Methods

Chris Piech

CS106A, Stanford University

This is Method Man. He is part of the Wu Tang Clan. ☺

Boolean Variable

```
boolean karelIsAwesome = true;

boolean myBool = 1 < 2;
```

Boolean Operations

```
boolean a = true;

boolean b = false;


boolean and = a && b;

boolean or = a || b;

boolean not = !a;
```

Logical Operators

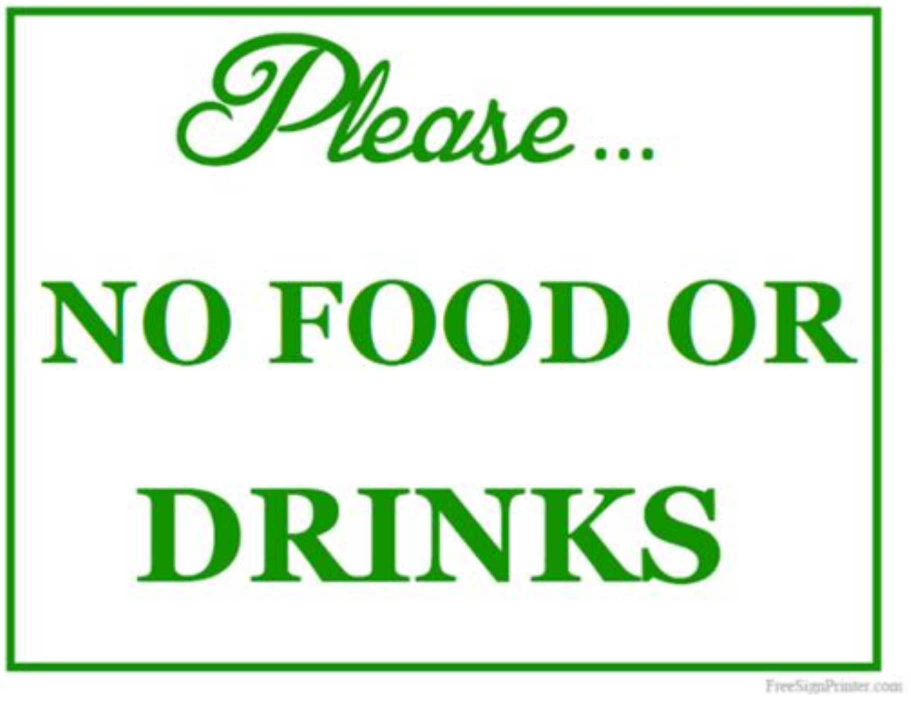
In order of precedence:

Operator	Description	Example	Result
`!`	not	`!(2 == 3)`	`true`
`&&`	and	`(2 == 3) && (-1 < 5)`	`false`
`||`	or	`(2 == 3) || (-1 < 5)`	`true`

Cannot "chain" tests as in algebra; use && or || instead

```
// assume x is 15
2 <= x <= 10
true   <= 10
Error!
```

```
// correct version
2 <= x && x <= 10
true   && false
false
```


Please...

NO FOOD OR DRINKS

FreeSignPrinter.com

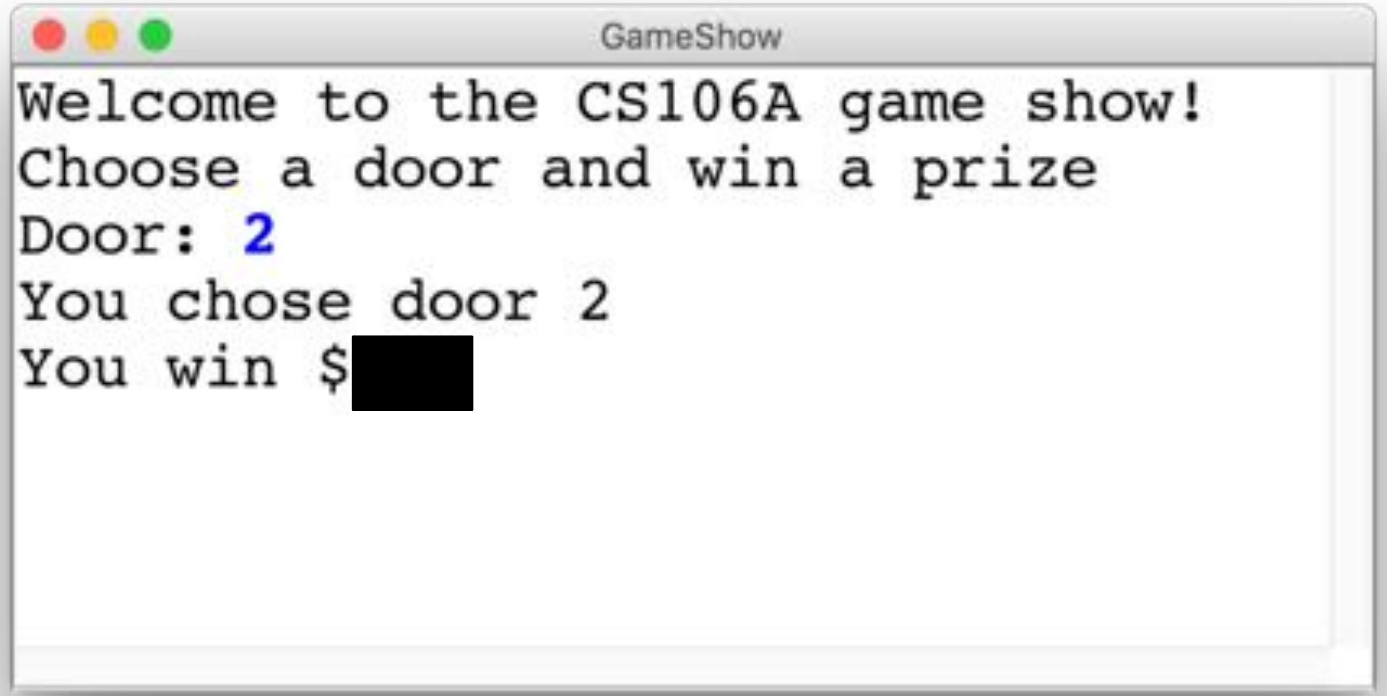
```
boolean food = true;
boolean drinks = true;
boolean isAllowed = !food || drinks;
```

*know your logical precedence

George Boole

English Mathematician 1815 – 1864
Boole died of being too cool

Game Show



```
Welcome to the CS106A game show!
Choose a door and win a prize
Door: 2
You chose door 2
You win $[redacted]
```

Choose a Door

```
int door = readInt("Door: ");
// while the input is invalid
while(door < 1 || door > 3) {
   // tell the user the input was invalid
   println("Invalid door!");
   // ask for a new input
   door = readInt("Door: ");
}
```

`||`	or
`&&`	and

The Door Logic

```java
int prize = 4;
if(door == 1) {
   prize = 2 + 9 / 10 * 100;
} else if(door == 2) {
   boolean locked = prize % 2 != 0;
   if(!locked) {
      prize += 6;
   }
} else if(door == 3) {
   prize++;
}
```

The Door Logic

```
int prize = 4;
if(door == 1) {
   prize = 2 + 9 / 10 * 100;
} else if(door == 2) {
   boolean locked = prize % 2 != 0;
   if(!locked) {
      prize += 6;
   }
} else if(door == 3) {
   prize++;
}
```

The Door Logic

```
int prize = 4;
if(door == 1) {
   prize = 2 + 9 / 10 * 100;
} else if(door == 2) {
   boolean locked = prize % 2 != 0;
   if(!locked) {
      prize += 6;
   }
} else if(door == 3) {
   prize++;
}
```

The Door Logic

```
int prize = 4;
if(door == 1) {
   prize = 2 + 9 / 10 * 100;
} else if(door == 2) {
   boolean locked = prize % 2 != 0;
   if(!locked) {
      prize += 6;
   }
} else if(door == 3) {
   prize++;
}
```

The Door Logic

```
int prize = 4;
if(door == 1) {
   prize = 2 + 9 / 10 * 100;
} else if(door == 2) {
   boolean locked = prize % 2 != 0;
   if(!locked) {
      prize += 6;
   }
} else if(door == 3) {
   prize++;
}
```

Civilization advances by extending the number of operations we can perform without thinking about them.

-Alfred North Whitehead

Learn How To:

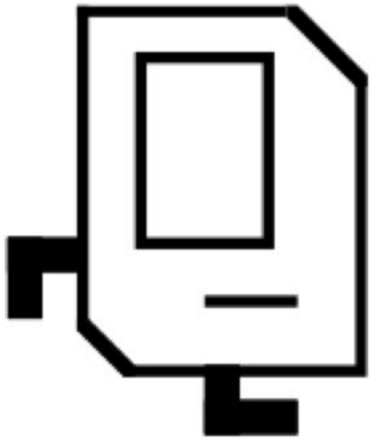
1. Write a method that takes in input
2. Write a method that gives back output
3. Trace method calls using stacks

Calling Methods

```
turnRight();

move();          readInt("Int please! ");

println("hello world");

rect.setFilled(true);

drawRobotFace();

add(rect);

preventGlobalWarming();
```

Defining a Method

```
private void turnRight() {
    turnLeft();
    turnLeft();
    turnLeft();
}
```



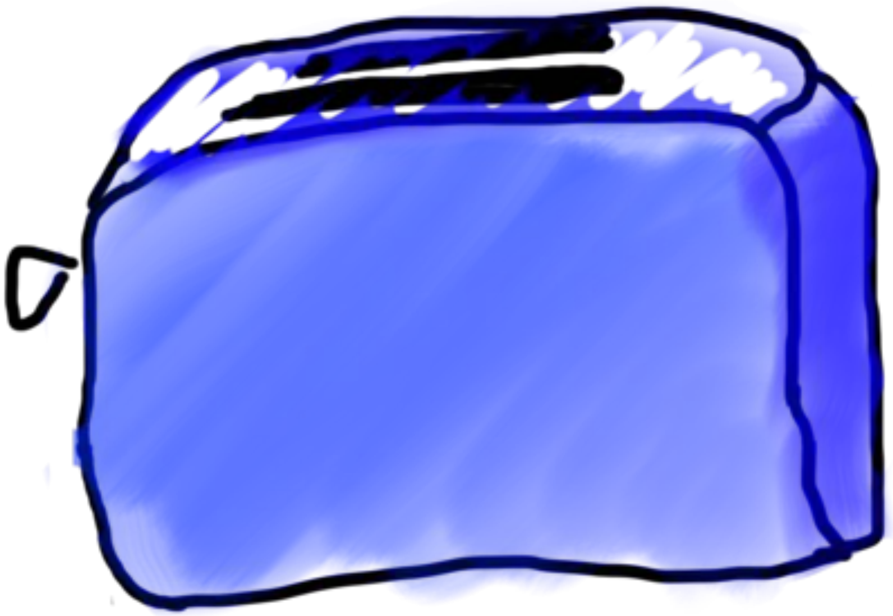
Big difference with Java methods:
Java methods can **take in data**, and can **return data**!

