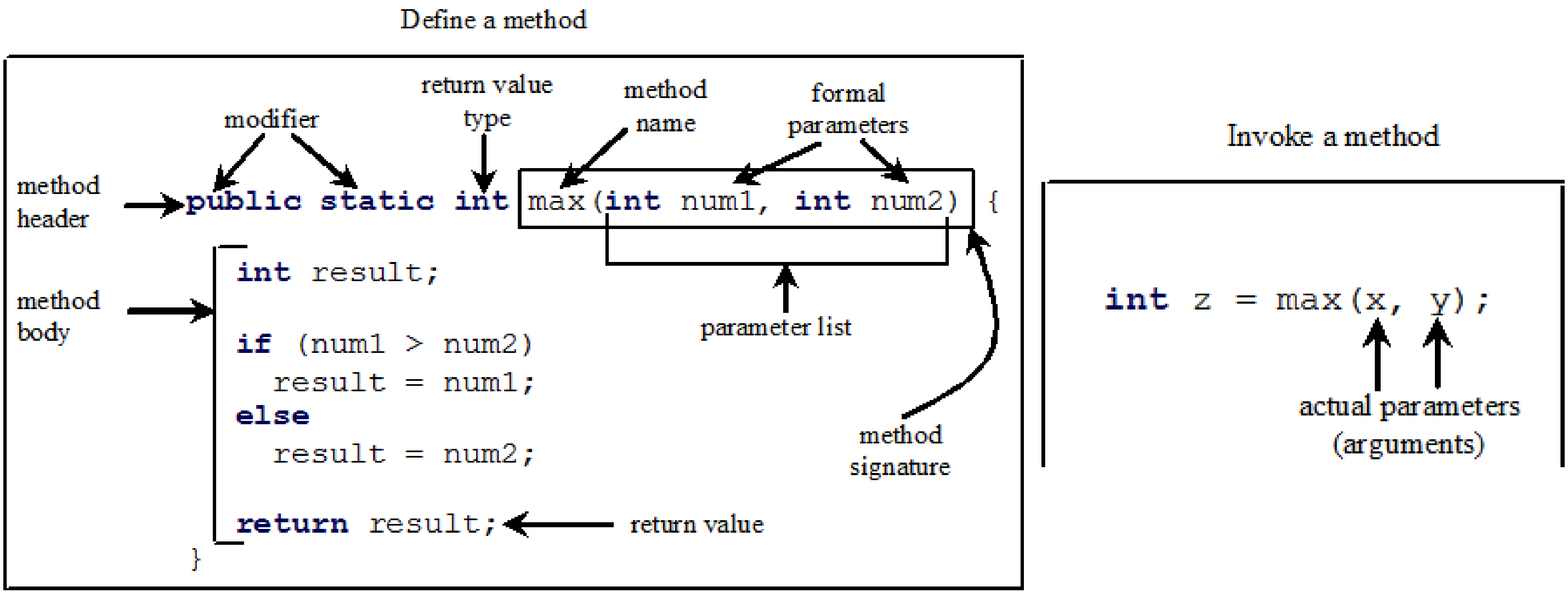
Methods

Defining Methods

❖ A method is a collection of statements that are grouped together to perform an operation.



Define a method

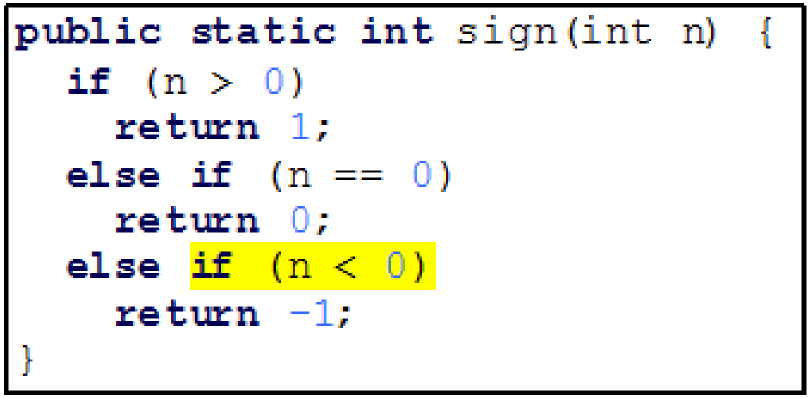
```
public static int max(int num1, int num2) {
  int result;

  if (num1 > num2)
    result = num1;
  else
    result = num2;

  return result;
}
```

