

# Variables

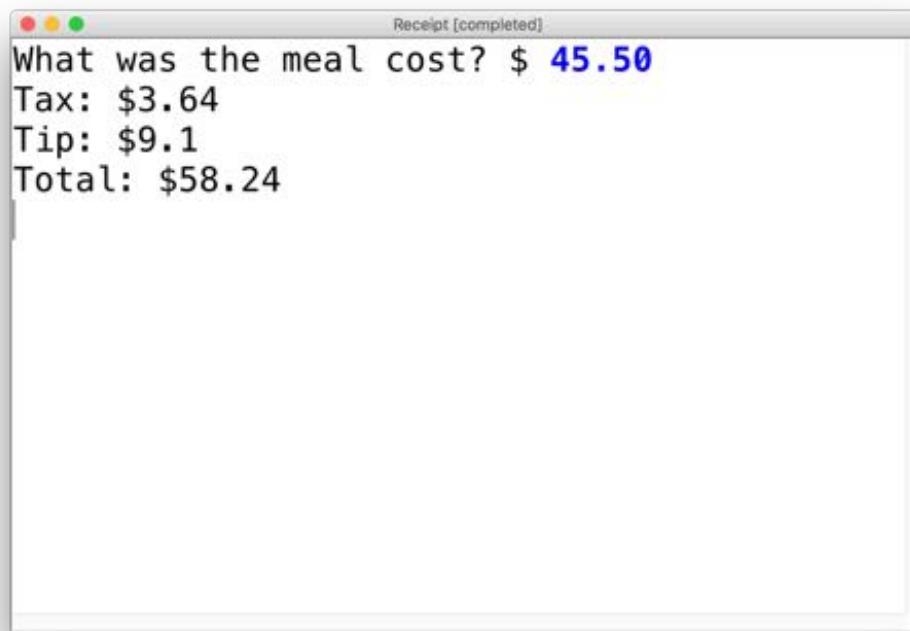
Chris Piech

CS106A, Stanford University

# New Ability

Write a program that calculates the tax, tip and total bill for us at a restaurant.

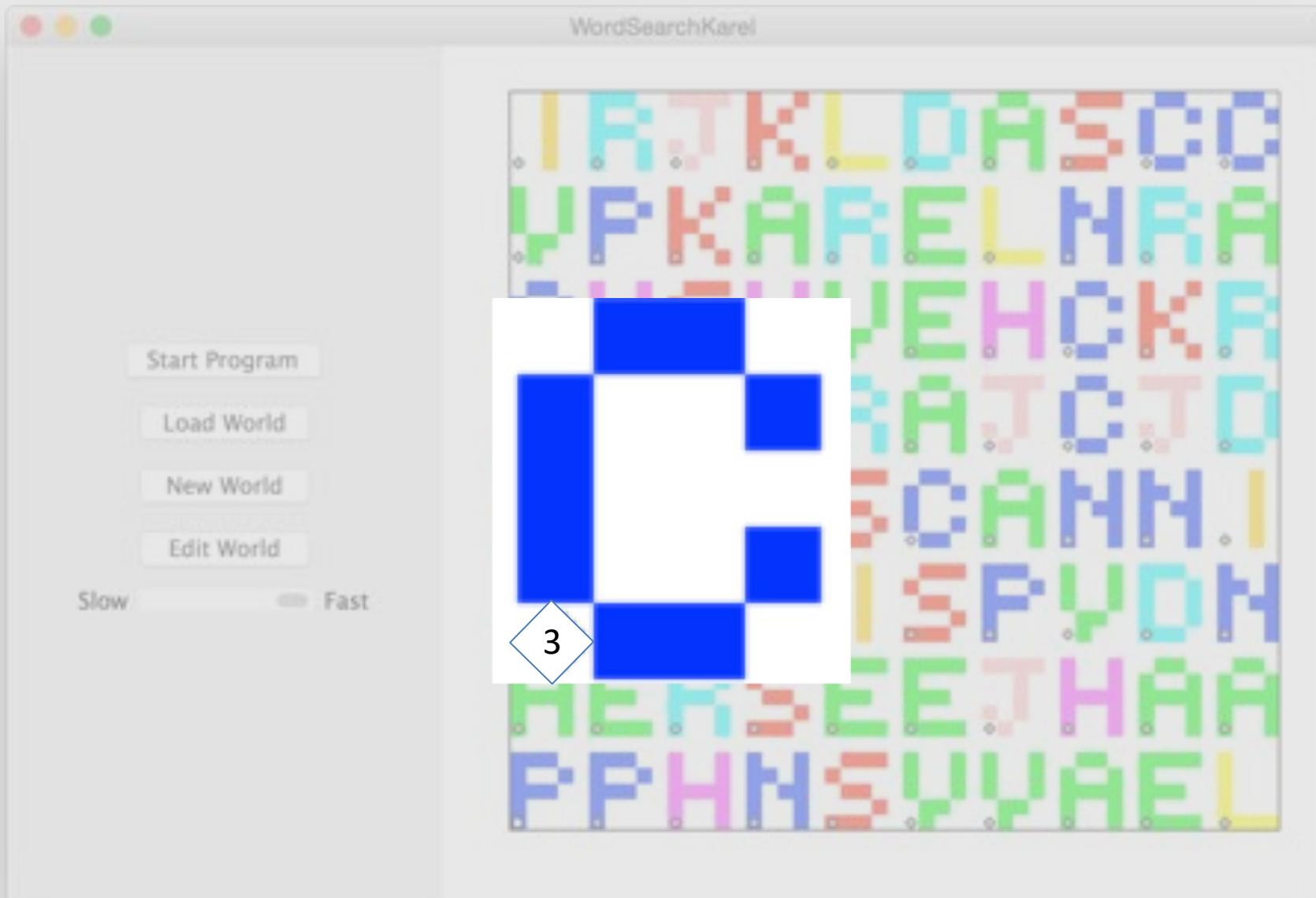
The program should ask the user for the subtotal, and then calculate and print out the tax, tip and total.



# Review: Decomposition

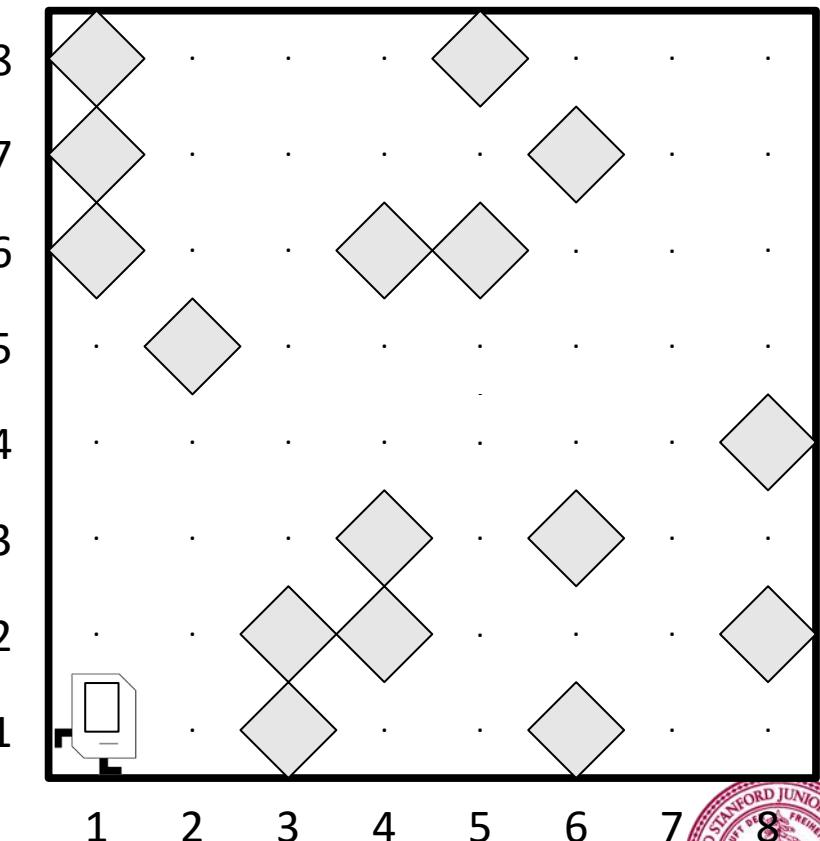
1. Each method solves one “problem”
2. Methods should have good names
3. Comment each of your methods
4. Length of methods should be < 15 lines
5. Methods should ideally be generalizable