Toasters are Methods

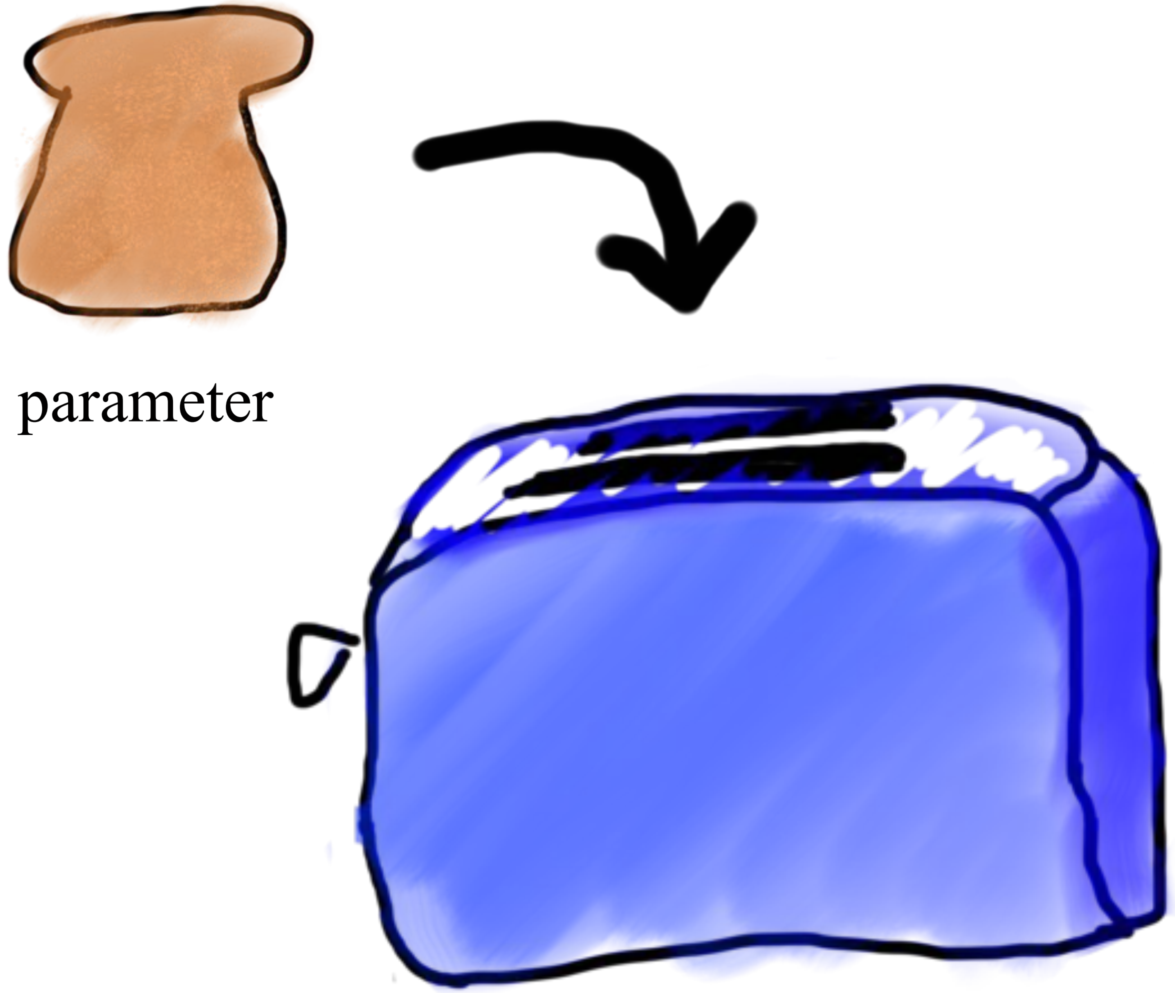
- Thanks Mehran

Toasters are Methods

parameter

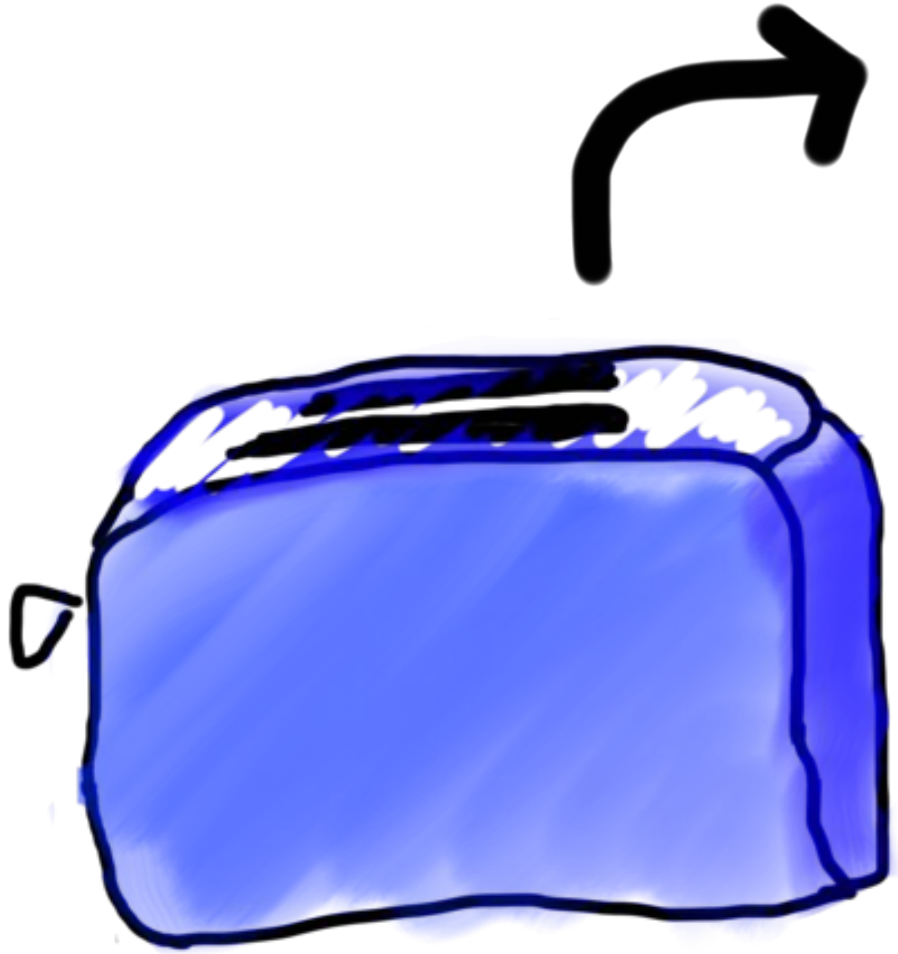


Toasters are Methods

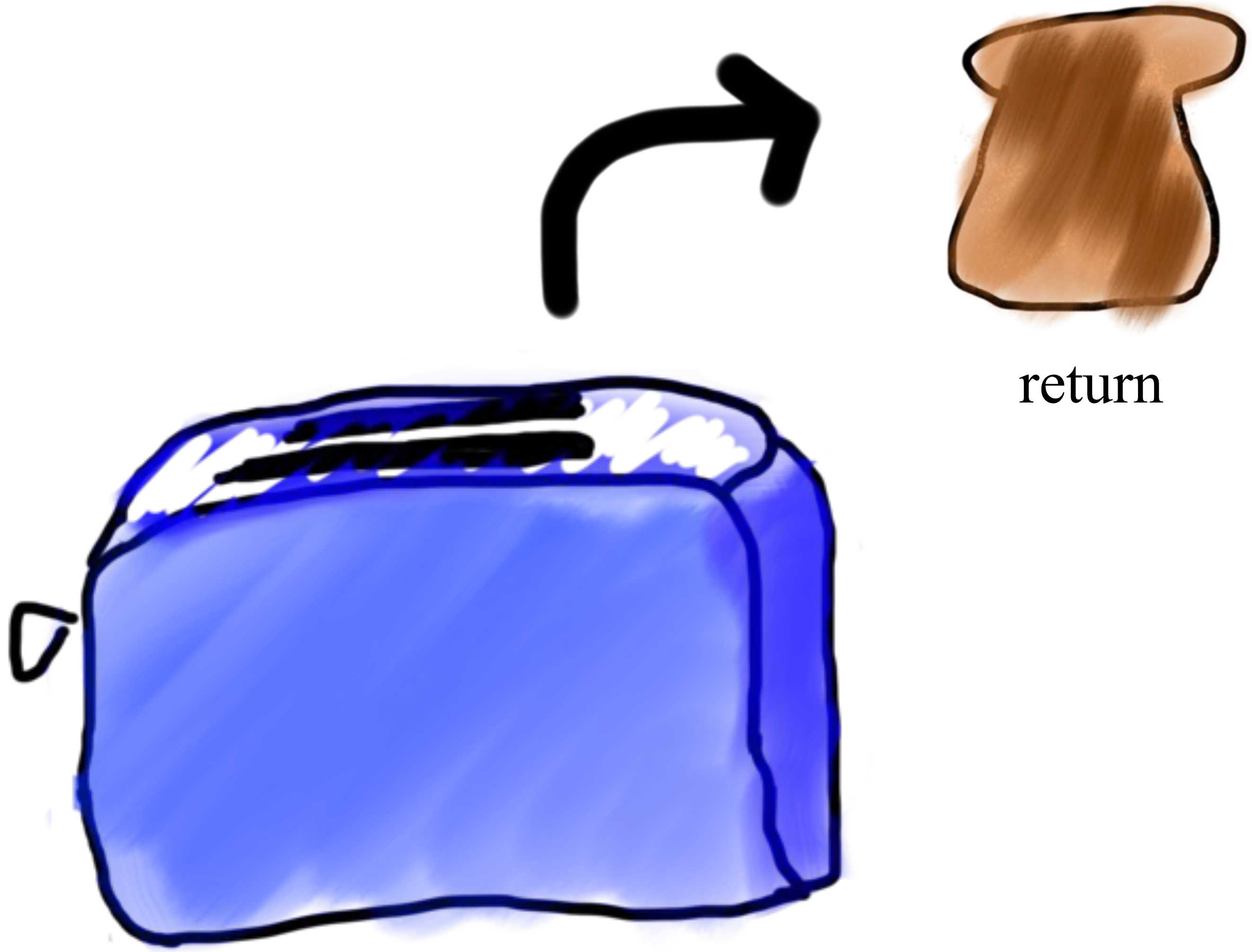


Toasters are Methods

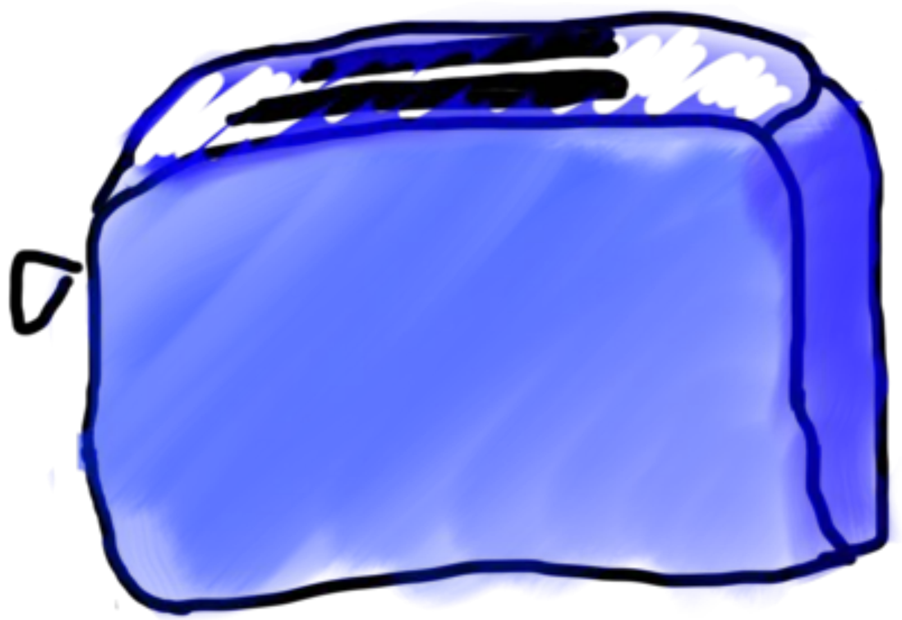
Toasters are Methods



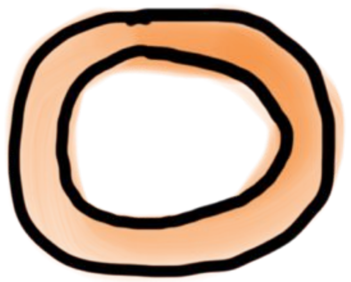
Toasters are Methods

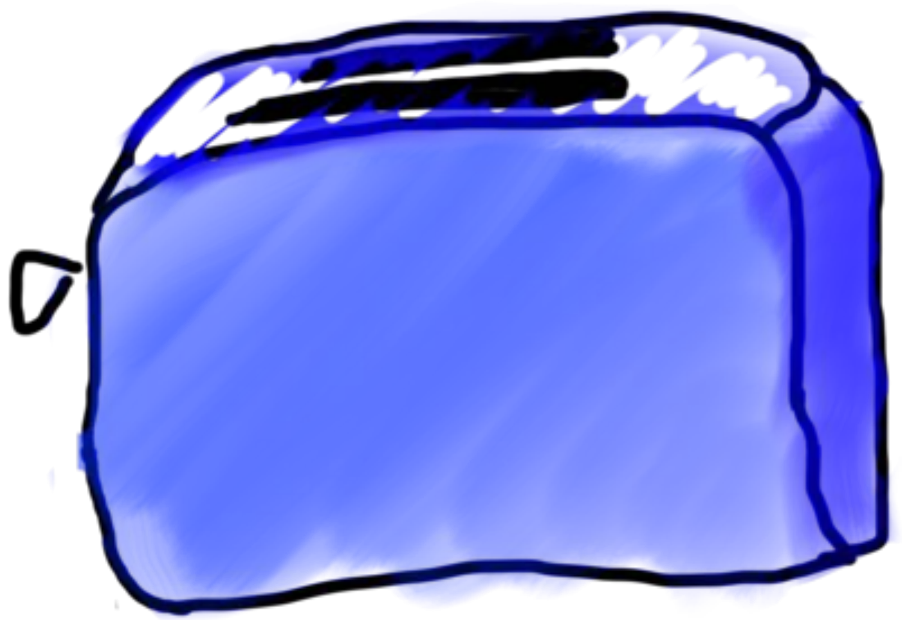


Toasters are Methods



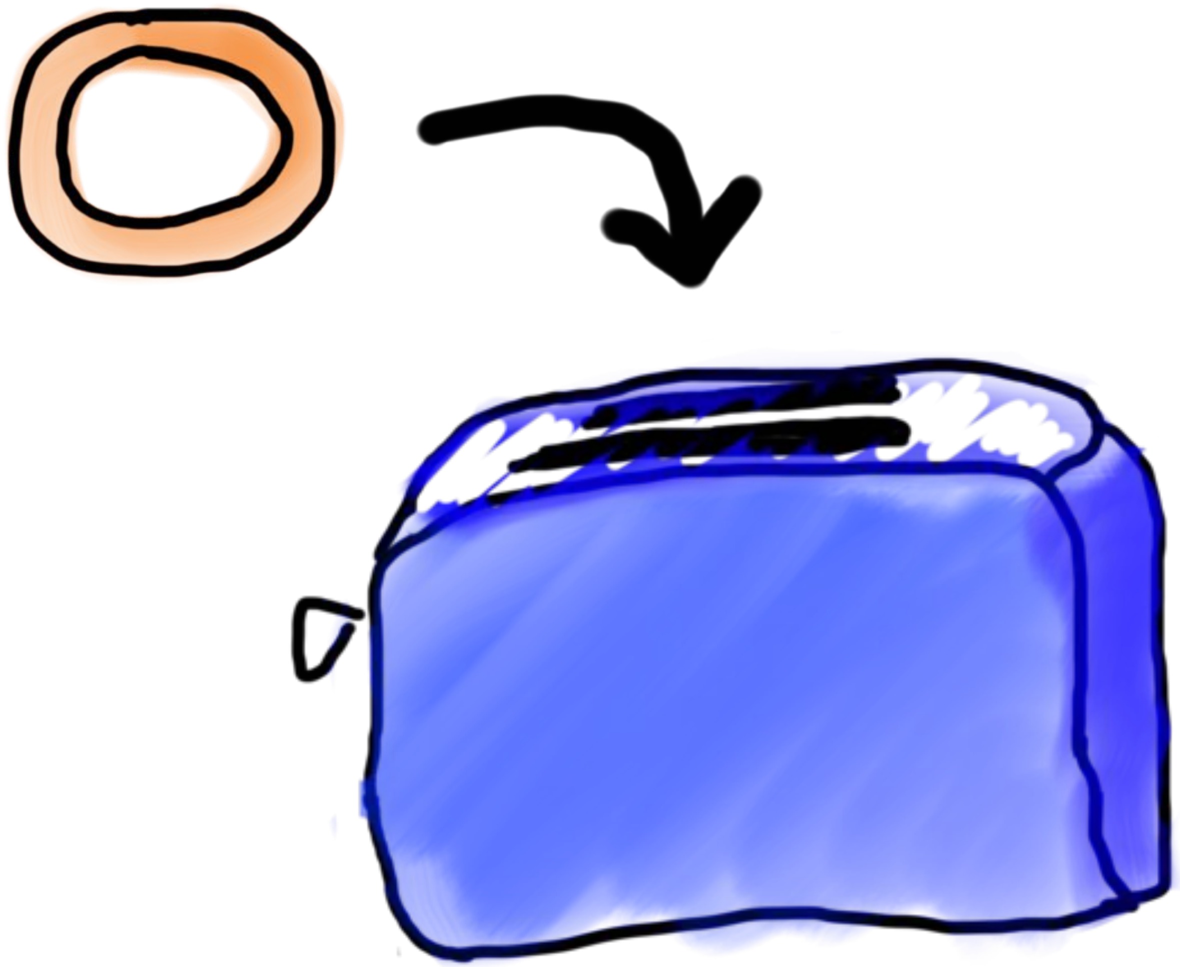
Toasters are Methods



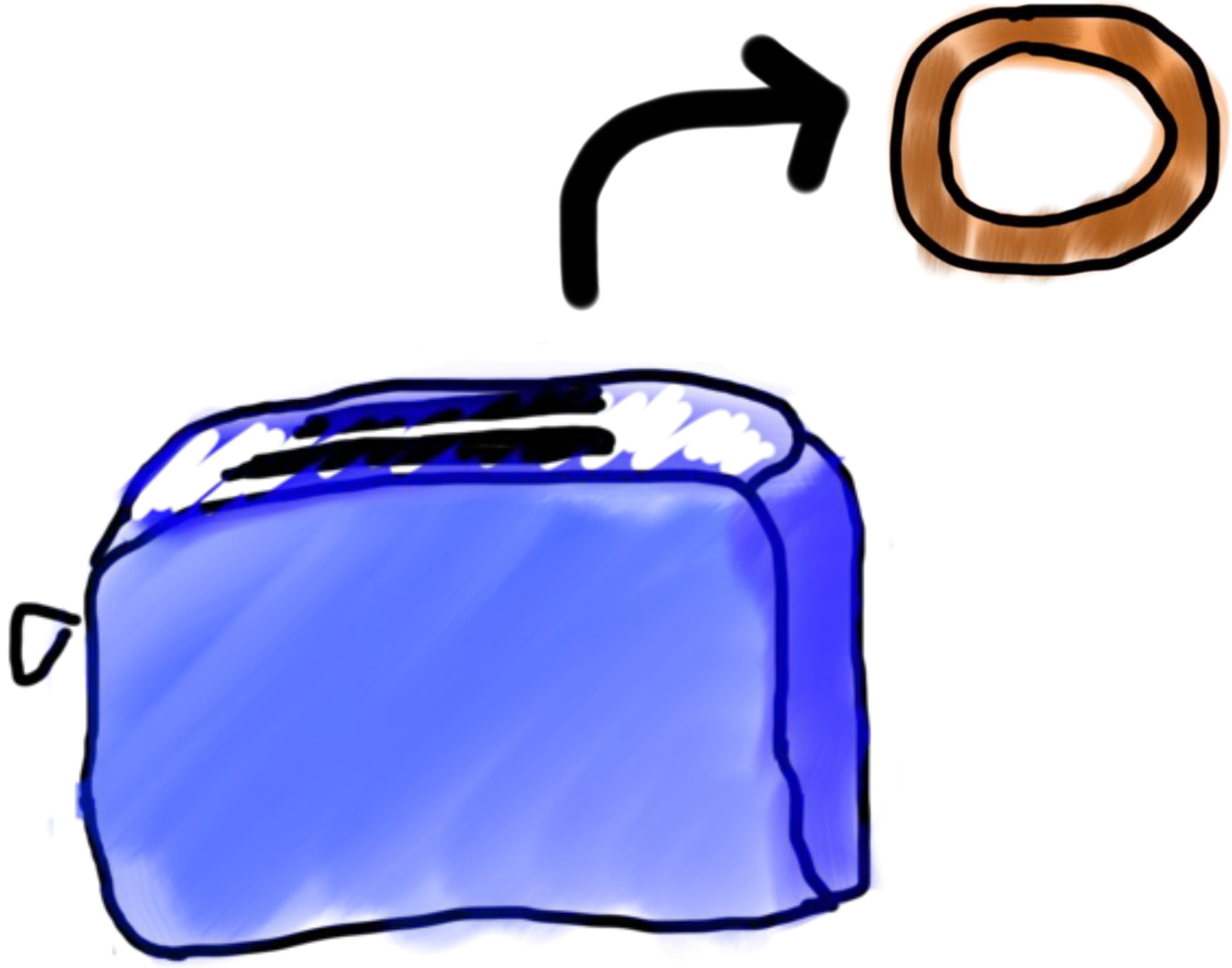


* You don't need a second toaster if you want to toast bagels. Use the same one.

