SCALA QUICK GUIDE

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SCALA - OVERVIEW

Scala, short for Scalable Language, is a hybrid functional programming language. It was created by Martin Odersky and it was first released in 2003.

Scala smoothly integrates features of object-oriented and functional languages and Scala is compiled to run on the Java Virtual Machine. Many existing companies, who depend on Java for business critical applications, are turning to Scala to boost their development productivity, applications scalability and overall reliability.

Here is the important list of features, which make Scala a first choice of the application developers.

Scala is object-oriented:

Scala is a pure object-oriented language in the sense that every value is an object. Types and behavior of objects are described by classes and traits which will be explained in subsequent chapters.

Classes are extended by **subclassing** and a flexible **mixin-based composition** mechanism as a clean replacement for multiple inheritance.

Scala is functional:

Scala is also a functional language in the sense that every function is a value and because every value is an object so ultimately every function is an object.

Scala provides a lightweight syntax for defining **anonymous functions**, it supports **higher-order functions**, it allows functions to be **nested**, and supports **currying**. These concepts will be explained in subsequent chapters.

Scala is statically typed:

Scala, unlike some of the other statically typed languages, does not expect you to provide redundant type information. You don't have to specify a type in most cases, and you certainly don't have to repeat it.

Scala runs on the JVM:

Scala is compiled into Java Byte Code which is executed by the Java Virtual Machine *JVM*. This means that Scala and Java have a common runtime platform. You can easily move from Java to Scala.

The Scala compiler compiles your Scala code into Java Byte Code, which can then be executed by the **scala** command. The **scala** command is similar to the **java** command, in that it executes your compiled Scala code.

Scala can Execute Java Code:

Scala enables you to use all the classes of the Java SDK's in Scala, and also your own, custom Java classes, or your favourite Java open source projects.

Scala vs Java:

Scala has a set of features, which differ from Java. Some of these are:

- All types are objects.
- Type inference.
- Nested Functions.

- Functions are objects.
- Domain specific language *DSL* support.
- Traits.
- Closures.
- Concurrency support inspired by Erlang.

Scala Web Frameworks:

Scala is being used everywhere and importantly in enterprise web applications. You can check few of the most popular Scala web frameworks:

SCALA ENVIRONMENT SETUP

The Scala language can be installed on any UNIX-like or Windows system. Before you start installing Scala on your machine, you must have Java 1.5 or greater installed on your computer.

Installing Scala on Windows:

Step 1: JAVA Setup:

First, you must set the JAVA_HOME environment variable and add the JDK's bin directory to your PATH variable. To verify if everything is fine, at command prompt, type **java -version** and press Enter. You should see something like the following:

```
C:\>java -version
java version "1.6.0_15"
Java(TM) SE Runtime Environment (build 1.6.0_15-b03)
Java HotSpot(TM) 64-Bit Server VM (build 14.1-b02, mixed mode)

C:\>
```

Next, test to see that the Java compiler is installed. Type **javac -version**. You should see something like the following:

```
C:\>javac -version
javac 1.6.0_15

C:\>
```

Step 2: Scala Setup:

Next, you can download Scala from http://www.scala-lang.org/downloads. At the time of writing this tutorial I downloaded *scala-2.9.0.1-installer.jar* and put it in C:/> directory. Make sure you have admin privilege to proceed. Now execute the following command at command prompt:

```
C:\>java -jar scala-2.9.0.1-installer.jar

C:\>
```

Above command will display an installation wizard, which will guide you to install scala on your windows machine. During installation, it will ask for license agreement, simply accept it and further it will ask a path where scala will be installed. I selected default given path *C:\Program Files\scala*, you can select a suitable path as per your convenience. Finally, open a new command prompt and type **scala -version** and press Enter. You should see the following:

```
C:\>scala -version
Scala code runner version 2.9.0.1 -- Copyright 2002-2011, LAMP/EPFL

C:\>
```

Congratulations, you have installed Scala on your Windows machine. Next section will teach you how to install scala on your Mac OS X and Unix/Linux machines.

Installing Scala on Mac OS X and Linux

Step 1: JAVA Setup:

Make sure you have got the Java JDK 1.5 or greater installed on your computer and set JAVA_HOME environment variable and add the JDK's bin directory to your PATH variable. To verify if everything is fine, at command prompt, type **java -version** and press Enter. You should see something like the following:

```
$java -version
java version "1.5.0_22"
Java(TM) 2 Runtime Environment, Standard Edition (build 1.5.0_22-b03)
Java HotSpot(TM) Server VM (build 1.5.0_22-b03, mixed mode)
$
```

Next, test to see that the Java compiler is installed. Type **javac -version**. You should see something like the following:

```
$javac -version
javac 1.5.0_22
javac: no source files
Usage: javac <options> <source files>
.............................................

$
```

Step 2: Scala Setup:

Next, you can download Scala from http://www.scala-lang.org/downloads. At the time of writing this tutorial I downloaded *scala-2.9.0.1-installer.jar* and put it in /tmp directory. Make sure you have admin privilege to proceed. Now, execute the following command at command prompt:

```
$java -jar scala-2.9.0.1-installer.jar
Welcome to the installation of scala 2.9.0.1!
The homepage is at: http://scala-lang.org/
press 1 to continue, 2 to quit, 3 to redisplay
1
.............................................
[ Starting to unpack ]
[ Processing package: Software Package Installation (1/1) ]
[ Unpacking finished ]
[ Console installation done ]

$
```

During installation, it will ask for license agreement, to accept it type 1 and it will ask a path where scala will be installed. I entered */usr/local/share*, you can select a suitable path as per your convenience. Finally, open a new command prompt and type **scala -version** and press Enter. You should see the following:

```
$scala -version
Scala code runner version 2.9.0.1 -- Copyright 2002-2011, LAMP/EPFL

$
```

Congratulations, you have installed Scala on your UNIX/Linux machine.

SCALA BASIC SYNTAX

If you have good understanding on Java, then it will be very easy for you to learn Scala. The biggest syntactic difference between Scala and Java is that the ; line end character is optional. When we consider a Scala program it can be defined as a collection of objects that communicate via invoking each others methods. Let us now briefly look into what do class, object, methods and instant variables mean.

