Variables
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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
• 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!

I will miss you.

Enjoy Java!

See you on the midterm 😢.
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

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

Programming is Awesome!
Types of Programs

Program

Karel Program

Console Program

Graphics Program
import acm.program.*;

public class HelloProgram extends ConsoleProgram {
    public void run() {
        println("hello, world");
    }
}

First Console Program: Hello World
In Pop Culture

You had me at "Hello, world"
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 + ".");
    }
}

<table>
<thead>
<tr>
<th>n1</th>
<th>n2</th>
<th>total</th>
</tr>
</thead>
<tbody>
<tr>
<td>17</td>
<td>25</td>
<td>42</td>
</tr>
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This program adds two numbers.
Enter n1: 17
Enter n2: 25
The total is 42.
Today’s Route

The River of Variables

- Variables
- Access
- Assign
- Modify

You are here

Examples
Programs are *control flow* and *variables*
What is a variable?
[suspense]
Variables are Like Boxes
My computer has space for about 2 billion boxes
Making a New Variable

```c
int age = 29;
```
Making a New Variable

```plaintext
int age = 29;
```

- **type**: `int`
- **name**: `age`
- **Initial value**: `29`
Three Properties

name

age

29

value

type

(contains an int)
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
public void run() {

    // integer values
    int age = 29;

    // real values
    double weight = 180.2;
}

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Can you access the value in a variable (aka box)?
// 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
// 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)?
```java
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 + ".");
    }
}
```

This program adds two numbers.
Enter n1: 17
Enter n2: 25
The total is 42.
Making a New Variable

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

- **type**: `int`
- **name**: `myBox`
- **Initial value**: `user input`
Making a New Variable

```
int myBox = expression;
```

- **Type**: `int`
- **Name**: `myBox`
- **Initial value**: `expression`
// 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?");
```java
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 + ".");
    }
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```

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

<table>
<thead>
<tr>
<th>Priority</th>
<th>Operator</th>
<th>Tie breaker</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highest</td>
<td>()</td>
<td>Left to right</td>
</tr>
<tr>
<td>Middle</td>
<td>* /</td>
<td>Left to right</td>
</tr>
<tr>
<td>Lowest</td>
<td>+ -</td>
<td>Left to right</td>
</tr>
</tbody>
</table>
What do you think this does?

// creates a variable called
// success rate

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

0.0
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
```
// creates a variable called
// success rate
double successRate = 1 / 2;
Resulting Type

\textbf{int} / \textbf{int} results in an \textbf{int}

\textbf{double} * \textbf{double} results in a \textbf{double}

\textbf{int} + \textbf{double} results in a \textbf{double}
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:

```markdown
boolean < char < int < double < String
```

Example:

```markdown
int / double results in a double
```
Even more examples...
Convert 100° Celsius temperature to its Fahrenheit equivalent:

```java
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`. 

```
1
  /  
  
9  /  5  *  c  +  32
  
  
100
  
  
  
132
```
You can fix this problem by converting the fraction to a `double`, either by inserting decimal points or by using a type cast:

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

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

2. You may not declare the same variable twice.

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

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

```java
z = 10;  // Error: z cannot be resolved
```
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Examples
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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”