CS 106A, Lecture 7

Parameters and Return

suggested reading:

Java Ch. 5.1-5.4

Plan For Today

- Announcements
- Recap: For Loops
- Recap: Scope
- Parameters
- Return

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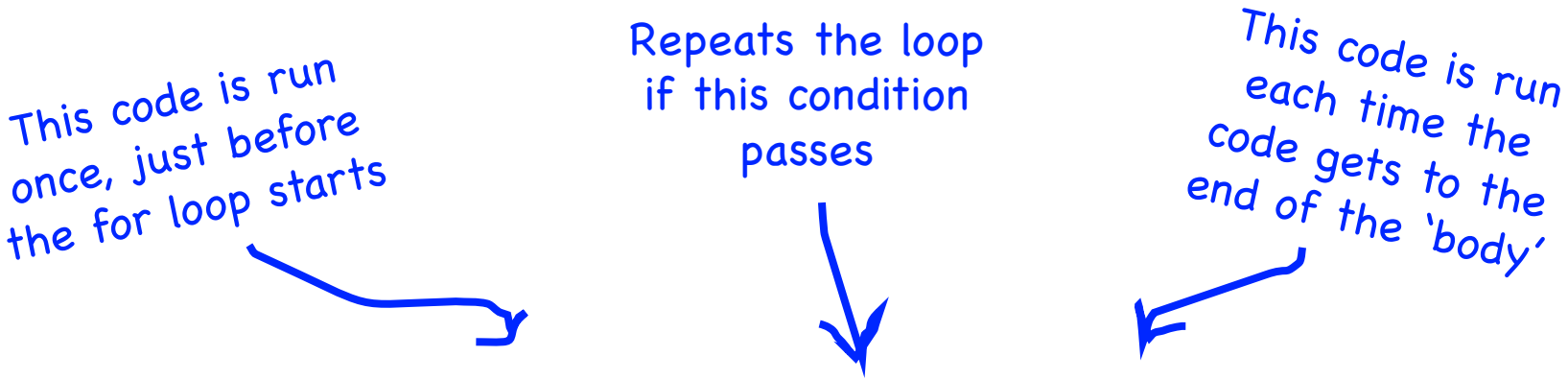
For Loops in Java




```
for (int i = 0; i < 3; i++) {
    println("I love CS 106A!");
}
```

Nested loops

- **nested loop**: A loop placed inside another loop.

```
for (int i = 0; i < 5; i++) {
    for (int j = 0; j < 10; j++) {
        print("*");
    }
    println();   // to end the line
}
```

- Output:

```
**********
**********
**********
**********
**********
```

- The outer loop repeats 5 times; the inner one 10 times.

Nested loop question 2

- How would we produce the following output?

```
....1
...22
..333
.4444
55555
```

- Answer:

```
for (int i = 0; i < 5; i++) {
    for (int j = 0; j < 5 - i - 1; j++) {
        print(".");
    }
    for (int j = 0; j <= i; j++) {
        print(i + 1);
    }
    println();
}
```

Methods in Java

We can define new **methods** in Java just like in Karel:

```
private void name() {
      statement;
      statement;
      ...
}
```

For example:

```
private void printGreeting() {
      println("Hello world!");
      println("I hope you have a great day.");
}
```

Methods in Java

```
public void run() {
      int x = 2;
      printX();
}

private void printX() {
      // ERROR!  "Undefined variable x"
      println("X has the value " + x);
}
```

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A Variable love story

By Chris Piech

Variable Scope

- The **scope** of a variable refers to the section of code where a variable can be accessed.
- **Scope starts** where the variable is declared.
- **Scope ends** at the termination of the code block in which the variable was declared.

- A **code block** is a chunk of code between { } brackets

Variable Scope

You *cannot* have two variables with the same name in the *same scope*.

```
for (int i = 1; i <= 100 * line; i++) {
    int i = 2;                    // ERROR
    print("/");
}
```

Variable Scope

You *cannot* have two variables with the same name in the *same scope*.

```
for (int i = 1; i <= 100 * line; i++) {
    int i = 2;                    // ERROR
    while (true) {
        int i = 5;                // ERROR
    }
}
```

Variable Scope

You *can* have two variables with the same name in *separate scopes*.

```
private void run() {
    for (int i = 0; i < 5; i++) {    // i ok here
      int w = 2;                     // w ok here
    }

    for (int i = 0; i < 2; i++) {    // i ok here
      int w = 3;                     // w ok here
    }
}
```

Variable Scope

You *can* have two variables with the same name in *separate scopes*.

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

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

Variable Scope

You *can* have two variables with the same name in *different scopes*.

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

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    int num = 10;
    println(num);
}
```

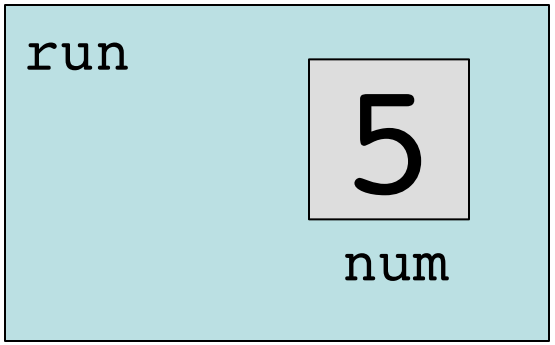

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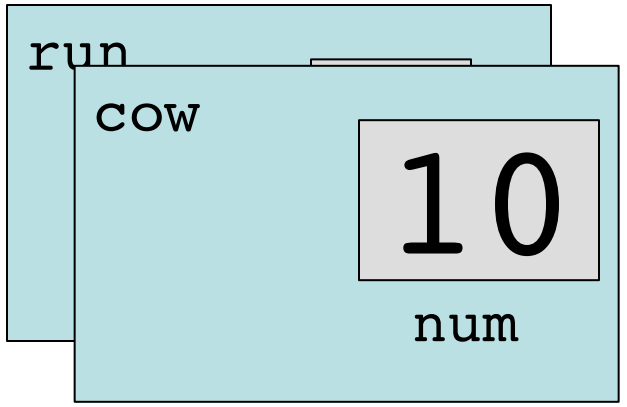

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```
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    println(num);
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    println(num);
}
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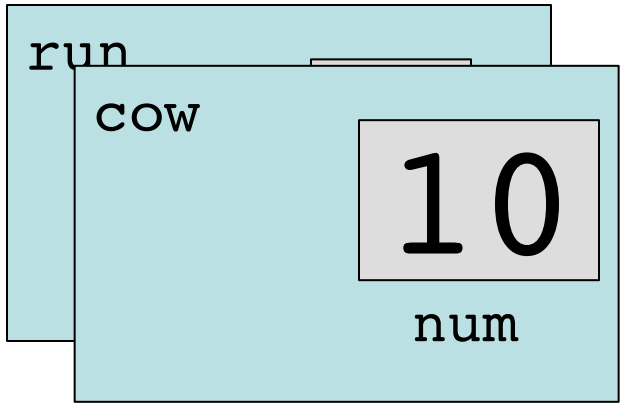

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```

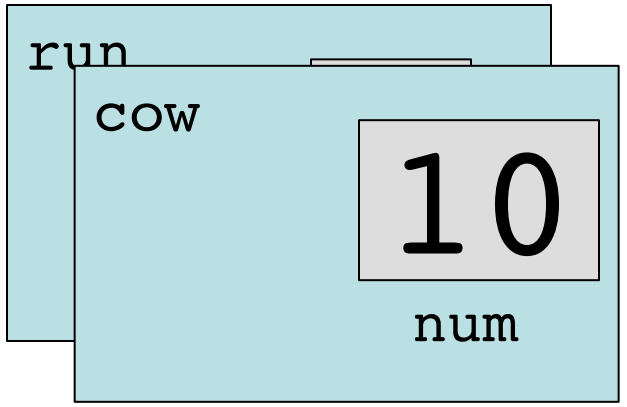

Variable Scope

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    println(num);
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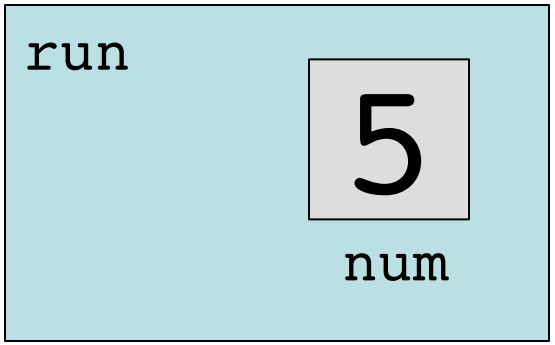
    println(num);
}
```



