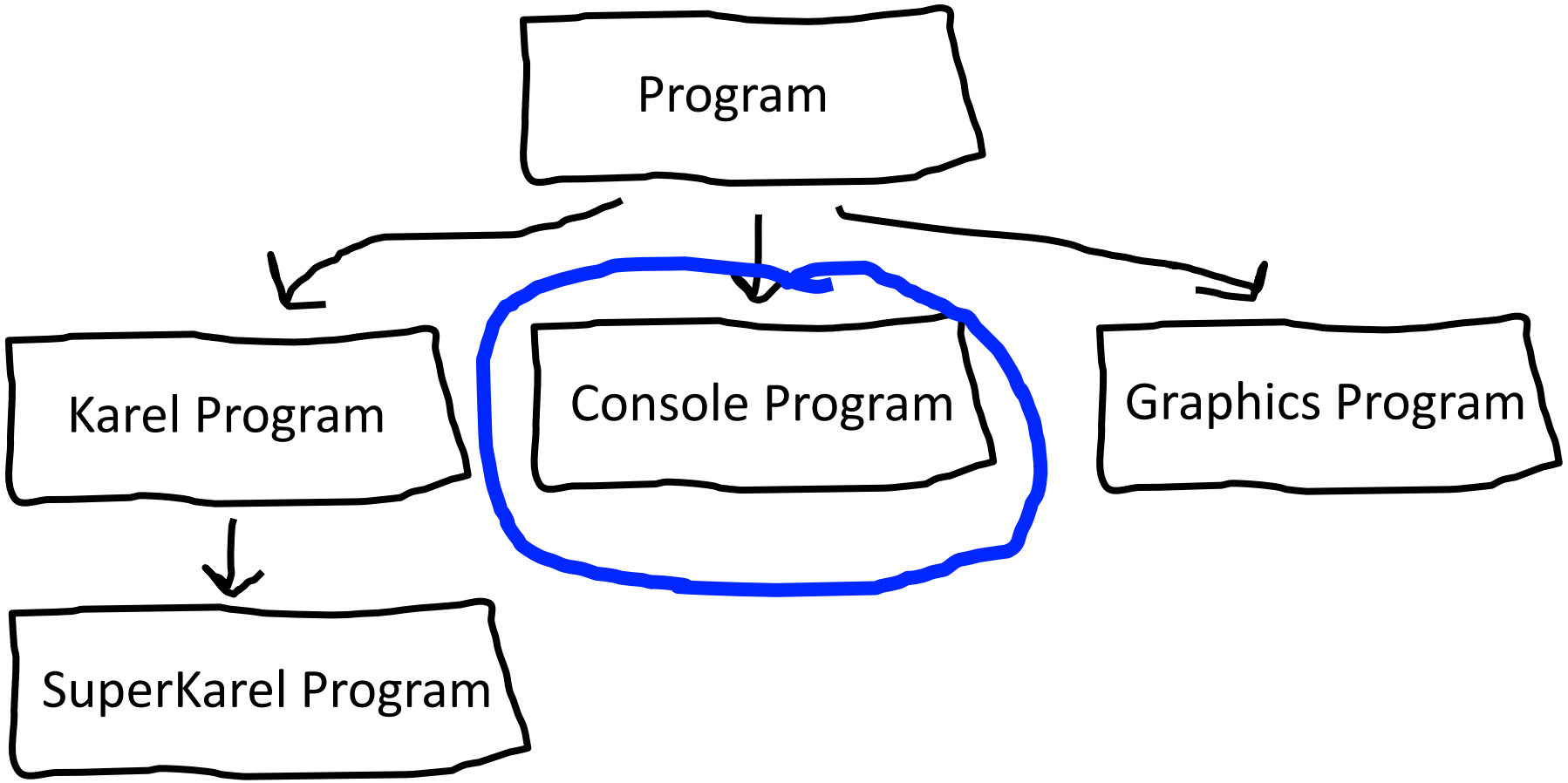
Today's Goal

1. How do you make a box?
2. How do you see what is in a box?
3. What can you put in a box?
4. How do you change what is in a box?