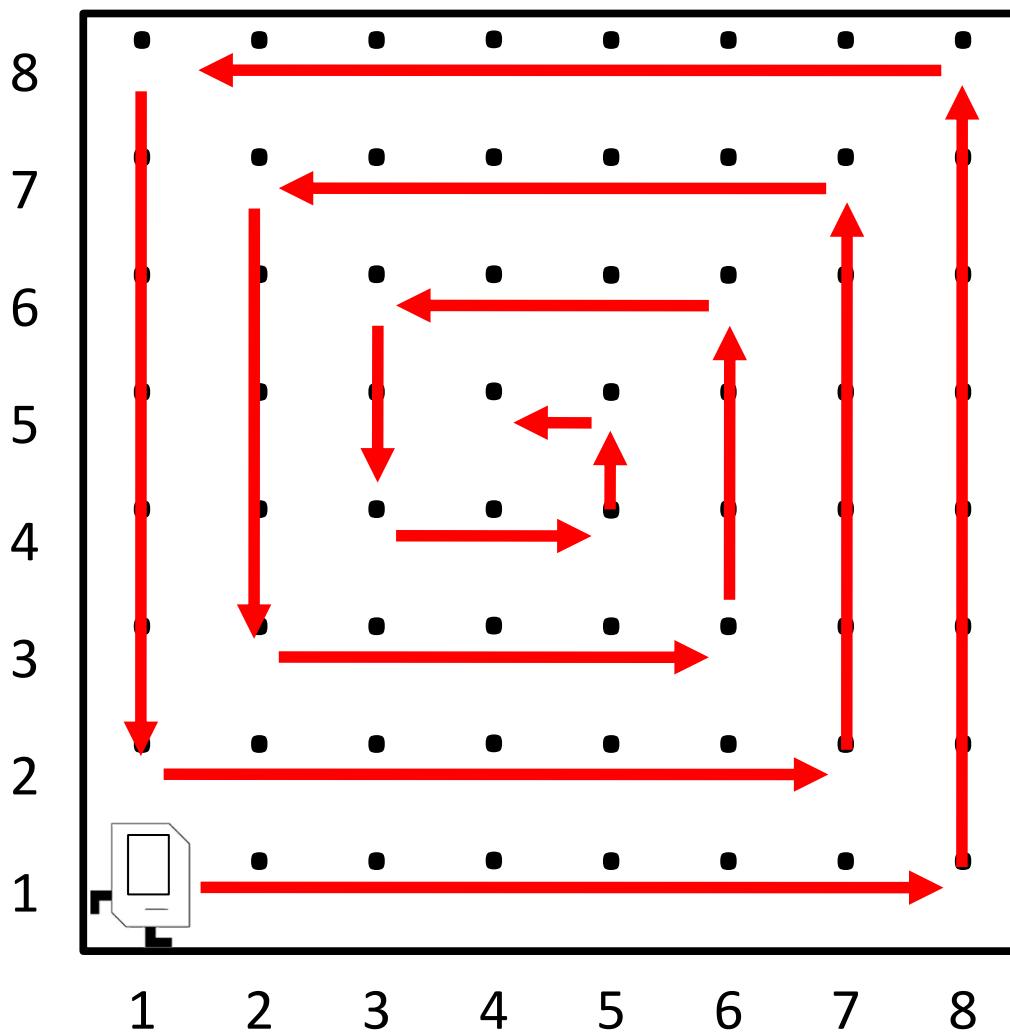


# Rhoomba Karel

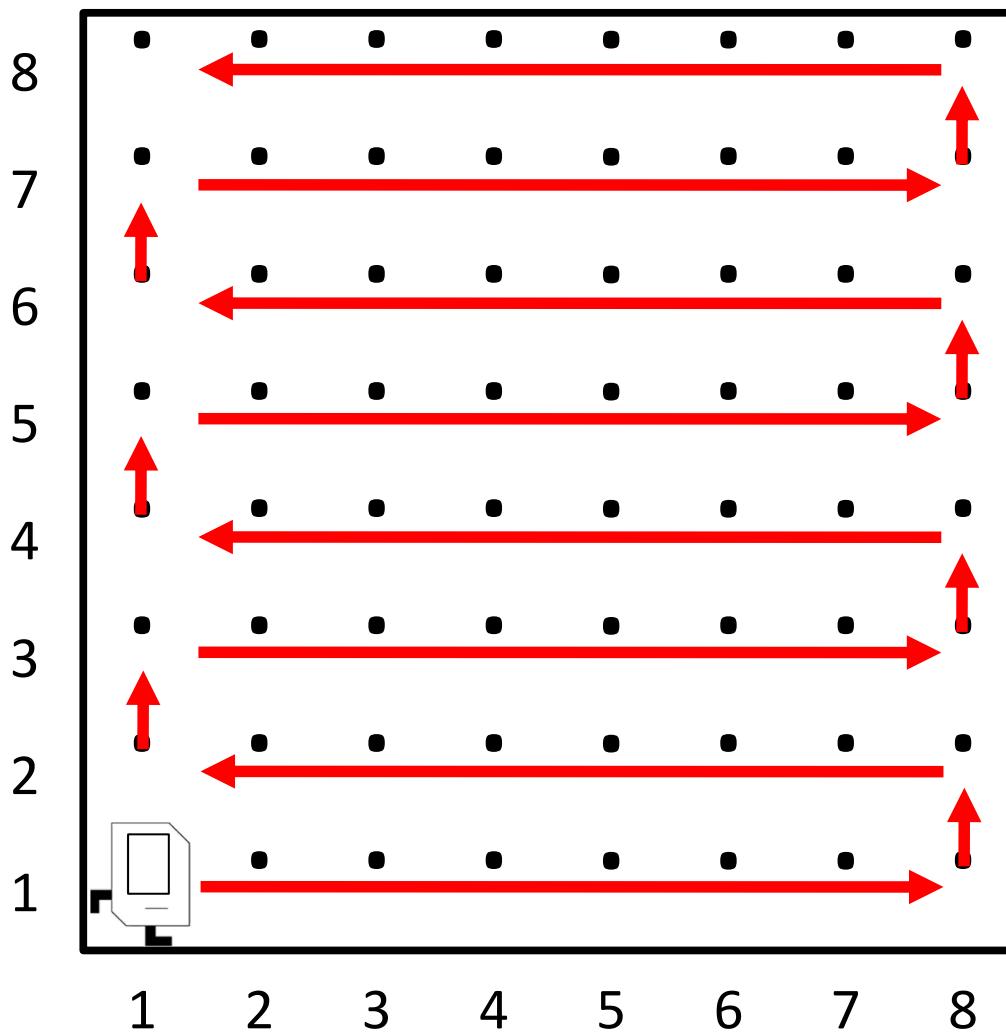
- Write a **Roomba** Karel that sweeps the entire world of all beepers.
  - Karel starts at (1,1) facing East.
  - The world is rectangular, and some squares contain beepers.
  - There are no interior walls.
  - When the program is done, the world should contain 0 beepers.
  - Karel's ending location does not matter.
- How should we approach this tricky problem?