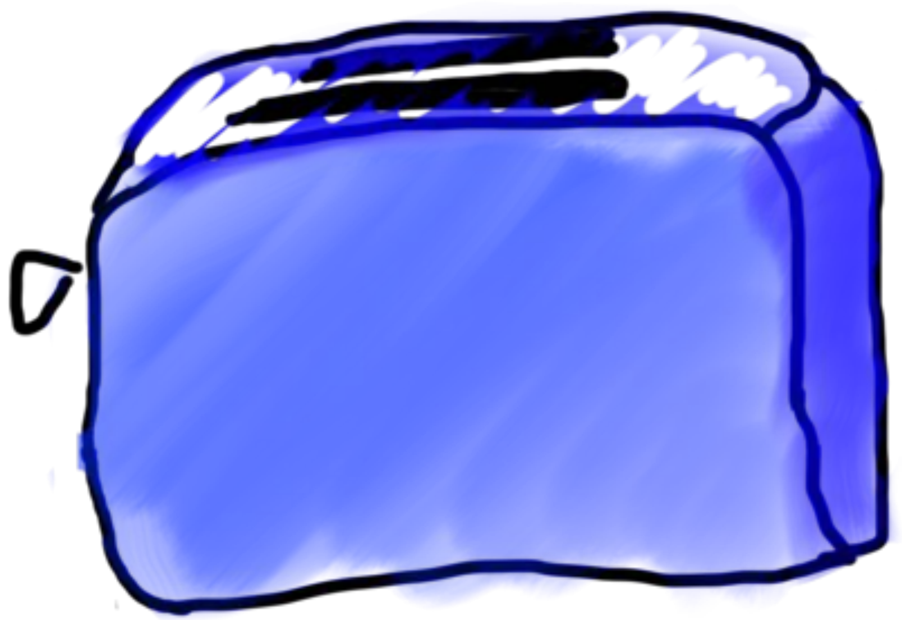
Toasters are Methods



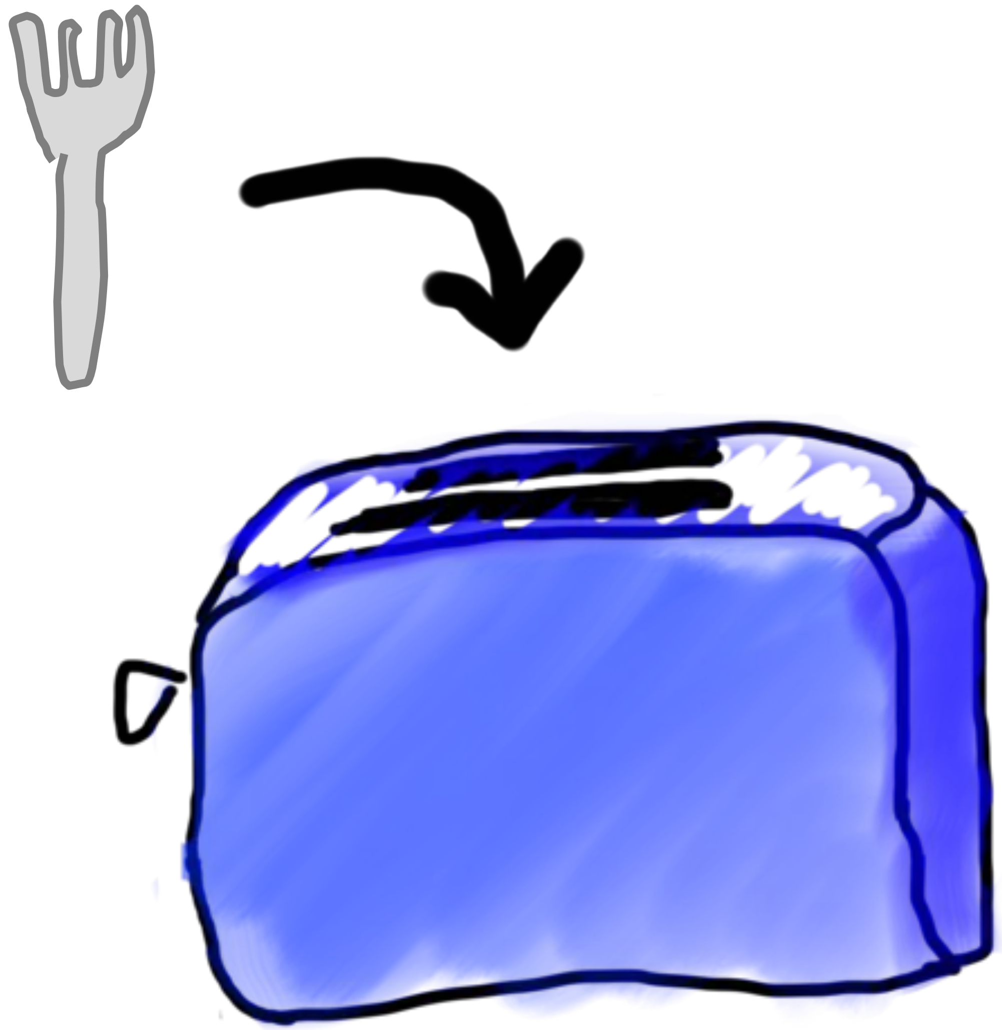
Toasters are Methods



Toasters are Methods

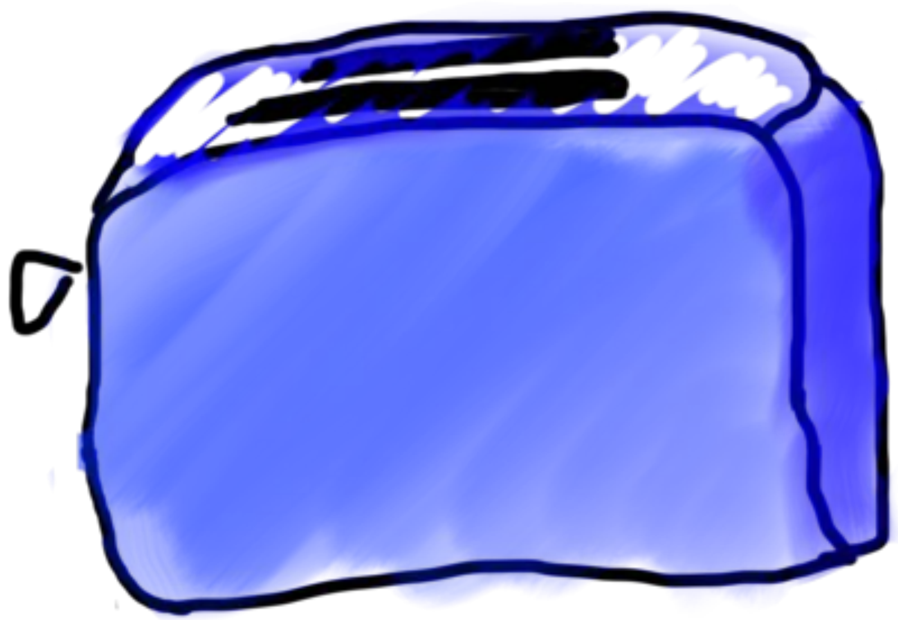


Toasters are Methods

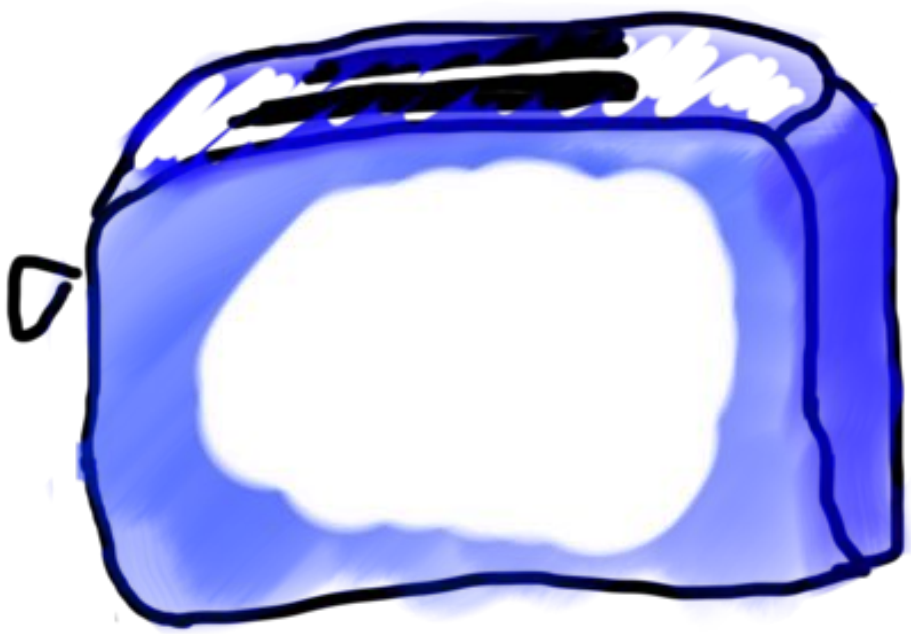


Toasters are Methods

Methods are Like Toasters

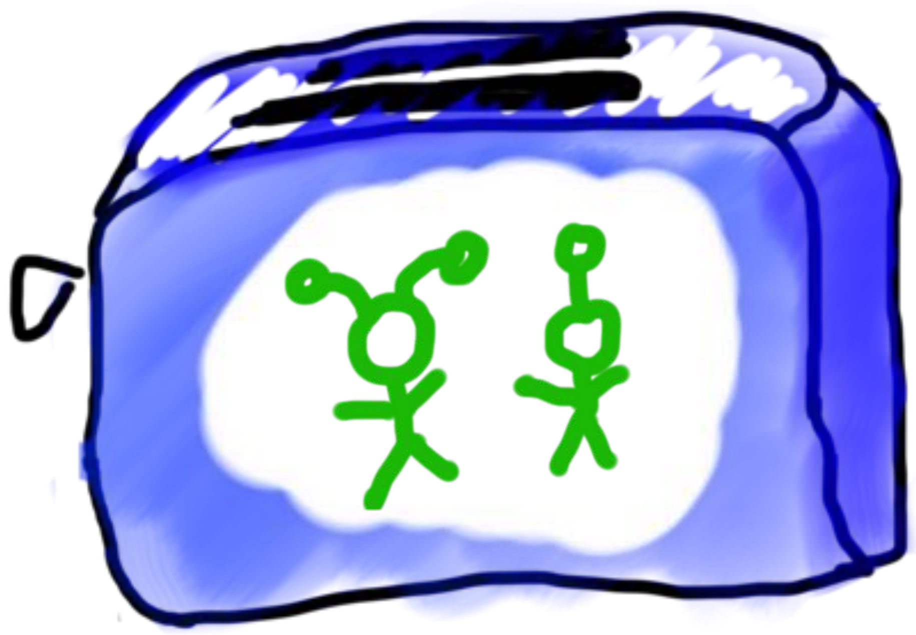


Methods are Like Toasters

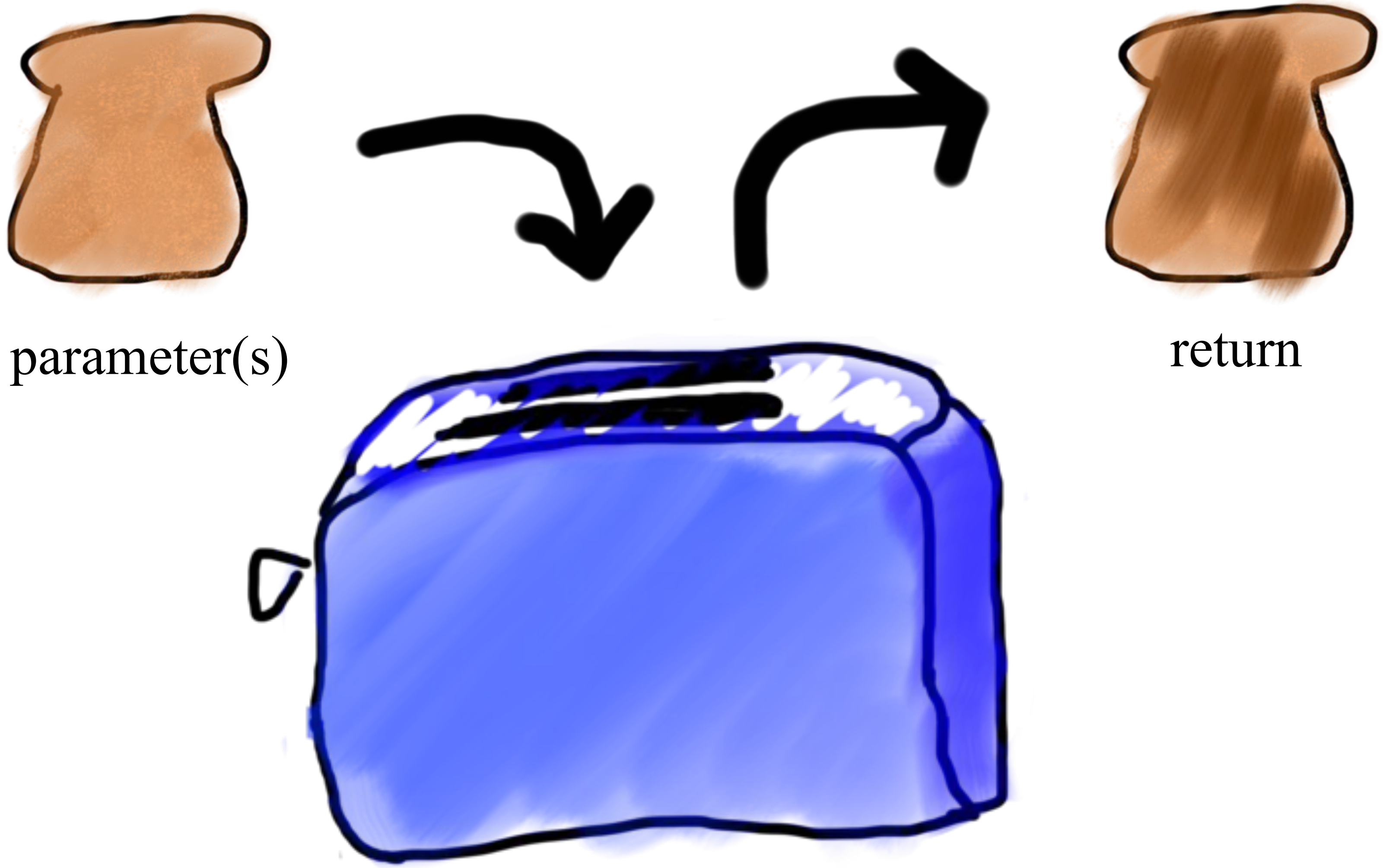


Methods are Like Toasters

Methods are Like Toasters



Methods are Like Toasters



Formally

```
visibility type nameOfMethod(parameters) {
    statements
}
```

- ***visibility:*** usually **`private`** or **`public`**
- ***type:*** type returned by method (e.g., **`int`** , **`double`**, *etc*.)
  - Can be **`void`** to indicate that nothing is returned
- ***parameters:*** information passed into method

Anatomy of a method

```
public void run() {
   double mid = average(5.0, 10.2);
   println(mid);
}



private double average(double a, double b) {
   double sum = a + b;
   return sum / 2;
}
```

Anatomy of a method

```
public void run() {
    double mid = average(5.0, 10.2);
    println(mid);
}
```

method "definition"

```
private double average(double a, double b) {
    double sum = a + b;
    return sum / 2;
}
```

Anatomy of a method

```
public void run() {
    double mid = average(5.0, 10.2);
    println(mid);
}
```

Output expected

Input expected

```
private double average(double a, double b) {
    double sum = a + b;
    return sum / 2;
}
```

Anatomy of a method

```
public void run() {
    double mid = average(5.0, 10.2);
    println(mid);
}
```

Return Type

Parameters

```
private double average(double a, double b) {
    double sum = a + b;
    return sum / 2;
}
```

Anatomy of a method

```
public void run() {
    double mid = average(5.0, 10.2);
    println(mid);
}
```

name

```
private double average(double a, double b) {
    double sum = a + b;
    return sum / 2;
}
```

Anatomy of a method

```
public void run() {
    double mid = average(5.0, 10.2);
    println(mid);
}


private double average(double a, double b) {
    double sum = a + b;
    return sum / 2;
}
```

body

Anatomy of a method

```
public void run() {
    double mid = average(5.0, 10.2);
    println(mid);
}



private double average(double a, double b) {
    double sum = a + b;
    return sum / 2;
}
```

Ends the method and gives back a single value

Anatomy of a method

```
public void run() {
    double mid = average(5.0, 10.2);
    println(mid);
}
```

```
private double average(double a, double b) {
    double sum = a + b;
    return sum / 2;
}
```

This statement is necessary because **`average`** promised to return a double

Anatomy of a method

method "call"

```
public void run() {
    double mid = average(5.0, 10.2);
    println(mid);
}



private double average(double a, double b) {
    double sum = a + b;
    return sum / 2;
}
```

Anatomy of a method

arguments

```
public void run() {
    double mid = average(5.0, 10.2);
    println(mid);
}



private double average(double a, double b) {
    double sum = a + b;
    return sum / 2;
}
```

Anatomy of a method

Return Type Parameters

```
public void run() {
    double mid = average(5.0, 10.2);
    println(mid);
}



private double average(double a, double b) {
    double sum = a + b;
    return sum / 2;
}
```

Anatomy of a method

```
public void run() {