Two Example Programs



Types of Programs



First Console Program: Hello World

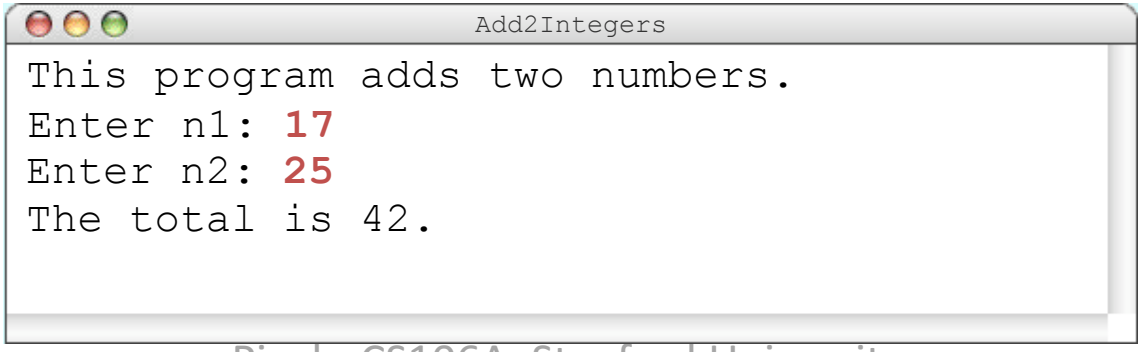
```
import acm.program.*;

public class HelloProgram extends ConsoleProgram {

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

In Pop Culture

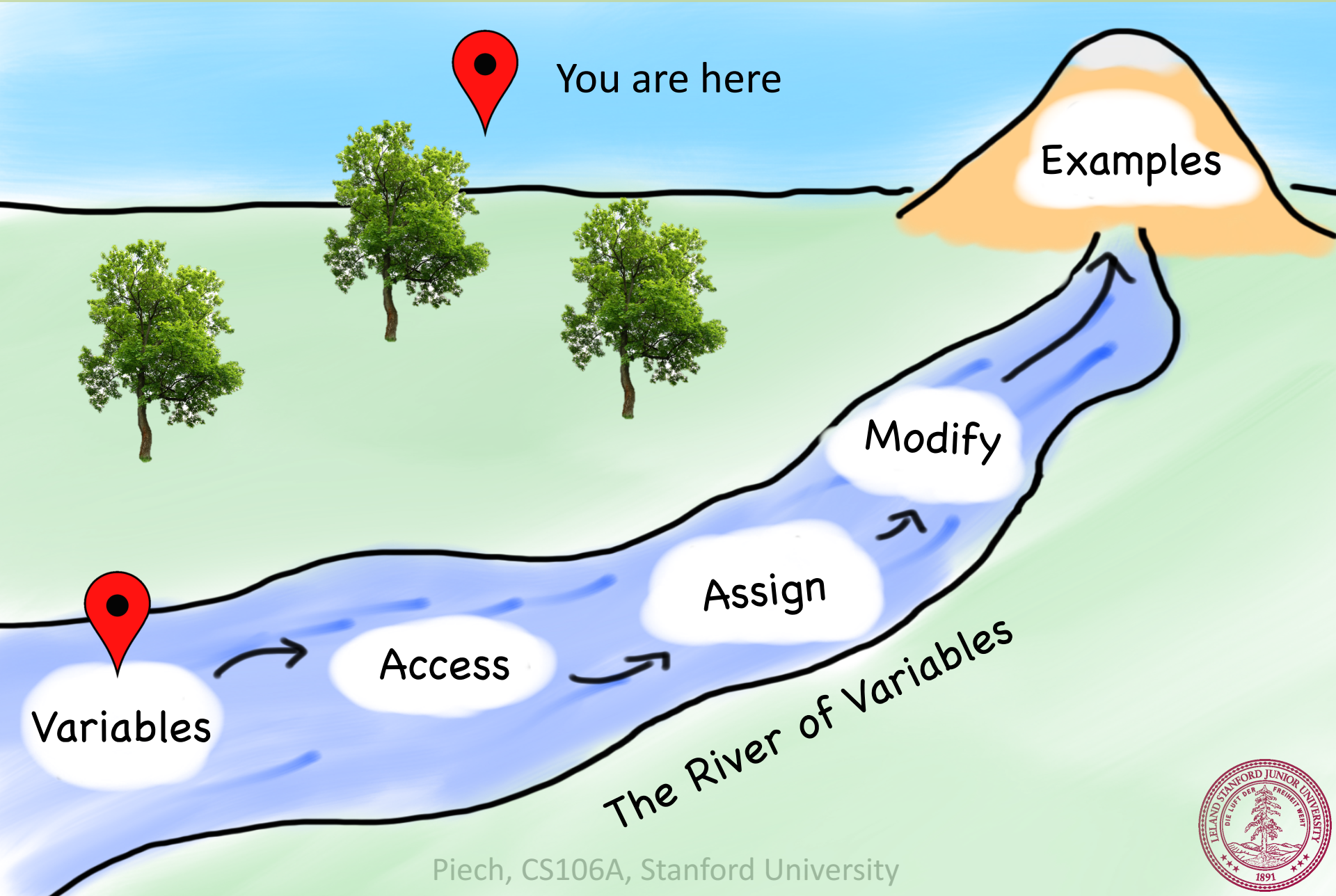
Add2Integers