- **Object -** Objects have states and behaviors. Example: A dog has states - color, name, breed as well as behaviors - wagging, barking, eating. An object is an instance of a class.
- **Class -** A class can be defined as a template/blueprint that describes the behaviors/states that object of its type support.
- **Methods -** A method is basically a behavior. A class can contain many methods. It is in methods where the logics are written, data is manipulated and all the actions are executed.
- **Fields -** Each object has its unique set of instant variables, which are called fields. An object's state is created by the values assigned to these fields.

First Scala Program:

Interactive Mode Programming:

Invoking the interpreter without passing a script file as a parameter brings up the following prompt:

```
C:\>scala
Welcome to Scala version 2.9.0.1
Type in expressions to have them evaluated.
Type :help for more information.

scala>
```

Type the following text to the right of the Scala prompt and press the Enter key:

```
scala> println("Hello, Scala!");
```

This will produce the following result:

```
Hello, Scala!
```

Script Mode Programming :

Let us look at a simple code that would print the words *Hello, World!*.

```
object HelloWorld {
   /* This is my first java program.
    * This will print 'Hello World' as the output
    */
   def main(args: Array[String]) {
      println("Hello, world!") // prints Hello World
   }
}
```

Let's look at how to save the file, compile and run the program. Please follow the steps given below:

- Open notepad and add the code as above.
- Save the file as: HelloWorld.scala.
- Open a command prompt window and go o the directory where you saved the program file. Assume it is C:\>
- Type 'scalac HelloWorld.scala' and press enter to compile your code. If there are no errors in

your code the command prompt will take you to the next line.

- Above command will generate a few class files in the current directory. One of them will be called **HelloWorld.class**. This is a bytecode which will run on Java Virtual Machine *JVM*.
- Now, type 'scala HelloWorld' to run your program.
- You will be able to see 'Hello, World!' printed on the window.

```
C:\> scalac HelloWorld.scala
C:\> scala HelloWorld
Hello, World!
```

Basic Syntax:

About Scala programs, it is very important to keep in mind the following points.

- **Case Sensitivity -** Scala is case-sensitive, which means identifier **Hello** and **hello** would have different meaning in Scala.
- **Class Names -** For all class names, the first letter should be in Upper Case.

  If several words are used to form a name of the class, each inner word's first letter should be in Upper Case.

  Example *class MyFirstScalaClass*
- **Method Names -** All method names should start with a Lower Case letter.

  If several words are used to form the name of the method, then each inner word's first letter should be in Upper Case.

  Example *def myMethodName*
- **Program File Name -** Name of the program file should exactly match the object name.

  When saving the file you should save it using the object name *Rememberscalaiscase − sensitive* and append '.scala' to the end of the name.
  ifthefilenameandtheobjectnamedonotmatchyourprogramwillnotcompile.

  Example: Assume 'HelloWorld' is the object name. Then the file should be saved as '*HelloWorld.scala*'
- **def main***args*: *Array*[*String*] **-** Scala program processing starts from the main method which is a mandatory part of every Scala Program.

Scala Identifiers:

All Scala components require names. Names used for objects, classes, variables and methods are called identifiers. A keyword cannot be used as an identifier and identifiers are case-sensitive. There are following four types of identifiers supported by Scala:

Alphanumeric identifiers

An alphanumeric identifier starts with a letter or underscore, which can be followed by further letters, digits, or underscores. The '$' character is a reserved keyword in Scala and should not be used in identifiers. Following are legal alphanumeric identifiers:

```
age, salary, _value,  __1_value
```

Following are illegal identifiers:

```
$salary, 123abc, -salary
```

Operator identifiers

An operator identifier consists of one or more operator characters. Operator characters are printable ASCII characters such as +, :, ?, ~ or #. Following are legal operator identifiers:

```
+ ++ ::: <?> :>
```

The Scala compiler will internally "mangle" operator identifiers to turn them into legal Java identifiers with embedded *characters. Forinstance, theidentifier*: − > *wouldberepresentedinternallyas*colon*minus* greater.

Mixed identifiers

A mixed identifier consists of an alphanumeric identifier, which is followed by an underscore and an operator identifier. Following are legal mixed identifiers:

```
unary_+,  myvar_=
```

Here, unary_+ used as a method name defines a unary + operator and myvar_= used as method name defines an assignment operator.

Literal identifiers

A literal identifier is an arbitrary string enclosed in back ticks ` . . . `. Following are legal literal identifiers:

```
`x` `<clinit>` `yield`
```

Scala Keywords:

The following list shows the reserved words in Scala. These reserved words may not be used as constant or variable or any other identifier names.

abstract	case	catch	class
def	do	else	extends
false	final	finally	for
forSome	if	implicit	import
lazy	match	new	null
object	override	package	private
protected	return	sealed	super
this	throw	trait	try
true	type	val	var
while	with	yield	
-	:	=	=>
<-	<:	<%	>:
#	@		

Comments in Scala

Scala supports single-line and multi-line comments very similar to Java. Multi-line comments may be nested, but are required to be properly nested. All characters available inside any comment are

ignored by Scala compiler.

```
object HelloWorld {
   /* This is my first java program.
    * This will print 'Hello World' as the output
    * This is an example of multi-line comments.
    */
   def main(args: Array[String]) {
      // Prints Hello World
      // This is also an example of single line comment.
      println("Hello, world!")
   }
}
```

Blank Lines and Whitespace:

A line containing only whitespace, possibly with a comment, is known as a blank line, and Scala totally ignores it. Tokens may be separated by whitespace characters and/or comments.

