Core Java® SE 9 for the Impatient

Second Edition

Cay S. Horstmann

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To Chi—the most patient person in my life.

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Preface

Java is now over twenty years old, and the classic book, *Core Java*, covers, in meticulous detail, not just the language but all core libraries and a multitude of changes between versions, spanning two volumes and well over 2,000 pages. However, if you just want to be productive with modern Java, there is a much faster, easier pathway for learning the language and core libraries. In this book, I don't retrace history and don't dwell on features of past versions. I show you the good parts of Java as it exists today, with Java 9, so you can put your knowledge to work quickly.

As with my previous "Impatient" books, I quickly cut to the chase, showing you what you need to know to solve a programming problem without lecturing about the superiority of one paradigm over another. I also present the information in small chunks, organized so that you can quickly retrieve it when needed.

Assuming you are proficient in some other programming language, such as C++, JavaScript, Objective C, PHP, or Ruby, with this book you will learn how to become a competent Java programmer. I cover all aspects of Java that a developer needs to know, including the powerful concepts of lambda expressions and streams. I tell you where to find out more about old-fashioned concepts that you might still see in legacy code, but I don't dwell on them.

A key reason to use Java is to tackle concurrent programming. With parallel algorithms and threadsafe data structures readily available in the Java library, the way application programmers should handle concurrent programming has completely changed. I provide fresh coverage, showing you how to use the powerful library features instead of error-prone low-level constructs.

Traditionally, books on Java have focused on user interface programming—but nowadays, few developers produce user interfaces on desktop computers. If you intend to use Java for server-side programming or Android programming, you will be able to use this book effectively without being distracted by desktop GUI code.

Finally, this book is written for application programmers, not for a college course and not for systems wizards. The book covers issues that application programmers need to wrestle with, such as logging and working with files—but you won't learn how to implement a linked list by hand or how to write a web server.

I hope you enjoy this rapid-fire introduction into modern Java, and I hope it will make your work with Java productive and enjoyable.

If you find errors or have suggestions for improvement, please visit `http://horstmann.com/javaimpatient` and leave a comment. On that page, you will also find a link to an archive file containing all code examples from the book.

Acknowledgments

My thanks go, as always, to my editor Greg Doench, who enthusiastically supported the vision of a short book that gives a fresh introduction to Java SE 9. Dmitry Kirsanov and Alina Kirsanova once again turned an XHTML manuscript into an attractive book with amazing speed and attention to detail. My special gratitude goes to the excellent team of reviewers for both editions who spotted many errors and gave thoughtful suggestions for improvement. They are: Andres Almiray, Gail Anderson, Paul Anderson, Marcus Biel, Brian Goetz, Marty Hall, Mark Lawrence, Doug Lea, Simon Ritter, Yoshiki Shibata, and Christian Ullenboom.

Cay Horstmann
San Francisco
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About the Author

Cay S. Horstmann is the author of *Java SE 8 for the Really Impatient* and *Scala for the Impatient* (both from Addison-Wesley), is principal author of *Core Java*™, *Volumes I and II, Tenth Edition* (Prentice Hall, 2016), and has written a dozen other books for professional programmers and computer science students. He is a professor of computer science at San Jose State University and is a Java Champion.

Fundamental Programming Structures

Topics in This Chapter

Chapter I

In this chapter, you will learn about the basic data types and control structures of the Java language. I assume that you are an experienced programmer in some other language and that you are familiar with concepts such as variables, loops, function calls, and arrays, but perhaps with a different syntax. This chapter will get you up to speed on the Java way. I will also give you some tips on the most useful parts of the Java API for manipulating common data types.

The key points of this chapter are:

1. In Java, all methods are declared in a class. You invoke a nonstatic method on an object of the class to which the method belongs.
2. Static methods are not invoked on objects. Program execution starts with the static `main` method.
3. Java has eight primitive types: four signed integral types, two floating-point types, `char`, and `boolean`.
4. The Java operators and control structures are very similar to those of C or JavaScript.
5. The `Math` class provides common mathematical functions.
6. `String` objects are sequences of characters or, more precisely, Unicode code points in the UTF-16 encoding.

7. With the `System.out` object, you can display output in a terminal window. A `Scanner` tied to `System.in` lets you read terminal input.
8. Arrays and collections can be used to collect elements of the same type.

1.1 Our First Program

When learning any new programming language, it is traditional to start with a program that displays the message "Hello, World!". That is what we will do in the following sections.