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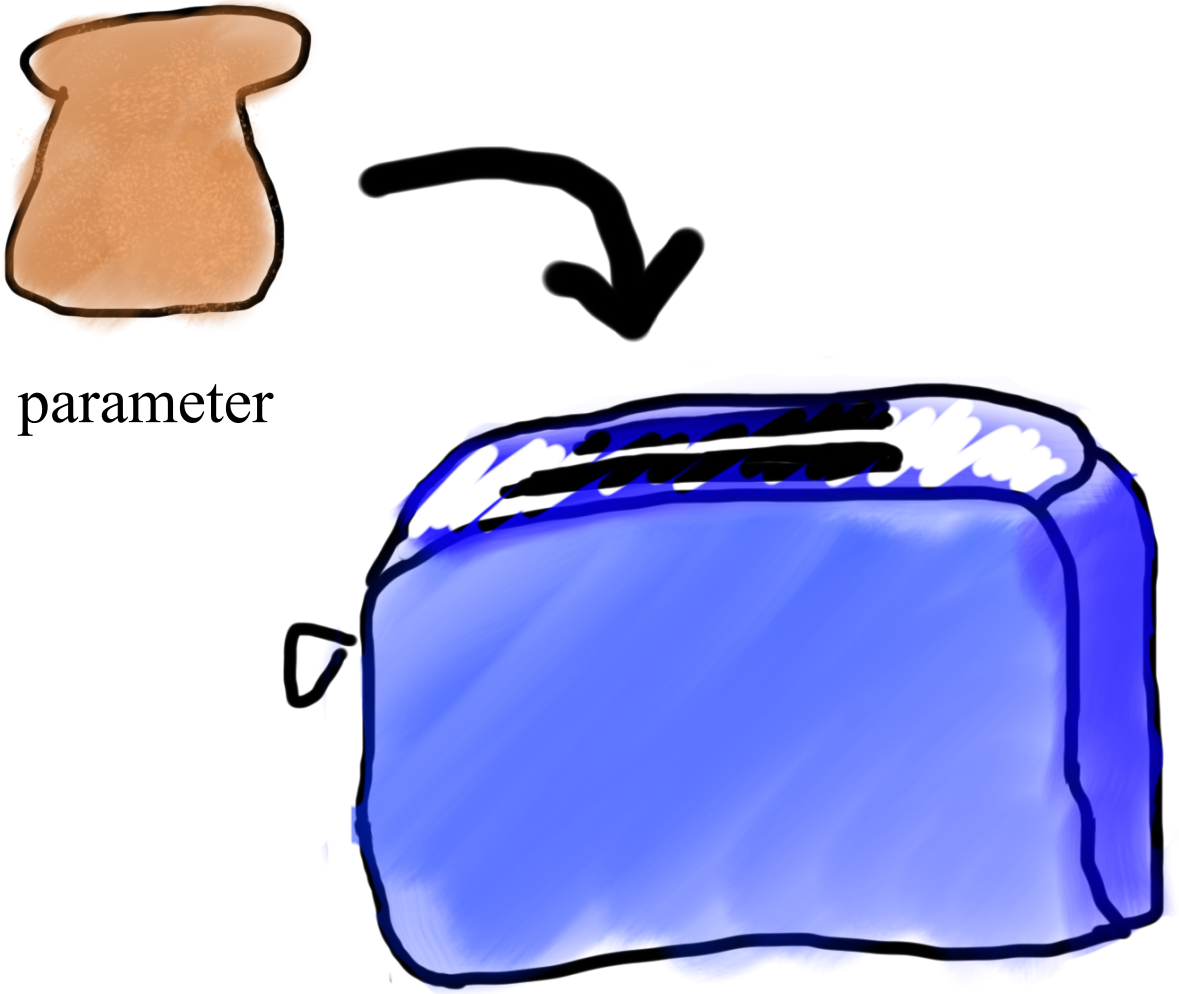
Parameters

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

Methods = Toasters



Example: readInt

```
readInt(”Your guess? ");
```

Example: readInt

We call readInt

We give readInt some information in parenthesis (the text to print to the user)

```
readInt("Your guess? ");
```

Example: printGreeting

```
printGreeting(5);
```

(Prints a greeting a certain number of times)

Wouldn't it be nice if...

We call printGreeting

We give printGreeting some information (the number of greetings to print)

```
printGreeting(5);
```

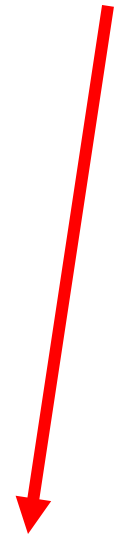
Methods with Parameters

Tells Java this method needs one *int* in order to execute.

```
private void printGreeting(int times) {
     // use 'times' to print the greeting
}
```

Methods with Parameters

```
printGreeting(5);
```



```
private void printGreeting(int times) {
      // use 'times' to print the greeting
}
```

Methods with Parameters

```
printGreeting(5);
```

```
private void printGreeting(int times) {
     for (int i = 0; i < times; i++) {
          println("Hello world!");
     }
}
```

Methods with Parameters

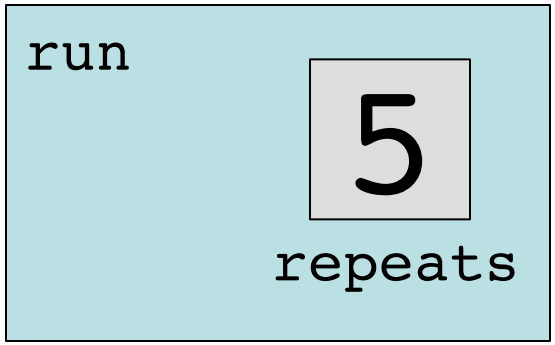
```
public void run() {
      int repeats = 5;
      printGreeting(repeats);
}

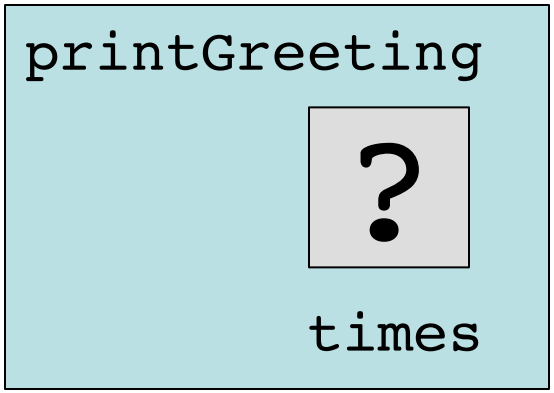
private void printGreeting(int times) {
      for (int i = 0; i < times; i++) {
            println("Hello world!");
      }
}
```

Methods with Parameters

```
public void run() {
      int repeats = 5;
      printGreeting(repeats);
}

private void printGreeting(int times) {
      for (int i = 0; i < times; i++) {
            println("Hello world!");
      }
}
```