    double mid = average(5.0, 10.2);
    println(mid);
}
```

When a method ends it “returns”

```
private double average(double a, double b) {
    double sum = a + b;
    return sum / 2;
}
```

Parameters

Parameters let you provide a method some information when you are calling it.

Learn by Example

Void Example

```
private void printIntro() {
   println("Welcome to class");
   println("It's the best part of my day.");
}


public void run() {
   printIntro();
}
```

Void Example

```
private void printIntro() {
    println("Welcome to class");
    println("It's the best part of my day.");
}

public void run() {
    printIntro();
}
```

Void Example

```
private void printIntro() {
   println("Welcome to class");
   println("It's the best part of my day.");
}


public void run() {
   printIntro();
}
```

Void Example

```
private void printIntro() {
    println("Welcome to class");
    println("It's the best part of my day.");
}


public void run() {
    printIntro();
}
```

Void Example

```
private void printIntro() {
   println("Welcome to class");
   println("It's the best part of my day.");
}


public void run() {
   printIntro();
}
```

Void Example

```
private void printIntro() {
    println("Welcome to class");
    println("It's the best part of my day.");
}


public void run() {
    printIntro();
}
```

Void Example

```
private void printIntro() {
   println("Welcome to class");
   println("It's the best part of my day.");
}

public void run() {
   printIntro();
}
```

Void Example

```
private void printIntro() {
    println("Welcome to class");
    println("It's the best part of my day.");
}

public void run() {
    printIntro();
}
```

Void Example

```
private void printIntro() {
   println("Welcome to class");
   println("It's the best part of my day.");
}


public void run() {
   printIntro();
}
```

Parameter Example

```
private void printOpinion(int num) {
    if(num == 5) {
        println("I love 5!");
    } else {
        println("Whattever");
    }
}

public void run() {
    printOpinion(5);
}
```

Parameter Example

Run memory

No variables

```
private void printOpinion(int num) {
    if(num == 5) {
        println("I love 5!");
    } else {
        println("Whattever");
    }
}

public void run() {
    printOpinion(5);
}
```

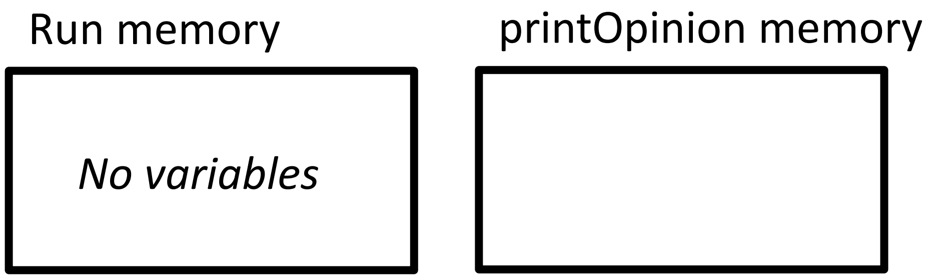
Parameter Example

Run memory

No variables

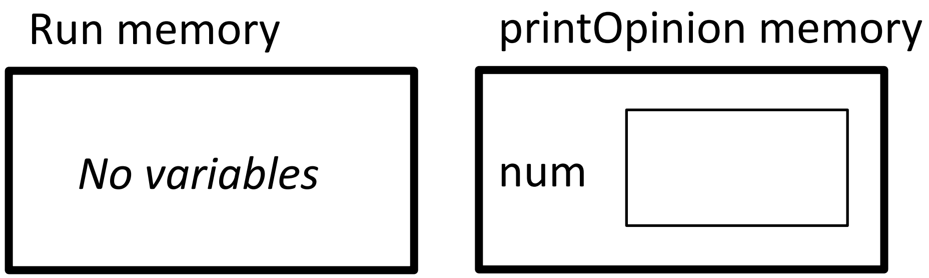
```
private void printOpinion(int num) {
    if(num == 5) {
        println("I love 5!");
    } else {
        println("Whattever");
    }
}

public void run() {
    printOpinion(5);
}
```

Parameter Example



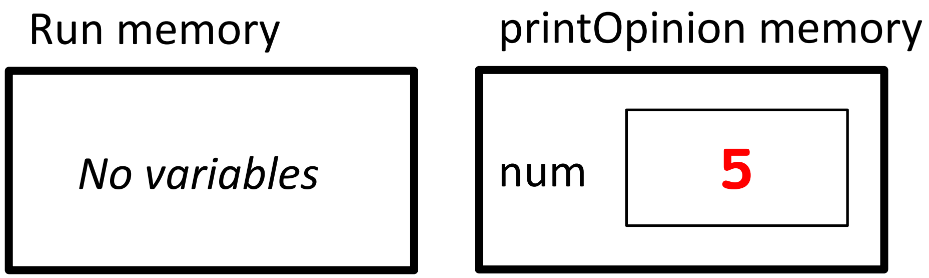
```
private void printOpinion(int num) {
    if(num == 5) {
        println("I love 5!");
    } else {
        println("Whattever");
    }
}

public void run() {
    printOpinion(5);
}
```

Parameter Example



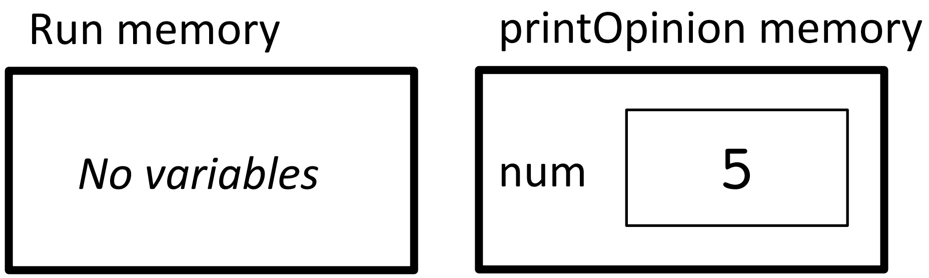
```
private void printOpinion(int num) {
    if(num == 5) {
        println(“I love 5!”);
    } else {
        println(“Whattever”);
    }
}

public void run() {
    printOpinion(5);
}
```

Parameter Example



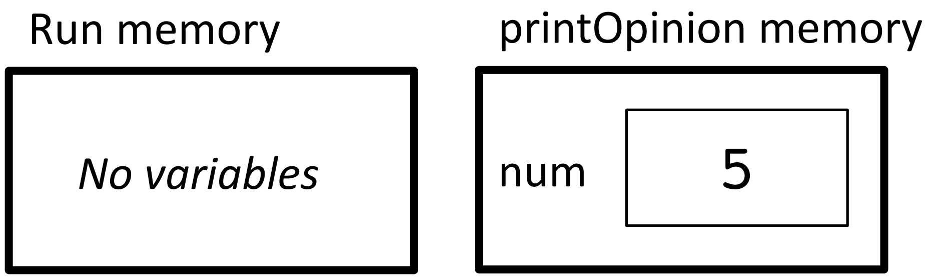
```
private void printOpinion(int num) {
    if(num == 5) {
        println(“I love 5!”);
    } else {
        println(“Whattever”);
    }
}

public void run() {
    printOpinion(5);
}
```