1.1.1 Dissecting the "Hello, World" Program

Without further ado, here is the "Hello, World" program in Java.

```
package ch01.sec01;

// Our first Java program

public class HelloWorld {
    public static void main(String[] args) {
        System.out.println("Hello, World!");
    }
}
```

Let's examine this program:

- Java is an object-oriented language. In your program, you manipulate (mostly) *objects* by having them do work. Each object that you manipulate belongs to a specific *class*, and we say that the object is an *instance* of that class. A class defines what an object's state can be and and what it can do. In Java, all code is defined inside classes. We will look at objects and classes in detail in Chapter 2. This program is made up of a single class `HelloWorld`.
- `main` is a *method*, that is, a function declared inside a class. The `main` method is the first method that is called when the program runs. It is declared as `static` to indicate that the method does not operate on any objects. (When `main` gets called, there are only a handful of predefined objects, and none of them are instances of the `HelloWorld` class.) The method is declared as `void` to indicate that it does not return any value. See Section 1.8.8, "Command-Line Arguments" (page 49) for the meaning of the parameter declaration `String[] args`.
- In Java, you can declare many features as `public` or `private`, and there are a couple of other visibility levels as well. Here, we declare the `HelloWorld`

class and the `main` method as `public`, which is the most common arrangement for classes and methods.

- A *package* is a set of related classes. It is a good idea to place each class in a package so you can group related classes together and avoid conflicts when multiple classes have the same name. In this book, we'll use chapter and section numbers as package names. The full name of our class is `ch01.sec01.HelloWorld`. Chapter 2 has more to say about packages and package naming conventions.
- The line starting with // is a comment. All characters between // and the end of the line are ignored by the compiler and are meant for human readers only.
- Finally, we come to the body of the `main` method. In our example, it consists of a single line with a command to print a message to `System.out`, an object representing the "standard output" of the Java program.

As you can see, Java is not a scripting language that can be used to quickly dash off a few commands. It is squarely intended as a language for larger programs that benefit from being organized into classes, packages, and modules. (Modules are introduced in Chapter 15.)

Java is also quite simple and uniform. Some languages have global variables and functions as well as variables and methods inside classes. In Java, everything is declared inside a class. This uniformity can lead to somewhat verbose code, but it makes it easy to understand the meaning of a program.

NOTE: You have just seen a `//` comment that extends to the end of the line. You can also have multiline comments between `/*` and `*/` delimiters, such as

```
/*
    This is the first sample program in Core Java for the Impatient.
    The program displays the traditional greeting "Hello, World!".
*/
```

There is a third comment style, called *documentation comment*, with `/**` and `*/` as delimiters, that you will see in the next chapter.

1.1.2 Compiling and Running a Java Program

To compile and run this program, you need to install the Java Development Kit (JDK) and, optionally, an integrated development environment (IDE). You should also download the sample code, which you will find at the companion website for this book, `http://horstmann.com/javaimpatient`. Since instructions for installing software don't make for interesting reading, I put them on the companion website as well.

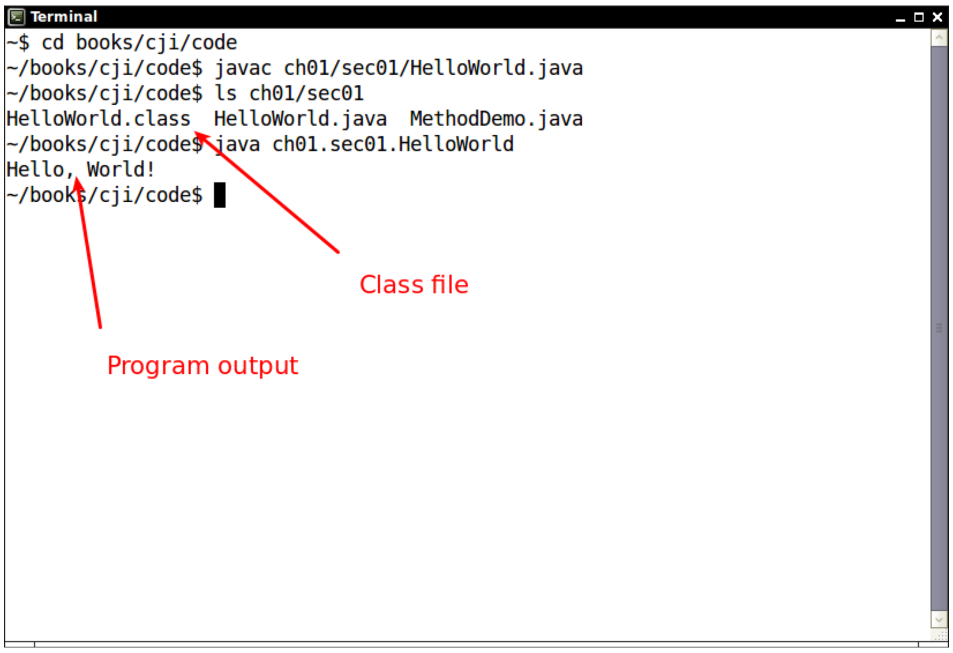
Once you have installed the JDK, open a terminal window, change to the directory containing the `ch01` directory, and run the commands

```
javac ch01/sec01/HelloWorld.java
java ch01.sec01.HelloWorld
```

The familiar greeting will appear in the terminal window (see Figure 1-1).