Methods with Parameters

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public void run() {
      int repeats = 5;
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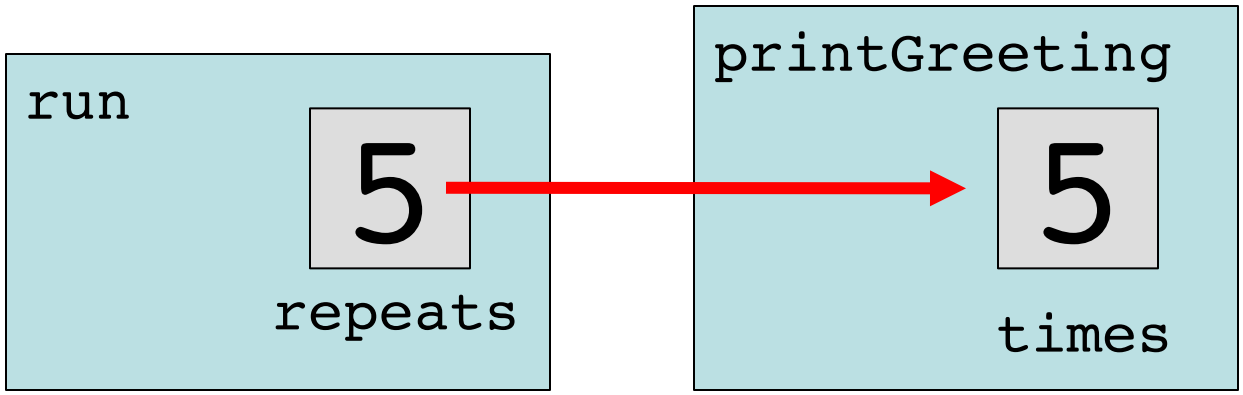

Methods with Parameters

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public void run() {
      int times = 5;
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private void printGreeting(int times) {
      for (int i = 0; i < times; i++) {
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}
```

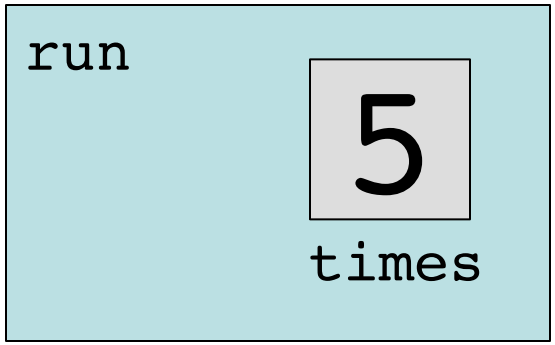

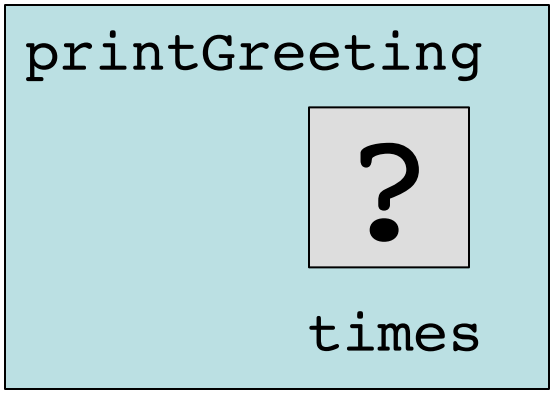

Methods with Parameters

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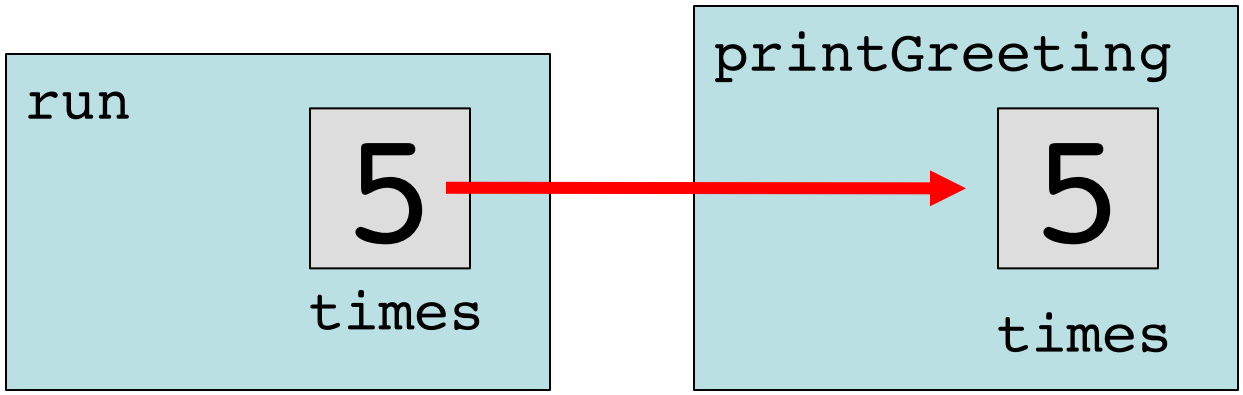
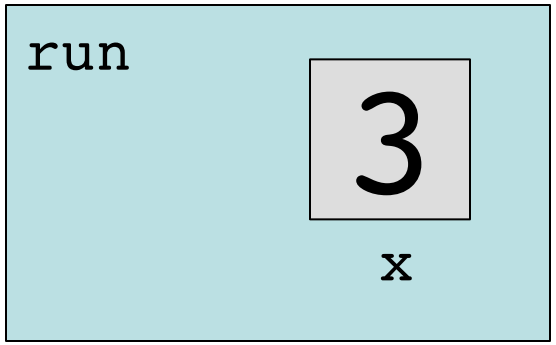


Parameters are Copies

```
// NOTE: This program is buggy!!
public void run() {
   int x = 3;
   addFive(x);
   // prints "x = 3"!
   println("x = " + x);
}

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



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// NOTE: This program is buggy!!
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   int x = 3;
   addFive(x);
   // prints "x = 3"!
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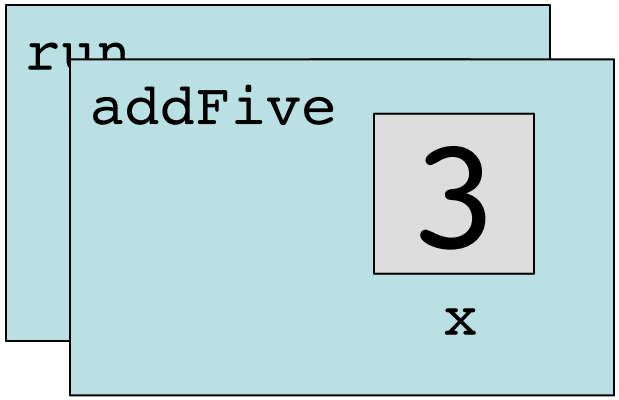
private void addFive(int x) {
   x += 5;
}
```



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   addFive(x);
   // prints "x = 3"!
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   x += 5;
}
```