Newline Characters:

Scala is a line-oriented language where statements may be terminated by semicolons ; or newlines. A semicolon at the end of a statement is usually optional. You can type one if you want but you don't have to if the statement appears by itself on a single line. On the other hand, a semicolon is required if you write multiple statements on a single line:

```
val s = "hello"; println(s)
```

Scala Packages:

A package is a named module of code. For example, the Lift utility package is net.liftweb.util. The package declaration is the first non-comment line in the source file as follows:

```
package com.liftcode.stuff
```

Scala packages can be imported so that they can be referenced in the current compilation scope. The following statement imports the contents of the scala.xml package:

```
import scala.xml._
```

You can import a single class and object, for example, HashMap from the scala.collection.mutable package:

```
import scala.collection.mutable.HashMap
```

You can import more than one class or object from a single package, for example, TreeMap and TreeSet from the scala.collection.immutable package:

```
import scala.collection.immutable.{TreeMap, TreeSet}
```

SCALA DATA TYPES

Scala has all the same data types as Java, with the same memory footprint and precision. Following is the table giving details about all the data types available in Scala:

Data Type	Description
Byte	8 bit signed value. Range from -128 to 127
Short	16 bit signed value. Range -32768 to 32767

Int	32 bit signed value. Range -2147483648 to 2147483647
Long	64 bit signed value. -9223372036854775808 to 9223372036854775807
Float	32 bit IEEE 754 single-precision float
Double	64 bit IEEE 754 double-precision float
Char	16 bit unsigned Unicode character. Range from U+0000 to U+FFFF
String	A sequence of Chars
Boolean	Either the literal true or the literal false
Unit	Corresponds to no value
Null	null or empty reference
Nothing	The subtype of every other type; includes no values
Any	The supertype of any type; any object is of type *Any*
AnyRef	The supertype of any reference type

All the data types listed above are objects. There are no primitive types like in Java. This means that you can call methods on an Int, Long, etc.

Scala Basic Literals:

The rules Scala uses for literals are simple and intuitive. This section explains all basic Scala Literals.

Integer Literals

Integer literals are usually of type Int, or of type Long when followed by a L or l suffix. Here are some integer literals:

```
0
035
21
0xFFFFFFFF
0777L
```

Floating Point Literals

Floating point literals are of type Float when followed by a floating point type suffix F or f, and are of type Double otherwise. Here are some floating point literals:

```
0.0
1e30f
3.14159f
1.0e100
.1
```

Boolean Literals

The boolean literals **true** and **false** are members of type Boolean.

Symbol Literals

A symbol literal 'x is a shorthand for the expression **scala.Symbol**"x". Symbol is a case class, which is defined as follows.

```
package scala
final case class Symbol private (name: String) {
   override def toString: String = "'" + name
}
```

Character Literals

A character literal is a single character enclosed in quotes. The character is either a printable unicode character or is described by an escape sequence. Here are some character literals:

```
'a'
'\u0041'
'\n'
'\t'
```

String Literals

A string literal is a sequence of characters in double quotes. The characters are either printable unicode character or are described by escape sequences. Here are some string literals:

```
"Hello,\nWorld!"
"This string contains a \" character."
```

Multi-Line Strings

A multi-line string literal is a sequence of characters enclosed in triple quotes """ ... """. The sequence of characters is arbitrary, except that it may contain three or more consuctive quote characters only at the very end.

Characters must not necessarily be printable; newlines or other control characters are also permitted. Here is a multi-line string literal:

```
"""the present string
spans three
lines."""
```

The Null Value

The null value is of type **scala.Null** and is thus compatible with every reference type. It denotes a reference value which refers to a special "null" object.

Escape Sequences:

The following escape sequences are recognized in character and string literals.

Escape Sequences	Unicode	Description
\b	\u0008	backspace BS
\t	\u0009	horizontal tab HT
\n	\u000c	formfeed FF
\f	\u000c	formfeed FF
\r	\u000d	carriage return CR
\"	\u0022	double quote "
\'	\u0027	single quote .

\\	\u005c	backslash \

A character with Unicode between 0 and 255 may also be represented by an octal escape, i.e., a backslash '\' followed by a sequence of up to three octal characters. Following is the example to show few escape sequence characters:

```
object Test {
   def main(args: Array[String]) {
      println("Hello\tWorld\n\n" );
   }
}
```

When the above code is compiled and executed, it produces the following result:

```
Hello   World
```

SCALA VARIABLES

Variables are nothing but reserved memory locations to store values. This means that when you create a variable you reserve some space in memory.

Based on the data type of a variable, the compiler allocates memory and decides what can be stored in the reserved memory. Therefore, by assigning different data types to variables, you can store integers, decimals, or characters in these variables.

Variable Declaration

Scala has the different syntax for the declaration of variables and they can be defined as value, i.e., constant or a variable. Following is the syntax to define a variable using **var** keyword:

```
var myVar : String = "Foo"
```

Here, myVar is declared using the keyword var. This means that it is a variable that can change value and this is called mutable variable. Following is the syntax to define a variable using **val** keyword:

```
val myVal : String = "Foo"
```

Here, myVal is declared using the keyword val. This means that it is a variable that can not be changed and this is called immutable variable.

Variable Data Types:

The type of a variable is specified after the variable name, and before equals sign. You can define any type of Scala variable by mentioning its data type as follows:

```
val or val VariableName : DataType [=  Initial Value]
```

If you do not assign any initial value to a variable, then it is valid as follows:

```
var myVar :Int;
val myVal :String;
```

Variable Type Inference:

When you assign an initial value to a variable, the Scala compiler can figure out the type of the variable based on the value assigned to it. This is called variable type inference. Therefore, you could write these variable declarations like this:

```
var myVar = 10;
val myVal = "Hello, Scala!";
```

Here by default myVar will be Int type and myVal will become String type variable.

Multiple assignments:

Scala supports multiple assignments. If a code block or method returns a Tuple, the Tuple can be assigned to a val variable. [Note: We will study Tuple in subsequent chapters.]

```
val (myVar1: Int, myVar2: String) = Pair(40, "Foo")
```

And the type inferencer gets it right:

```
val (myVar1, myVar2) = Pair(40, "Foo")
```

Variable Types:

Variables in Scala can have three different scopes depending on the place where they are being used. They can exist as **fields**, as **method parameters** and as **local variables**. Below are the details about each type of scope:

Fields:

Fields are variables that belong to an object. The fields are accessible from inside every method in the object. Fields can also be accessible outside the object depending on what access modifiers the field is declared with. Object fields can be both mutable or immutable types and can be defined using either var or val.

Method Parameters:

Method parameters are variables, which are used to pass the value inside a method when the method is called. Method parameters are only accessible from inside the method but the objects passed in may be accessible from the outside, if you have a reference to the object from outside the method. Method parameters are always mutable and defined by val keyword.

Local Variables:

Local variables are variables declared inside a method. Local variables are only accessible from inside the method, but the objects you create may escape the method if you return them from the method. Local variables can be both mutable or immutable types and can be defined using either var or val.

