

6.3 static Methods, static Fields and Class Math

Most methods execute in response to method calls *on specific objects*. However, sometimes a method performs a task that does not depend on an object. Such a method applies to the class in which it's declared as a whole and is known as a **static** method or a **class method**. (In [Section 10.10](#), you'll see that interfaces also may contain **static** methods.)

Classes often contain convenient **static** methods to perform common tasks. For example, recall that we used class **Math**'s **static** method **pow** to raise a value to a power in [Fig. 5.6](#). To declare a method as **static**, place the keyword **static** before the return type in the method's declaration. For any class imported into your program, you can call the class's **static** methods by specifying the class's name, followed by a dot (.) and the method name, as in

```
ClassName.methodName(arguments)
```



Math Class Methods

We use various `Math` class methods here to present the concept of `static` methods. Class `Math` provides a collection of methods that enable you to perform common mathematical calculations. For example, you can calculate the square root of `900.0` with the `static` method call

```
Math.sqrt(900.0)
```

This expression evaluates to `30.0`. Method `sqrt` takes an argument of type `double` and returns a result of type `double`. To output the value of the preceding method call in the command window, you might write the statement

```
System.out.println(Math.sqrt(900.0));
```

In this statement, the value that `sqrt` returns becomes the argument to method `println`. There was no need to create a `Math` object before calling method `sqrt`. Also *all* `Math` class methods are `static`—therefore, each is called by preceding its name with the class name `Math` and the dot (`.`) separator.



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Class Math is part of the `java.lang` package, which is implicitly imported by the compiler, so it's not necessary to import class Math to use its methods.

Method arguments may be constants, variables or expressions. If `c = 13.0`, `d = 3.0` and `f = 4.0`, then the statement

```
System.out.println(Math.sqrt(c + d * f));
```

calculates and prints the square root of $13.0 + 3.0 * 4.0 = 25.0$ —namely, 5.0 . [Figure 6.2](#) summarizes several Math class methods. In the figure, `x` and `y` are of type `double`.

Fig. 6.2

Math class methods.

Method	Description	Example
<code>abs(x)</code>	absolute value of <code>x</code>	<code>abs(23.7)</code> is 23.7 <code>abs(0.0)</code> is 0.0 <code>abs(-23.7)</code> is 23.7
<code>ceil(x)</code>	rounds <code>x</code> to the smallest integer not less than <code>x</code>	<code>ceil(9.2)</code> is 10.0 <code>ceil(-9.8)</code> is -9.0
<code>cos(x)</code>	trigonometric cosine of <code>x</code> (<code>x</code> in radians)	<code>cos(0.0)</code> is 1.0
<code>exp(x)</code>	exponential method e^x	<code>exp(1.0)</code> is 2.71828 <code>exp(2.0)</code> is 7.38906

<code>floor(x)</code>	rounds x to the largest integer not greater than x	<code>floor(9.2)</code> is 9.0 <code>floor(-9.8)</code> is -10.0
<code>log(x)</code>	natural logarithm of x (base e)	<code>log(Math.E)</code> is 1.0 <code>log(Math.E * Math.E)</code> is 2.0
<code>max(x, y)</code>	larger value of x and y	<code>max(2.3, 12.7)</code> is 12.7 <code>max(-2.3, -12.7)</code> is -2.3
<code>min(x, y)</code>	smaller value of x and y	<code>min(2.3, 12.7)</code> is 2.3 <code>min(-2.3, -12.7)</code> is -12.7
<code>pow(x, y)</code>	x raised to the power y (i.e., x^y)	<code>pow(2.0, 7.0)</code> is 128.0 <code>pow(9.0, 0.5)</code> is 3.0
<code>sin(x)</code>	trigonometric sine of x (x in radians)	<code>sin(0.0)</code> is 0.0
<code>sqrt(x)</code>	square root of x	<code>sqrt(900.0)</code> is 30.0
<code>tan(x)</code>	trigonometric tangent of x (x in radians)	<code>tan(0.0)</code> is 0.0

static Variables

Recall from [Section 3.2](#) that each object of a class maintains its own copy of every instance variable of the class. There are variables for which each object of a class does *not* need its own separate copy (as you'll see momentarily). Such variables

are declared `static` and are also known as **class variables**. When objects of a class containing `static` variables are created, all the objects of that class share *one* copy of the `static` variables. Together a class's `static` variables and instance variables are known as its **fields**. You'll learn more about `static` fields in [Section 8.11](#).

Math Class `static` Constants `PI` and `E`

Class `Math` declares two constants, `Math.PI` and `Math.E`, that represent *high-precision approximations* to commonly used mathematical constants:

- `Math.PI` (3.141592653589793) is the ratio of a circle's circumference to its diameter.
- `Math.E` (2.718281828459045) is the base value for natural logarithms (calculated with class `Math`'s `static` method `log`).

These constants are declared in class `Math` with the modifiers `public`, `final` and `static`. Making them `public` allows you to use them in your own classes. Any field declared with keyword `final` is *constant*—its value cannot change after the field is initialized. Making these fields `static` allows them to be accessed via the class name `Math` and a dot (`.`) separator, just as class `Math`'s methods are.

Why Is Method `main` Declared `static`?

When you execute the Java Virtual Machine (JVM) with the `java` command, the JVM attempts to invoke the `main` method of the class you specify—at this point no objects of the class have been created. Declaring `main` as `static` allows the JVM to invoke `main` without creating an instance of the class. When you execute your application, you specify its class name as an argument to the `java` command, as in

```
java ClassName argument1 argument2 ...
```



The JVM loads the class specified by *ClassName* and uses that class name to invoke method `main`. In the preceding command, *ClassName* is a **command-line argument** to the JVM that tells it which class to execute. Following the *ClassName*, you can also specify a list of `Strings` (separated by spaces) as command-line arguments that the JVM will pass to your application. Such arguments might be used to specify options (e.g., a filename) to run the application. Every class may contain `main`—only the `main` of the class used to execute the application is called. As you’ll learn in [Chapter 7](#), `Arrays` and `ArrayLists`, your application can access those command-line arguments and use them to customize the application.