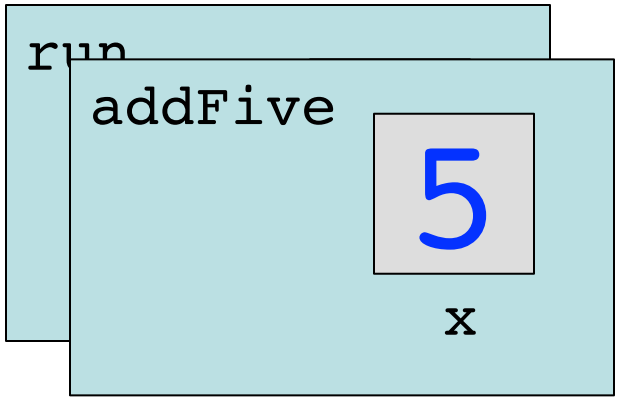

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```
// NOTE: This program is buggy!!
public void run() {
   int x = 3;
   addFive(x);
   // prints "x = 3"!
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}

private void addFive(int x) {
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}
```
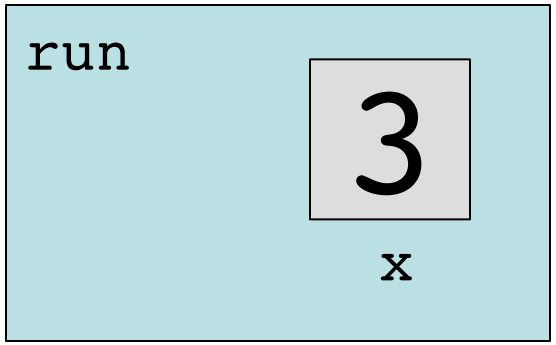
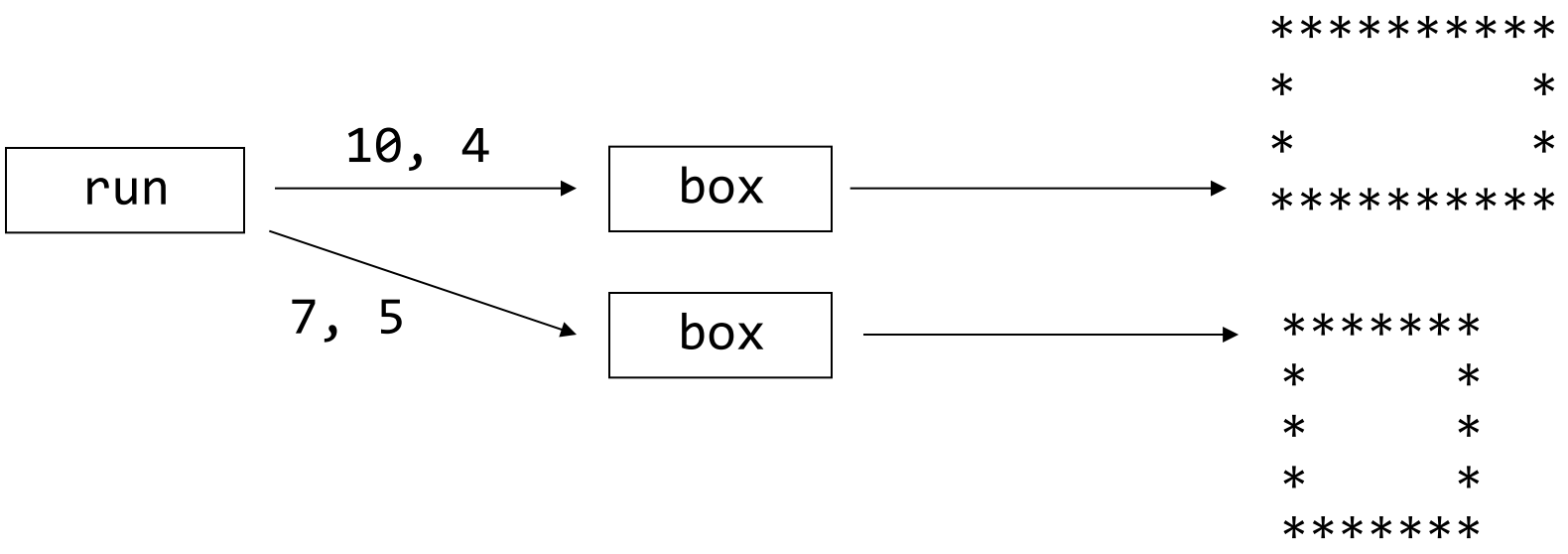



Parameters

- **parameter**: A value passed to a method by its caller.
  - Write a method **box** to draw a box of any size.
    - When *declaring* the method, we will state that it requires the caller to tell it the width and height of the box.
    - When *calling* the method, we will specify the width and height to use.



Declaring a parameter

Stating that a method requires a parameter in order to run

```
public void name(type name) {
    statements;
}
```

- Example:

```
public void password(int code) {
    println("The password is: " + code);
}
```

  - When `password` is called, the caller must specify the integer code to print.

Multiple parameters

- A method can accept multiple parameters separated by commas: ,
  - When calling it, you must pass values for each parameter.

- Declaration:

```
public void name(type name, ..., type name) {
    statements;
}
```

- Call:

```
name(value, value, ..., value);
```

Passing a parameter

Calling a method and specifying values for its parameters

```
methodName(expression);
```

- Example:

```
public void run() {
    password(42);
    password(12345);
}
```

Output:

```
The password is 42
The password is 12345
```

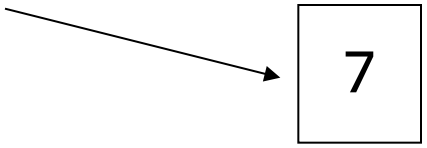
- Illegal to call without passing an `int` for that parameter.

```
password();      // Error
password(3.7);   // Error
```

How params are passed

- When the method is called:
  - The value is stored into the parameter variable.
  - The method's code executes using that value.

```
public void run() {
  chant(7);
}

public void chant(int times) {
    for (int i = 0; i < times; i++) {
        println("Java is great!");
    }
}
```



Drawing boxes

- Lets write a program that uses methods and parameters to print the following boxes:

```
**********
*        *
*        *
**********

*******
*     *
*     *
*     *
*     *
*******
```

  - The code to draw each box will be very similar.
    - Would variables help? Would constants help?

drawBox

```
drawBox(10, 4);
```

drawBox

We call drawBox

We give drawBox some information (the size of the box we want)

```
drawBox(10, 4);
```

drawBox

```
private void drawBox(int width, int height) {
     // use width and height variables
     // to draw a box
}
```

drawBox

```
**********
*        *
*        *
**********
```

```
private void drawBox(int width, int height) {
      line(width);
      for (int line = 0; line < height - 2; line++) {
            boxSide(width);
      }
      line(width);
}
```

drawBox

```
**********
*        *
*        *
**********
```

```
private void drawBox(int width, int height) {
      line(width);
      for (int line = 0; line < height - 2; line++) {
            boxSide(width);
      }
      line(width);
}
```

drawBox

```
**********
*        *
*        *
**********
```

```
private void drawBox(int width, int height) {
        line(width);
        for (int line = 0; line < height - 2; line++) {
                boxSide(width);
        }
        line(width);
}
```

drawBox

```
**********
*        *
*        *
**********
```

```
private void drawBox(int width, int height) {
      line(width);
      for (int line = 0; line < height - 2; line++) {
            boxSide(width);
      }
      line(width);
}
```

drawBox

```
**********
*        *
*        *
**********
```

```
private void drawBox(int width, int height) {
      line(width);
      for (int line = 0; line < height - 2; line++) {
            boxSide(width);
      }
      line(width);
}
```

line

****

```
private void line(int count) {
      for (int i = 0; i < count; i++) {
            print("*");
      }
      println();
}
```

boxSide

```
*       *
```

```
private void boxSide(int width) {
      print("*");
      for (int i = 0; i < width - 2; i++) {
            print(" ");
      }
      println("*");
}
```

boxSide