SCALA ACCESS MODIFIERS

Members of packages, classes, or objects can be labeled with the access modifiers **private** and **protected**, and if we are not using either of these two keywords, then access will be assumed as **public**. These modifiers restrict accesses to the members to certain regions of code. To use an access modifier, you include its keyword in the definition of members of package, class or object as we will see in the following section.

Private members:

A **private** member is visible only inside the class or object that contains the member definition. Following is the example:

```
class Outer {
   class Inner {
      private def f() { println("f") }
      class InnerMost {
         f() // OK
      }
   }
   (new Inner).f() // Error: f is not accessible
}
```

In Scala, the access new Inner.f is illegal because f is declared private in Inner and the access is not from within class Inner. By contrast, the first access to f in class InnerMost is OK, because that access is contained in the body of class Inner. Java would permit both accesses because it lets an outer class access private members of its inner classes.

Protected members:

A **protected** member is only accessible from subclasses of the class in which the member is defined. Following is the example:

```
package p {
   class Super {
      protected def f() { println("f") }
   }
   class Sub extends Super {
      f()
   }
   class Other {
     (new Super).f() // Error: f is not accessible
   }
}
```

The access to f in class Sub is OK because f is declared protected in Super and Sub is a subclass of Super. By contrast the access to f in Other is not permitted, because Other does not inherit from Super. In Java, the latter access would be still permitted because Other is in the same package as Sub.

Public members:

Every member not labeled private or protected is public. There is no explicit modifier for public members. Such members can be accessed from anywhere. Following is the example:

```
class Outer {
   class Inner {
      def f() { println("f") }
      class InnerMost {
         f() // OK
      }
   }
   (new Inner).f() // OK because now f() is public
}
```

Scope of protection:

Access modifiers in Scala can be augmented with qualifiers. A modifier of the form private[X] or protected[X] means that access is private or protected "up to" X, where X designates some enclosing package, class or singleton object. Consider the following example:

```
package society {
   package professional {
      class Executive {
         private[professional] var workDetails = null
         private[society] var friends = null
         private[this] var secrets = null

         def help(another : Executive) {
            println(another.workDetails)
            println(another.secrets) //ERROR
         }
      }
   }
}
```

Note the following points from the above example:

- Variable *workDetails* will be accessible to any class within the enclosing package *professional*.
- Variable *friends* will be accessible to any class within the enclosing package *society*.
- Variable *secrets* will be accessible only on the implicit object within instance methods this.

SCALA OPERATORS

An operator is a symbol that tells the compiler to perform specific mathematical or logical manipulations. Scala is rich in built-in operators and provides following type of operators:

- Arithmetic Operators
- Relational Operators
- Logical Operators
- Bitwise Operators
- Assignment Operators

This chapter will examine the arithmetic, relational, logical, bitwise, assignment and other operators one by one.

Arithmetic Operators:

There are following arithmetic operators supported by Scala language:

Assume variable A holds 10 and variable B holds 20, then:

Show Examples

Operator	Description	Example
+	Adds two operands	A + B will give 30
-	Subtracts second operand from the first	A - B will give -10
*	Multiplies both operands	A * B will give 200
/	Divides numerator by de-numerator	B / A will give 2
%	Modulus Operator and remainder of after an integer division	B % A will give 0

Relational Operators:

There are following relational operators supported by Scala language

Assume variable A holds 10 and variable B holds 20, then:

Show Examples

Operator	Description	Example
==	Checks if the values of two operands are equal or not, if yes then condition becomes true.	A == B is not true.
!=	Checks if the values of two operands are equal or not, if values are not equal then condition becomes true.	A != B is true.

>	Checks if the value of left operand is greater than the value of right operand, if yes then condition becomes true.	A > B is not true.
<	Checks if the value of left operand is less than the value of right operand, if yes then condition becomes true.	A < B is true.
>=	Checks if the value of left operand is greater than or equal to the value of right operand, if yes then condition becomes true.	A >= B is not true.
<=	Checks if the value of left operand is less than or equal to the value of right operand, if yes then condition becomes true.	A <= B is true.

Logical Operators:

There are following logical operators supported by Scala language

Assume variable A holds 1 and variable B holds 0, then:

Show Examples

Operator	Description	Example
&&	Called Logical AND operator. If both the operands are non zero then condition becomes true.	A && B is false.
||	Called Logical OR Operator. If any of the two operands is non zero then condition becomes true.	A || B is true.
!	Called Logical NOT Operator. Use to reverses the logical state of its operand. If a condition is true then Logical NOT operator will make false.	!A && B is true.

Bitwise Operators:

Bitwise operator works on bits and perform bit by bit operation. The truth tables for &, |, and ^ are as follows:

p	q	p & q	p | q	p ^ q
0	0	0	0	0
0	1	0	1	1
1	1	1	1	0
1	0	0	1	1

Assume if A = 60; and B = 13; now in binary format they will be as follows:

A = 0011 1100

B = 0000 1101

A&B = 0000 1100

A|B = 0011 1101

A^B = 0011 0001

~A = 1100 0011

The Bitwise operators supported by Scala language is listed in the following table. Assume variable A holds 60 and variable B holds 13, then:

Show Examples

Operator	Description	Example
&	Binary AND Operator copies a bit to the result if it exists in both operands.	A & B will give 12, which is 0000 1100
|	Binary OR Operator copies a bit if it exists in eather operand.	A | B will give 61, which is 0011 1101
^	Binary XOR Operator copies the bit if it is set in one operand but not both.	A ^ B will give 49, which is 0011 0001
~	Binary Ones Complement Operator is unary and has the efect of 'flipping' bits.	~A will give -61, which is 1100 0011 in 2's complement form due to a signed binary number.
<<	Binary Left Shift Operator. The left operands value is moved left by the number of bits specified by the right operand.	A << 2 will give 240, which is 1111 0000
>>	Binary Right Shift Operator. The left operands value is moved right by the number of bits specified by the right operand.	A >> 2 will give 15, which is 1111
>>>	Shift right zero fill operator. The left operands value is moved right by the number of bits specified by the right operand and shifted values are filled up with zeros.	A >>>2 will give 15 which is 0000 1111

Assignment Operators:

There are following assignment operators supported by Scala language:

Show Examples

Operator	Description	Example
=	Simple assignment operator, Assigns values from right side operands to left side operand	C = A + B will assign value of A + B into C
+=	Add AND assignment operator, It adds right operand to the left operand and assign the result to left operand	C += A is equivalent to C = C + A

-=	Subtract AND assignment operator, It subtracts right operand from the left operand and assign the result to left operand	C -= A is equivalent to C = C - A
*=	Multiply AND assignment operator, It multiplies right operand with the left operand and assign the result to left operand	C *= A is equivalent to C = C * A
/=	Divide AND assignment operator, It divides left operand with the right operand and assign the result to left operand	C /= A is equivalent to C = C / A
%=	Modulus AND assignment operator, It takes modulus using two operands and assign the result to left operand	C %= A is equivalent to C = C % A
<<=	Left shift AND assignment operator	C <<= 2 is same as C = C << 2
>>=	Right shift AND assignment operator	C >>= 2 is same as C = C >> 2
&=	Bitwise AND assignment operator	C &= 2 is same as C = C & 2
^=	bitwise exclusive OR and assignment operator	C ^= 2 is same as C = C ^ 2
|=	bitwise inclusive OR and assignment operator	C |= 2 is same as C = C | 2

Operators Precedence in Scala:

Operator precedence determines the grouping of terms in an expression. This affects how an expression is evaluated. Certain operators have higher precedence than others; for example, the multiplication operator has higher precedence than the addition operator:

For example x = 7 + 3 * 2; here, x is assigned 13, not 20 because operator * has higher precedence than +, so it first get multiplied with 3*2 and then adds into 7.

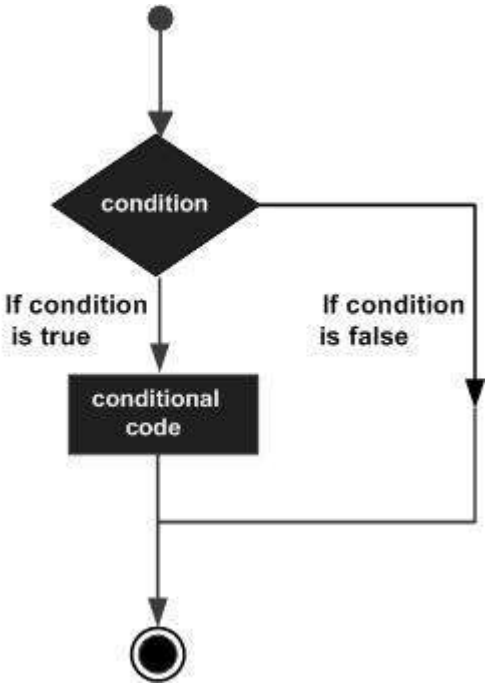
Here, operators with the highest precedence appear at the top of the table, those with the lowest appear at the bottom. Within an expression, higher precedence operators will be evaluated first.

Category	Operator	Associativity
Postfix	[]	Left toright
Unary	! ~	Right to left
Multiplicative	* / %	Left to right
Additive	+ -	Left to right
Shift	>> >>> <<	Leftto right
Relational	> >= < <=	Left to right
Equality	== !=	Left to right
Bitwise AND	&	Left to right
Bitwise XOR	^	Left to right
Bitwise OR	|	Left to right

Logical AND	&&	Left to right
Logical OR	||	Left to right
Assignment	= += -= *= /= %= >>= <<= &= ^= |=	Right to left
Comma	,	Left to right

SCALA IF...ELSE STATEMENTS

Following is the general form of a typical decision making IF...ELSE structure found in most of the programming languages:



The if Statement:

An if statement consists of a Boolean expression followed by one or more statements.

Syntax:

The syntax of an if statement is:

```
if(Boolean_expression)
{
   // Statements will execute if the Boolean expression is true
}
```

If the boolean expression evaluates to true then the block of code inside the if statement will be executed. If not, the first set of code after the end of the if statement after the closing curly brace will be executed.

Example:

```
object Test {
   def main(args: Array[String]) {
      var x = 10;

      if( x < 20 ){
         println("This is if statement");
      }
   }
}
```

This would produce following result:

```
C:/>scalac Test.scala
C:/>scala Test
This is if statement

C:/>
```

The if...else Statement:

An if statement can be followed by an optional *else* statement, which executes when the Boolean expression is false.

Syntax:

The syntax of a if...else is:

```
if(Boolean_expression){
   //Executes when the Boolean expression is true
}else{
   //Executes when the Boolean expression is false
}
```

Example:

```
object Test {
   def main(args: Array[String]) {
      var x = 30;

      if( x < 20 ){
         println("This is if statement");
      }else{
         println("This is else statement");
      }
   }
}
```

This would produce the following result:

```
C:/>scalac Test.scala
C:/>scala Test
This is else statement

C:/>
```

The if...else if...else Statement:

An if statement can be followed by an optional *else if...else* statement, which is very useful to test various conditions using single if...else if statement.

When using if , else if , else statements there are few points to keep in mind.

- An if can have zero or one else's and it must come after any else if's.
- An if can have zero to many else if's and they must come before the else.
- Once an else if succeeds, none of he remaining else if's or else's will be tested.

Syntax:

The syntax of a if...else if...else is:

```
if(Boolean_expression 1){
```

```
   //Executes when the Boolean expression 1 is true
}else if(Boolean_expression 2){
   //Executes when the Boolean expression 2 is true
}else if(Boolean_expression 3){
   //Executes when the Boolean expression 3 is true
}else {
   //Executes when the none of the above condition is true.
}
```

Example:

```
object Test {
   def main(args: Array[String]) {
      var x = 30;

      if( x == 10 ){
         println("Value of X is 10");
      }else if( x == 20 ){
         println("Value of X is 20");
      }else if( x == 30 ){
         println("Value of X is 30");
      }else{
         println("This is else statement");
      }
   }
}
```

This would produce the following result:

```
C:/>scalac Test.scala
C:/>scala Test
Value of X is 30

C:/>
```

Nested if...else Statement:

It is always legal to nest if-else statements, which means you can use one if or else if statement inside another if or else if statement.

Syntax:

The syntax for a nested if...else is as follows:

```
if(Boolean_expression 1){
   //Executes when the Boolean expression 1 is true
   if(Boolean_expression 2){
      //Executes when the Boolean expression 2 is true
   }
}
```

You can nest *else if...else* in the similar way as we have nested *if* statement.