Invoke a method

```
int z = max(x, y);
```

CAUTION

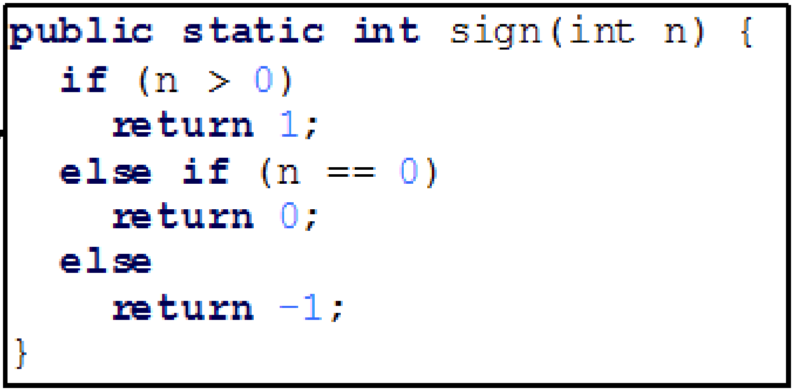
- A **return** statement is required for a value-returning method.
- The method shown below in (a) is logically correct, but it has a compilation error because the Java compiler thinks it possible that this method does not return any value.



```
public static int sign(int n) {
  if (n > 0)
    return 1;
  else if (n == 0)
    return 0;
  else if (n < 0)
    return -1;
}
```

(a)

Should be



```
public static int sign(int n) {
  if (n > 0)
    return 1;
  else if (n == 0)
    return 0;
  else
    return -1;
}
```

(b)

□ To fix this problem, delete ***if (n < 0)*** in (a), so that the compiler will see a **return** statement to be reached regardless of how the **if** statement is evaluated.

Passing Parameters

```
public static void nPrintln(String message, int n) {
    for (int i = 0; i < n; i++)
        System.out.println(message);
}
```

- Suppose you invoke the method using

  nPrintln(“Welcome to Java”, 5);

What is the output?

- Suppose you invoke the method using

  nPrintln(“Computer Science”, 15);

What is the output?

- Can you invoke the method using

  nPrintln(15, “Computer Science”);

Ambiguous Invocation

```
public class AmbiguousOverloading {
 public static void main(String[] args) {
     System.out.println(max(1, 2));
 }

 public static double max(int num1, double num2) {
  if (num1 > num2)
   return num1;
  else
   return num2;
 }

 public static double max(double num1, int num2) {
  if (num1 > num2)
   return num1;
  else
   return num2;
 }
}
```

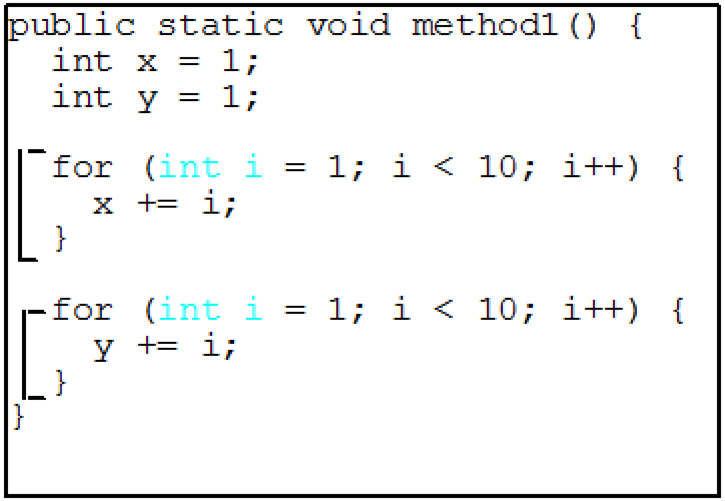
Scope of Local Variables

- A **local variable**: a variable defined inside a method.
- **Scope**: the part of the program where the variable can be referenced.
- The scope of a local variable **starts from its declaration and continues to the end of the block that contains the variable**.
- A local variable **must** be declared before it can be used.