Parameter Example



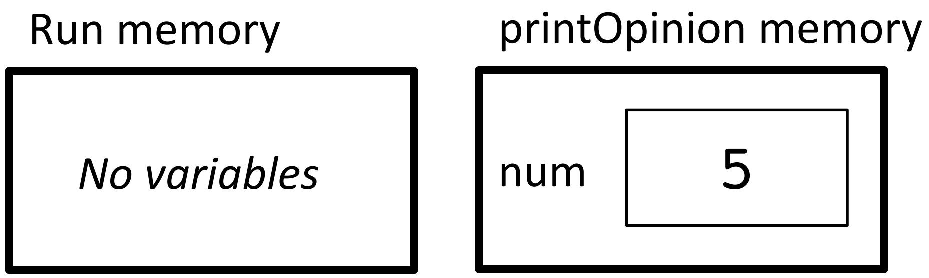
```
private void printOpinion(int num) {
    if(num == 5) {
        println("I love 5!");
    } else {
        println("Whattever");
    }
}

public void run() {
    printOpinion(5);
}
```

Parameter Example



```
private void printOpinion(int num) {
    if(num == 5) {
        println(“I love 5!”);
    } else {
        println(“Whattever”);
    }
}

public void run() {
    printOpinion(5);
}
```

Parameter Example



```
private void printOpinion(int num) {
    if(num == 5) {
        println("I love 5!");
    } else {
        println("Whattever");
    }
}

public void run() {
    printOpinion(5);
}
```

Parameter Example

Run memory

No variables

```
private void printOpinion(int num) {
    if(num == 5) {
        println("I love 5!");
    } else {
        println("Whattever");
    }
}

public void run() {
    printOpinion(5);
}
```

Parameter Example

Run memory

No variables

```
private void printOpinion(int num) {
    if(num == 5) {
        println("I love 5!");
    } else {
        println("Whattever");
    }
}

public void run() {
    printOpinion(5);
}
```

Parameter Example

Run memory

No variables

```
private void printOpinion(int num) {
    if(num == 5) {
        println("I love 5!");
    } else {
        println("Whattever");
    }
}

public void run() {
    printOpinion(5);
}
```

Parameter and Return Example

```
private double metersToCm(double meters) {
    return 100 * meters;
}


public void run() {
    double result = metersToCm(5.2);
    println(result);
}
```

Parameter and Return Example

Run memory

No variables

```
private double metersToCm(double meters) {
    return 100 * meters;
}



public void run() {
    double result = metersToCm(5.2);
    println(result);
}
```

Parameter and Return Example

Run memory

No variables

```
private double metersToCm(double meters) {
    return 100 * meters;
}



public void run() {
    double result = metersToCm(5.2);
    println(result);
}
```

Parameter and Return Example

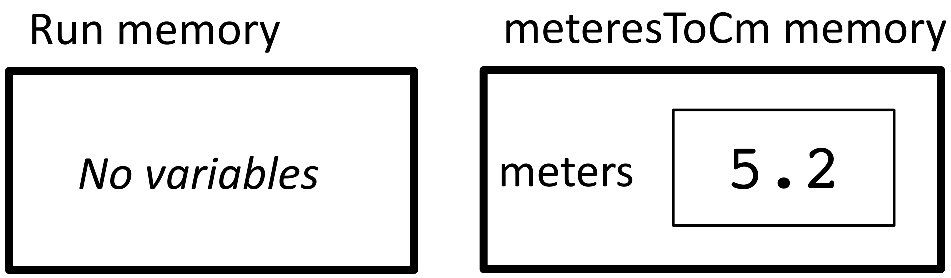
Run memory

No variables

meteresToCm memory

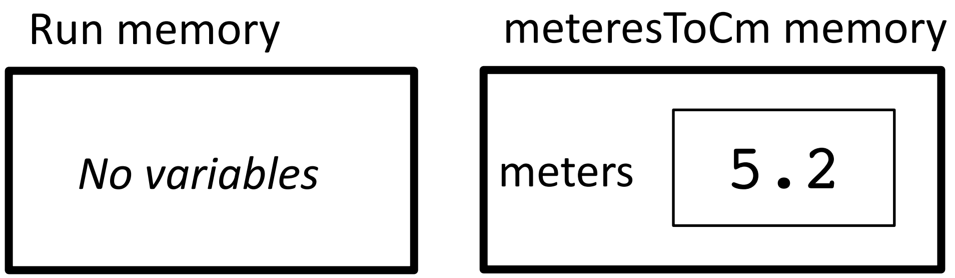
```
private double metersToCm(double meters) {
    return 100 * meters;
}



public void run() {
    double result = metersToCm(5.2);
    println(result);
}
```

Parameter and Return Example



```
private double metersToCm(double meters) {
    return 100 * meters;
}



public void run() {
    double result = metersToCm(5.2);
    println(result);
}
```

Parameter and Return Example



```
private double metersToCm(double meters) {
    return 100 * meters;  520.0
}



public void run() {
    double result = metersToCm(5.2);
    println(result);
}
```

Parameter and Return Example

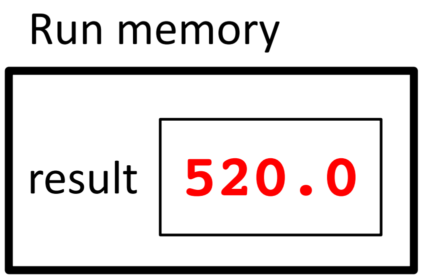
Run memory

No variables

```
private double metersToCm(double meters) {
    return 100 * meters;
}



public void run() {
    double result = metersToCm(5.2);
    println(result);
}
```

520.0

Parameter and Return Example

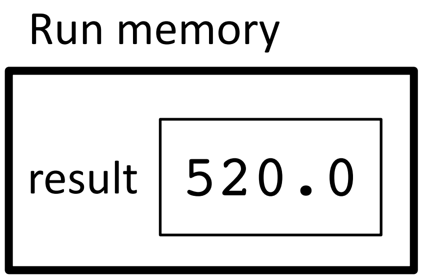


```
private double metersToCm(double meters) {
    return 100 * meters;
}
```

520.0

```
public void run() {
    double result = metersToCm(5.2);
    println(result);
}
```

Parameter and Return Example



```
private double metersToCm(double meters) {
    return 100 * meters;
}



public void run() {
    double result = metersToCm(5.2);
    println(result);
}
```

Parameter and Return Example

```
private double metersToCm(double meters) {
   return 100 * meters;
}


public void run() {
   println(metersToCm(5.2));
   println(metersToCm(9.1));
}
```

Multiple Return Statements

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


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

Multiple Return Statements

Run memory

No variables

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


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

Multiple Return Statements

Run memory

No variables

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


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

Multiple Return Statements

Run memory

No variables

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


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

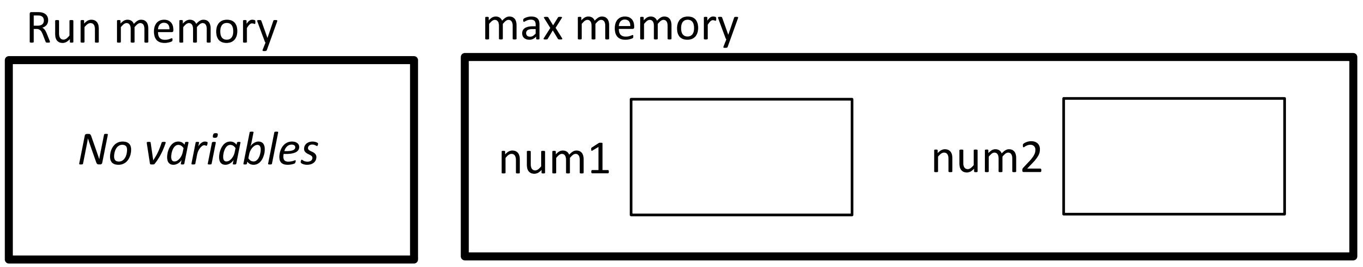
Multiple Return Statements

Run memory

No variables

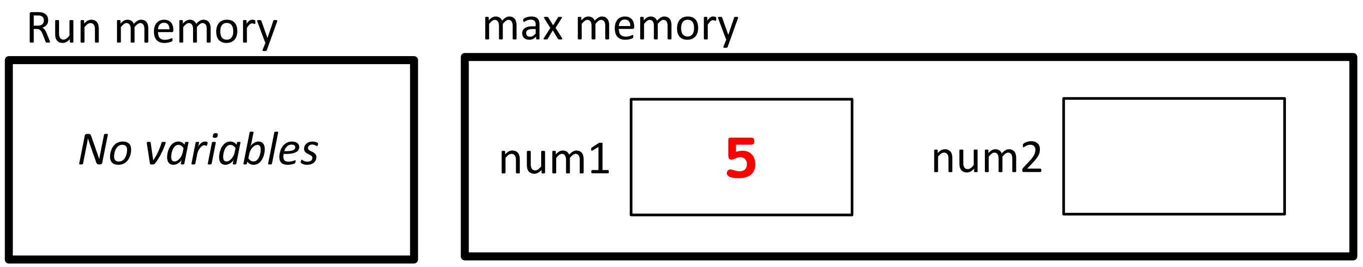
```
private int max(int num1, int num2) {
    if(num1 >= num2) {
        return num1;
    }
    return num2;
}


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

Multiple Return Statements



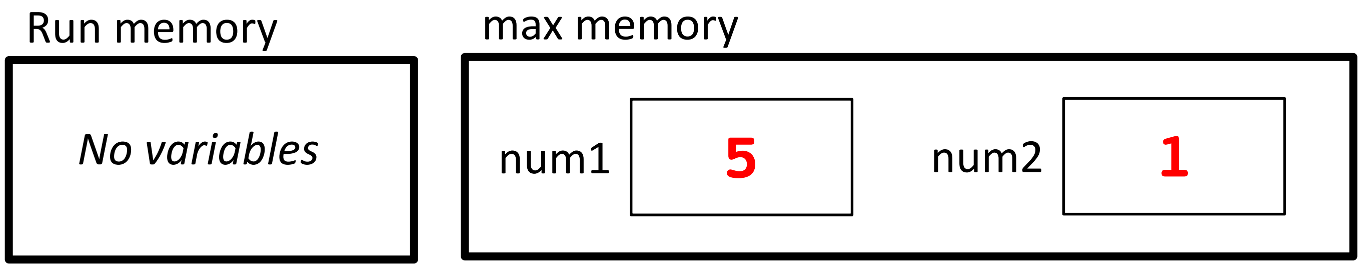
```
private int max(int num1, int num2) {
    if(num1 >= num2) {
        return num1;
    }
    return num2;
}


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

Multiple Return Statements



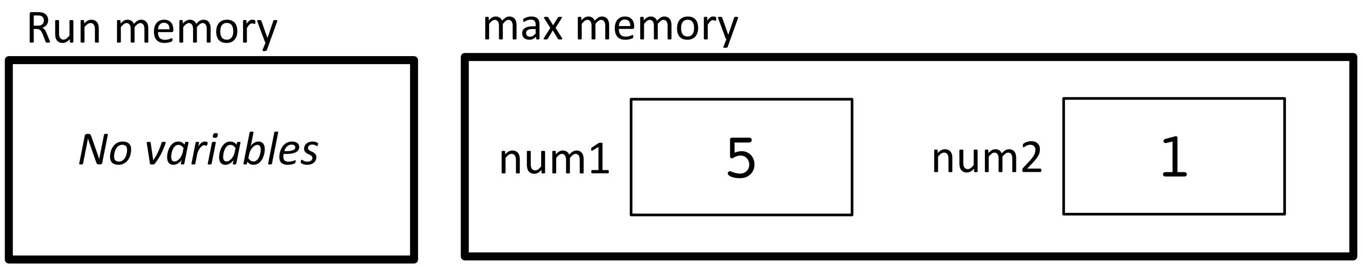
```
private int max(int num1, int num2) {
    if(num1 >= num2) {
        return num1;
    }
    return num2;
}


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

Multiple Return Statements



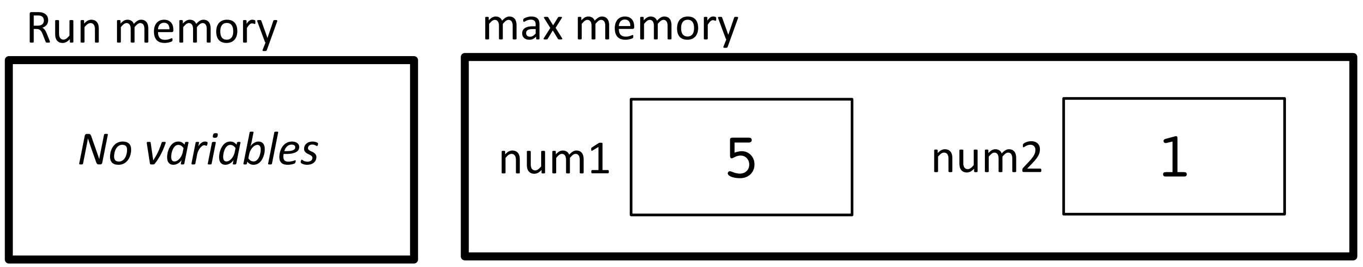
```
private int max(int num1, int num2) {
    if(num1 >= num2) {
        return num1;
    }
    return num2;
}


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

Multiple Return Statements



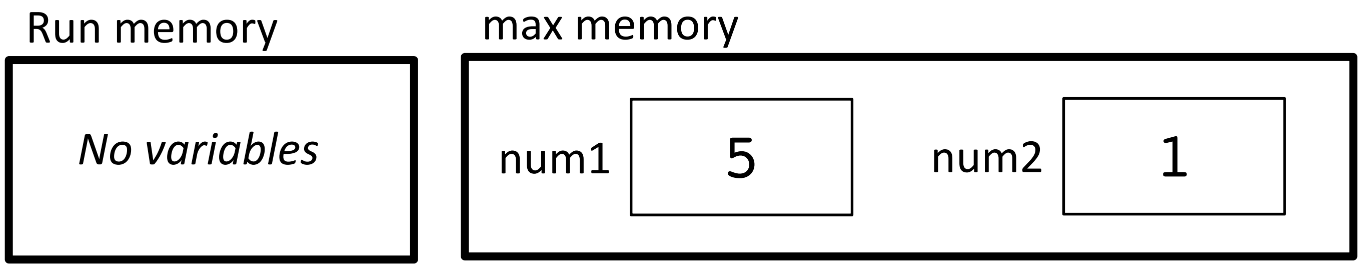
```
private int max(int num1, int num2) {
    if(num1 >= num2) {
        return num1;
    }
    return num2;
}


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

Multiple Return Statements



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


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

Multiple Return Statements