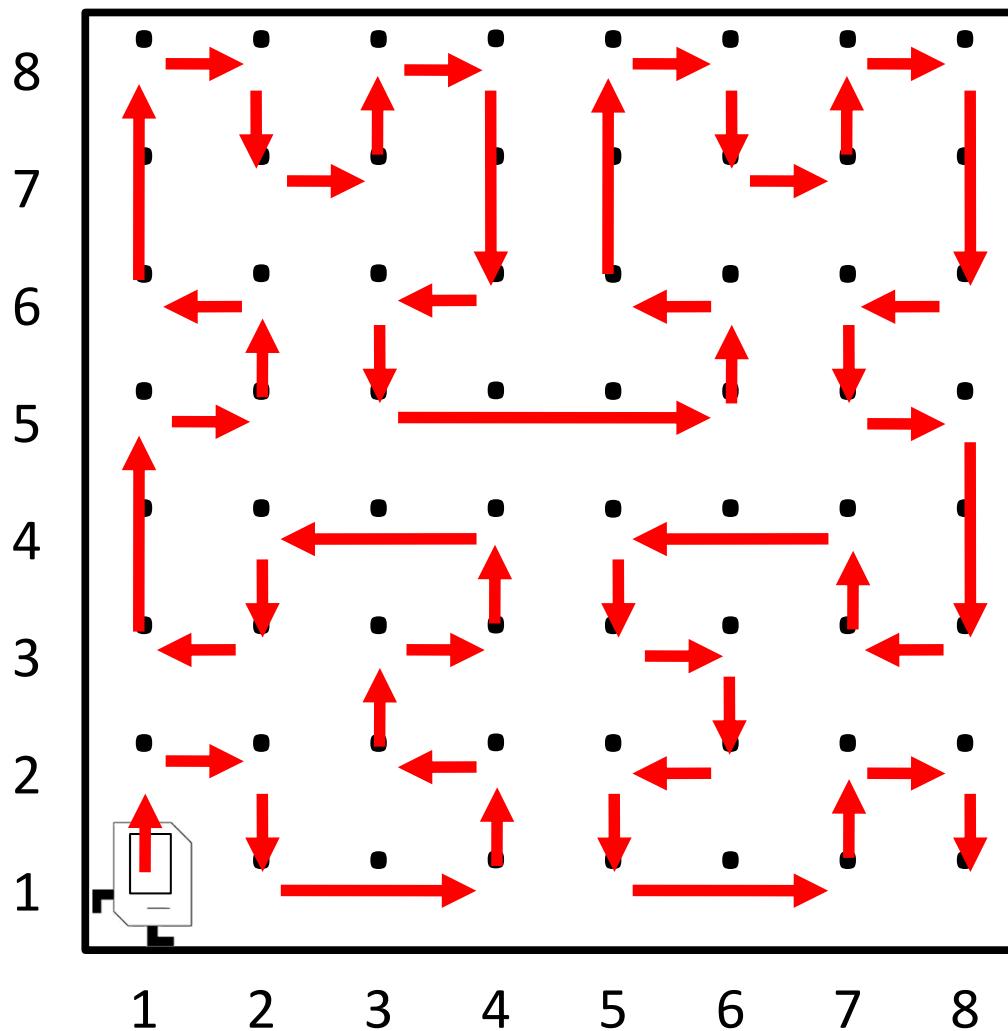
# Possible Algorithm 1



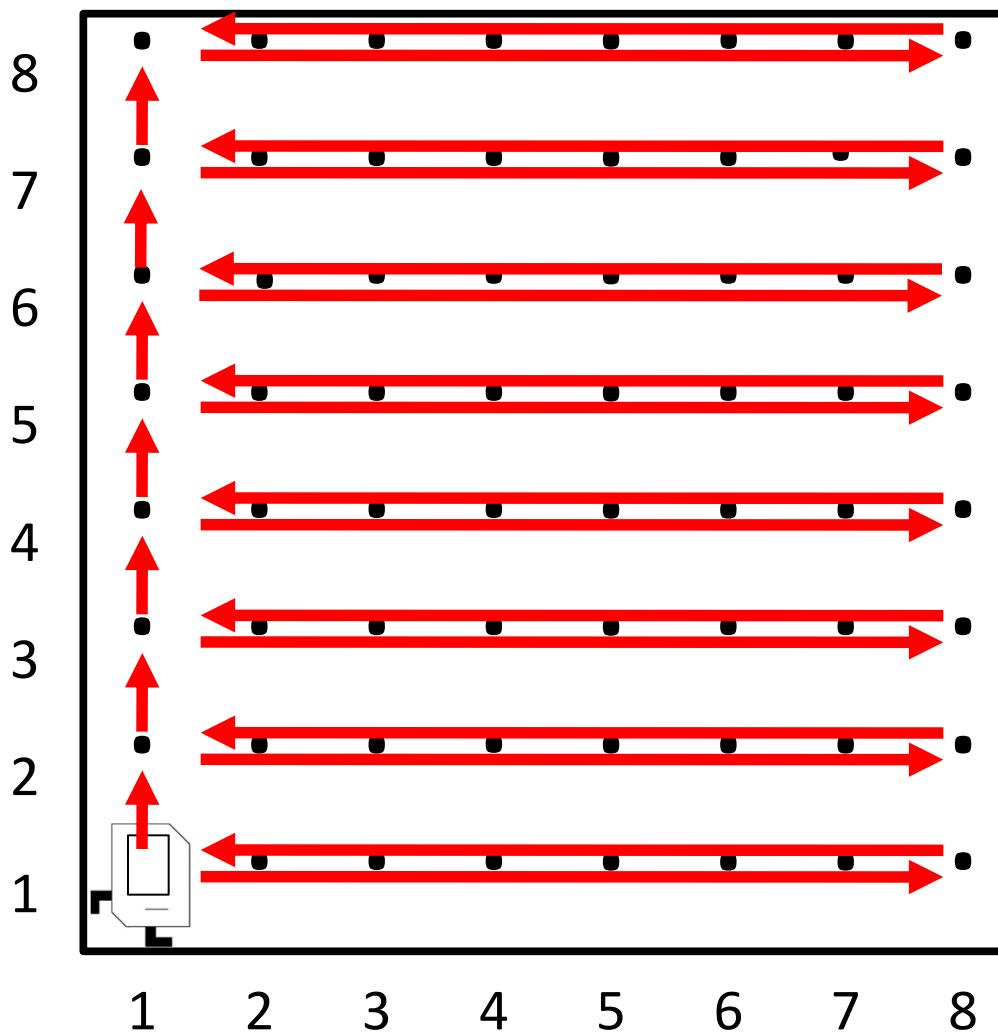
# Possible Algorithm 2



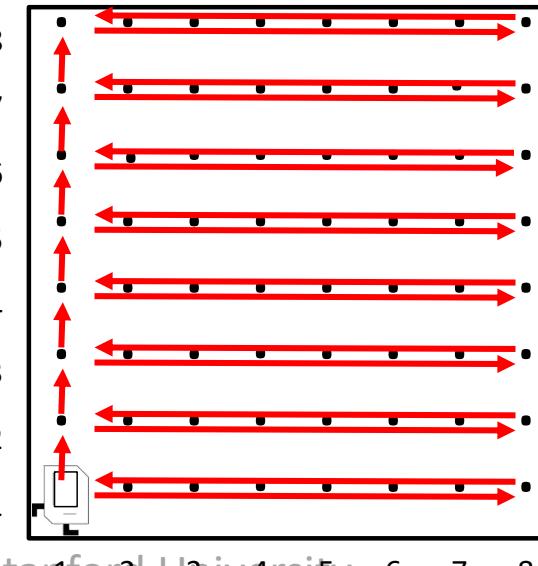
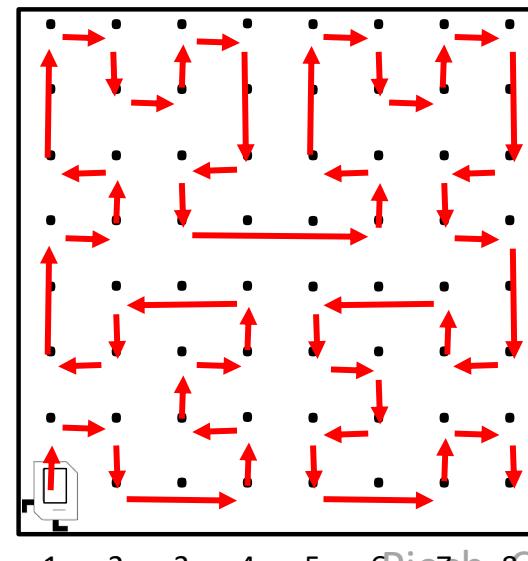
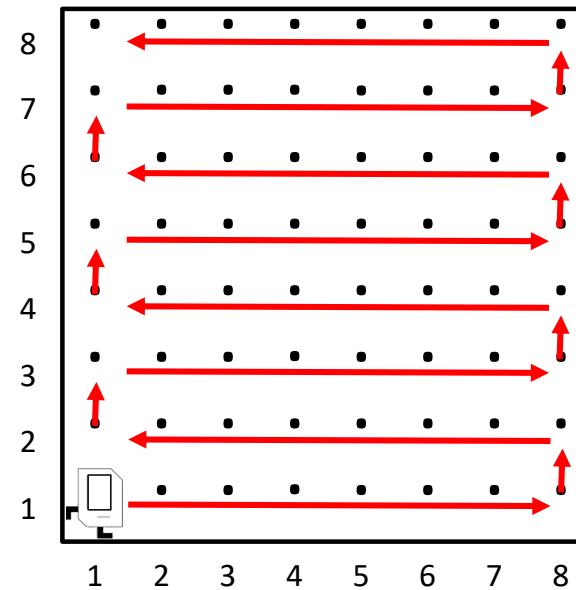
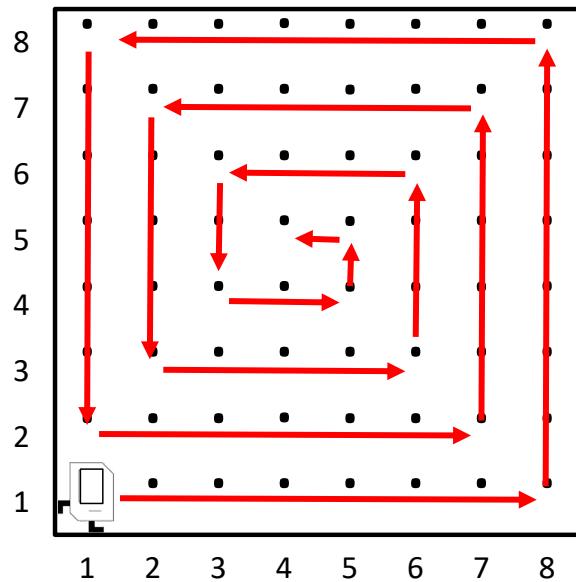