Example:

```
object Test {
   def main(args: Array[String]) {
        var x = 30;
        var y = 10;

         if( x == 30 ){
            if( y == 10 ){
            println("X = 30 and Y = 10");
         }
      }
```

```
   }
}
```

This would produce the following result:

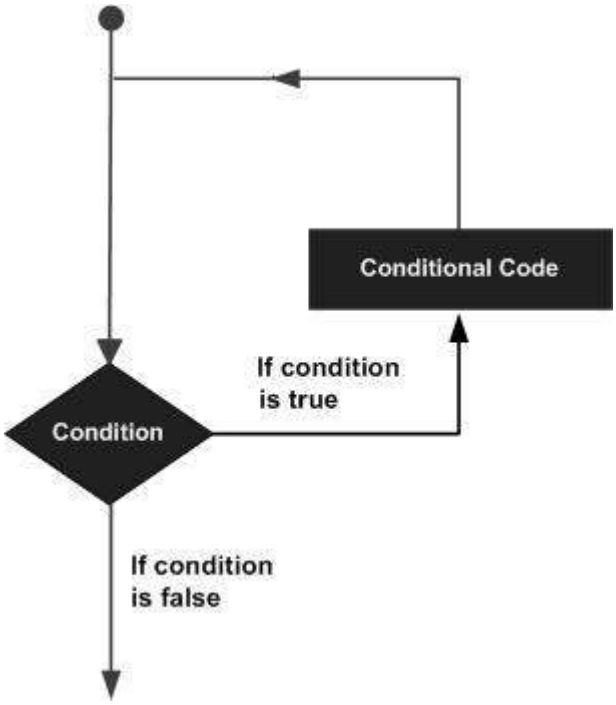
```
C:/>scalac Test.scala
C:/>scala Test
X = 30 and Y = 10

C:/>
```

SCALA LOOP TYPES

There may be a situation, when you need to execute a block of code several number of times. In general, statements are executed sequentially: The first statement in a function is executed first, followed by the second, and so on.

Programming languages provide various control structures that allow for more complicated execution paths.

A loop statement allows us to execute a statement or group of statements multiple times and following is the general from of a loop statement in most of the programming languages:



Scala programming language provides the following types of loops to handle looping requirements. Click the following links to check their detail.

Loop Type	Description
while loop	Repeats a statement or group of statements while a given condition is true. It tests the condition before executing the loop body.
do...while loop	Like a while statement, except that it tests the condition at the end of the loop body
for loop	Executes a sequence of statements multiple times and abbreviates the code that manages the loop variable.

Loop Control Statements:

Loop control statements change execution from its normal sequence. When execution leaves a scope, all automatic objects that were created in that scope are destroyed. As such Scala does not support **break** or **continue** statement like Java does but starting from Scala version 2.8, there is a way to break the loops. Click the following links to check the detail.

Control Statement	Description
break statement	Terminates the **loop** statement and transfers execution to the statement immediately following the loop.

The Infinite Loop:

A loop becomes infinite loop if a condition never becomes false. If you are using Scala, the **while** loop is the best way to implement infinite loop as follows

```
object Test {
   def main(args: Array[String]) {
      var a = 10;
      // An infinite loop.
      while( true ){
         println( "Value of a: " + a );
      }
   }
}
```

If you will execute above code, it will go in infinite loop whcih you can terminate by pressing Ctrl + C keys.

SCALA FUNCTIONS

A function is a group of statements that together perform a task. You can divide up your code into separate functions. How you divide up your code among different functions is up to you, but logically, the division usually is so that each function performs a specific task.

Scala has both functions and methods and we use the terms method and function interchangeably with a minor difference. A Scala method is a part of a class which has a name, a signature, optionally some annotations, and some bytecode where as a function in Scala is a complete object which can be assigned to a variable. In other words, a function, which is defined as a member of some object, is called a method.

A function definition can appear anywhere in a source file and Scala permits nested function definitions, that is, function definitions inside other function definitions. Most important point to note is that Scala function's name can have characters like +, ++, ~, &,-, -- , \, /, : etc.

Function Declarations:

A scala function declaration has the following form:

```
def functionName ([list of parameters]) : [return type]
```

Methods are implicitly declared *abstract* if you leave off the equals sign and method body. The enclosing type is then itself abstract.

Function Definitions:

A scala function definition has the following form:

```
def functionName ([list of parameters]) : [return type] = {
   function body
   return [expr]
}
```

Here, **return type** could be any valid scala data type and **list of parameters** will be a list of variables separated by comma and list of parameters and return type are optional. Very similar to Java, a **return** statement can be used along with an expression in case function returns a value. Following is the function which will add two integers and return their sum:

```
object add{
   def addInt( a:Int, b:Int ) : Int = {
      var sum:Int = 0
      sum = a + b

      return sum
   }
}
```

A function, which does not return anything, can return **Unit** which is equivalent to **void** in Java and indicates that function does not return anything. The functions which do not return anything in Scala, they are called procedures. Following is the syntax

```
object Hello{
   def printMe( ) : Unit = {
      println("Hello, Scala!")
   }
}
```

Calling Functions:

Scala provides a number of syntactic variations for invoking methods. Following is the standard way to call a method:

```
functionName( list of parameters )
```

If function is being called using an instance of the object then we would use dot notation similar to Java as follows:

```
[instance.]functionName( list of parameters )
```

Following is the final example to define and then call the same function:

```
object Test {
   def main(args: Array[String]) {
        println( "Returned Value : " + addInt(5,7) );
   }
   def addInt( a:Int, b:Int ) : Int = {
      var sum:Int = 0
      sum = a + b

      return sum
   }
}
```

When the above code is compiled and executed, it produces the following result:

```
C:/>scalac Test.scala
C:/>scala Test
Returned Value : 12

C:/>
```

Scala functions are the heart of Scala programming and that's why Scala is assumed as a functional programming language. Following are few important concepts related to Scala functions which should be understood by a Scala programmer.