```
private int max(int num1, int num2) {
    if(num1 >= num2) {
        return num1;   5
    }
    return num2;
}


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

Multiple Return Statements

Run memory

No variables

max memory

num1 5   num2 1

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


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

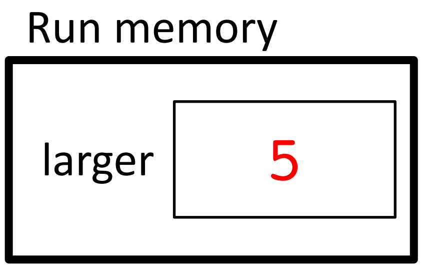
Multiple Return Statements

Run memory

No variables

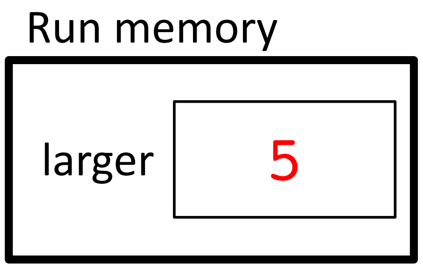
```
private int max(int num1, int num2) {
    if(num1 >= num2) {
        return num1;
    }
    return num2;
}


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

Multiple Return Statements



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


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

Multiple Return Statements



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


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

Multiple Return Statements

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

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

Multiple Return Statements

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


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

Multiple Return Statements

Run memory

No variables

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


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

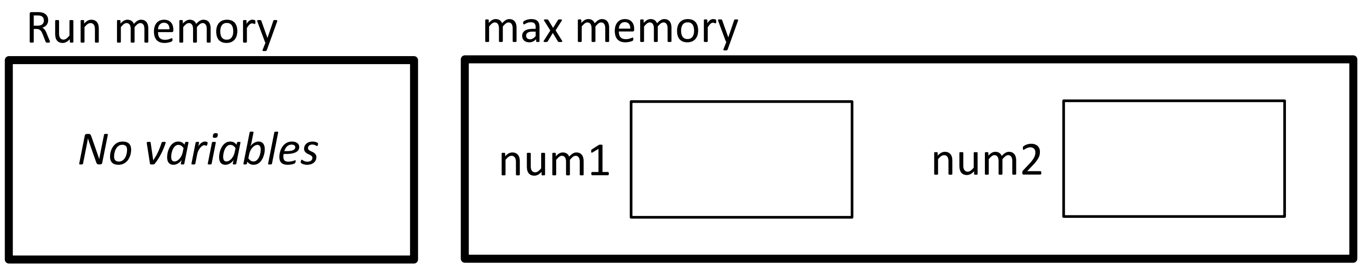
Multiple Return Statements

Run memory

No variables

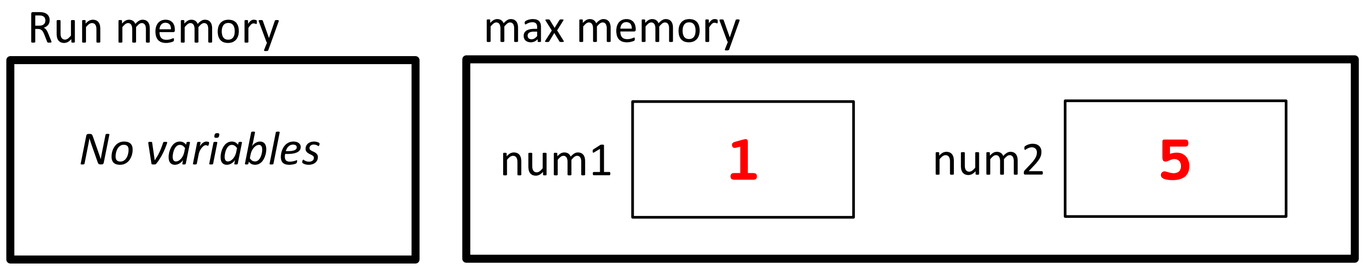
```
private int max(int num1, int num2) {
    if(num1 >= num2) {
        return num1;
    }
    return num2;
}


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

Multiple Return Statements



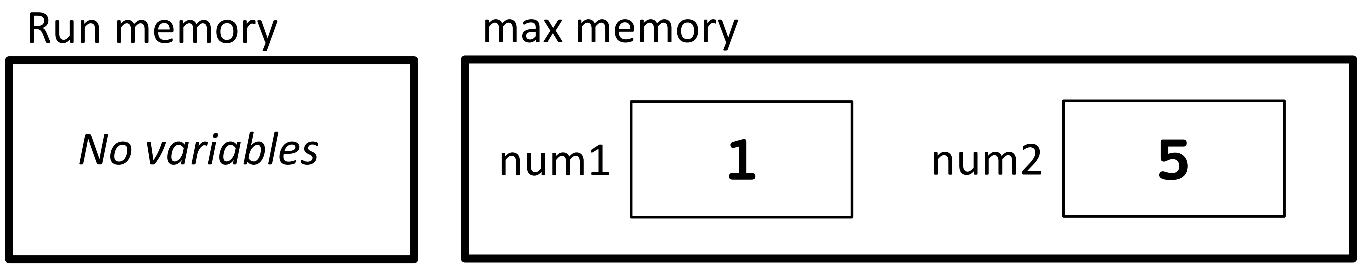
```
private int max(int num1, int num2) {
    if(num1 >= num2) {
        return num1;
    }
    return num2;
}


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

Multiple Return Statements



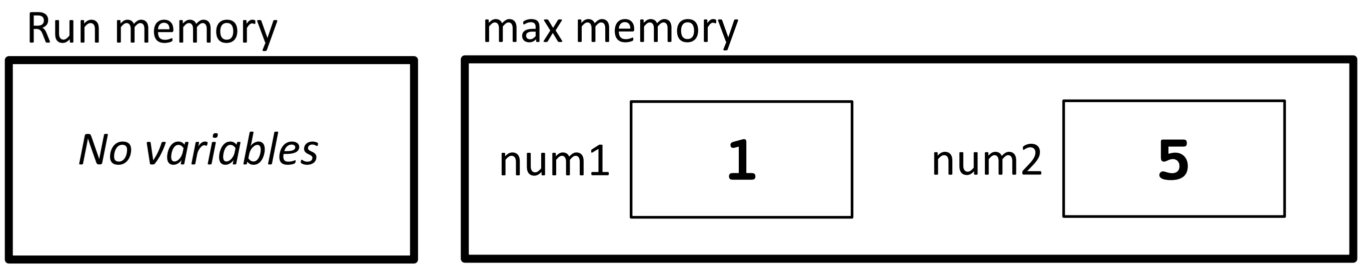
```
private int max(int num1, int num2) {
    if(num1 >= num2) {
        return num1;
    }
    return num2;
}


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

Multiple Return Statements



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


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

Multiple Return Statements



```
private int max(int num1, int num2) {
    if(num1 >= num2) {
        return num1;
    }
    return num2;  5
}


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

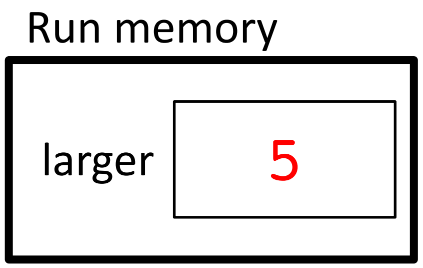
Multiple Return Statements

Run memory

No variables

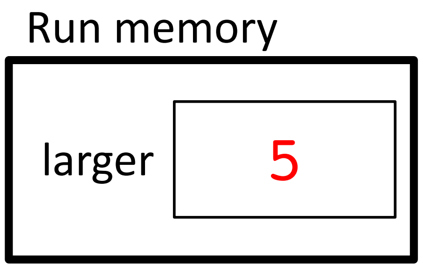
```
private int max(int num1, int num2) {
    if(num1 >= num2) {
        return num1;
    }
    return num2;
}


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

Multiple Return Statements



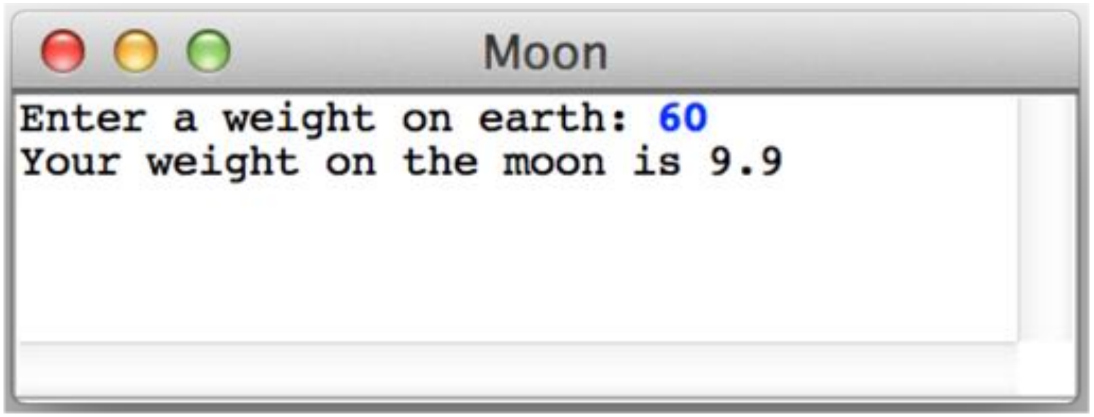
```
private int max(int num1, int num2) {
    if(num1 >= num2) {
        return num1;
    }
    return num2;
}


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

Multiple Return Statements



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


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

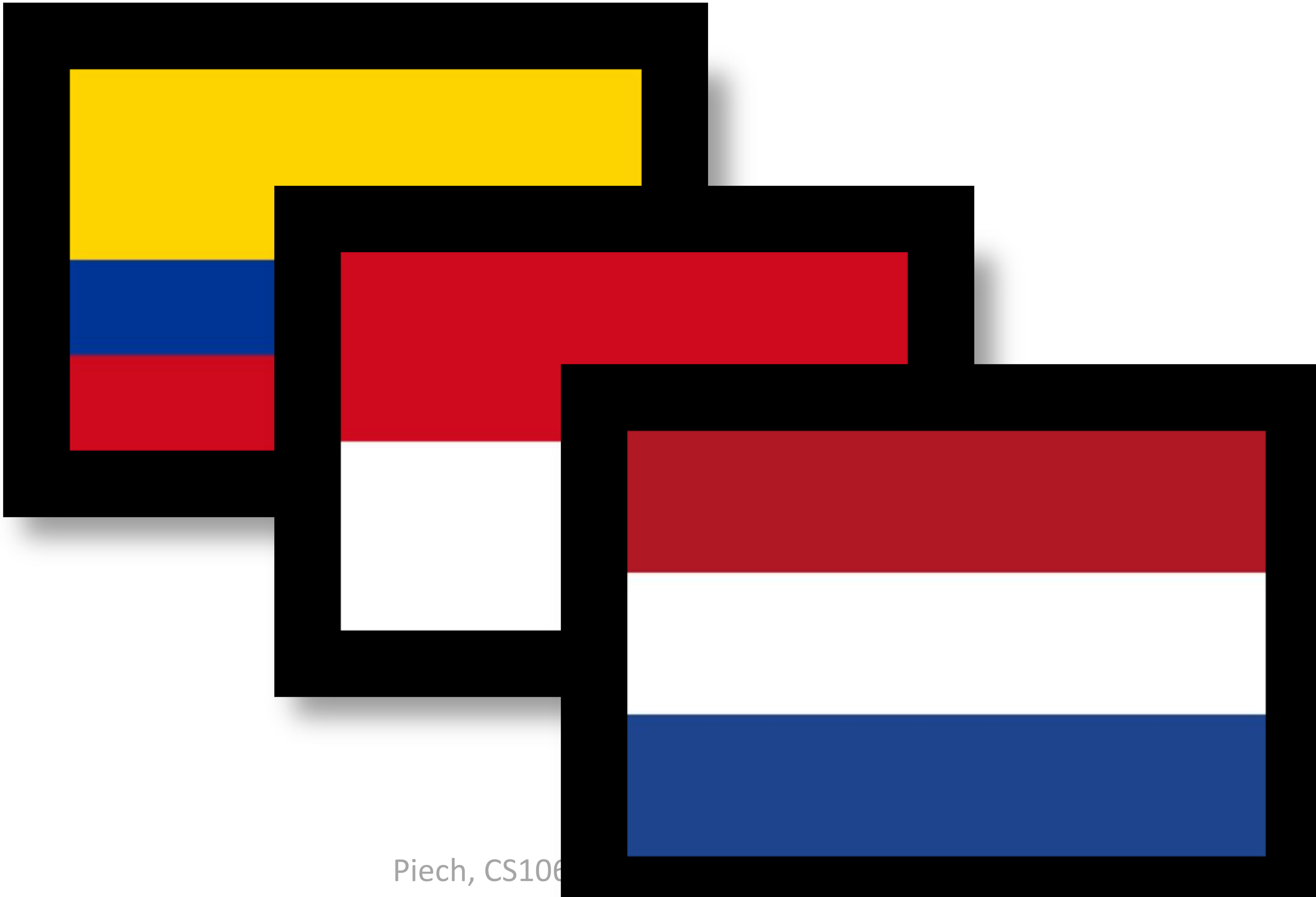
Method for Weight on Moon



```
Enter a weight on earth: 60
Your weight on the moon is 9.9
```

* Your weight on the moon is 16.5% your weight on the earth

Passing in Colors



Flags

```
private void drawColombiasFlag() {
    // Call drawStripe three times
    // with different inputs each time
    drawStripe(Color.YELLOW, 0, 0.5);
    drawStripe(Color.BLUE, 0.5, 0.75);
    drawStripe(Color.RED, 0.75, 1.0);
}
```

```
// Define drawStripe
// drawStripe needs three inputs (which come as variables)
// First a color, then a start (in screen percent) and end y.
private void drawStripe(Color color, double yStart, double yEnd) {
    double yStartPx = getHeight() * yStart;
    double yEndPx = getHeight() * yEnd;
    GRect rect = new GRect(getWidth(), yEndPx - yStartPx);
    rect.setColor(color);
    rect.setFilled(true);
    add(rect, 0, yStartPx);
}
```

method "definition"

Flags

```java
private void drawColombiasFlag() {
    // Call drawStripe three times
    // with different inputs each time
    drawStripe(Color.YELLOW, 0, 0.5);
    drawStripe(Color.BLUE, 0.5, 0.75);
    drawStripe(Color.RED, 0.75, 1.0);
}
```

Takes three inputs: (1) a color, (2) a fraction start, (3) a fraction end

```java
// Define drawStripe
// drawStripe needs three inputs (which come as variables)
// First a color, then a start (in screen percent) and end y.
private void drawStripe(Color color, double yStart, double yEnd) {
    double yStartPx = getHeight() * yStart;
    double yEndPx = getHeight() * yEnd;
    GRect rect = new GRect(getWidth(), yEndPx - yStartPx);
    rect.setColor(color);
    rect.setFilled(true);
    add(rect, 0, yStartPx);
}
```

Flags

```
private void drawColombiasFlag() {
    // Call drawStripe three times
    // with different inputs each time
    drawStripe(Color.YELLOW, 0, 0.5);
    drawStripe(Color.BLUE, 0.5, 0.75);
    drawStripe(Color.RED, 0.75, 1.0);
}
```

Thus, every time the method is called, three inputs must be given!

