

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

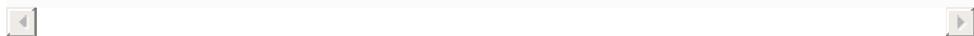
className.methodName(arguments)



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.



Software Engineering Observation 6.4

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
$\text{abs}(x)$	absolute value of x	$\text{abs}(23.7)$ is 23.7 $\text{abs}(0.0)$ is 0.0 $\text{abs}(-23.7)$ is 23.7
$\text{ceil}(x)$	rounds x to the smallest integer not less than x	$\text{ceil}(9.2)$ is 10.0 $\text{ceil}(-9.8)$ is -9.0
$\text{cos}(x)$	trigonometric cosine of x (x in radians)	$\text{cos}(0.0)$ is 1.0
$\text{exp}(x)$	exponential method e^x	$\text{exp}(1.0)$ is 2.71828 $\text{exp}(2.0)$ is 7.38906

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

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:

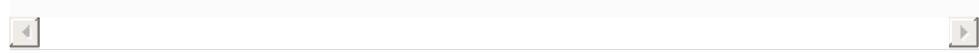
- **Math.PI** (3.141592653589793) is the ratio of a circle's circumference to its diameter.
- **Math.E** (2.718281828459045) is the base value for natural logarithms (calculated with class **Math**'s **static** method **log**).

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.