Functions Call-by-Name Functions with Named Arguments

SCALA CLOSURES

A **closure** is a function, whose return value depends on the value of one or more variables declared outside this function. Consider the following piece of code with anonymous function:

```
val multiplier = (i:Int) => i * 10
```

Here the only variable used in the function body, i * 0, is i, which is defined as a parameter to the function. Now let us take another piece of code:

```
val multiplier = (i:Int) => i * factor
```

There are two free variables in multiplier: **i** and **factor**. One of them, i, is a formal parameter to the function. Hence, it is bound to a new value each time multiplier is called. However, **factor** is not a formal parameter, then what is this? Let us add one more line of code:

```
var factor = 3
val multiplier = (i:Int) => i * factor
```

Now, **factor** has a reference to a variable outside the function but in the enclosing scope. Let us try the following example:

```
object Test {
   def main(args: Array[String]) {
      println( "muliplier(1) value = " +  multiplier(1) )
      println( "muliplier(2) value = " +  multiplier(2) )
   }
   var factor = 3
   val multiplier = (i:Int) => i * factor
}
```

When the above code is compiled and executed, it produces the following result:

```
C:/>scalac Test.scala
C:/>scala Test
muliplier(1) value = 3
muliplier(2) value = 6

C:/>
```

Above function references **factor** and reads its current value each time. If a function has no external references, then it is trivially closed over itself. No external context is required.

SCALA STRINGS

Consider the following simple example where we assign a string in a variable of type val:

```
object Test {
   val greeting: String = "Hello, world!"

   def main(args: Array[String]) {
      println( greeting )
   }
```

```
}
```

Here, the type of the value above is **java.lang.String** borrowed from Java, because Scala strings are also Java strings. It is very good point to note that every Java class is available in Scala. As such, Scala does not have a String class and makes use of Java Strings. So this chapter has been written keeping Java String as a base.

In Scala, as in Java, a string is an immutable object, that is, an object that cannot be modified. On the other hand, objects that can be modified, like arrays, are called mutable objects. Since strings are very useful objects, in the rest of this section, we present the most important methods class java.lang.String defines.

Creating Strings:

The most direct way to create a string is to write:

```
var greeting = "Hello world!";

or

var greeting:String = "Hello world!";
```

Whenever it encounters a string literal in your code, the compiler creates a String object with its value, in this case, "Hello world!', but if you like, you can give String keyword as I have shown you in alternate declaration.

```
object Test {
   val greeting: String = "Hello, world!"

   def main(args: Array[String]) {
      println( greeting )
   }
}
```

When the above code is compiled and executed, it produces the following result:

```
C:/>scalac Test.scala
C:/>scala Test
Hello, world!

C:/>
```

As I mentioned earlier, String class is immutable, so that once it is created a String object cannot be changed. If there is a necessity to make a lot of modifications to Strings of characters then you should use String Builder Class available in Scala itself.

String Length:

Methods used to obtain information about an object are known as accessor methods. One accessor method that you can use with strings is the length method, which returns the number of characters contained in the string object.

After the following two lines of code have been executed, len equals 17:

```
object Test {
   def main(args: Array[String]) {
      var palindrome = "Dot saw I was Tod";
      var len = palindrome.length();
      println( "String Length is : " + len );
   }
}
```

When the above code is compiled and executed, it produces the following result:

```
C:/>scalac Test.scala
C:/>scala Test
String Length is : 17

C:/>
```

Concatenating Strings:

The String class includes a method for concatenating two strings:

```
string1.concat(string2);
```

This returns a new string that is string1 with string2 added to it at the end. You can also use the concat method with string literals, as in:

```
"My name is ".concat("Zara");
```

Strings are more commonly concatenated with the + operator, as in:

```
"Hello," + " world" + "!"
```

Which results in:

```
"Hello, world!"
```

Let us look at the following example:

```
object Test {
   def main(args: Array[String]) {
      var str1 = "Dot saw I was ";
      var str2 =  "Tod";
      println("Dot " + str1 + str2);
   }
}
```

When the above code is compiled and executed, it produces the following result:

```
C:/>scalac Test.scala
C:/>scala Test
Dot Dot saw I was Tod

C:/>
```

Creating Format Strings:

You have printf and format methods to print output with formatted numbers. The String class has an equivalent class method, format, that returns a String object rather than a PrintStream object. Let us look at the following example, which makes use of printf method:

```
object Test {
   def main(args: Array[String]) {
      var floatVar = 12.456
      var intVar = 2000
      var stringVar = "Hello, Scala!"
      var fs = printf("The value of the float variable is " +
                   "%f, while the value of the integer " +
                   "variable is %d, and the string " +
                   "is %s", floatVar, intVar, stringVar)
      println(fs)
   }
}
```

When the above code is compiled and executed, it produces the following result:

```
C:/>scalac Test.scala
C:/>scala Test
The value of the float variable is 12.456000, while the
value of the integer var iable is 2000, and the
string is Hello, Scala!()

C:/>
```

String Methods:

Following is the list of methods defined by **java.lang.String** class and can be used directly in your Scala programs:

SN	Methods with Description
1	**char charAt**int index Returns the character at the specified index.
2	**int compareTo**Object o Compares this String to another Object.
3	**int compareTo**String anotherString Compares two strings lexicographically.
4	**int compareToIgnoreCase**String str Compares two strings lexicographically, ignoring case differences.
5	**String concat**String str Concatenates the specified string to the end of this string.
6	**boolean contentEquals**StringBuffer sb Returns true if and only if this String represents the same sequence of characters as the specified StringBuffer.
7	**static String copyValueOf**char[] data Returns a String that represents the character sequence in the array specified.
8	**static String copyValueOf**char[] data, int offset, int count Returns a String that represents the character sequence in the array specified.
9	**boolean endsWith**String suffix Tests if this string ends with the specified suffix.

10

boolean equals Object anObject

Compares this string to the specified object.

11

boolean equalsIgnoreCase String anotherString

Compares this String to another String, ignoring case considerations.

12

byte getBytes

Encodes this String into a sequence of bytes using the platform's default charset, storing the result into a new byte array.

13

byte[] getBytes(String charsetName

Encodes this String into a sequence of bytes using the named charset, storing the result into a new byte array.

14

void getCharsint srcBegin, int srcEnd, char[] dst, int dstBegin

Copies characters from this string into the destination character array.

15

int hashCode

Returns a hash code for this string.

16

int indexOfint ch

Returns the index within this string of the first occurrence of the specified character.

17

int indexOfint ch, int fromIndex

Returns the index within this string of the first occurrence of the specified character, starting the search at the specified index.