Scope of Local Variables

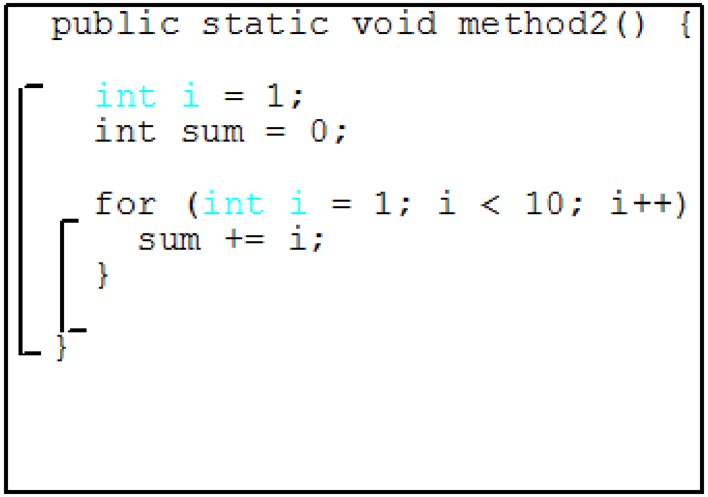
❖ You can declare a local variable with the same name multiple times in different **non-nesting** blocks in a method, but you cannot declare a local variable twice in nested blocks.

It is fine to declare i in two non-nesting blocks



```
public static void method1() {
  int x = 1;
  int y = 1;

  for (int i = 1; i < 10; i++) {
    x += i;
  }

  for (int i = 1; i < 10; i++) {
    y += i;
  }
}
```

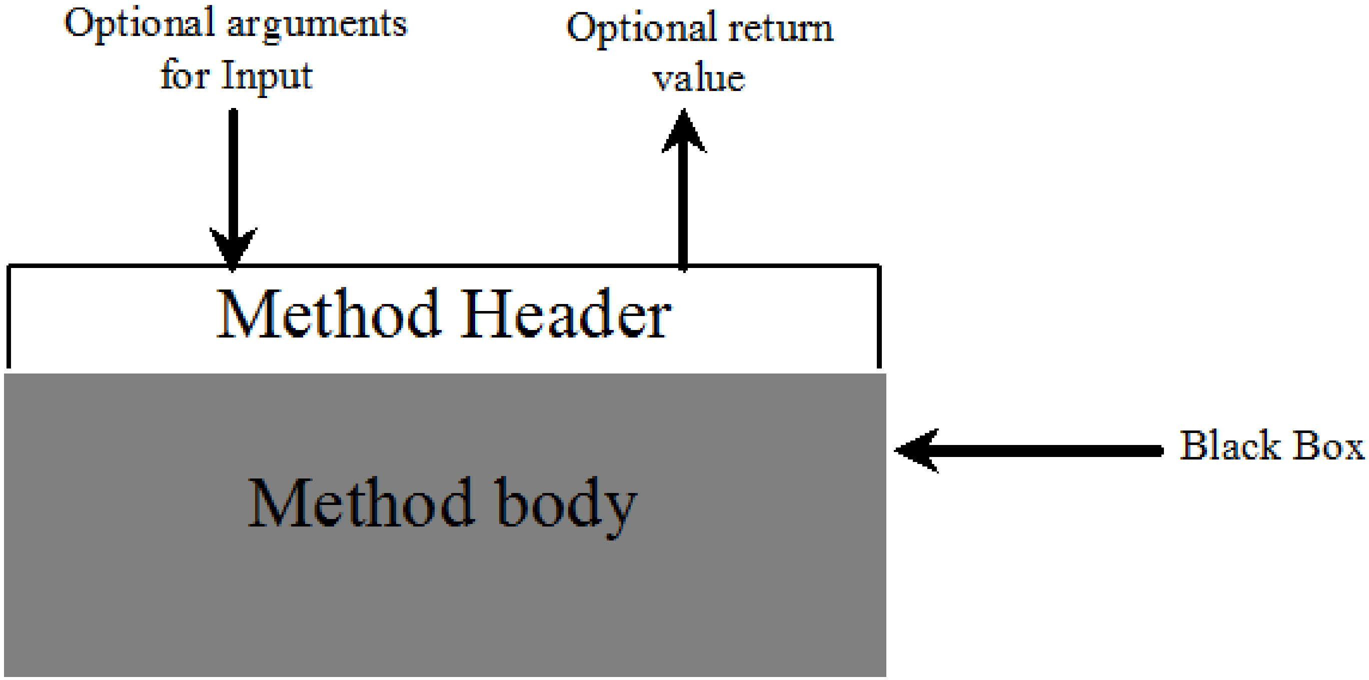
It is wrong to declare i in two nesting blocks



```
  public static void method2() {

    int i = 1;
    int sum = 0;

    for (int i = 1; i < 10; i++)
      sum += i;
    }
  }
```

