Section 2.1

The Basic Java Application

A PROGRAM IS A SEQUENCE of instructions that a computer can execute to perform some task. A simple enough idea, but for the computer to make any use of the instructions, they must be written in a form that the computer can use. This means that programs have to be written in programming languages. Programming languages differ from ordinary human languages in being completely unambiguous and very strict about what is and is not allowed in a program. The rules that determine what is allowed are called the syntax of the language. Syntax rules specify the basic vocabulary of the language and how programs can be constructed using things like loops, branches, and subroutines. A syntactically correct program is one that can be successfully compiled or interpreted; programs that have syntax errors will be rejected (hopefully with a useful error message that will help you fix the problem).

So, to be a successful programmer, you have to develop a detailed knowledge of the syntax of the programming language that you are using. However, syntax is only part of the story. It's not enough to write a program that will run -- you want a program that will run and produce the correct result! That is, the **meaning** of the program has to be right. The meaning of a program is referred to as its semantics. A semantically correct program is one that does what you want it to.

Furthermore, a program can be syntactically and semantically correct but still be a pretty bad program. Using the language correctly is not the same as using it **well**. For example, a good program has "style." It is written in a way that will make it easy for people to read and to understand. It follows conventions that will be familiar to other programmers. And it has an overall design that will make sense to human readers. The computer is completely oblivious to such things, but to a human reader, they are paramount. These aspects of programming are sometimes referred to as pragmatics.

When I introduce a new language feature, I will explain the syntax, the semantics, and some of the pragmatics of that feature. You should memorize the syntax; that's the easy part. Then you should get a feeling for the semantics by following the examples given, making sure that you understand how they work, and maybe writing short programs of your own to test your understanding. And you should try to appreciate and absorb the pragmatics -- this means learning how to use the language feature *well*, with style that will earn you the admiration of other programmers.

Of course, even when you've become familiar with all the individual features of the language, that doesn't make you a programmer. You still have to learn how to construct complex programs to solve particular problems. For that, you'll need both experience and taste. You'll find hints about software development throughout this textbook.

We begin our exploration of Java with the problem that has become traditional for such beginnings:

to write a program that displays the message "Hello World!". This might seem like a trivial problem, but getting a computer to do this is really a big first step in learning a new programming language (especially if it's your first programming language). It means that you understand the basic process of:

1. getting the program text into the computer,
2. compiling the program, and
3. running the compiled program.

The first time through, each of these steps will probably take you a few tries to get right. I won't go into the details here of how you do each of these steps; it depends on the particular computer and Java programming environment that you are using. See Section 2.6 for information about creating and running Java programs in specific programming environments. But in general, you will type the program using some sort of text editor and save the program in a file. Then, you will use some command to try to compile the file. You'll either get a message that the program contains syntax errors, or you'll get a compiled version of the program. In the case of Java, the program is compiled into Java bytecode, not into machine language. Finally, you can run the compiled program by giving some appropriate command. For Java, you will actually use an interpreter to execute the Java bytecode. Your programming environment might automate some of the steps for you -- for example, the compilation step is often done automatically -- but you can be sure that the same three steps are being done in the background.

Here is a Java program to display the message "Hello World!". Don't expect to understand what's going on here just yet; some of it you won't really understand until a few chapters from now:

```
// A program to display the message
// "Hello World!" on standard output

public class HelloWorld {

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

}   // end of class HelloWorld
```

The command that actually displays the message is:

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

This command is an example of a subroutine call statement. It uses a "built-in subroutine" named `System.out.println` to do the actual work. Recall that a subroutine consists of the instructions for performing some task, chunked together and given a name. That name can be used to "call" the subroutine whenever that task needs to be performed. A built-in subroutine is one that is already defined as part of the language and therefore automatically available for use in any program.

When you run this program, the message "Hello World!" (without the quotes) will be displayed on standard output. Unfortunately, I can't say exactly what that means! Java is meant to run on many different platforms, and standard output will mean different things on different platforms. However, you can expect the message to show up in some convenient place. (If you use a command-line interface, like that in Oracle's Java Development Kit, you type in a command to tell the computer to run the program. The computer will type the output from the program, Hello World!, on the next line. In an integrated development environment such as Eclipse, the output might appear somewhere in one of the environment's windows.)

You must be curious about all the other stuff in the above program. Part of it consists of comments. Comments in a program are entirely ignored by the computer; they are there for human readers only. This doesn't mean that they are unimportant. Programs are meant to be read by people as well as by computers, and without comments, a program can be very difficult to understand. Java has two types of comments. The first type, used in the above program, begins with `//` and extends to the end of a line. The computer ignores the `//` and everything that follows it on the same line. Java has another style of comment that can extend over many lines. That type of comment begins with `/*` and ends with `*/`.

Everything else in the program is required by the rules of Java syntax. All programming in Java is done inside "classes." The first line in the above program (not counting the comments) says that this is a class named *HelloWorld*. "HelloWorld," the name of the class, also serves as the name of the program. Not every class is a program. In order to define a program, a class must include a subroutine named `main`, with a definition that takes the form:

```
public static void main(String[] args) {
      statements
}
```

When you tell the Java interpreter to run the program, the interpreter calls this `main()` subroutine, and the statements that it contains are executed. These statements make up the script that tells the computer exactly what to do when the program is executed. The `main()` routine can call subroutines that are defined in the same class or even in other classes, but it is the `main()` routine that determines how and in what order the other subroutines are used.

The word "public" in the first line of `main()` means that this routine can be called from outside the program. This is essential because the `main()` routine is called by the Java interpreter, which is something external to the program itself. The remainder of the first line of the routine is harder to explain at the moment; for now, just think of it as part of the required syntax. The definition of the subroutine -- that is, the instructions that say what it does -- consists of the sequence of "statements" enclosed between braces, `{` and `}`. Here, I've used **statements** as a placeholder for the actual statements that make up the program. Throughout this textbook, I will always use a similar format: anything that you see in **this style of text** (green and in boldface) is a placeholder that describes something you need to type when you write an actual program.

As noted above, a subroutine can't exist by itself. It has to be part of a "class". A program is defined by a public class that takes the form:

```
public class program-name {

    optional-variable-declarations-and-subroutines

    public static void main(String[] args) {
       statements
    }
```

```
        optional-variable-declarations-and-subroutines

    }
```

The name on the first line is the name of the program, as well as the name of the class. (Remember, again, that **program-name** is a placeholder for the actual name!) If the name of the class is HelloWorld, then the class must be saved in a file called `HelloWorld.java`. When this file is compiled, another file named `HelloWorld.class` will be produced. This class file, `HelloWorld.class`, contains the translation of the program into Java bytecode, which can be executed by a Java interpreter. `HelloWorld.java` is called the source code for the program. To execute the program, you only need the compiled `class` file, not the source code.

The layout of the program on the page, such as the use of blank lines and indentation, is not part of the syntax or semantics of the language. The computer doesn't care about layout -- you could run the entire program together on one line as far as it is concerned. However, layout is important to human readers, and there are certain style guidelines for layout that are followed by most programmers. These style guidelines are part of the pragmatics of the Java programming language.

Also note that according to the above syntax specification, a program can contain other subroutines besides `main()`, as well as things called "variable declarations." You'll learn more about these later, but not until Chapter 4.

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