```
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



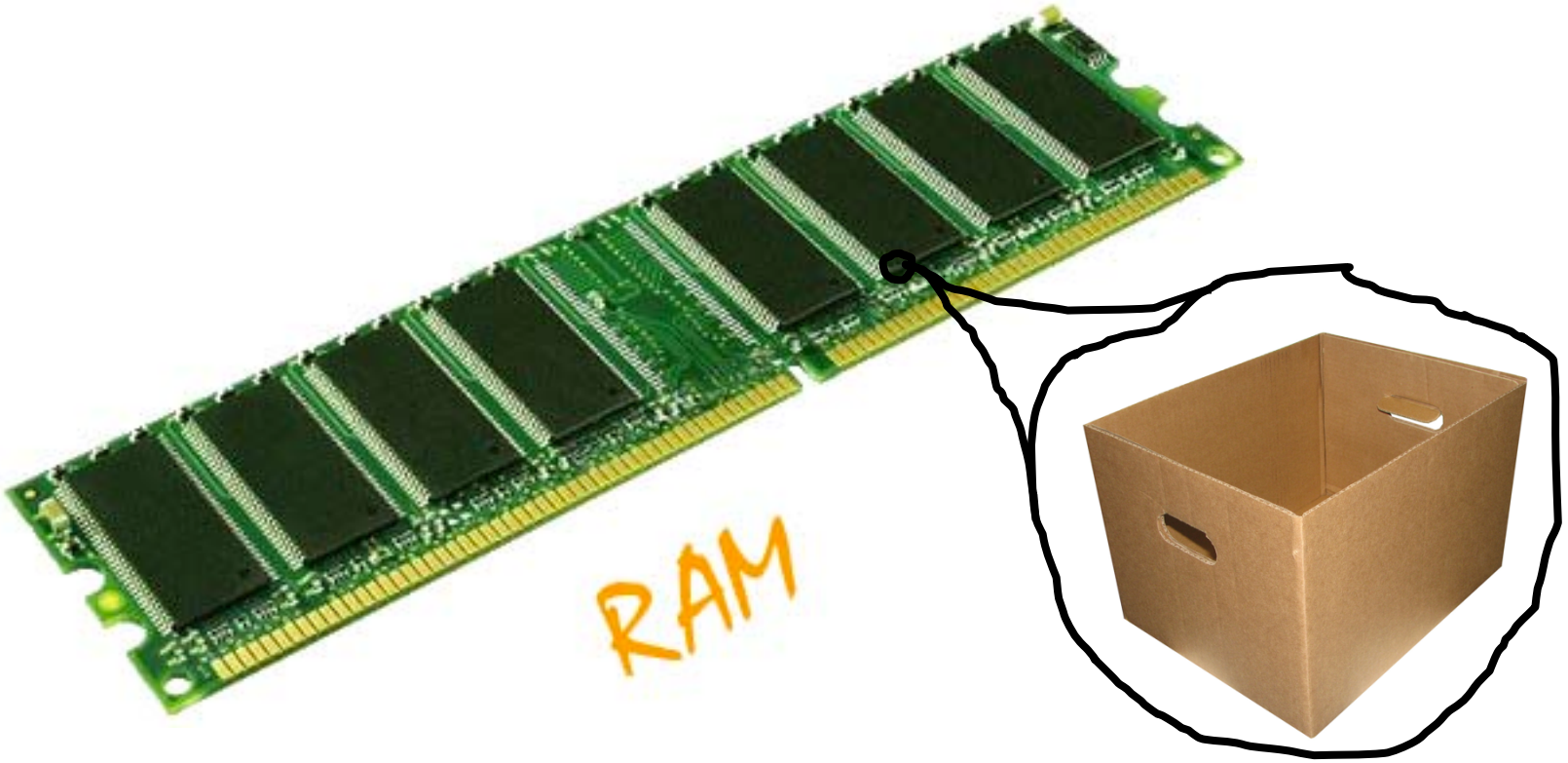
Programs are *control flow* and *variables*

What is a variable?

[suspense]

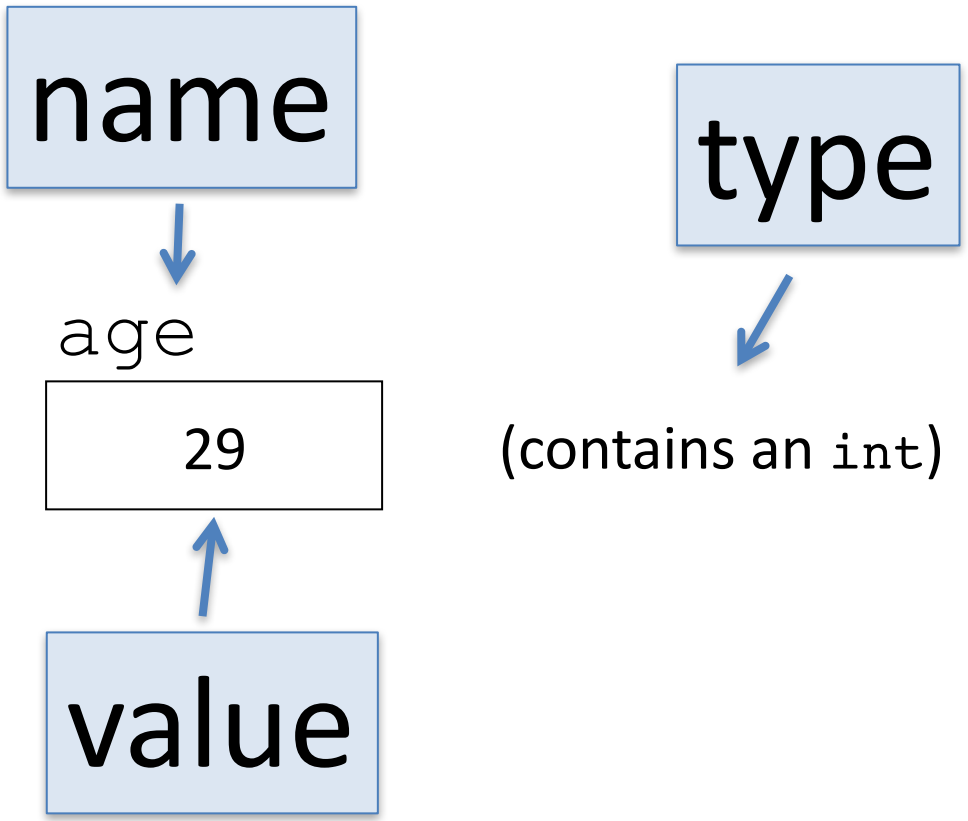
Variables are Like Boxes

Teeny Tiny Boxes



My computer has space for about 2 billion boxes

Three Properties



Making a New Variable

```
int age = 29;
```


Making a New Variable

type

name

```
int age = 29;
```

Initial value

Resulting Type of Binary Expression

When a line starts with a variable ***type***, it is creating a new variable …aka a box.