```
public void run() {
	drawBox(10, 4);
	drawBox(7, 6);
}
```

```
**********
*        *
*        *
**********
*******
*     *
*     *
*     *
*     *
*******
```

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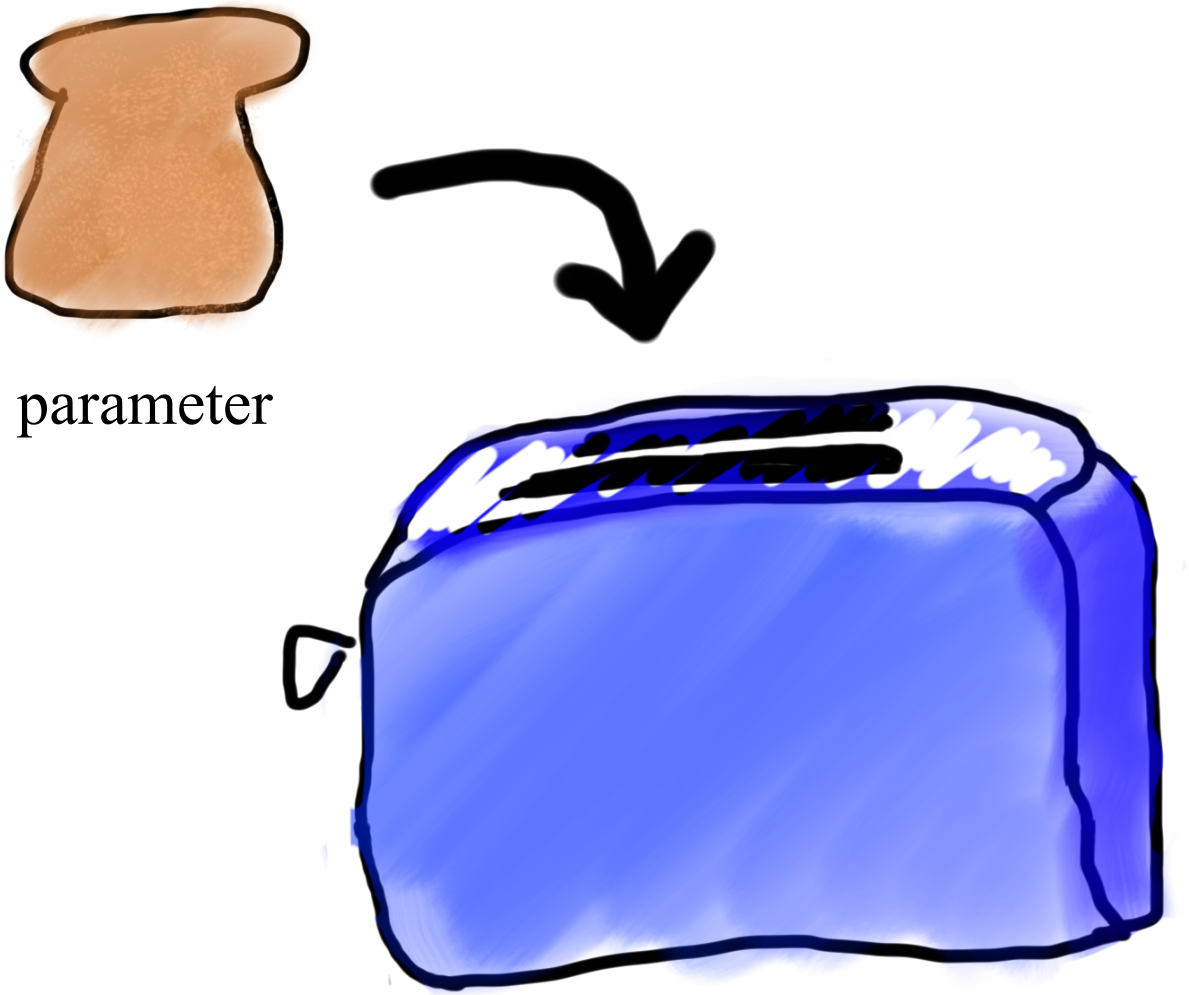
Return

Return values let you give back some information when a method is finished.

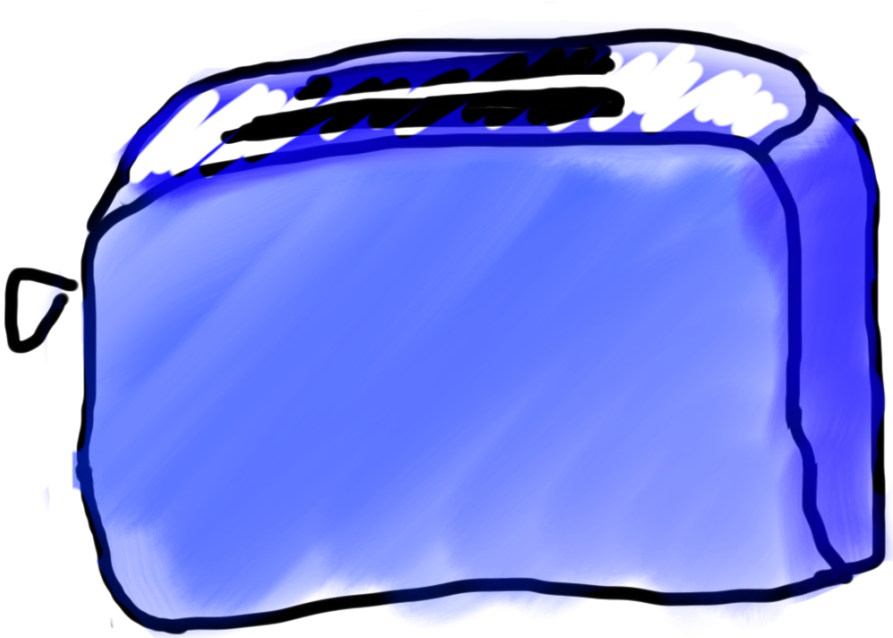
Methods = Toasters

parameter

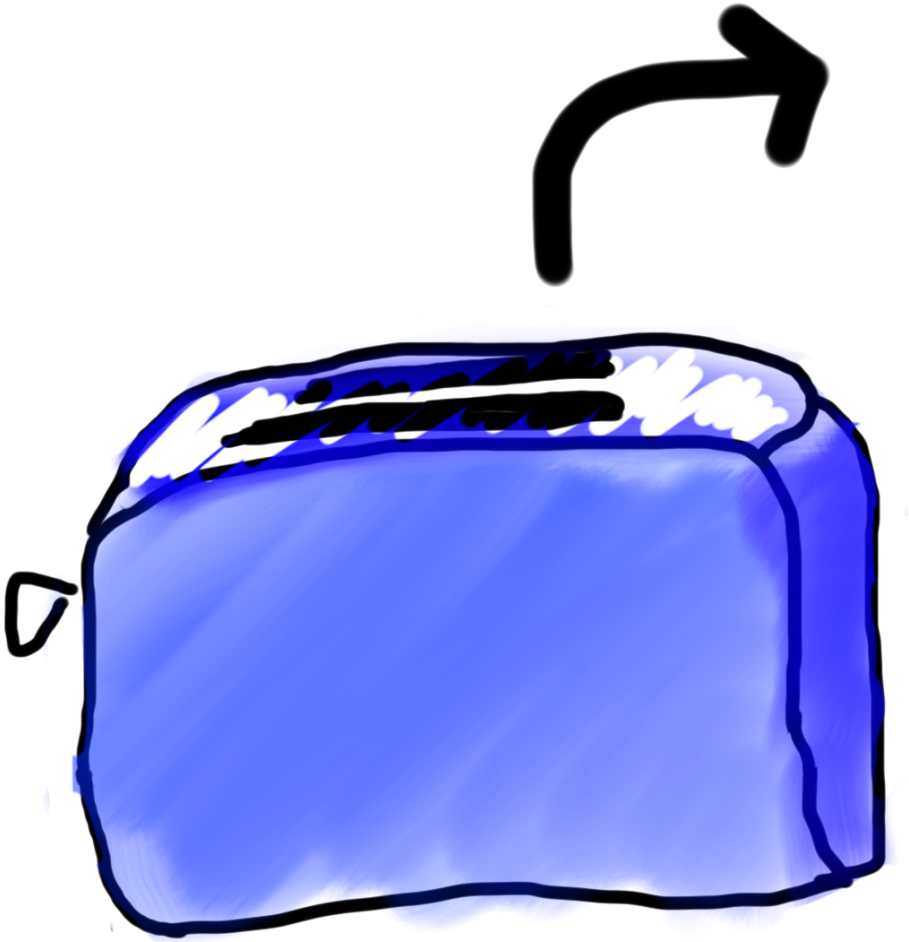
Methods = Toasters



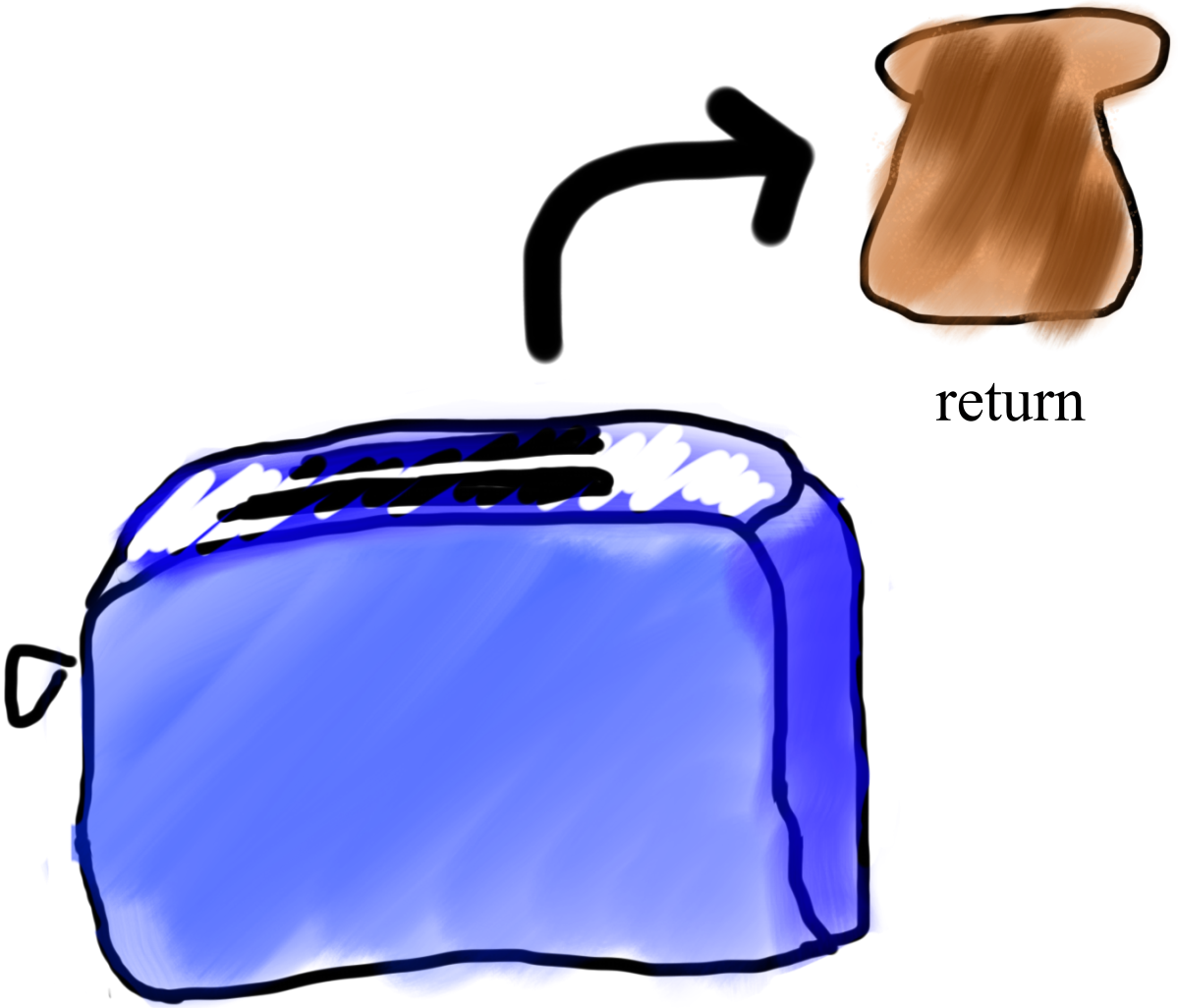
Methods = Toasters



Methods = Toasters



Methods = Toasters



Example: readInt

