

Programming in Scala

Excerpt

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The difference between this chapter and its appearance in the paper book is that the paper book uses shades of gray, not color, to syntax highlight code. We hope you find this sample chapter useful and enjoyable.

Bill Venners
President, Artima, Inc.

Chapter 2

First Steps in Scala

It's time to write some Scala code. Before we start on the in-depth Scala tutorial, we put in two chapters that will give you the big picture of Scala, and most importantly, get you writing code. We encourage you to actually try out all the code examples presented in this chapter and the next as you go. The best way to start learning Scala is to program in it.

To run the examples in this chapter, you should have a standard Scala installation. To get one, go to <http://www.scala-lang.org/downloads> and follow the directions for your platform. You can also use a Scala plugin for Eclipse, IntelliJ, or NetBeans, but for the steps in this chapter, we'll assume you're using the Scala distribution from [scala-lang.org](http://www.scala-lang.org).¹

If you are a veteran programmer new to Scala, the next two chapters should give you enough understanding to enable you to start writing useful programs in Scala. If you are less experienced, some of the material may seem a bit mysterious to you. But don't worry. To get you up to speed quickly, we had to leave out some details. Everything will be explained in a less "fire hose" fashion in later chapters. In addition, we inserted quite a few footnotes in these next two chapters to point you to later sections of the book where you'll find more detailed explanations.

Step 1. Learn to use the Scala interpreter

The easiest way to get started with Scala is by using the Scala interpreter, an interactive "shell" for writing Scala expressions and programs. Simply type

¹We tested the examples in this book with Scala version 2.7.2.

an expression into the interpreter and it will evaluate the expression and print the resulting value. The interactive shell for Scala is simply called `scala`. You use it by typing `scala` at a command prompt:²

```
$ scala
Welcome to Scala version 2.7.2.
Type in expressions to have them evaluated.
Type :help for more information.

scala>
```

After you type an expression, such as `1 + 2`, and hit enter:

```
scala> 1 + 2
```

The interpreter will print:

```
res0: Int = 3
```

This line includes:

- an automatically generated or user-defined name to refer to the computed value (`res0`, which means result 0),
- a colon (`:`), followed by the type of the expression (`Int`),
- an equals sign (`=`),
- the value resulting from evaluating the expression (`3`).

The type `Int` names the class `Int` in the package `scala`. Packages in Scala are similar to packages in Java: they partition the global namespace and provide a mechanism for information hiding.³ Values of class `Int` correspond to Java's `int` values. More generally, all of Java's primitive types have corresponding classes in the `scala` package. For example, `scala.Boolean` corresponds to Java's `boolean`. `scala.Float` corresponds to Java's `float`.

²If you're using Windows, you'll need to type the `scala` command into the "Command Prompt" DOS box.

³If you're not familiar with Java packages, you can think of them as providing a full name for classes. Because `Int` is a member of package `scala`, "`Int`" is the class's simple name, and "`scala.Int`" is its full name. The details of packages are explained in Chapter 13.

And when you compile your Scala code to Java bytecodes, the Scala compiler will use Java's primitive types where possible to give you the performance benefits of the primitive types.

The `resX` identifier may be used in later lines. For instance, since `res0` was set to 3 previously, `res0 * 3` will be 9:

```
scala> res0 * 3
res1: Int = 9
```

To print the necessary, but not sufficient, Hello, world! greeting, type:

```
scala> println("Hello, world!")
Hello, world!
```

The `println` function prints the passed string to the standard output, similar to `System.out.println` in Java.

Step 2. Define some variables

Scala has two kinds of variables, `vals` and `vars`. A `val` is similar to a final variable in Java. Once initialized, a `val` can never be reassigned. A `var`, by contrast, is similar to a non-final variable in Java. A `var` can be reassigned throughout its lifetime. Here's a `val` definition:

```
scala> val msg = "Hello, world!"
msg: java.lang.String = Hello, world!
```

This statement introduces `msg` as a name for the string "Hello, world!". The type of `msg` is `java.lang.String`, because Scala strings are implemented by Java's `String` class.