Note that two steps were involved to execute the program. The `javac` command *compiles* the Java source code into an intermediate machine-independent representation, called *byte codes*, and saves them in *class files*. The `java` command launches a *virtual machine* that loads the class files and executes the byte codes.

Once compiled, byte codes can run on any Java virtual machine, whether on your desktop computer or on a device in a galaxy far, far away. The promise of "write once, run anywhere" was an important design criterion for Java.

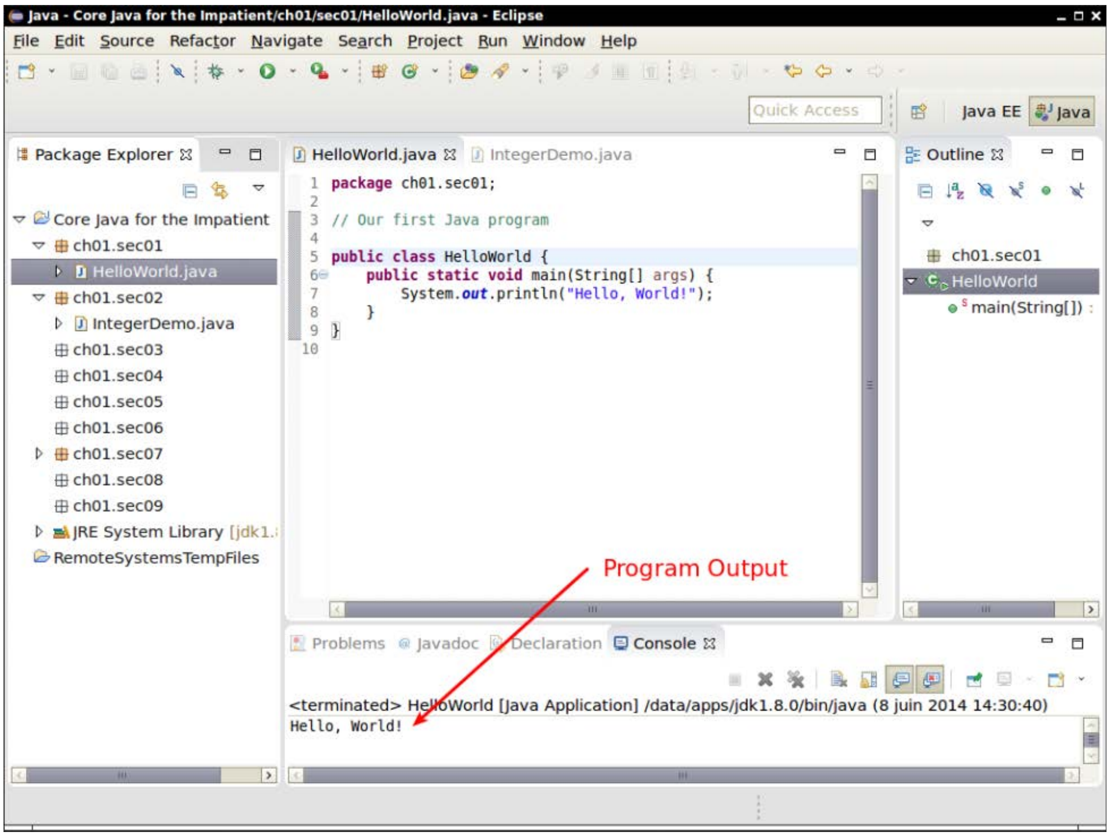


```
~$ cd books/cji/code
~/books/cji/code$ javac ch01/sec01/HelloWorld.java
~/books/cji/code$ ls ch01/sec01
HelloWorld.class  HelloWorld.java  MethodDemo.java
~/books/cji/code$ java ch01.sec01.HelloWorld
Hello, World!
~/books/cji/code$
```

Figure 1-1 Running a Java program in a terminal window

NOTE: The `javac` compiler is invoked with the name of a *file*, with slashes separating the path segments, and an extension `.java`. The `java` virtual machine launcher is invoked with the name of a *class*, with dots separating the package segments, and no extension.