# Possible Algorithm 3



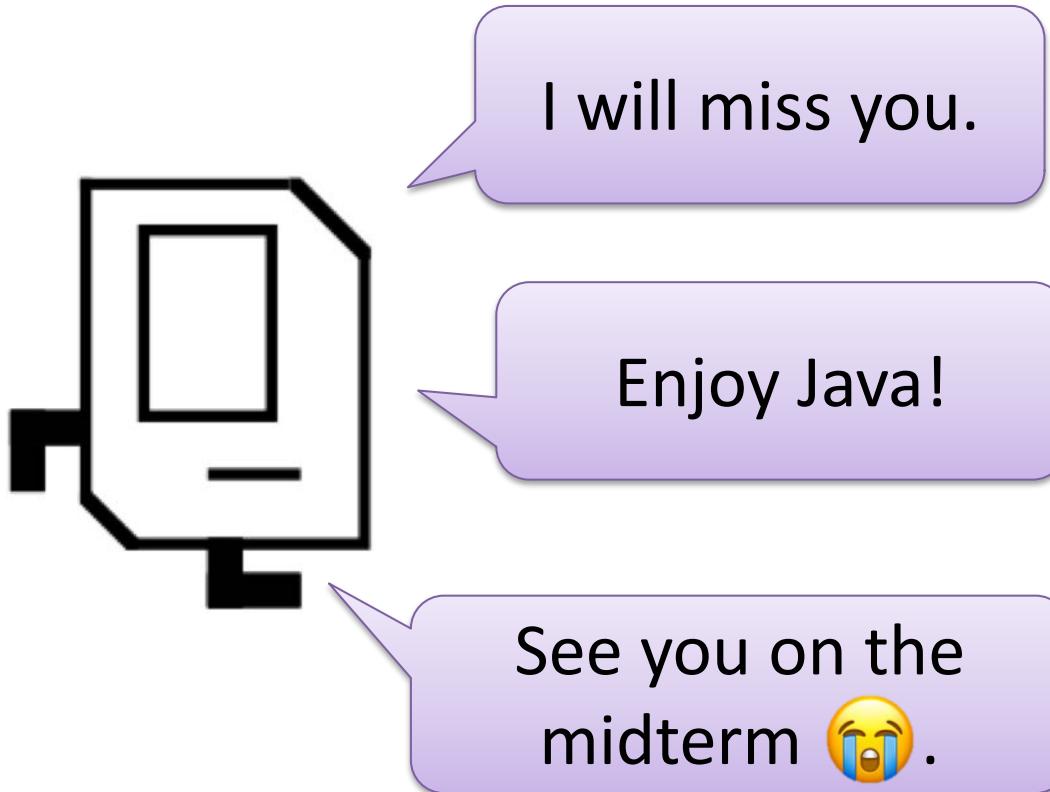
# Possible Algorithm 4



# Decision 2018



# See You Later!



# Java



Piech, CS106A, Stanford University



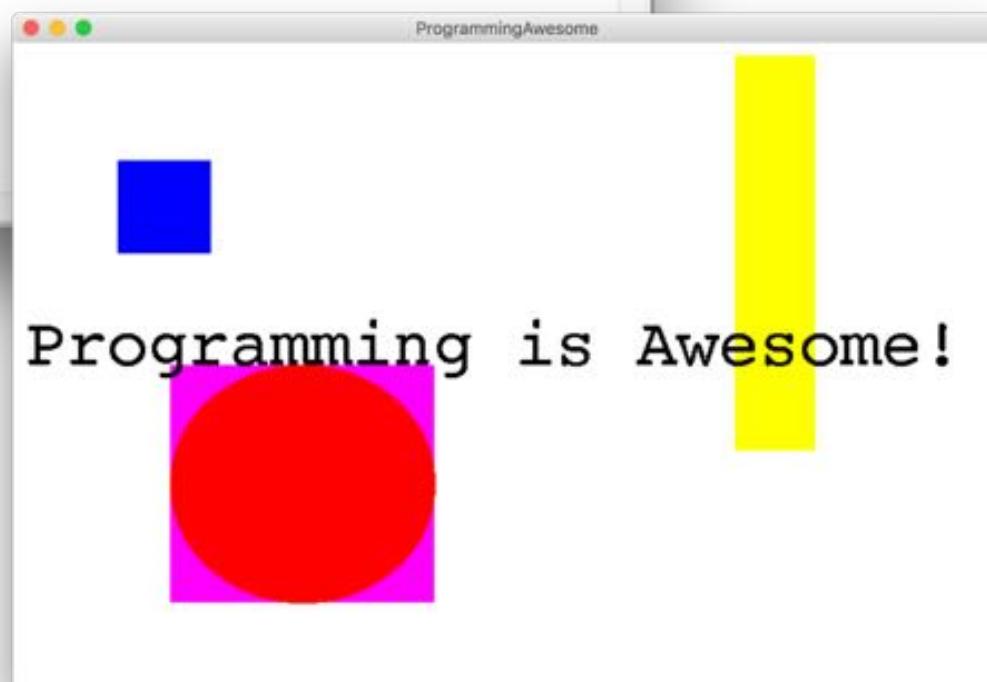
# Today's Goal

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?