```
int x = readInt("Your guess? ");
```

Example: readInt

We call readInt

We give readInt some information (the text to print to the user)

```
int x = readInt("Your guess? ");
```

Example: readInt

When finished, readInt gives us information back (the user's number) and we put it in x.

```
int x = readInt("Your guess? ");
```

Example: readInt

When we set a variable equal to a method, this tells Java to save the return value of the method in that variable.

```
int x = readInt("Your guess? ");
```

Example: metersToCm

```
double cm = metersToCm(5);
```

```
(Returns the given number of m as cm)
```

Example: metersToCm

We call metersToCm

We give metersToCm some information (the number of meters)

```
double cm = metersToCm(5);
```

Example: metersToCm

When metersToCm finishes, it returns the number of cm, and we put that in this variable.

```
double cm = metersToCm(5);
```

Methods and Return

Tells Java this method needs one *double* in order to execute.

```
private double metersToCm(double meters) {
      ...
}
```

Methods and Return

Tells Java that, when this method finishes, it will return a *double*.

```
private double metersToCm(double meters) {
    ...
}
```

Methods and Return

Tells Java that, when this method finishes, it will return a *double*.

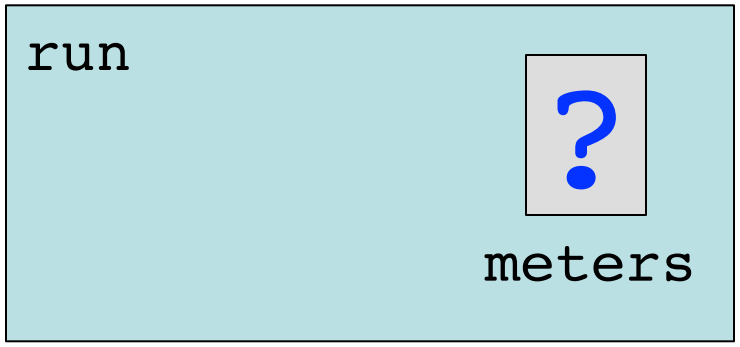
```
private double metersToCm(double meters) {
    return 100 * meters;
}
```

Methods and Return

```
public void run() {
      int meters = readInt("# meters? ");
      int cm = metersToCm(meters);
      println(cm + " centimeters.");
}

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

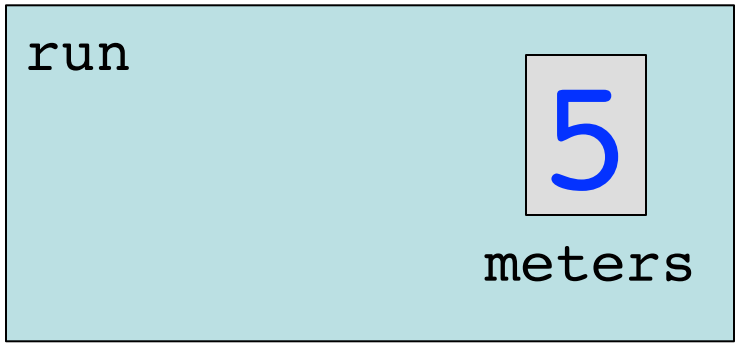
Methods and Return

```
public void run() {
      int meters = readInt("# meters? ");
      int cm = metersToCm(meters);
      println(cm + " centimeters.");
}

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



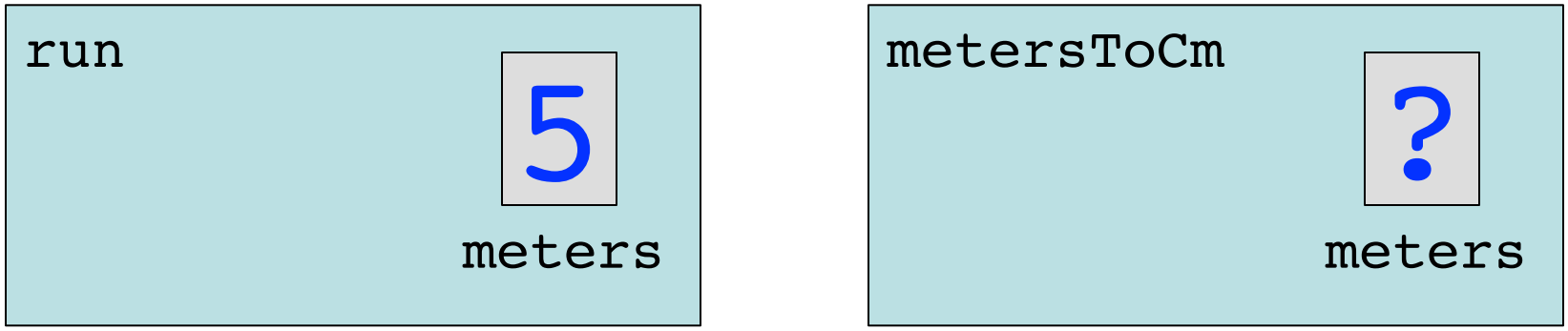
Methods and Return