Example:

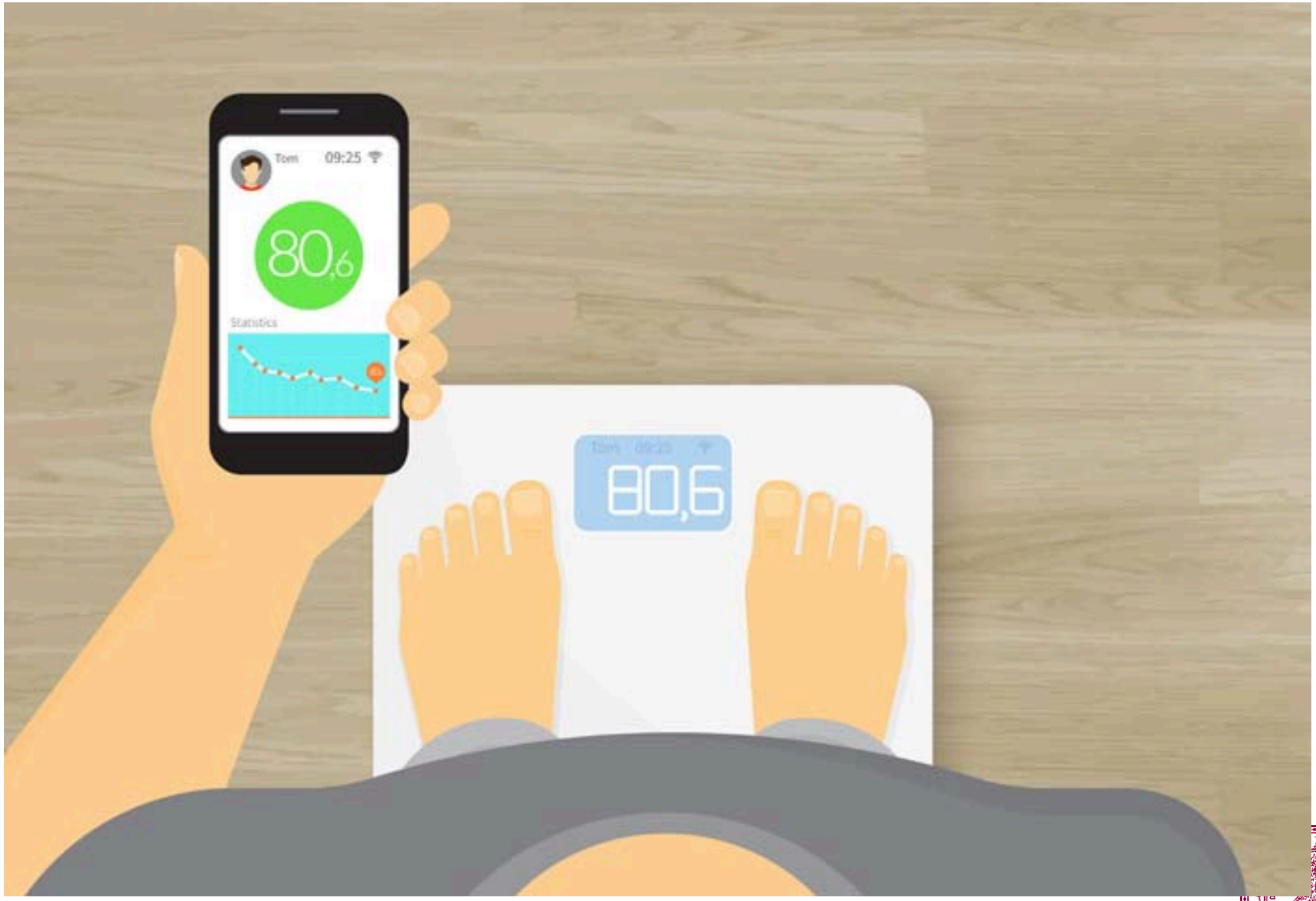
```
int myBox = 5;
```

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

Lots of Boxes

```
public void run() {

    // integer values
    int age = 29;

    // real values
    double weight = 180.2;
}
```


Can you access the value in a variable (aka box)?

Outputting Variable Value

```
// creates a variable called
// age with the value 29.
int age = 29;

// puts the value of the age
// variable on the screen.
println(age);
```

* Fun fact. Chris turns 30 this year. He is young at heart.

Fancy Output

```
// creates a variable called
// age with the value 29.
int age = 29;

// puts the following on the
// screen:
// age is <value>
println("age is: " + age);
```

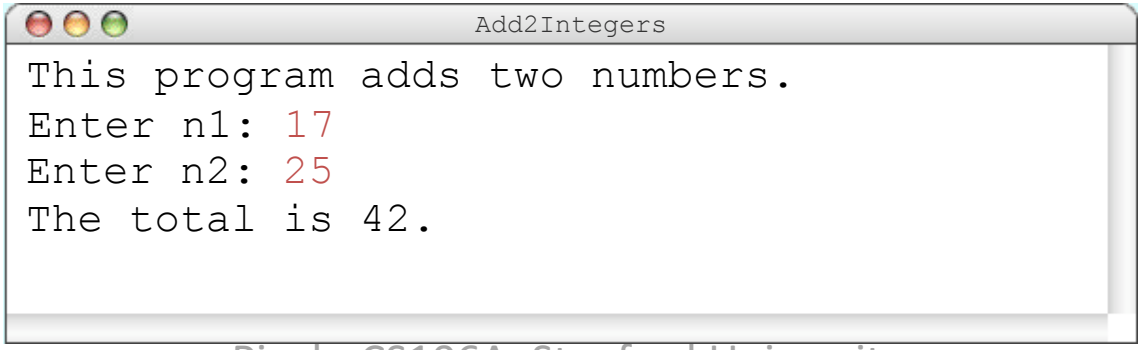
* Fun fact. Chris turns 30 this year. He is young at heart.