```
// Define drawStripe
// drawStripe needs three inputs (which come as variables)
// First a color, then a start (in screen percent) and end y.
private void drawStripe(Color color, double yStart, double yEnd) {
    double yStartPx = getHeight() * yStart;
    double yEndPx = getHeight() * yEnd;
    GRect rect = new GRect(getWidth(), yEndPx - yStartPx);
    rect.setColor(color);
    rect.setFilled(true);
    add(rect, 0, yStartPx);
}
```

Flags

```
private void drawColombiasFlag() {
    // Call drawStripe three times
    // with different inputs each time
    drawStripe(Color.YELLOW, 0, 0.5);
    drawStripe(Color.BLUE, 0.5, 0.75);
    drawStripe(Color.RED, 0.75, 1.0);
}
```

Thus, every time the method is called, three inputs must be given!

The method receives the first input in a box (aka as a variable), with the name color

```
// Define drawS
// drawStripe r
// First a color, then a start (in screen percent) and end y.
private void drawStripe(Color color, double yStart, double yEnd) {
    double yStartPx = getHeight() * yStart;
    double yEndPx = getHeight() * yEnd;
    GRect rect = new GRect(getWidth(), yEndPx - yStartPx);
    rect.setColor(color);
    rect.setFilled(true);
    add(rect, 0, yStartPx);
}
```

A Full Program

```
public class FactorialExample extends ConsoleProgram {

  private static final int MAX_NUM = 4;

  public void run() {
      for(int i = 0; i < MAX_NUM; i++) {
            println(i + "! = " + factorial(i));
      }
  }

  private int factorial(int n) {
      int result = 1;
      for (int i = 1; i <= n; i++) {
            result *= i;
      }
      return result;
  }
}
```

A Full Program

```
public class FactorialExample extends ConsoleProgram {

  private static final int MAX_NUM = 4;

  public void run() {
      for(int i = 0; i < MAX_NUM; i++) {
            println(i + "! = " + factorial(i));
      }
  }

  private int factorial(int n) {
      int result = 1;
      for (int i = 1; i <= n; i++) {
            result *= i;
      }
      return result;
  }
}
```

Understand the Mechanism

```
public void run() {
   for(int i = 0; i < MAX_NUM; i++) {
      println(i + "! = " + factorial(i));
   }
}
```

i

```
public void run() {
    for(int i = 0; i < MAX_NUM; i++) {
        println(i + "! = " + factorial(i));
    }
}
```

i 0

```
public void run() {
    for(int i = 0; i < MAX_NUM; i++) {
        println(i + "! = " + factorial(i));
    }
}
```

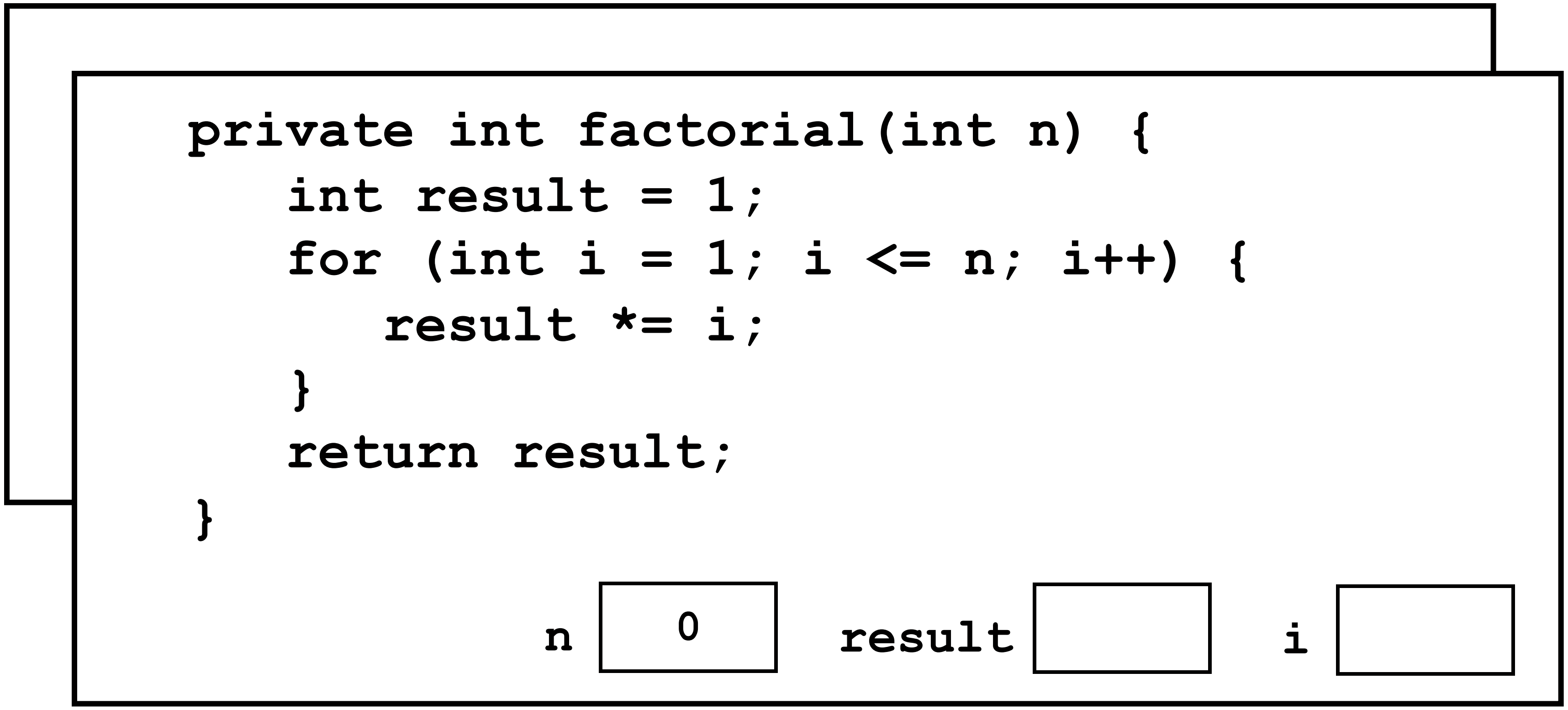
i 0

```
public void run() {
   for(int i = 0; i < MAX_NUM; i++) {
      println(i + "! = " + factorial(i));
   }
}
```

```
i  0
```

```
public void run() {
    for(int i = 0; i < MAX_NUM; i++) {
        println(i + "! = " + factorial(i));
    }
}
```

i 0



```
private int factorial(int n) {
    int result = 1;
    for (int i = 1; i <= n; i++) {
        result *= i;
    }
    return result;
}
```

```
private int factorial(int n) {
    int result = 1;
    for (int i = 1; i <= n; i++) {
        result *= i;
    }
    return result;
}
```

```
            n  0      result  1      i
```

```
private int factorial(int n) {
    int result = 1;
    for (int i = 1; i <= n; i++) {
        result *= i;
    }
    return result;
}
```

n	0	result	1	i	1

```
private int factorial(int n) {
    int result = 1;
    for (int i = 1; i <= n; i++) {
        result *= i;
    }
    return result;
}
```

n 0   result 1   i 1

```
private int factorial(int n) {
    int result = 1;
    for (int i = 1; i <= n; i++) {
        result *= i;
    }
    return result;
}
```

n $\boxed{0}$ result $\boxed{1}$ i $\boxed{1}$

```
public void run() {
   for(int i = 0; i < MAX_NUM; i++) {
      println(i + "! = " + factorial(i));
   }
}
```

$\underbrace{\texttt{factorial(i)}}_{\boxed{1}}$

i $\boxed{0}$

```
public void run() {
    for(int i = 0; i < MAX_NUM; i++) {
        println(i + "! = " + factorial(i));
    }
}
```

$\underbrace{\texttt{factorial(i)}}_{\boxed{1}}$

i $\boxed{0}$

```
0! = 1
```

```
public void run() {
    for(int i = 0; i < MAX_NUM; i++) {
        println(i + "! = " + factorial(i));
    }
}
```

```
i  1
```

```
0! = 1
```

```
public void run() {
    for(int i = 0; i < MAX_NUM; i++) {
        println(i + "! = " + factorial(i));
    }
}
```

i $\boxed{1}$

```
0! = 1
```

```
public void run() {
    for(int i = 0; i < MAX_NUM; i++) {
        println(i + "! = " + factorial(i));
    }
}
```

```
i  1
```

```
0! = 1
```

```
public void run() {
    for(int i = 0; i < MAX_NUM; i++) {
        println(i + "! = " + factorial(i));
    }
}
```

```
i  1
```

```
0! = 1
```

```
private int factorial(int n) {
    int result = 1;
    for (int i = 1; i <= n; i++) {
        result *= i;
    }
    return result;
}
```

n 1 result i

```
0! = 1
```

```
private int factorial(int n) {
   int result = 1;
   for (int i = 1; i <= n; i++) {
      result *= i;
   }
   return result;
}
```

n 1   result 1   i

```
0! = 1
```

```
private int factorial(int n) {
    int result = 1;
    for (int i = 1; i <= n; i++) {
        result *= i;
    }
    return result;
}
```

```
n  1     result  1     i  1
```

```
0! = 1
```

```
private int factorial(int n) {
   int result = 1;
   for (int i = 1; i <= n; i++) {
      result *= i;
   }
   return result;
}
```

```
n  1     result  1     i  1
```

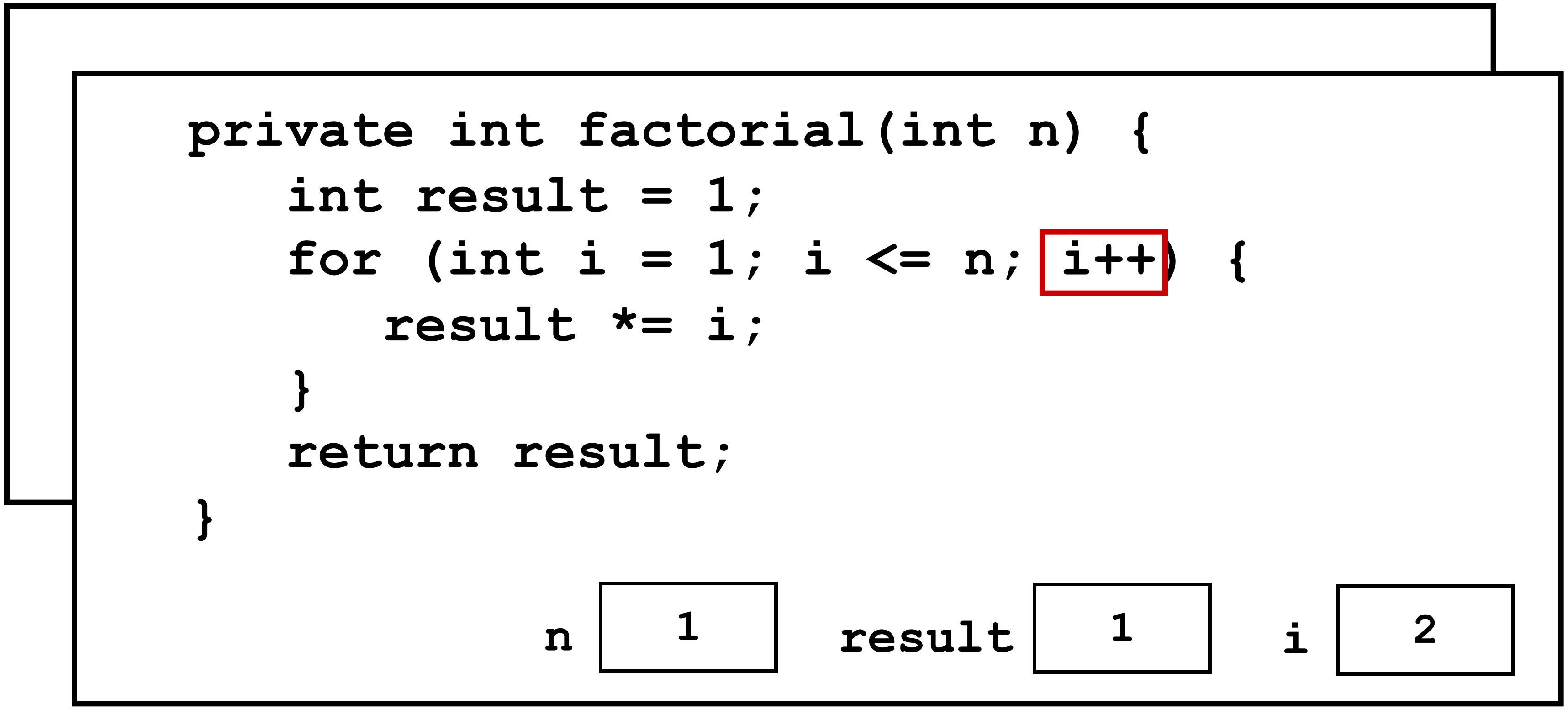
```
0! = 1
```