Method Abstraction

❖ You can think of the method body as a black box that contains the detailed implementation for the method.



Benefits of Methods

- Write a method once and **reuse** it anywhere.
- **Information hiding**. Hide the implementation from the user.
- **Reduce complexity**.

The **Math** Class

- Class constants:
  - **PI**
  - **E**
- Class methods:
  - Trigonometric Methods
  - Exponent Methods
  - Rounding Methods
  - min, max, abs, and random Methods

Trigonometric Methods

- sin(double a)
- cos(double a)
- tan(double a)
- acos(double a)
- asin(double a)
- atan(double a)

Radians

Math.toRadians(90)

Examples:

Math.sin(0)	returns 0.0
Math.sin(Math.PI / 6)	returns 0.5
Math.sin(Math.PI / 2)	returns 1.0
Math.cos(0)	returns 1.0
Math.cos(Math.PI / 6)	returns 0.866
Math.cos(Math.PI / 2)	returns 0.0

Exponent Methods

- exp(double a)

  Returns e raised to the power of a.

- log(double a)

  Returns the natural logarithm of a.

- log10(double a)

  Returns the 10-based logarithm of a.

- pow(double a, double b)

  Returns a raised to the power of b.

- sqrt(double a)

  Returns the square root of a.

Examples:

Math.exp(1)	returns 2.71
Math.log(2.71)	returns 1.0
Math.pow(2, 3)	returns 8.0
Math.pow(3, 2)	returns 9.0
Math.pow(3.5, 2.5)	returns 22.917
Math.sqrt(4)	returns 2.0
Math.sqrt(10.5)	returns 3.24

Rounding Methods

- **double ceil(double x)** x rounded up to its nearest integer. This integer is returned as a double value.
- **double floor(double x)** x is rounded down to its nearest integer. This integer is returned as a double value.
- **double rint(double x)** x is rounded to its nearest integer. If x is equally close to two integers, the even one is returned as a double.
- **int round(float x)** Return (int)Math.floor(x+0.5).
- **long round(double x)** Return (long)Math.floor(x+0.5).

min, max, and abs

- max(a, b) and min(a, b)

  Returns the maximum or minimum of two parameters.

- abs(a)

  Returns the absolute value of the parameter.

- random()

  Returns a random double value in the range [0.0, 1.0).

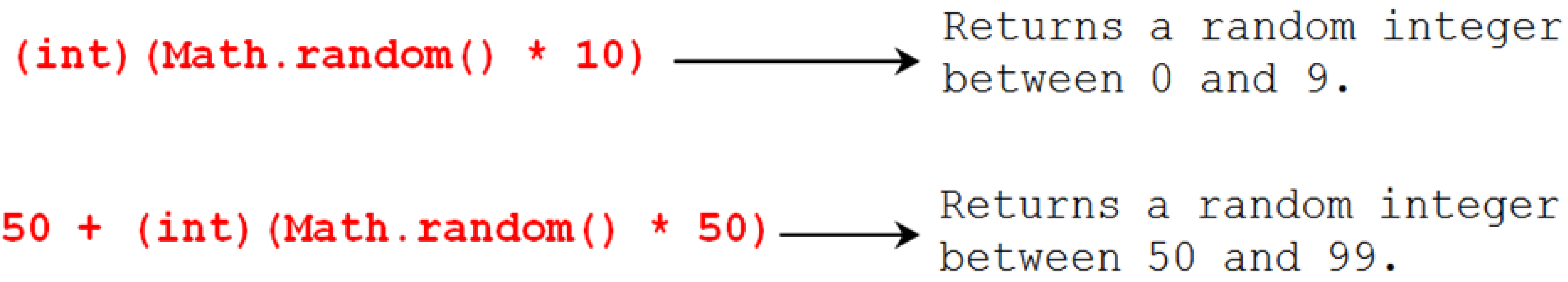
Examples:

Math.max(2, 3)	returns 3
Math.max(2.5, 3)	returns 3.0
Math.min(2.5, 3.6)	returns 2.5
Math.abs(-2)	returns 2
Math.abs(-2.1)	returns 2.1

The random Method

❖ Generates a random double value greater than or equal to 0.0 and less than 1.0

(0 <= Math.random() < 1.0)



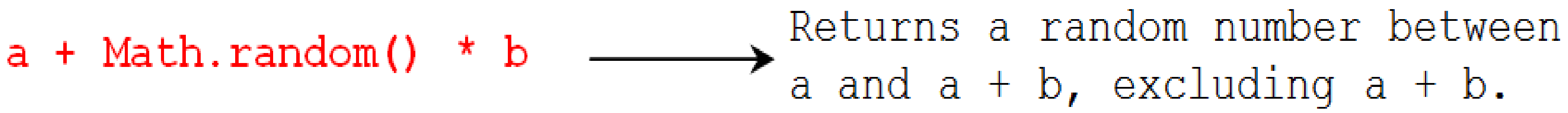
```
(int)(Math.random() * 10)
```

→ Returns a random integer between 0 and 9.

```
50 + (int)(Math.random() * 50)
```

→ Returns a random integer between 50 and 99.

In general:



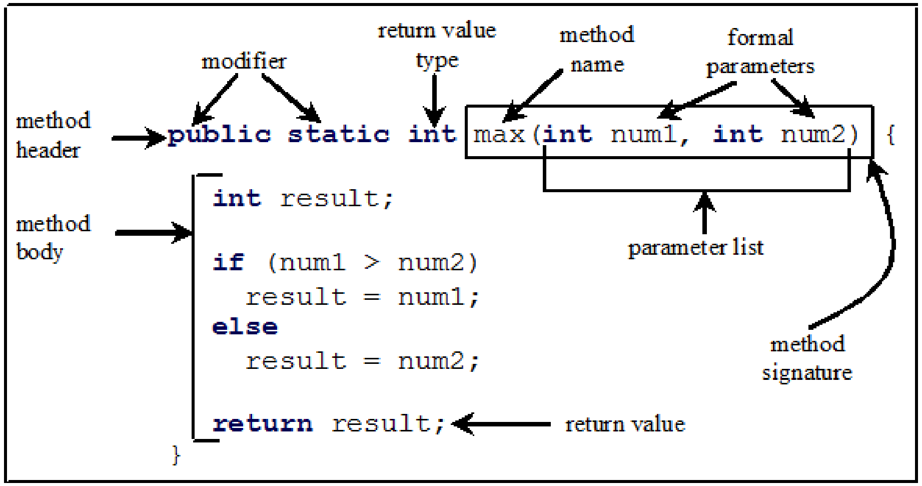
```
a + Math.random() * b
```

→ Returns a random number between a and a + b, excluding a + b.