If you're used to declaring variables in Java, you'll notice one striking difference here: neither `java.lang.String` nor `String` appear anywhere in the `val` definition. This example illustrates *type inference*, Scala's ability to figure out types you leave off. In this case, because you initialized `msg` with a string literal, Scala inferred the type of `msg` to be `String`. When the Scala interpreter (or compiler) can infer types, it is often best to let it do so rather than fill the code with unnecessary, explicit type annotations. You can, however, specify a type explicitly if you wish, and sometimes you probably should. An explicit type annotation can both ensure the Scala compiler

infers the type you intend, as well as serve as useful documentation for future readers of the code. In contrast to Java, where you specify a variable's type before its name, in Scala you specify a variable's type after its name, separated by a colon. For example:

```
scala> val msg2: java.lang.String = "Hello again, world!"  
msg2: java.lang.String = Hello again, world!
```

Or, since `java.lang` types are visible with their simple names⁴ in Scala programs, simply:

```
scala> val msg3: String = "Hello yet again, world!"  
msg3: String = Hello yet again, world!
```

Going back to the original `msg`, now that it is defined, you can use it as you'd expect, for example:

```
scala> println(msg)  
Hello, world!
```

What you can't do with `msg`, given that it is a `val`, not a `var`, is reassign it.⁵ For example, see how the interpreter complains when you attempt the following:

```
scala> msg = "Goodbye cruel world!"  
<console>:5: error: reassignment to val  
      msg = "Goodbye cruel world!"  
        ^
```

If reassignment is what you want, you'll need to use a `var`, as in:

```
scala> var greeting = "Hello, world!"  
greeting: java.lang.String = Hello, world!
```

Since `greeting` is a `var` not a `val`, you can reassign it later. If you are feeling grouchy later, for example, you could change your greeting to:

```
scala> greeting = "Leave me alone, world!"  
greeting: java.lang.String = Leave me alone, world!
```

⁴The simple name of `java.lang.String` is `String`.

⁵In the interpreter, however, you can *define* a new `val` with a name that was already used before. This mechanism is explained in [Section ??](#).

To enter something into the interpreter that spans multiple lines, just keep typing after the first line. If the code you typed so far is not complete, the interpreter will respond with a vertical bar on the next line.

```
scala> val multiLine =  
    |   "This is the next line."  
multiLine: java.lang.String = This is the next line.
```

If you realize you have typed something wrong, but the interpreter is still waiting for more input, you can escape by pressing enter twice:

```
scala> val oops =  
    |  
    |  
You typed two blank lines. Starting a new command.  
scala>
```

In the rest of the book, we'll leave out the vertical bars to make the code easier to read (and easier to copy and paste from the PDF eBook into the interpreter).

Step 3. Define some functions

Now that you've worked with Scala variables, you'll probably want to write some functions. Here's how you do that in Scala:

```
scala> def max(x: Int, y: Int): Int = {  
    |   if (x > y) x  
    |   else y  
    | }  
max: (Int,Int)Int
```

Function definitions start with `def`. The function's name, in this case `max`, is followed by a comma-separated list of parameters in parentheses. A type annotation must follow every function parameter, preceded by a colon, because the Scala compiler (and interpreter, but from now on we'll just say compiler) does not infer function parameter types. In this example, the function named `max` takes two parameters, `x` and `y`, both of type `Int`. After the close parenthesis of `max`'s parameter list you'll find another “`: Int`” type annotation.