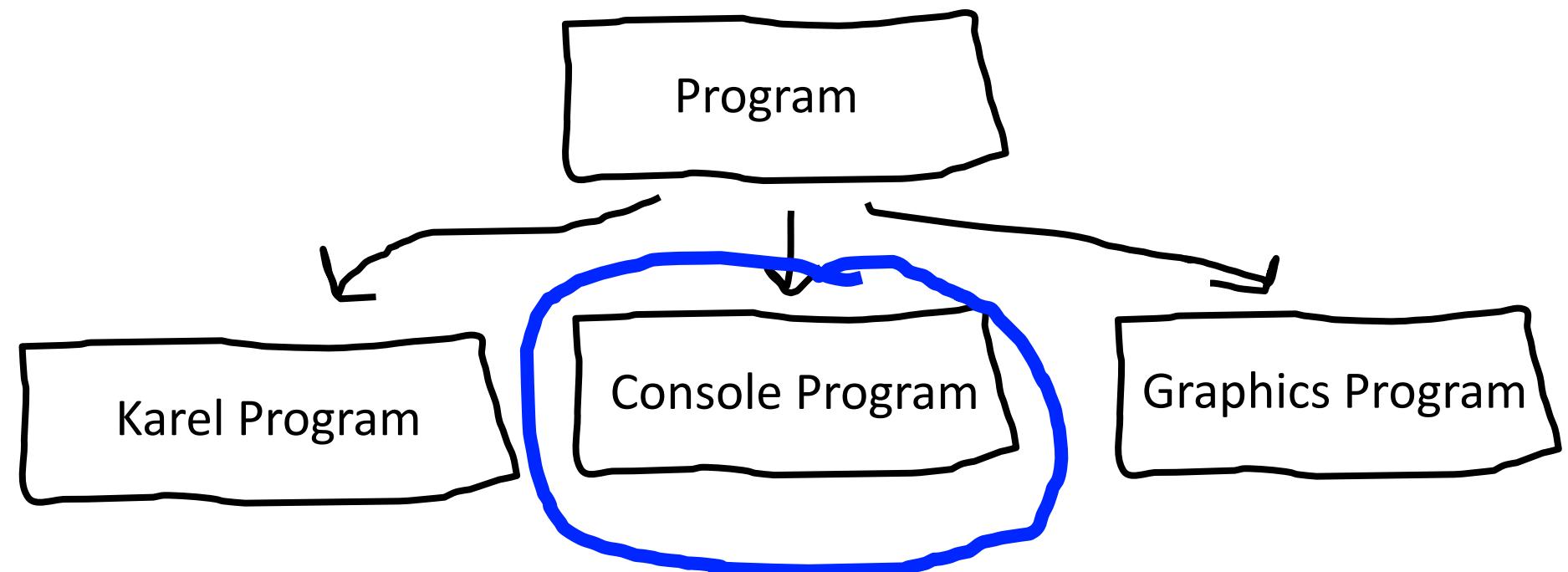


# Two Example Programs

```
Add2Numbers
This program adds two numbers.
Enter n1: 17
Enter n2: 25
The total is 42.
```



# 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



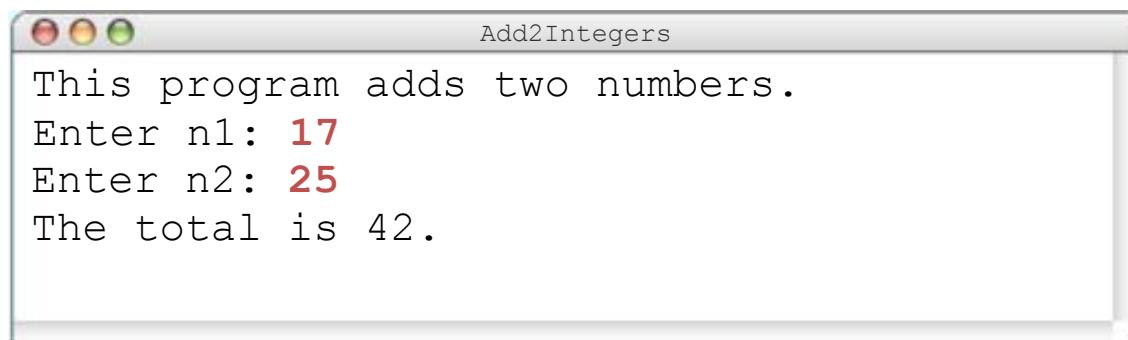
You had me at  
"Hello, world"