To run the program in an IDE, you need to first make a project, as described in the installation instructions. Then, select the `HelloWorld` class and tell the IDE to run it. Figure 1-2 shows how this looks in Eclipse. Eclipse is a popular IDE, but there are many other excellent choices. As you get more comfortable with Java programming, you should try out a few and pick one that you like.



```java
package ch01.sec01;

// Our first Java program

public class HelloWorld {
    public static void main(String[] args) {
        System.out.println("Hello, World!");
    }
}
```

```
<terminated> HelloWorld [Java Application] /data/apps/jdk1.8.0/bin/java (8 juin 2014 14:30:40)
Hello, World!
```

Figure 1-2 Running a Java program inside the Eclipse IDE

Congratulations! You have just followed the time-honored ritual of running the "Hello, World!" program in Java. Now we are ready to examine the basics of the Java language.

1.1.3 Method Calls

Let us have a closer look at the single statement of the `main` method:

```
System.out.println("Hello, World!");
```

`System.out` is an object. It is an *instance* of a class called `PrintStream`. The `PrintStream` class has methods `println`, `print`, and so on. These methods are called *instance methods* because they operate on objects, or instances, of the class.

To invoke an instance method on an object, you use the *dot notation*

object.*methodName*(*arguments*)

In this case, there is just one argument, the string `"Hello, World!"`.

Let's try it with another example. Strings such as `"Hello, World!"` are instances of the `String` class. The `String` class has a method `length` that returns the length of a `String` object. To call the method, you again use the dot notation:

```
"Hello, World!".length()
```

The `length` method is invoked on the object `"Hello, World!"`, and it has no arguments. Unlike the `println` method, the `length` method returns a result. One way of using that result is to print it:

```
System.out.println("Hello, World!".length());
```

Give it a try. Make a Java program with this statement and run it to see how long the string is.

In Java, you need to *construct* most objects (unlike the `System.out` and `"Hello, World!"` objects, which are already there, ready for you to use). Here is a simple example.

An object of the `Random` class can generate random numbers. You construct a `Random` object with the `new` operator:

```
new Random()
```

After the class name is the list of construction arguments, which is empty in this example.

You can call a method on the constructed object. The call

```
new Random().nextInt()
```

yields the next integer that the newly constructed random number generator has to offer.

If you want to invoke more than one method on an object, store it in a variable (see Section 1.3, "Variables," page 14). Here we print two random numbers:

```
Random generator = new Random();
System.out.println(generator.nextInt());
System.out.println(generator.nextInt());
```

NOTE: The `Random` class is declared in the `java.util` package. To use it in your program, add an `import` statement, like this:

```
package ch01.sec01;

import java.util.Random;

public class MethodDemo {
    ...
}
```

We will look at packages and the `import` statement in more detail in Chapter 2.

1.1.4 JShell

In Section 1.1.2, "Compiling and Running a Java Program" (page 3), you saw how to compile and run a Java program. Java 9 introduces another way of working with Java. The JShell program provides a "read-evaluate-print loop" (REPL) where you type a Java expression, JShell evaluates your input, prints the result, and waits for your next input. To start JShell, simply type `jshell` in a terminal window (Figure 1-3).

JShell starts with a greeting, followed by a prompt:

```
|  Welcome to JShell -- Version 9-ea
|  For an introduction type: /help intro

jshell>
```

Now type any Java expression, such as

```
"Hello, World!".length()
```

JShell responds with the result and another prompt.