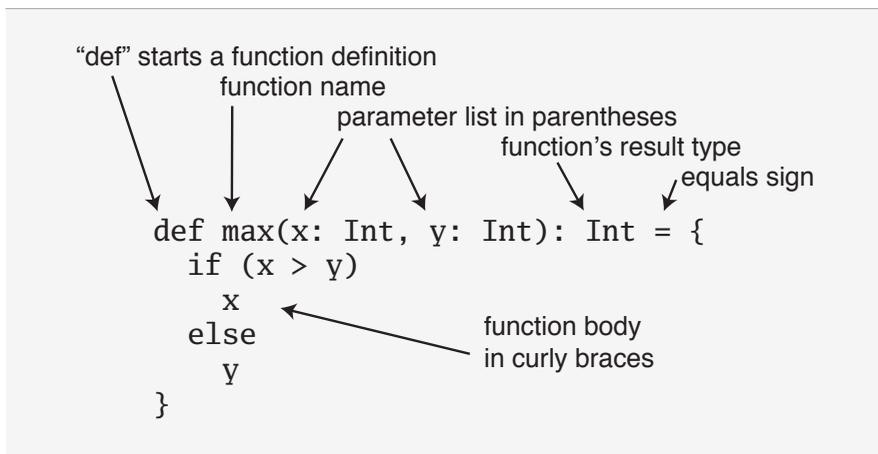


Figure 2.1 · The basic form of a function definition in Scala.

This one defines the result type of the `max` function itself.⁶ Following the function's result type is an equals sign and pair of curly braces that contain the body of the function. In this case, the body contains a single `if` expression, which selects either `x` or `y`, whichever is greater, as the result of the `max` function. As demonstrated here, Scala's `if` expression can result in a value, similar to Java's ternary operator. For example, the Scala expression “`if (x > y) x else y`” behaves similarly to “`(x > y) ? x : y`” in Java. The equals sign that precedes the body of a function hints that in the functional world view, a function defines an expression that results in a value. The basic structure of a function is illustrated in [Figure ??](#).

Sometimes the Scala compiler will require you to specify the result type of a function. If the function is recursive,⁷ for example, you must explicitly specify the function's result type. In the case of `max` however, you may leave the result type off and the compiler will infer it.⁸ Also, if a function consists of just one statement, you can optionally leave off the curly braces. Thus, you could alternatively write the `max` function like this:

⁶In Java, the type of the value returned from a method is its return type. In Scala, that same concept is called *result type*.

⁷A function is recursive if it calls itself.

⁸Nevertheless, it is often a good idea to indicate function result types explicitly, even when the compiler doesn't require it. Such type annotations can make the code easier to read, because the reader need not study the function body to figure out the inferred result type.

```
scala> def max2(x: Int, y: Int) = if (x > y) x else y
max2: (Int,Int)Int
```

Once you have defined a function, you can call it by name, as in:

```
scala> max(3, 5)
res6: Int = 5
```

Here's the definition of a function that takes no parameters and returns no interesting result:

```
scala> def greet() = println("Hello, world!")
greet: ()Unit
```

When you define the `greet()` function, the interpreter will respond with `greet: ()Unit`. “`greet`” is, of course, the name of the function. The empty parentheses indicate the function takes no parameters. And `Unit` is `greet`'s result type. A result type of `Unit` indicates the function returns no interesting value. Scala's `Unit` type is similar to Java's `void` type, and in fact every `void`-returning method in Java is mapped to a `Unit`-returning method in Scala. Methods with the result type of `Unit`, therefore, are only executed for their side effects. In the case of `greet()`, the side effect is a friendly greeting printed to the standard output.

In the next step, you'll place Scala code in a file and run it as a script. If you wish to exit the interpreter, you can do so by entering `:quit` or `:q`.

```
scala> :quit
$
```

Step 4. Write some Scala scripts

Although Scala is designed to help programmers build very large-scale systems, it also scales down nicely to scripting. A script is just a sequence of statements in a file that will be executed sequentially. Put this into a file named `hello.scala`:

```
println("Hello, world, from a script!")
```

then run:⁹

```
$ scala hello.scala
```

And you should get yet another greeting:

```
Hello, world, from a script!
```

Command line arguments to a Scala script are available via a Scala array named `args`. In Scala, arrays are zero based, and you access an element by specifying an index in parentheses. So the first element in a Scala array named `steps` is `steps(0)`, not `steps[0]`, as in Java. To try this out, type the following into a new file named `helloarg.scala`:

```
// Say hello to the first argument
println("Hello, "+ args(0) +"!")
```

then run:

```
$ scala helloarg.scala planet
```

In this command, "planet" is passed as a command line argument, which is accessed in the script as `args(0)`. Thus, you should see:

```
Hello, planet!
```