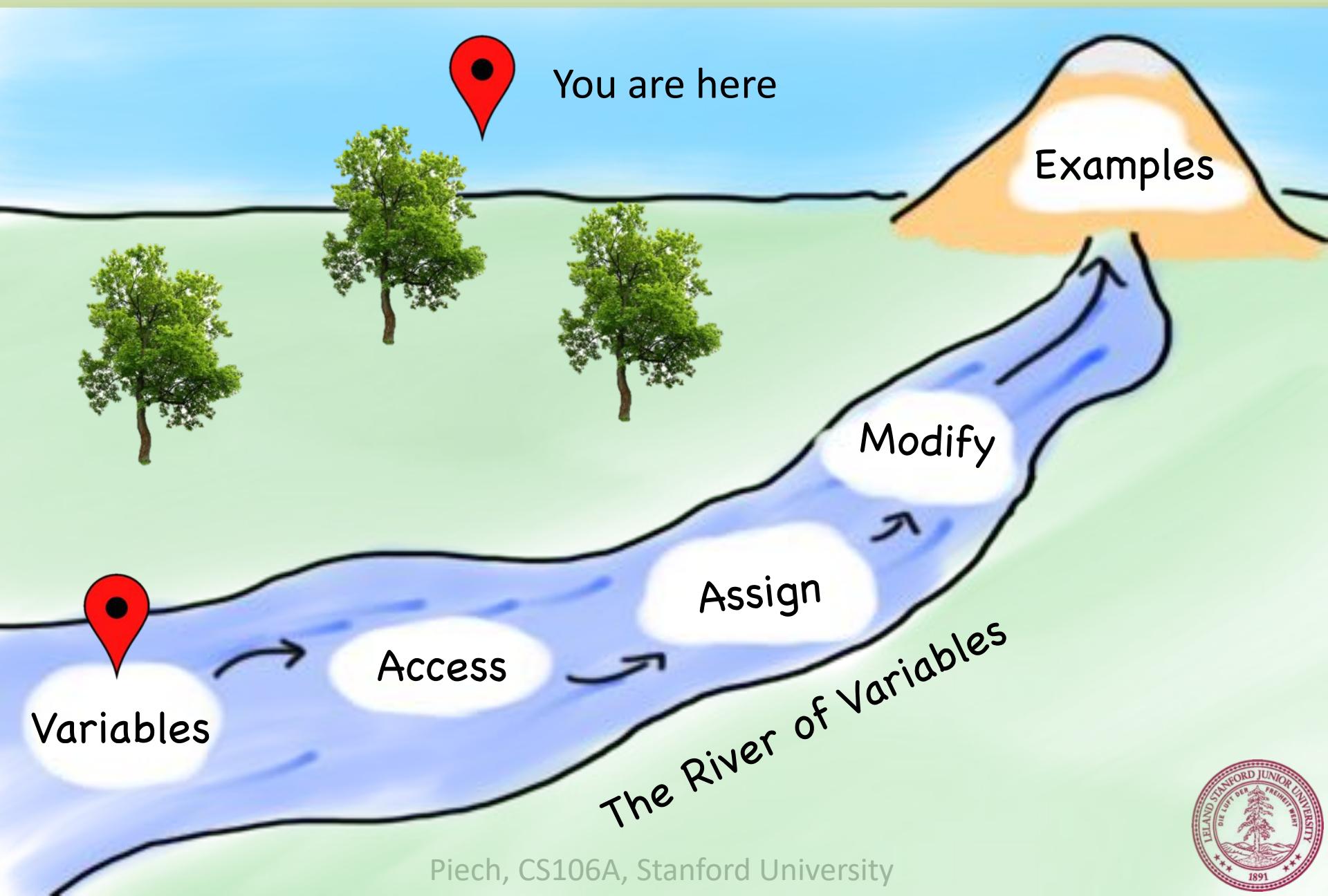
# Add2Integers

```
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



Programs are *control flow* and *variables*

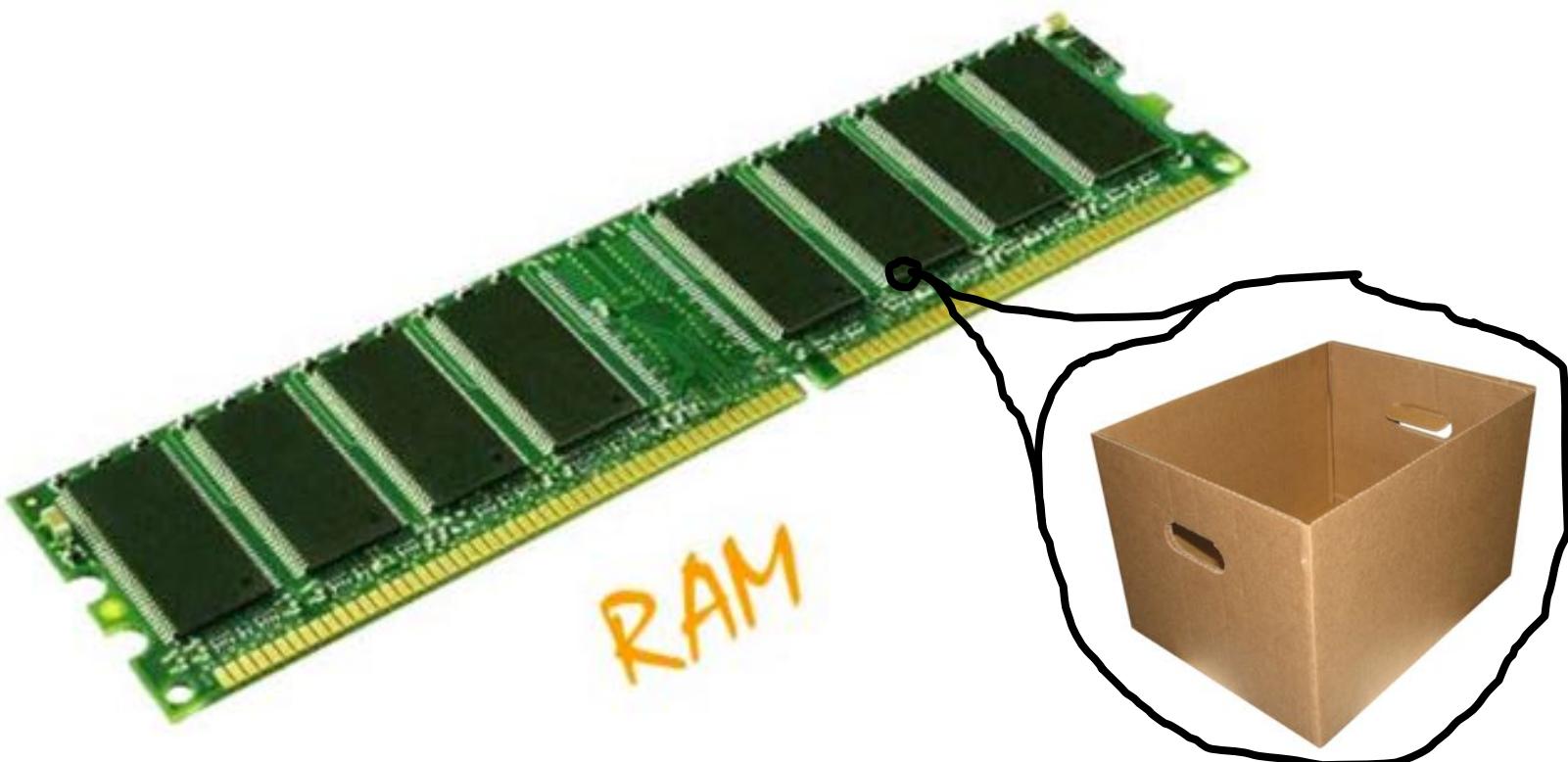
# What is a variable?

[suspense]

# Variables are Like Boxes



# Teeny Tiny Boxes



My computer has space for about 2 billion boxes

# Making a New Variable

```
int age = 29;
```



# Making a New Variable

type

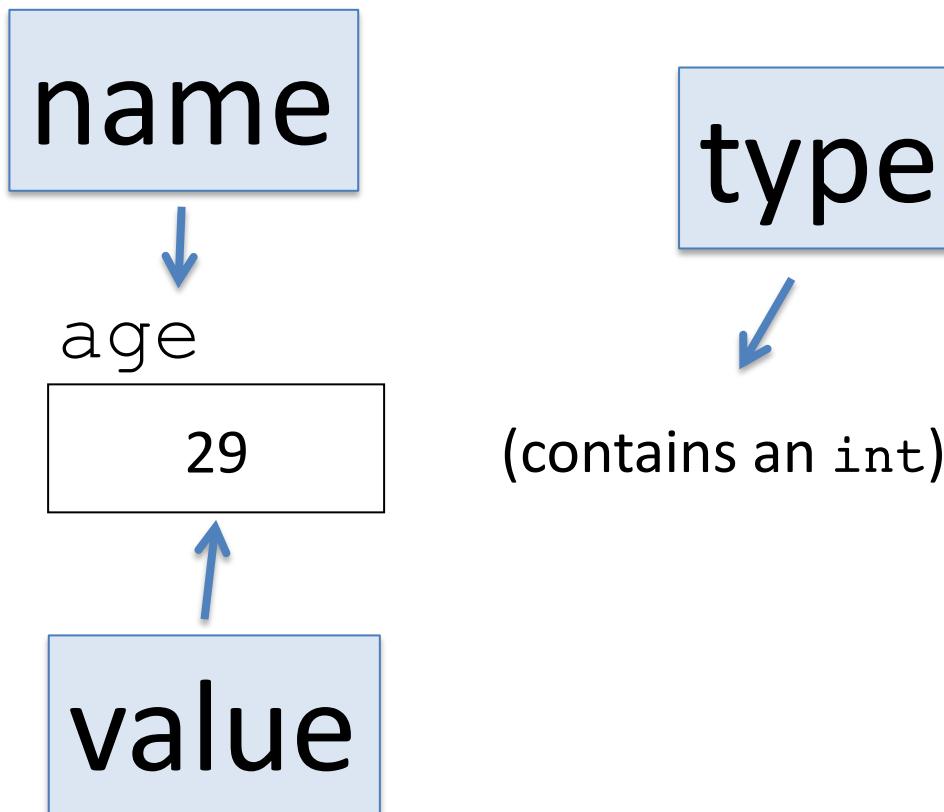
name

```
int age = 29;
```

Initial value



# Three Properties



# 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;
```



# Core Types

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

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

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

\* Why is it called a double? /



# Core Types

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

```
// "strings" of letters  
String phrase = "Spring rocks!";
```