```
public void run() {
      int meters = readInt("# meters? ");
      int cm = metersToCm(meters);
      println(cm + " centimeters.");
}

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



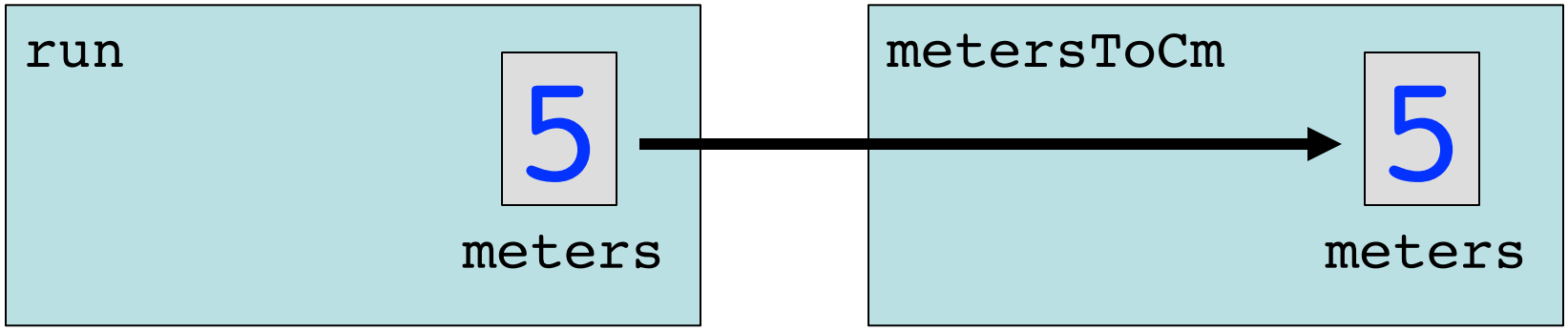
Methods and Return

```
public void run() {
      int meters = readInt("# meters? ");
      int cm = metersToCm(meters);
      println(cm + " centimeters.");
}

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



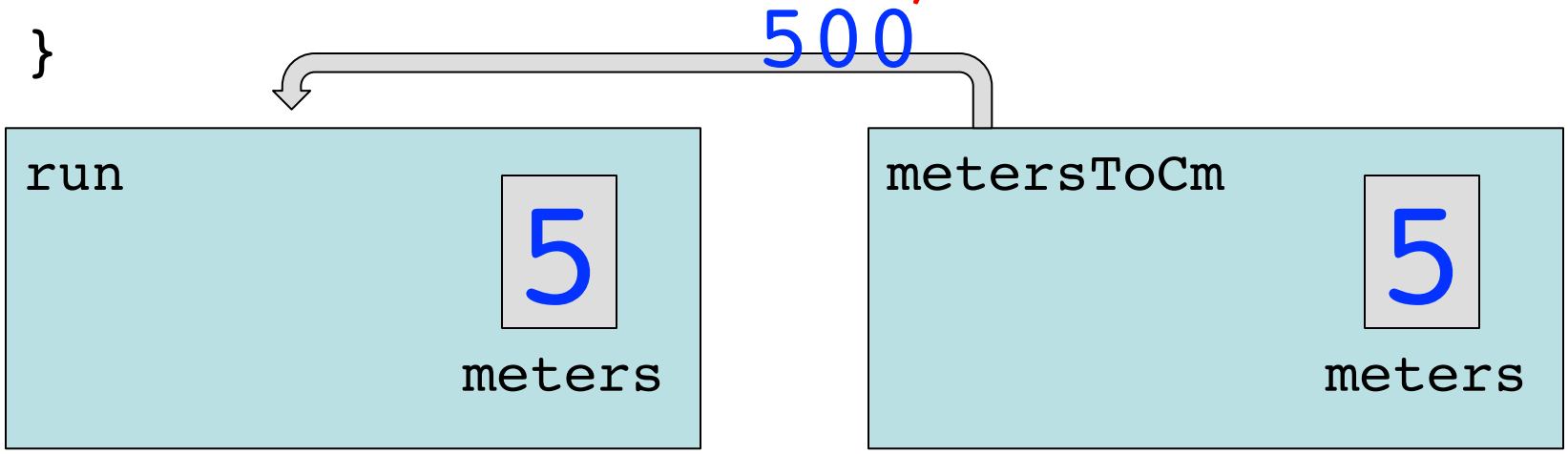
Methods and Return

```
public void run() {
      int meters = readInt("# meters? ");
      int cm = metersToCm(meters);
      println(cm + " centimeters.");
}

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



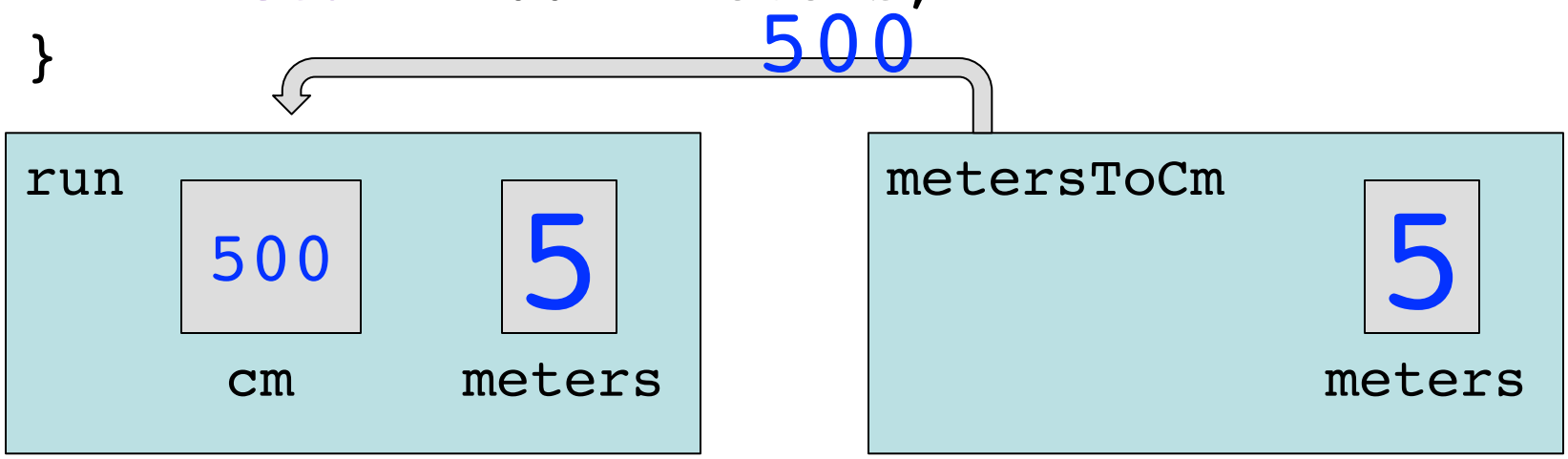
Methods and Return

```
public void run() {
      int meters = readInt("# meters? ");
      int cm = metersToCm(meters);
      println(cm + " centimeters.");
}

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



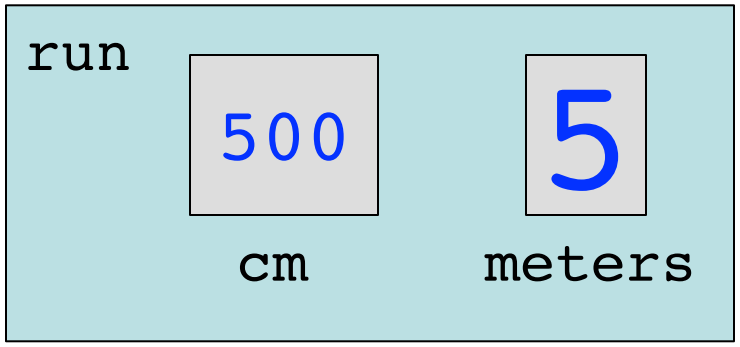
Methods and Return

