

# Methods

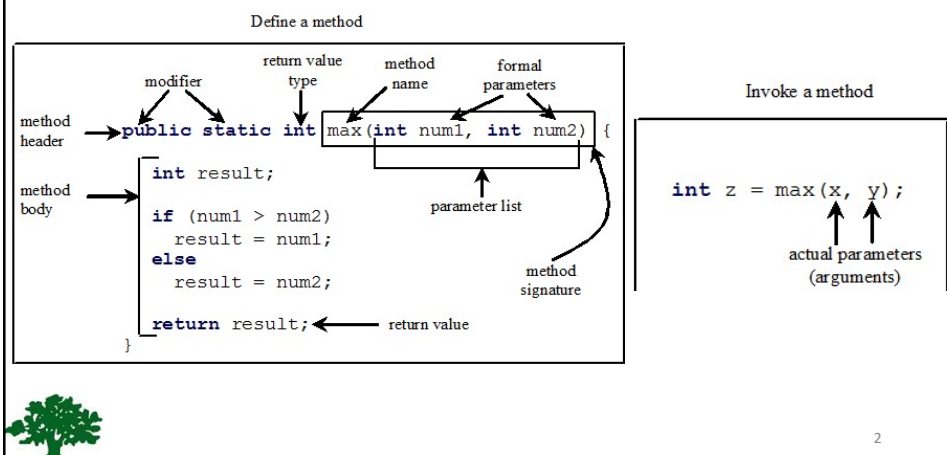
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## Defining Methods

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



## 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.



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## 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");**



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## Ambiguous Invocation

```
public class Test {
    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;
    }
}
```

```
Exception in thread "main" java.lang.Error: Unresolved compilation problem:
The method max(int, double) is ambiguous for the type Test
at Test.main(Test.java:3)
```



## Scope of Local Variables

- ❖ A **local variable**: a variable defined inside a **block** (e.g. method, loop).
- ❖ **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.



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## 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

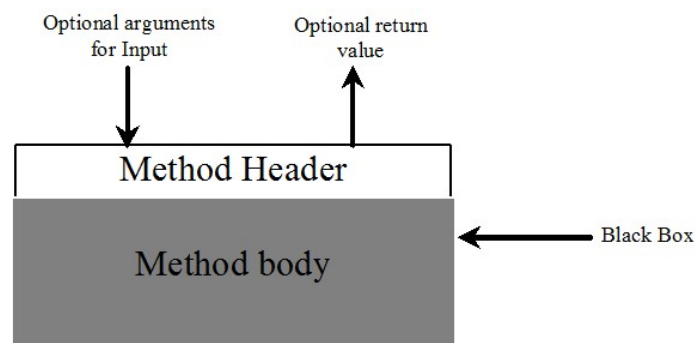
```
public static void method2() {
    int i = 1;
    int sum = 0;

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

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## Method Abstraction

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



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## Benefits of Methods

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



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## The Math Class

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



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## 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

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## 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



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## 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)`.



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## 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:

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



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## The **random** Method

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

$$(0 \leq \text{Math.random()} < 1.0)$$

`(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.

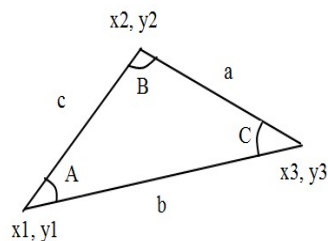
In general:

`a + Math.random() * b` → Returns a random number between a and a + b, excluding a + b.



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## Case Study: Computing Angles of a Triangle



$$A = \arccos\left(\frac{a^2 + a^2 - b^2 - c^2}{-2 * b * c}\right)$$

$$B = \arccos\left(\frac{b^2 + b^2 - a^2 - c^2}{-2 * a * c}\right)$$

$$C = \arccos\left(\frac{c^2 + c^2 - b^2 - a^2}{-2 * a * b}\right)$$

Write a program that prompts the user to enter the x- and y-coordinates of the three corner points in a triangle and then displays the triangle's angles.



$$\sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

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