# Core Types

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

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

```
// 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 on April 25th



# 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 on April 25th

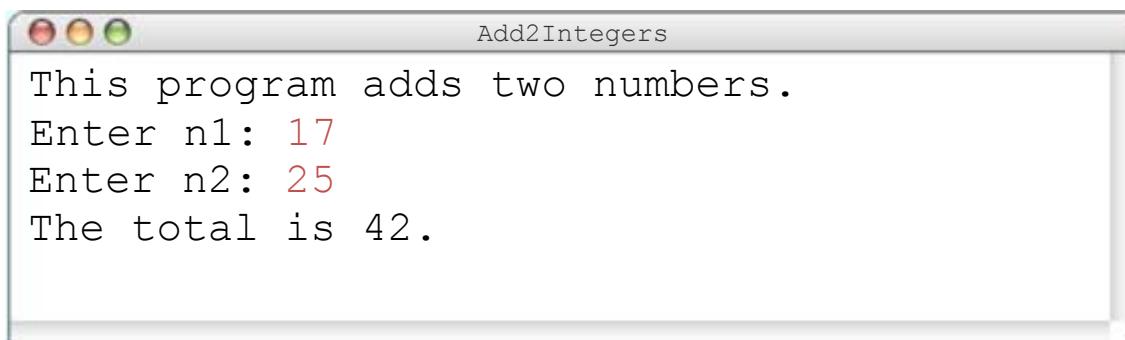


What data can you put in a variable  
(aka box)?

# 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? $");
```

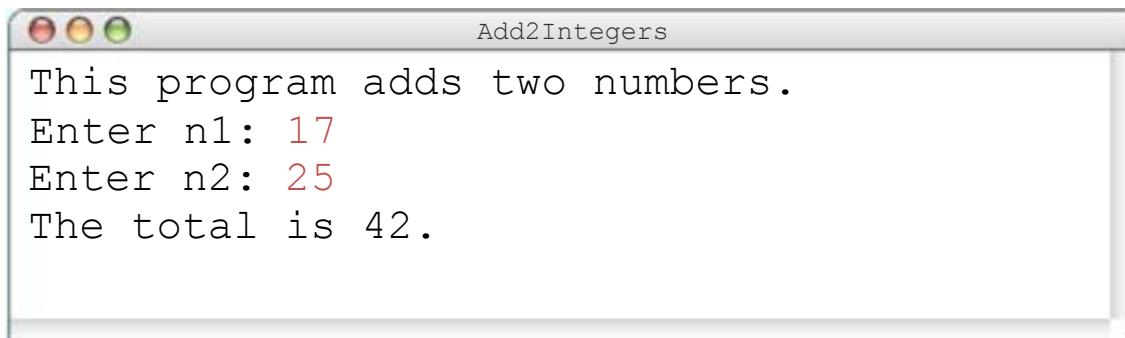
```
// Haven't you ever wondered, who was the first  
// person to eat a carrot???  
boolean edible = readBoolean("Subject alive?")
```



# 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

- Subtraction

\* Multiplication

/ 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;
```



# AHHHHHHHH!!!!!!

```
// 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.

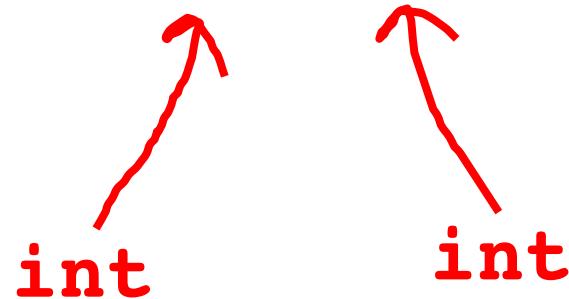
Most important example:

**int / int** results in an **int**



# AHHHHHHHH!!!!!!

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



int                  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** < **String**

Example:

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



Even more examples...