What data can you put in a variable (aka box)?

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



Making a New Variable

type

name

```
int myBox = user input;
```

Initial value

Making a New Variable

type

name

```
int myBox = expression;
```

Initial value

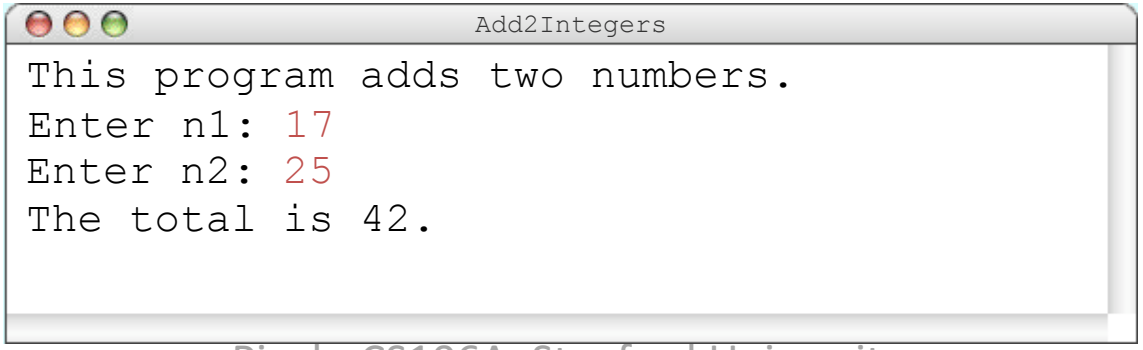
Values from User Input

```
// Prompts user for a whole number. Stores
// result in a variable (aka a box)
int kids = readInt("How many children?");


// Prompts user for a decimal number. Stores
// result in a variable (aka a box)
double tip = readDouble("Tip? $");


// Haven't you ever wondered, who was the first
// person to eat a carrot???
boolean edible = readBoolean("Subject alive?")
```

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



Binary Operators

+	Addition	*	Multiplication
–	Subtraction	/	Division
		%	Remainder

See you another day, tio.

Learn by examples

Order of Operation

```
// Mult before addition first!
int result = 4 + 2 * 3;      // 10

// Left to right!
int sum = 1 + 2 + (3 * 4);   // 15
```

Priority	Operator	Tie breaker
Highest	()	Left to right
Middle	* /	Left to right
Lowest	+ -	Left to right

What do you think this does?

```
// creates a variable called
// success rate
double successRate =  1 / 2;
```


AHHHHHHH!!!!!!

```
// creates a variable called
// success rate
double successRate =  1 / 2;
```

0.0

Resulting Type of Binary Expression

All *binary operators* result in a value (like a temporary variable) which ***has a type***. You need to know what type that will be.

Most important example:

`int` / `int` results in an `int`

Resulting Type

`int` / `int` results in an `int`

`double` * `double` results in a `double`

`int` + `double` results in a `double`

Resulting Type of Binary Expression

All *binary operators* result in a value (like a temporary variable) which ***has a type***. The general rule is: operations always return the ***most expressive*** type:

Expressive hierarchy:

`boolean` < `char` < `int` < `double`

Example:

`int` / `double` results in a **`double`**

Even more examples…

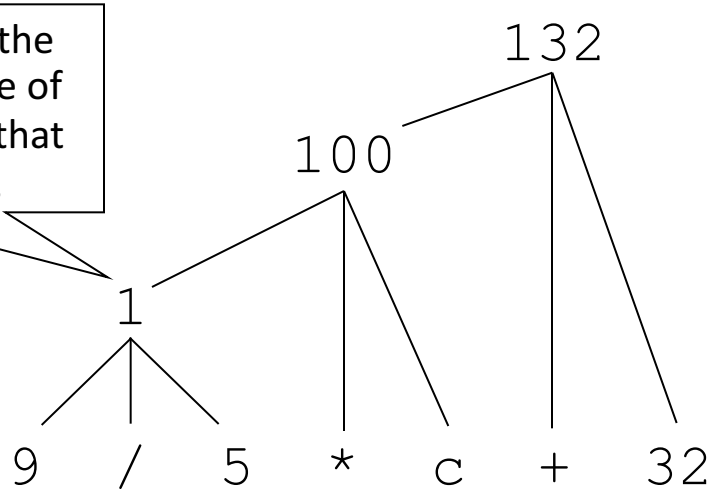
Pitfalls of Integer Division

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`.