```
public void run() {
      int meters = readInt("# meters? ");
      int cm = metersToCm(meters);
      println(cm + " centimeters.");
}

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



Methods and Return

```
public void run() {
      int meters = readInt("# meters? ");
      int cm = metersToCm(meters);
      println(cm + " centimeters.");
}

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

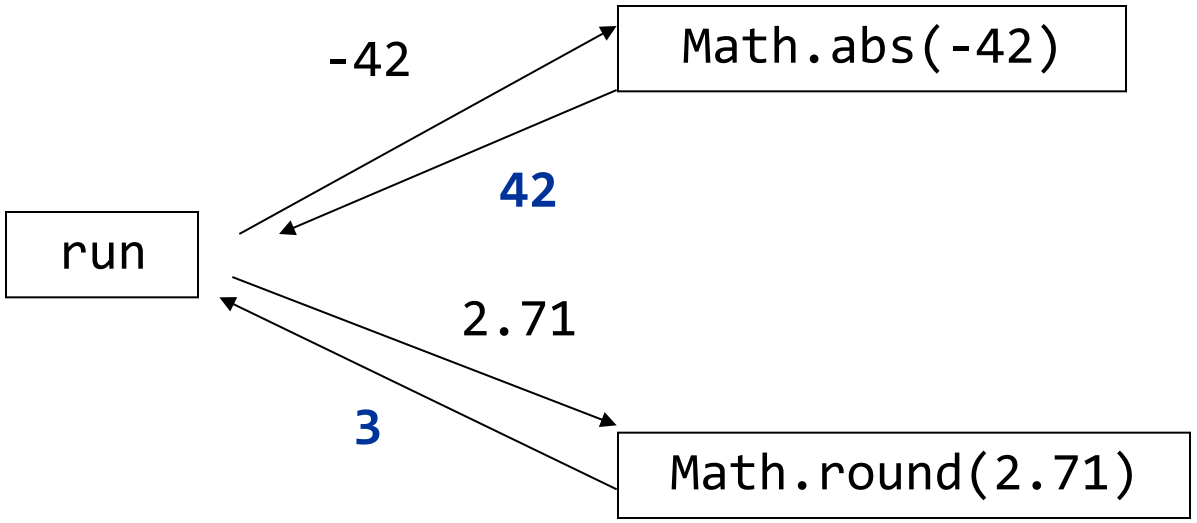


Methods and Return

```
public void run() {
      int meters = readInt("# meters? ");
      println(metersToCm(meters) + "cm.");
}

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

Return

- **return**: To send out a value as the result of a method.
  - Parameters send information *in* from the caller to the method.
  - Return values send information *out* from a method to its caller.
    - A call to the method can be used as part of an expression.



  - **Q:** Why return? Why not just println the result value?

Methods

```
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

Returning Booleans

```
private boolean isEven(int number) {

}
```

Returning Booleans

```
private boolean isEven(int number) {
	if (number % 2 == 0) {
		return true;
	else {
		return false;
	}
}
```

Returning Booleans

```
private boolean isEven(int number) {
	if (number % 2 == 0) {
		return true;
	else {
		return false;
	}
}

public void run() {
	int num = readInt("? ");
	if (isEven(num)) {
		println("Even!");
	} else {
		println("Odd!");
	}
}
```

Returning Booleans

```
private boolean isEven(int number) {
      return number % 2 == 0;
}
```

Returning Booleans

```
private void run() {
   for(int i = 1; i <= 100; i++) {
      if(isDivisibleBy(i, 7)) {
         println(i);
      }
   }
}

private void isDivisibleBy(int a, int b) {
   return a % b == 0;
}
```

Return

Return *ends* a method's execution.

```
private int multiplyByTwo(int num) {
      return num * 2;
      println("Hello world?"); // not executed!
}
```

Return

Return *ends* a method's execution.

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


public void run() {
    println(max(2,3));
}
```

Parameters are Copies

```
// NOTE: This program is buggy!!
public void run() {
   int x = 3;
   addFive(x);
   // prints "x = 3"!
   println("x = " + x);
}

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

Parameters are Copies

```
// NOTE: This program is feeling just fine
public void run() {
   int x = 3;
   x = addFive(x);
   // prints "x = 5"!
   println("x = " + x);
}

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

```
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

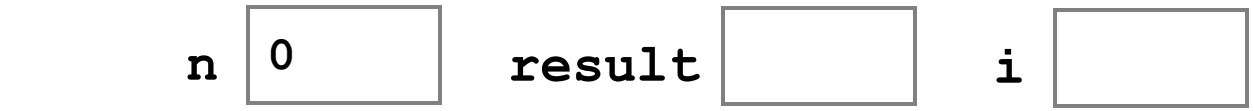
```
public void run() {
    for(int i = 0; i < MAX_NUM; i++) {
        println(i + "! = " + factorial(i));
    }
}
```

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

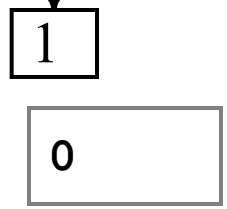
```
private int factorial(int n) {
    int result = 1;
    for (int i = 1; i <= n; i++) {
        result *= i;
    }
    return result;
}
```

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 0 result 1 i 1

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



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


```
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
```

```
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;
}
```

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

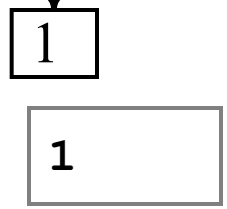
```
0! = 1
```

```
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

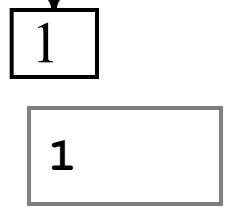
0! = 1

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




```
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 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));
   }
}
```

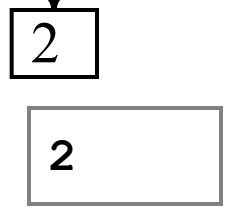
i 2

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

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


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

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




```
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 3

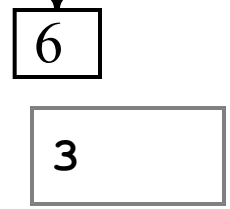
```
0! = 1
1! = 1
2! = 2
```

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

i 3

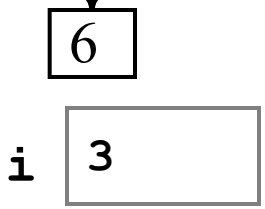
```
0! = 1
1! = 1
2! = 2
```

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




```
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 4

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

Recap

- Announcements
- Recap: For Loops
- Recap: Scope
- Parameters
- Return

Next time: Strings (new variable type!)