# Pitfalls of Integer Division

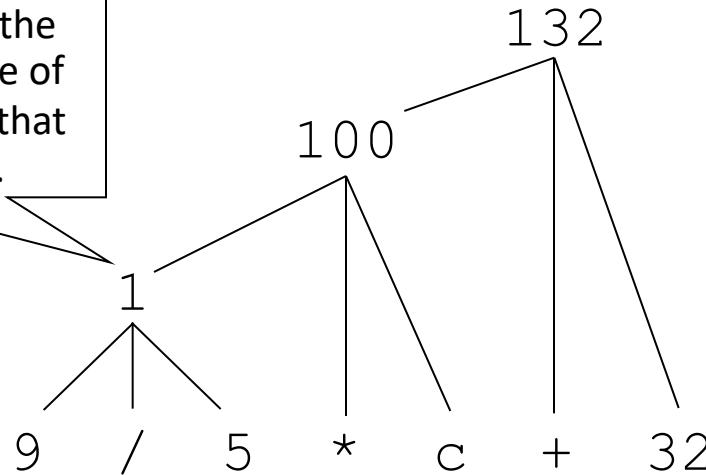
Convert 100° Celsius temperature to its Fahrenheit equivalent:

```
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`.

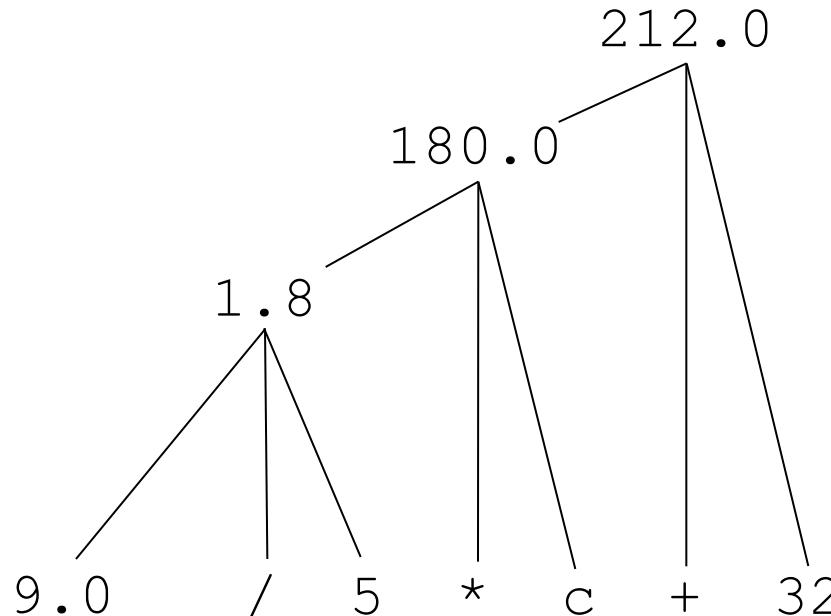


# Pitfalls of Integer Division

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.

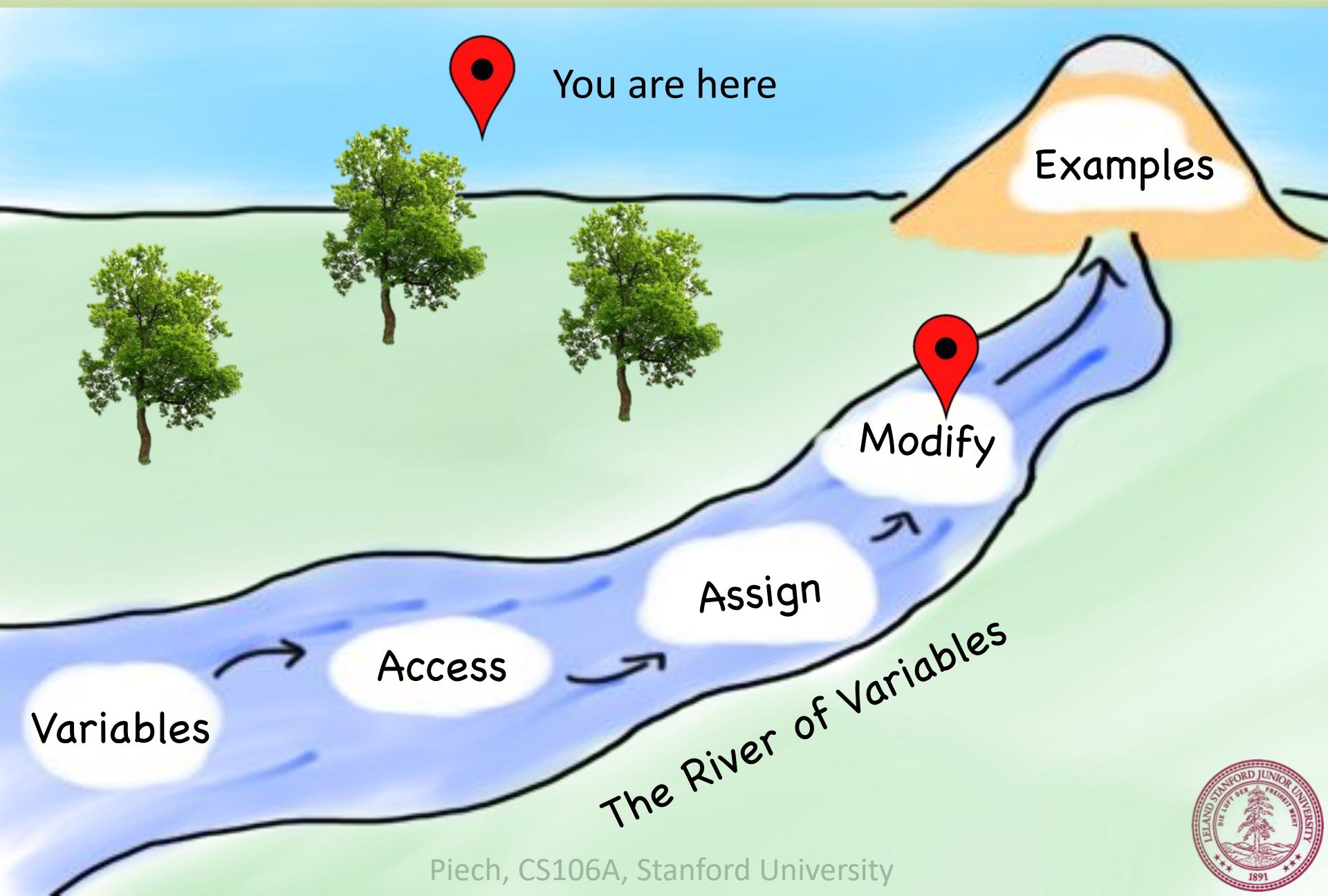
```
int y = 3;  
int y = 5; // Error: y already exists
```

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

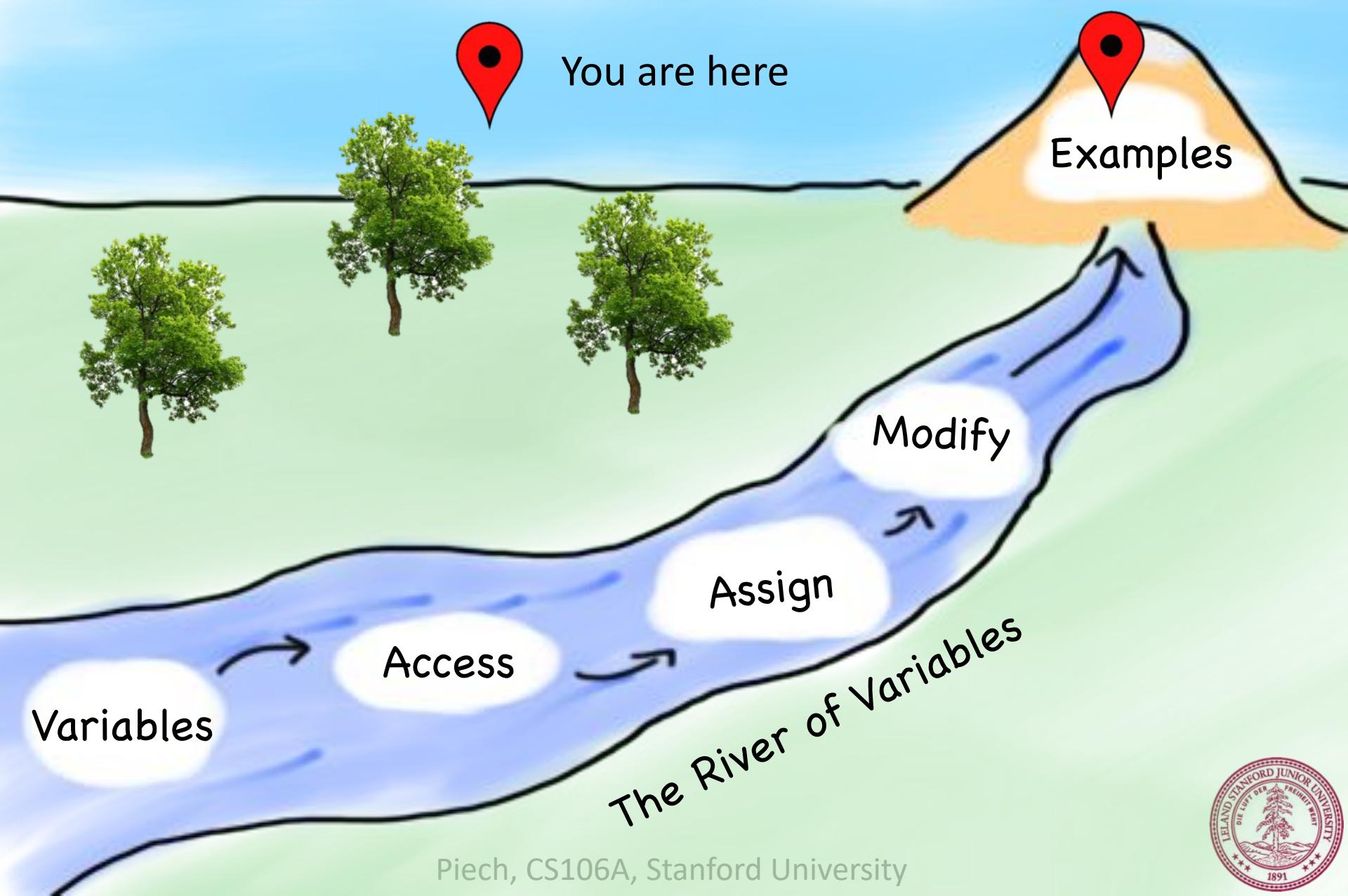
```
z = 10; // Error: z cannot be resolved
```



# Today's Route



# Today's Route



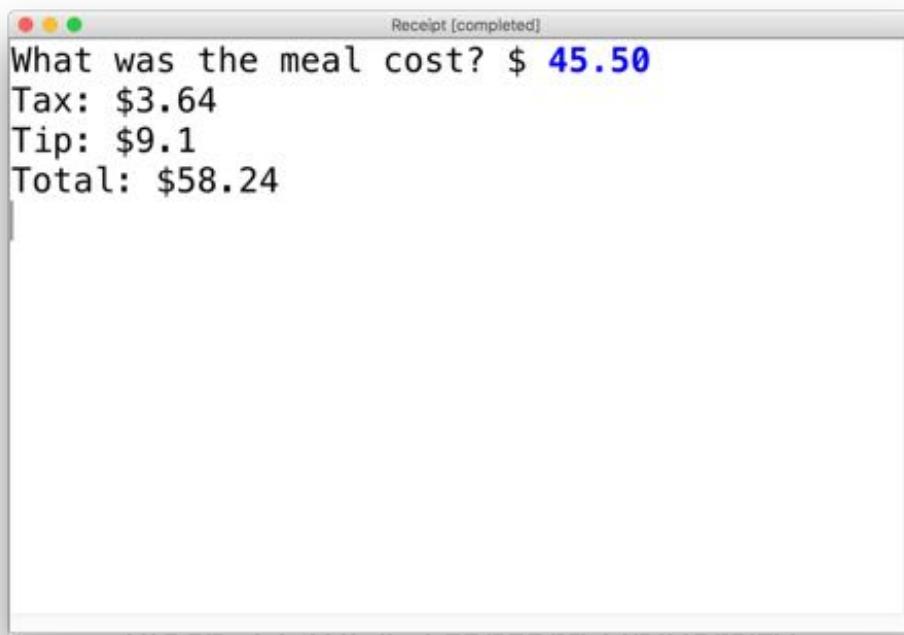
# Today's Goal

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.



# If there is time “Remaining”