```
private int factorial(int n) {
    int result = 1;
    for (int i = 1; i <= n; i++) {
        result *= i;
    }
    return result;
}
```

```
n  1    result  1    i  1
```

```
0! = 1
```

```
private int factorial(int n) {
   int result = 1;
   for (int i = 1; i <= n; i++) {
      result *= i;
   }
   return result;
}
```



```
0! = 1
```

```
private int factorial(int n) {
   int result = 1;
   for (int i = 1; i <= n; i++) {
      result *= i;
   }
   return result;
}
```

```
            n  1      result  1      i  2
```

```
0! = 1
```

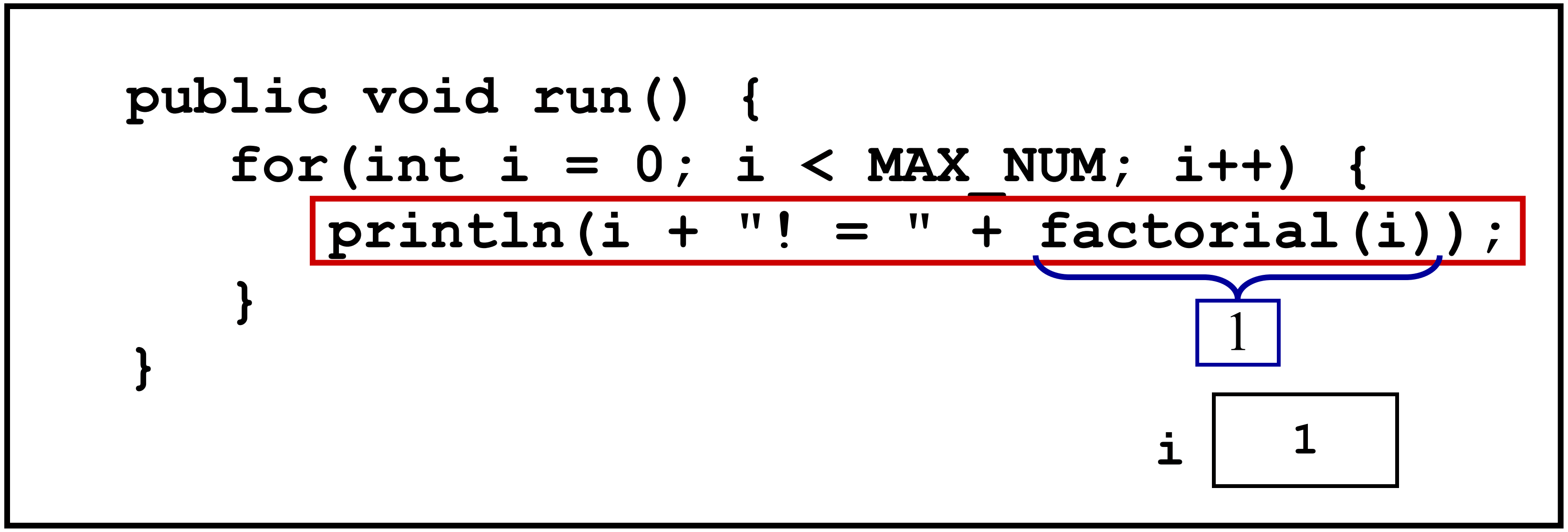
```
private int factorial(int n) {
    int result = 1;
    for (int i = 1; i <= n; i++) {
        result *= i;
    }
    return result;
}
```

n `1`   result `1`   i `2`

```
0! = 1
```

```
public void run() {
   for(int i = 0; i < MAX_NUM; i++) {
      println(i + "! = " + factorial(i));
   }                           \_____________/
}                                     1

                                    i  [ 1 ]
```

```
0! = 1
```



```
public void run() {
    for(int i = 0; i < MAX_NUM; i++) {
        println(i + "! = " + factorial(i));
    }
}
```

```
0! = 1
1! = 1
```

```
public void run() {
    for(int i = 0; i < MAX_NUM; i++) {
        println(i + "! = " + factorial(i));
    }
}
```

```
i  2
```

```
0! = 1
1! = 1
```

```
public void run() {
    for(int i = 0; i < MAX_NUM; i++) {
        println(i + "! = " + factorial(i));
    }
}
```

i $\boxed{2}$

```
0! = 1
1! = 1
```

```
public void run() {
    for(int i = 0; i < MAX_NUM; i++) {
        println(i + "! = " + factorial(i));
    }
}
```

```
i  2
```

```
0! = 1
1! = 1
```

```
public void run() {
    for(int i = 0; i < MAX_NUM; i++) {
        println(i + "! = " + factorial(i));
    }
}
```

```
i  2
```

```
0! = 1
1! = 1
```

```
public void run() {
   for(int i = 0; i < MAX_NUM; i++) {
      println(i + "! = " + factorial(i));
   }
}
```

$\underbrace{\texttt{factorial(i)}}_{\boxed{2}}$

i $\boxed{2}$

```
0! = 1
1! = 1
```

```
public void run() {
   for(int i = 0; i < MAX_NUM; i++) {
      println(i + "! = " + factorial(i));
   }
}
```

$\underbrace{\texttt{factorial(i)}}_{\boxed{2}}$

i $\boxed{2}$

```
0! = 1
1! = 1
2! = 2
```

```
public void run() {
    for(int i = 0; i < MAX_NUM; i++) {
        println(i + "! = " + factorial(i));
    }
}
```

i 3

```
0! = 1
1! = 1
2! = 2
```

```
public void run() {
   for(int i = 0; i < MAX_NUM; i++) {
      println(i + "! = " + factorial(i));
   }
}
```

i 3

```
0! = 1
1! = 1
2! = 2
```

```
public void run() {
    for(int i = 0; i < MAX_NUM; i++) {
        println(i + "! = " + factorial(i));
    }
}
```

i $\boxed{3}$

```
0! = 1
1! = 1
2! = 2
```

```
public void run() {
    for(int i = 0; i < MAX_NUM; i++) {
        println(i + "! = " + factorial(i));
    }
}
```

```
i  3
```

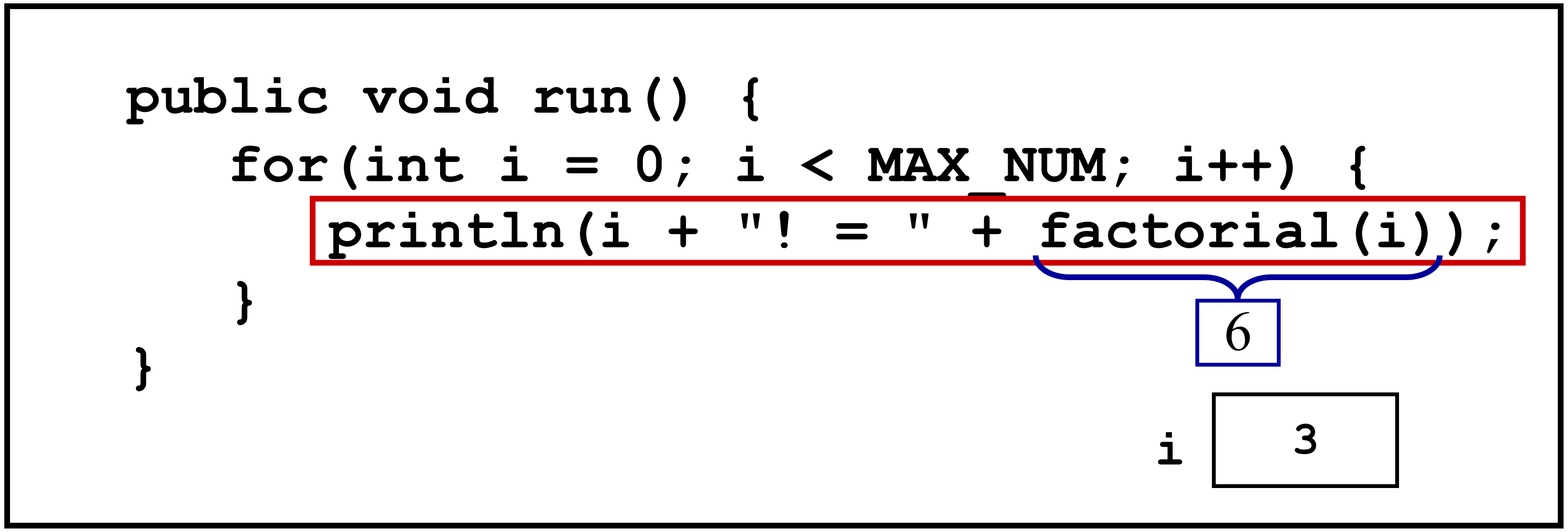
```
0! = 1
1! = 1
2! = 2
```

```
public void run() {
   for(int i = 0; i < MAX_NUM; i++) {
      println(i + "! = " + factorial(i));
   }
}
```

$\underbrace{\texttt{factorial(i)}}_{\boxed{6}}$

i $\boxed{3}$

```
0! = 1
1! = 1
2! = 2
```



```
public void run() {
   for(int i = 0; i < MAX_NUM; i++) {
      println(i + "! = " + factorial(i));
   }
}
```

```
0! = 1
1! = 1
2! = 2
3! = 6
```

```
public void run() {
    for(int i = 0; i < MAX_NUM; i++) {
        println(i + "! = " + factorial(i));
    }
}
```

```
i   4
```

```
0! = 1
1! = 1
2! = 2
3! = 6
```

```
public void run() {
    for(int i = 0; i < MAX_NUM; i++) {
        println(i + "! = " + factorial(i));
    }
}
```

i $\boxed{4}$

```
0! = 1
1! = 1
2! = 2
3! = 6
```

Parameters

Every time a method is called, new memory is created for the call.

Bad Times With Methods

```
// NOTE: This program is buggy!!

private void addFive(int x) {
   x += 5;
}


public void run() {
   int x = 3;
   addFive(x);
   println("x = " + x);
}
```

Let's "trace" this program on the board

Good Times With Methods

```
// NOTE: This program is feeling just fine...

private int addFive(int x) {
   x += 5;
   return x;
}

public void run() {
   int x = 3;
   x = addFive(x);
   println("x = " + x);
}
```

For primitives: Variables are **not** passed when you use parameters. Values are passed

Pass by "Value"

- Thanks Mehran

More Examples

Changed Name

```
private void run() {
    int num = 5;
    cow(num);
}

private void cow(int grass) {
    println(grass);
}
```

Same Variable Name

```
private void run() {
    int num = 5;
    cow();
    println(num);
}

private void cow() {
    int num = 10;
    println(num);
}
```

No Methods in Methods

```
private void run() {
   println("hello world");
   private void sayGoodbye() {
      println("goodbye!");
   }
}
```

Illegal modifier for parameter goodbye, only final is permitted

Huh?!?

No Methods in Methods

```
private void run() {
   println("hello world");
   sayGoodbye();
}

private void sayGoodbye() {
   println("goodbye!");
}
```

Learn How To:

1. Write a method that takes in input
2. Write a method that gives back output
3. Trace method calls using stacks

Remember Booleans?

Boolean Variable

```
boolean karelIsAwesome = true;

boolean myBool = 1 < 2;
```

Is Square

```
private void run() {
    for(int i = 1; i <= 100; i++) {
        if(isSquare(i)) {
            println(i);
        }
    }
}
```

Boolean Return

```java
public void run() {
    for(int i = 1; i <= 100; i++) {
        if(isSquare(i)) {
            println(i);
        }
    }
}

private boolean isSquare(int x) {
    double root = Math.sqrt(x);
    if(root == Math.floor(root)) {
        return true;
    } else {
        return false;
    }
}
```

Boolean Return

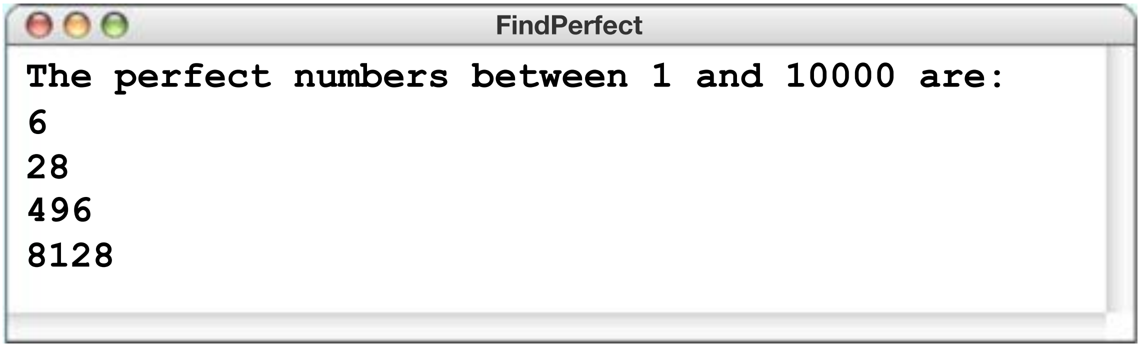
```
public void run() {
    for(int i = 1; i <= 100; i++) {
        if(isSquare(i)) {
            println(i);
        }
    }
}

private boolean isSquare(int x) {
    double root = Math.sqrt(x);
    return root == Math.floor(root);
}
```

Boolean Return

```
public void run() {
    for(int i = 1; i <= 100; i++) {
        if(isSquare(i)) {
            println(i);
        }
    }
}

private boolean isSquare(int x) {
    double root = Math.sqrt(x);
    return root == (int)root;
}
```

Extra Exercise

- Greek mathematicians took a special interest in numbers that are equal to the sum of their proper divisors (a proper divisor of *n* is any divisor less than *n* itself). They called such numbers ***perfect numbers***. For example, 6 is a perfect number because it is the sum of 1, 2, and 3, which are the integers less than 6 that divide evenly into 6. Similarly, 28 is a perfect number because it is the sum of 1, 2, 4, 7, and 14.
- Design and implement a Java program that finds all the perfect numbers between two limits. For example, if the limits are 1 and 10000, the output should look like this:



```
The perfect numbers between 1 and 10000 are:
6
28
496
8128
```