Note that this script included a comment. The Scala compiler will ignore characters between `//` and the next end of line and any characters between `/*` and `*/`. This example also shows Strings being concatenated with the `+` operator. This works as you'd expect. The expression "Hello, "+"world!" will result in the string "Hello, world!".¹⁰

Step 5. Loop with `while`; decide with `if`

To try out a `while`, type the following into a file named `printargs.scala`:

⁹You can run scripts without typing "scala" on Unix and Windows using a "pound-bang" syntax, which is shown in [Appendix ??](#).

¹⁰You can also put spaces around the plus operator, as in "Hello, " + "world!". In this book, however, we'll leave the space off between '+' and string literals.

```
var i = 0
while (i < args.length) {
  println(args(i))
  i += 1
}
```

Note

Although the examples in this section help explain while loops, they do not demonstrate the best Scala style. In the next section, you'll see better approaches that avoid iterating through arrays with indexes.

This script starts with a variable definition, `var i = 0`. Type inference gives `i` the type `scala.Int`, because that is the type of its initial value, `0`. The `while` construct on the next line causes the block (the code between the curly braces) to be repeatedly executed until the boolean expression `i < args.length` is false. `args.length` gives the length of the `args` array. The block contains two statements, each indented two spaces, the recommended indentation style for Scala. The first statement, `println(args(i))`, prints out the `i`th command line argument. The second statement, `i += 1`, increments `i` by one. Note that Java's `++i` and `i++` don't work in Scala. To increment in Scala, you need to say either `i = i + 1` or `i += 1`. Run this script with the following command:

```
$ scala printargs.scala Scala is fun
```

And you should see:

```
Scala
is
fun
```

For even more fun, type the following code into a new file with the name `echoargs.scala`:

```
var i = 0
while (i < args.length) {
  if (i != 0)
    print(" ")
  print(args(i))
  i += 1
}
```

```
}  
println()
```

In this version, you've replaced the `println` call with a `print` call, so that all the arguments will be printed out on the same line. To make this readable, you've inserted a single space before each argument except the first via the `if (i != 0)` construct. Since `i != 0` will be `false` the first time through the `while` loop, no space will get printed before the initial argument. Lastly, you've added one more `println` to the end, to get a line return after printing out all the arguments. Your output will be very pretty indeed. If you run this script with the following command:

```
$ scala echoargs.scala Scala is even more fun
```

You'll get:

```
Scala is even more fun
```

Note that in Scala, as in Java, you must put the boolean expression for a `while` or an `if` in parentheses. (In other words, you can't say in Scala things like `if i < 10` as you can in a language such as Ruby. You must say `if (i < 10)` in Scala.) Another similarity to Java is that if a block has only one statement, you can optionally leave off the curly braces, as demonstrated by the `if` statement in `echoargs.scala`. And although you haven't seen any of them, Scala does use semicolons to separate statements as in Java, except that in Scala the semicolons are very often optional, giving some welcome relief to your right little finger. If you had been in a more verbose mood, therefore, you could have written the `echoargs.scala` script as follows:

```
var i = 0;  
while (i < args.length) {  
  if (i != 0) {  
    print(" ");  
  }  
  print(args(i));  
  i += 1;  
}  
println();
```

Step 6. Iterate with `foreach` and `for`

Although you may not have realized it, when you wrote the `while` loops in the previous step, you were programming in an *imperative* style. In the imperative style, which is the style you normally use with languages like Java, C++, and C, you give one imperative command at a time, iterate with loops, and often mutate state shared between different functions. Scala enables you to program imperatively, but as you get to know Scala better, you'll likely often find yourself programming in a more *functional* style. In fact, one of the main aims of this book is to help you become as comfortable with the functional style as you are with imperative style.