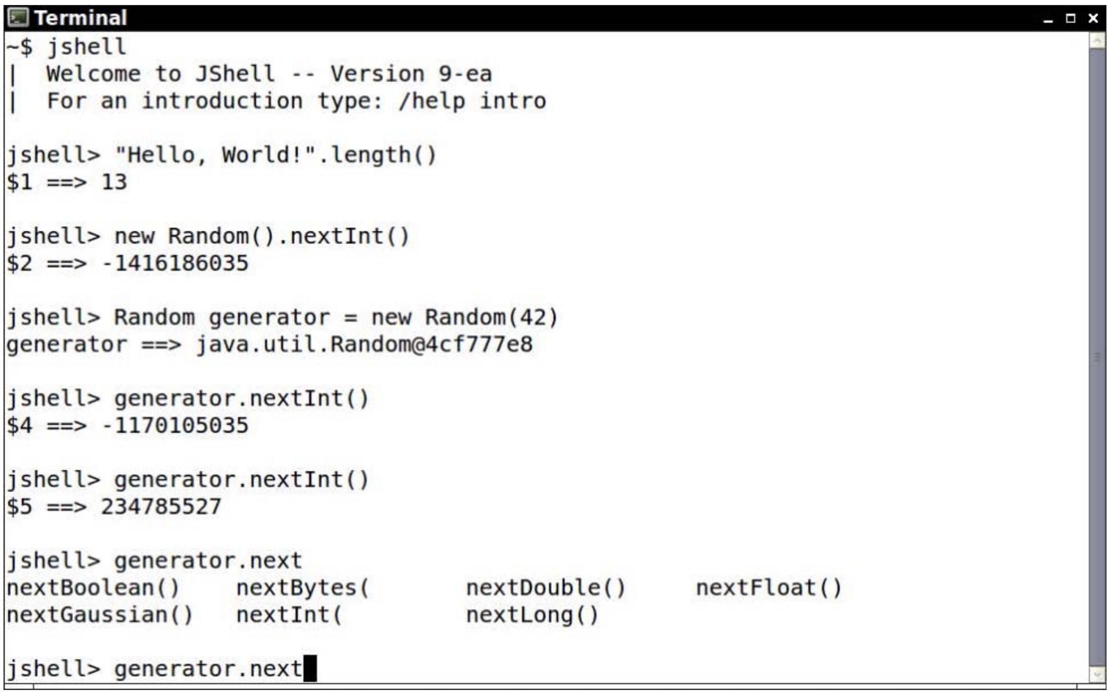
```
$1 ==> 13

jshell>
```

Note that you do *not* type `System.out.println`. JShell automatically prints the value of every expression that you enter.

The `$1` in the output indicates that the result is available in further calculations. For example, if you type

```
3 * $1 + 3
```



```
~$ jshell
|  Welcome to JShell -- Version 9-ea
|  For an introduction type: /help intro

jshell> "Hello, World!".length()
$1 ==> 13

jshell> new Random().nextInt()
$2 ==> -1416186035

jshell> Random generator = new Random(42)
generator ==> java.util.Random@4cf777e8

jshell> generator.nextInt()
$4 ==> -1170105035

jshell> generator.nextInt()
$5 ==> 234785527

jshell> generator.next
nextBoolean()    nextBytes(       nextDouble()     nextFloat()
nextGaussian()   nextInt(         nextLong()

jshell> generator.next
```

Figure 1–3 Running JShell

the response is

```
$2 ==> 42
```

If you need a variable many times, you can give it a more memorable name. You have to follow the Java syntax and specify both the type and the name (see Section 1.3, "Variables," page 14). For example,

```
jshell> int answer = 42
answer ==> 42
```

You can have JShell fill in the type for you. Type an expression and instead of hitting the Enter key, hit Shift+Tab and then the V key. For example, when you type

```
new Random()
```

followed by Shift+Tab and the V key, you get

```
jshell> Random  = new Random()
```

with the cursor positioned just before the `=` symbol. Now type a variable name and hit Enter:

```
jshell> Random generator = new Random()
generator ==> java.util.Random@3fee9989
```

Another useful feature is tab completion. Type

```
generator.
```

followed by the Tab key. You get a list of all methods that you can invoke on the `generator` variable:

```
jshell> generator.
doubles(         equals(          getClass()       hashCode()
ints(            longs(           nextBoolean()    nextBytes(
nextDouble()     nextFloat()      nextGaussian()   nextInt(
nextLong()       notify()         notifyAll()      setSeed(
toString()       wait(
```

Now type `ne` and hit the Tab key again. The method name is completed to `next`, and you get a shorter list:

```
jshell> generator.next
nextBoolean()    nextBytes(       nextDouble()     nextFloat()
nextGaussian()   nextInt(         nextLong()
```

Type a D and Tab again, and now the only completion, `nextDouble()`, is filled in. Hit Enter to accept it:

```
jshell> generator.nextDouble()
$8 ==> 0.9560346568377398
```

NOTE: Note that in the autocompletion list, methods that require an argument are only followed by a left parenthesis, such as `nextInt(`, but methods without arguments have both parentheses, such as `nextBoolean()`.

To repeat a command, hit the ↑ key until you see the line that you want to reissue or edit. You can move the cursor in the line with the ← and → keys, and add or delete characters. Hit Enter when you are done. For example, hit ↑ and replace `Double` with `Int`, then hit Enter:

```
jshell> generator.nextInt()
$9 ==> -352355569
```

By default, JShell imports the following packages:

```
java.io
java.math
java.net
java.nio.file
java.util
java.util.concurrent
java.util.function
java.util.prefs
java.util.regex
java.util.stream
```