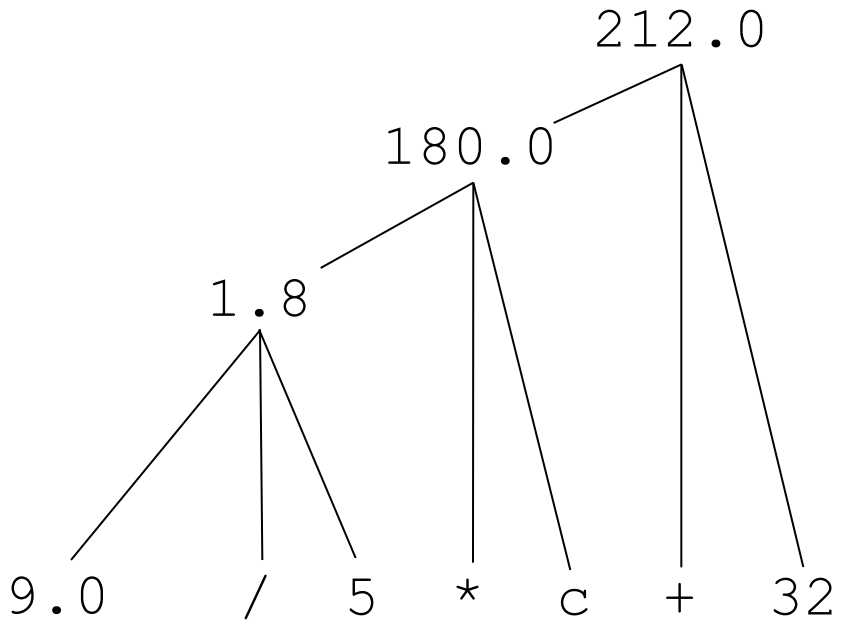


Pitfalls of Integer Division

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:



Practice

- 5 + 3 / 2 - 4 // 2
- 15 / 2.0 + 6 // 13.5

Can you change the value in a variable (aka box)?

Modifying a Variable

```
// creates a variable called
// age with the value 29.
int age = 29;

// this puts a new value in the box
age = 30;

// In what world does this make sense?
// Welcome to Java
age = age + 2;
```

Compiler Errors

1. A variable can't be used until it is assigned a value.

```
int x;
println(x);   // Error: x has no value
```

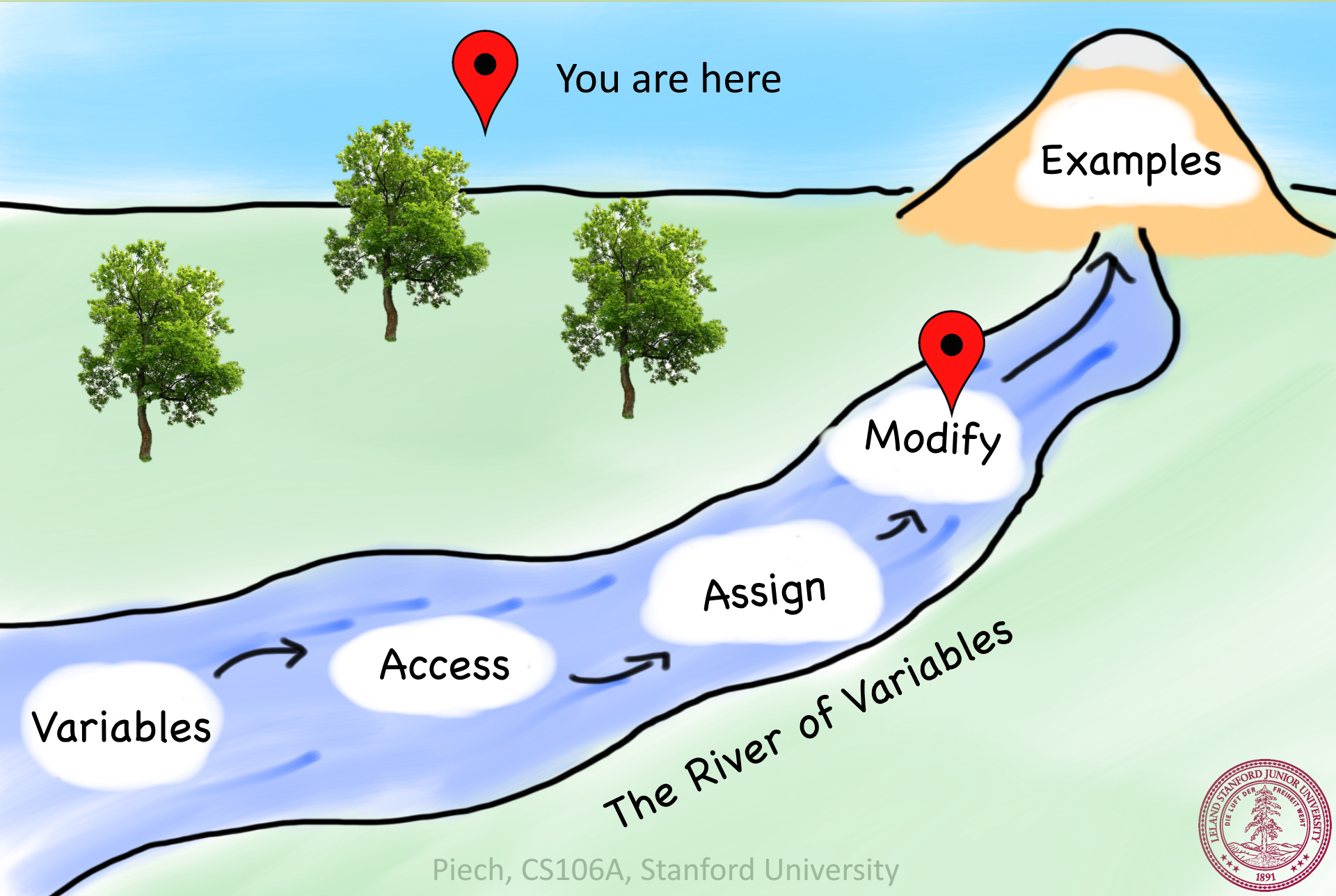
2. You may not declare the same variable twice.

```
int y = 3;
int y = 5;   // Error: y already exists
```