One of the main characteristics of a functional language is that functions are first class constructs, and that's very true in Scala. For example, another (far more concise) way to print each command line argument is:

```
args.foreach(arg => println(arg))
```

In this code, you call the `foreach` method on `args`, and pass in a function. In this case, you're passing in a function literal that takes one parameter named `arg`. The body of the function is `println(arg)`. If you type the above code into a new file named `pa.scala`, and execute with the command:

```
$ scala pa.scala Concise is nice
```

You should see:

```
Concise
is
nice
```

In the previous example, the Scala interpreter infers the type of `arg` to be `String`, since `String` is the element type of the array on which you're calling `foreach`. If you'd prefer to be more explicit, you can mention the type name, but when you do you'll need to wrap the argument portion in parentheses (which is the normal form of the syntax anyway):

```
args.foreach((arg: String) => println(arg))
```

Running this script has the same behavior as the previous one.

If you're in the mood for more conciseness instead of more explicitness, you can take advantage of a special shorthand in Scala. If a function literal

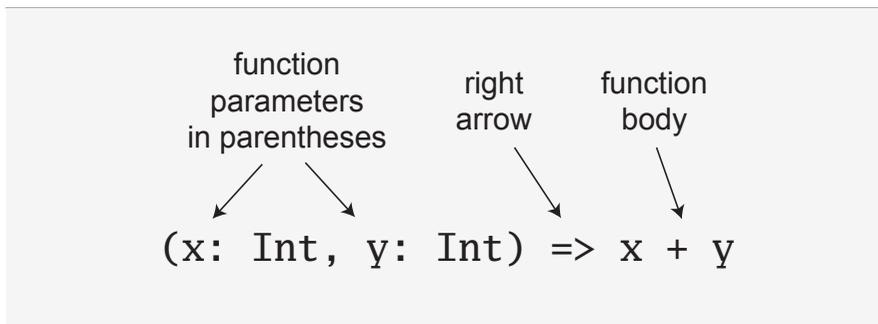


Figure 2.2 · The syntax of a function literal in Scala.

consists of one statement that takes a single argument, you need not explicitly name and specify the argument.¹¹ Thus, the following code also works:

```
args.foreach(println)
```

To summarize, the syntax for a function literal is a list of named parameters, in parentheses, a right arrow, and then the body of the function. This syntax is illustrated in [Figure ??](#).

Now, by this point you may be wondering what happened to those trusty `for` loops you have been accustomed to using in imperative languages such as Java or C. In an effort to guide you in a functional direction, only a functional relative of the imperative `for` (called a *for expression*) is available in Scala. While you won't see their full power and expressiveness until you reach (or peek ahead to) [Section ??](#), we'll give you a glimpse here. In a new file named `forargs.scala`, type the following:

```
for (arg <- args)
  println(arg)
```

The parentheses after the “`for`” contain `arg <- args`.¹² To the right of the `<-` symbol is the familiar `args` array. To the left of `<-` is “`arg`”, the name of a `val`, not a `var`. (Because it is always a `val`, you just write “`arg`” by itself, not “`val arg`”.) Although `arg` may seem to be a `var`, because it will get a new value on each iteration, it really is a `val`: `arg` can't be reassigned

¹¹This shorthand, called a *partially applied function*, is described in [Section ??](#).

¹²You can say “in” for the `<-` symbol. You'd read `for (arg <- args)`, therefore, as “for `arg` in `args`.”

inside the body of the `for` expression. Instead, for each element of the `args` array, a *new* `arg val` will be created and initialized to the element value, and the body of the `for` will be executed.

If you run the `forargs.scala` script with the command:

```
$ scala forargs.scala for arg in args
```

You'll see:

```
for  
arg  
in  
args
```

Scala's `for` expression can do much more than this, but this example is enough to get you started. We'll show you more about `for` in [Section ??](#) and [Chapter 23](#).

Conclusion

In this chapter, you learned some Scala basics and, hopefully, took advantage of the opportunity to write a bit of Scala code. In the next chapter, we'll continue this introductory overview and get into more advanced topics.