Overloading Methods

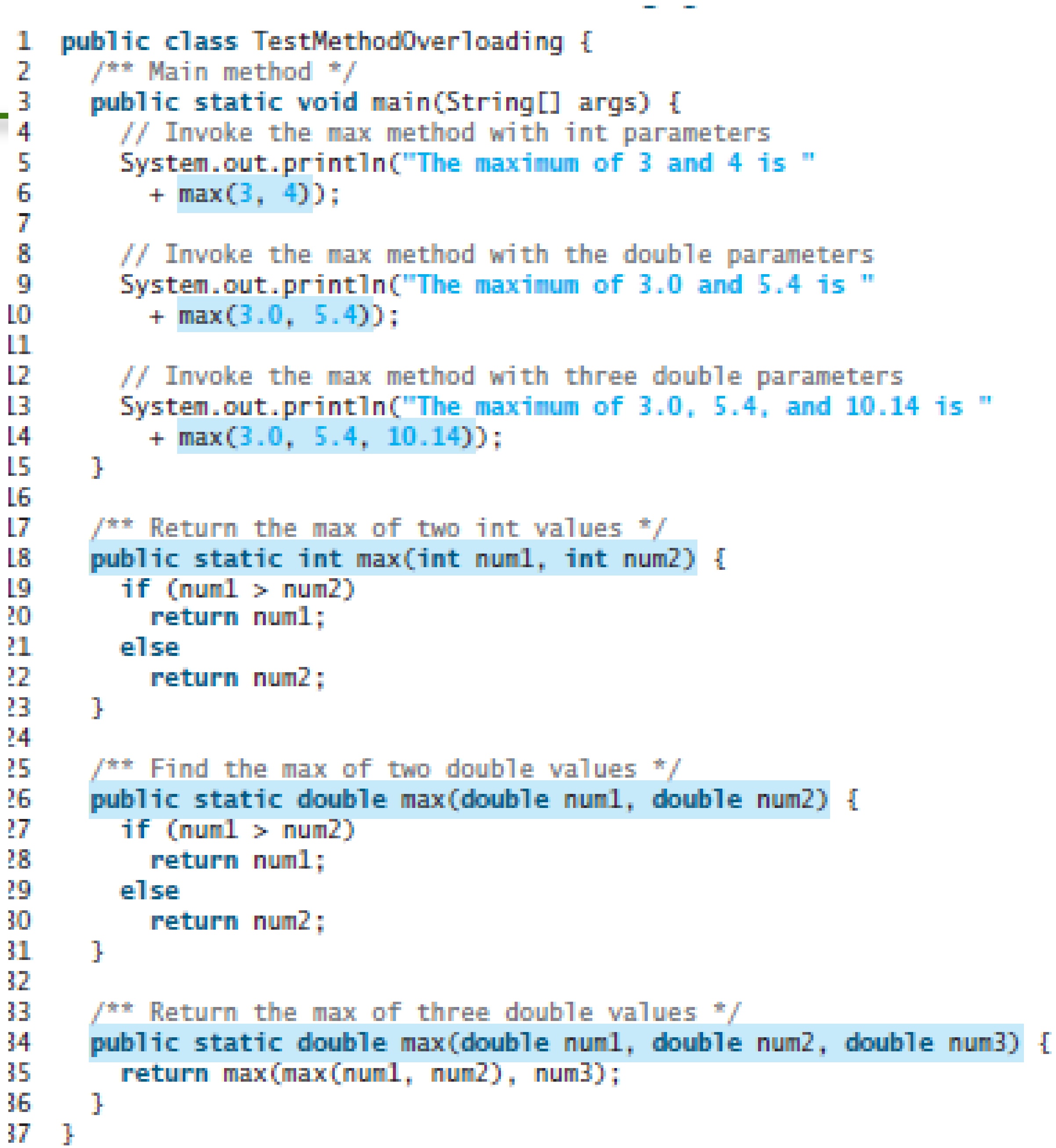
- *Overloading methods enables you to define the methods with the same name as long as their signatures are different.*

Define a method



```
public static int max(int num1, int num2) {
    int result;

    if (num1 > num2)
      result = num1;
    else
      result = num2;

    return result;
}
```

```
public static double max(double num1, double num2) {
  if (num1 > num2)
    return num1;
  else
    return num2;
}
```



```java
public class TestMethodOverloading {
  /** Main method */
  public static void main(String[] args) {
    // Invoke the max method with int parameters
    System.out.println("The maximum of 3 and 4 is "
      + max(3, 4));

    // Invoke the max method with the double parameters
    System.out.println("The maximum of 3.0 and 5.4 is "
      + max(3.0, 5.4));

    // Invoke the max method with three double parameters
    System.out.println("The maximum of 3.0, 5.4, and 10.14 is "
      + max(3.0, 5.4, 10.14));
  }

  /** Return the max of two int values */
  public static int max(int num1, int num2) {
    if (num1 > num2)
      return num1;
    else
      return num2;
  }

  /** Find the max of two double values */
  public static double max(double num1, double num2) {
    if (num1 > num2)
      return num1;
    else
      return num2;
  }

  /** Return the max of three double values */
  public static double max(double num1, double num2, double num3) {
    return max(max(num1, num2), num3);
  }
}
```