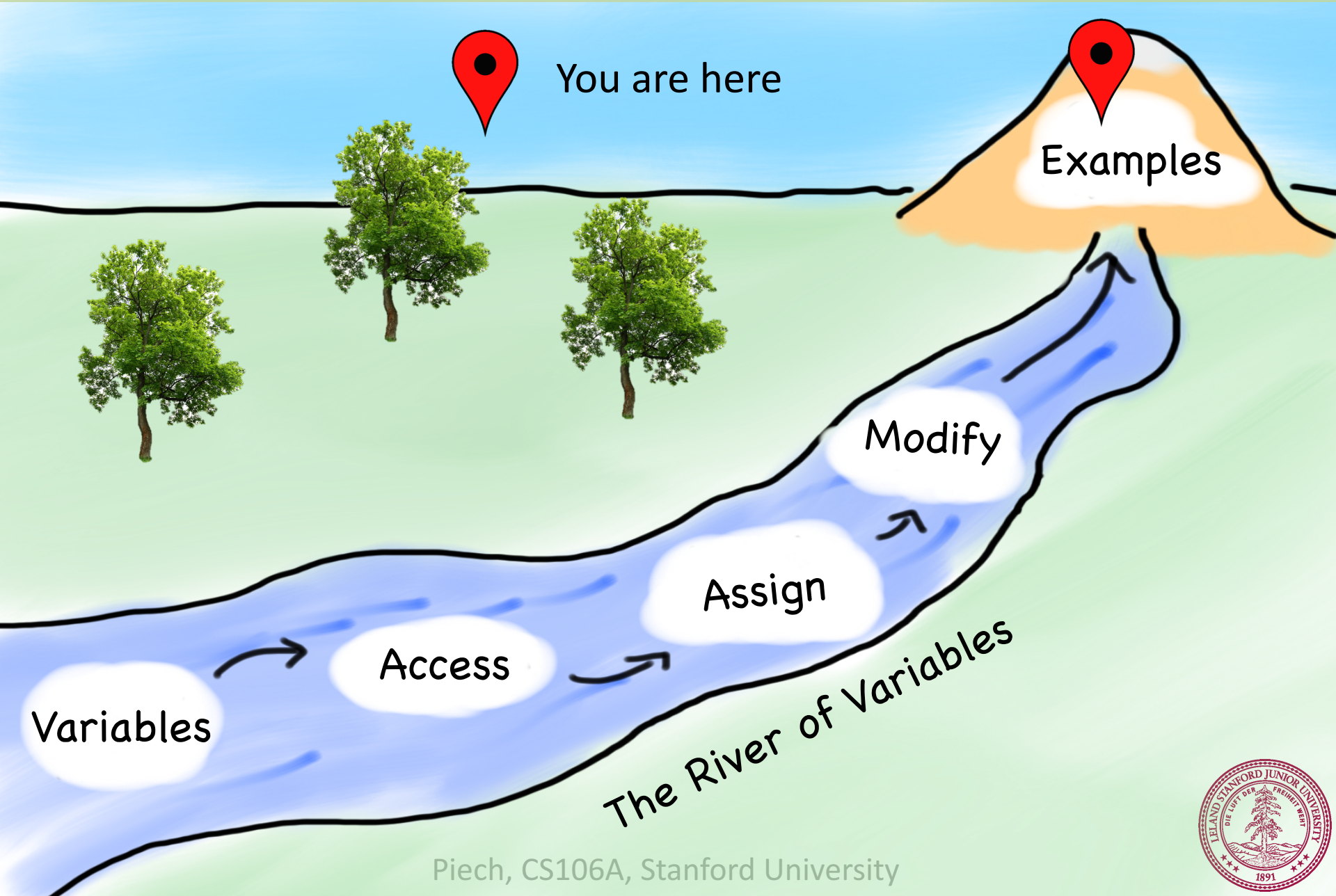
3. You may not use a variable until it is declared.

```
z = 10;      // Error: z cannot be resolved
```


Today's Route



Today's Route



Today's Goal

1. How do you make a box?
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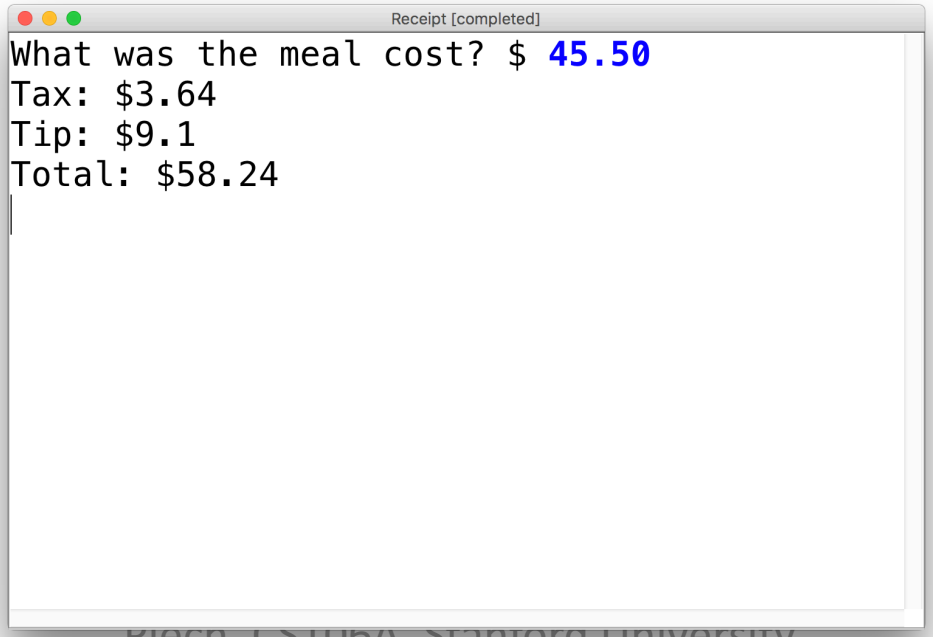
Practice 1: Receipt Program

- Let's write a ConsoleProgram that calculates the tax, tip and total bill for us at a restaurant.
- The program should ask the user for the subtotal, and then calculate and print out the tax, tip and total.



Practice 2: Challenge Carbon Dating

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

CarbonDating

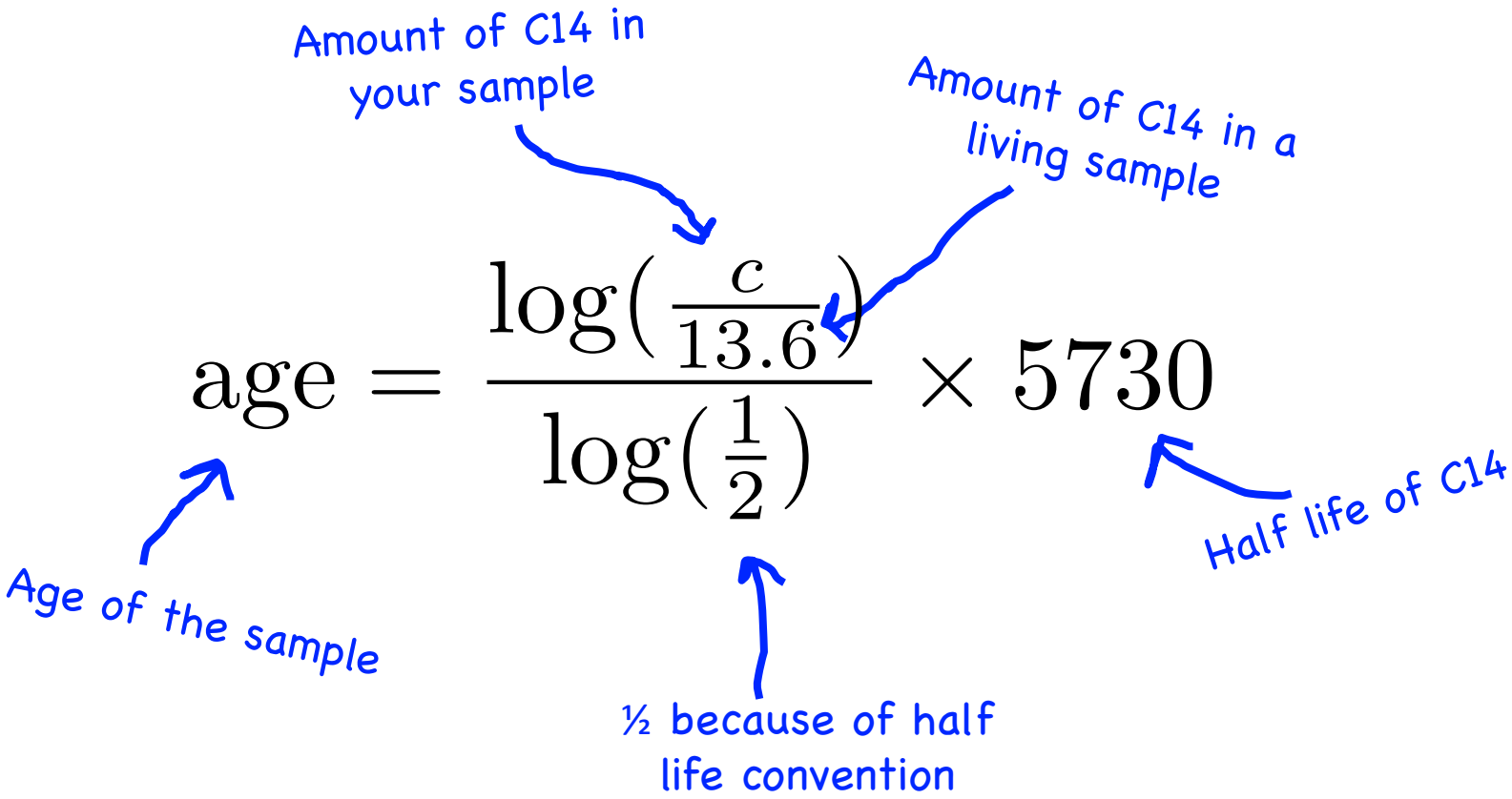
```
Radioactive molecule = C14
Halflife = 5730 years
C14 in living organisms = 13.6 dpm
-----

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



* Some of these values are constants

** Use the function: `Math.log(` *num* `)`