18

int indexOf String str

Returns the index within this string of the first occurrence of the specified substring.

19

int indexOf String str, int fromIndex

Returns the index within this string of the first occurrence of the specified substring, starting at the specified index.

20

String intern

Returns a canonical representation for the string object.

21

int lastIndexOfint ch

Returns the index within this string of the last occurrence of the specified character.

22

int lastIndexOfint ch, int fromIndex

Returns the index within this string of the last occurrence of the specified character, searching backward starting at the specified index.

23

int lastIndexOf String str

Returns the index within this string of the rightmost occurrence of the specified substring.

24

int lastIndexOf String str, int fromIndex

Returns the index within this string of the last occurrence of the specified substring, searching backward starting at the specified index.

25

int length

Returns the length of this string.

26

boolean matches String regex

Tells whether or not this string matches the given regular expression.

27

boolean regionMatchesboolean ignoreCase, int toffset, String other, int ooffset, int len

Tests if two string regions are equal.

28

boolean regionMatchesint toffset, String other, int ooffset, int len

Tests if two string regions are equal.

29

String replacechar oldChar, char newChar

Returns a new string resulting from replacing all occurrences of oldChar in this string with newChar.

30

String replaceAll(String regex, String replacement

Replaces each substring of this string that matches the given regular expression with the given replacement.

31

String replaceFirst String regex, String replacement

Replaces the first substring of this string that matches the given regular expression with the given replacement.

32

String[] split String regex

Splits this string around matches of the given regular expression.

33

String[] split String regex, int limit

Splits this string around matches of the given regular expression.

34

boolean startsWith String prefix

Tests if this string starts with the specified prefix.

35

boolean startsWith String prefix, int toffset

Tests if this string starts with the specified prefix beginning a specified index.

36

CharSequence subSequenceint beginIndex, int endIndex

Returns a new character sequence that is a subsequence of this sequence.

37

String substringint beginIndex

Returns a new string that is a substring of this string.

38

String substringint beginIndex, int endIndex

Returns a new string that is a substring of this string.

39

char[] toCharArray

Converts this string to a new character array.

40

String toLowerCase

Converts all of the characters in this String to lower case using the rules of the default locale.

41

String toLowerCase Locale locale

Converts all of the characters in this String to lower case using the rules of the given Locale.

42

String toString

This object which is already a string! is itself returned.

43

String toUpperCase

Converts all of the characters in this String to upper case using the rules of the default locale.

44

String toUpperCaseLocale locale

Converts all of the characters in this String to upper case using the rules of the given Locale.

45

String trim

Returns a copy of the string, with leading and trailing whitespace omitted.

46

static String valueOfprimitive data type x

Returns the string representation of the passed data type argument.

SCALA ARRAYS

Scala provides a data structure, the **array**, which stores a fixed-size sequential collection of elements of the same type. An array is used to store a collection of data, but it is often more useful to think of an array as a collection of variables of the same type.

Instead of declaring individual variables, such as number0, number1, ..., and number99, you declare one array variable such as numbers and use numbers[0], numbers[1], and ..., numbers[99] to represent individual variables. This tutorial introduces how to declare array variables, create arrays, and process arrays using indexed variables. The index of the first element of an array is the number zero and the index of the last element is the total number of elements minus one.

Declaring Array Variables:

To use an array in a program, you must declare a variable to reference the array and you must specify the type of array the variable can reference. Here is the syntax for declaring an array variable:

```
var z:Array[String] = new Array[String](3)

or

var z = new Array[String](3)
```

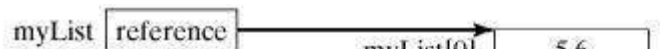
Here, z is declared as an array of Strings that may hold up to three elements. You can assign values to individual elements or get access to individual elements, it can be done by using commands like the following:

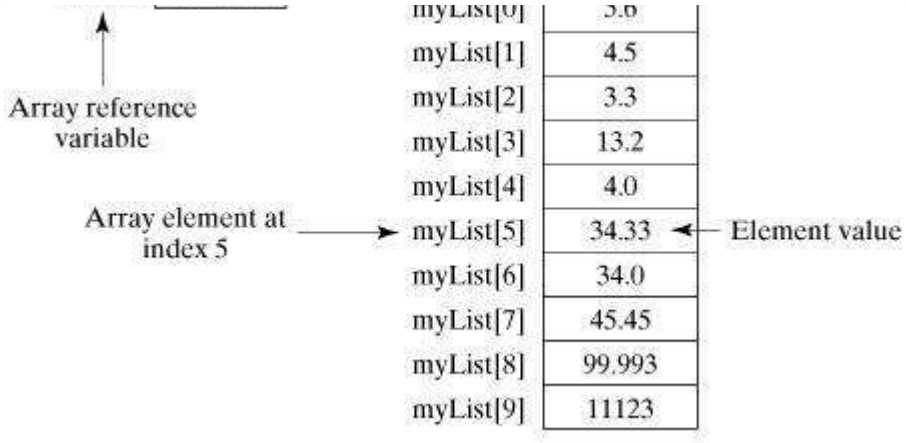
```
z(0) = "Zara"; z(1) = "Nuha"; z(4/2) = "Ayan"
```

Here, the last example shows that in general the index can be any expression that yields a whole number. There is one more way of defining an array:

```
var z = Array("Zara", "Nuha", "Ayan")
```

Following picture represents array myList. Here, myList holds ten double values and the indices are from 0 to 9.





Processing Arrays:

When processing array elements, we often use either for loop because all of the elements in an array are of the same type and the size of the array is known. Here is a complete example of showing how to create, initialize and process arrays:

```
object Test {
   def main(args: Array[String]) {
      var myList = Array(1.9, 2.9, 3.4, 3.5)

      // Print all the array elements
      for ( x <- myList ) {
         println( x )
      }

      // Summing all elements
      var total = 0.0;
      for ( i <- 0 to (myList.length - 1)) {
         total += myList(i);
      }
      println("Total is " + total);

      // Finding the largest element
      var max = myList(0);
      for ( i <- 1 to (myList.length - 1) ) {
         if (myList(i) > max) max = myList(i);
      }
      println("Max is " + max);

   }
}
```

When the above code is compiled and executed, it produces the following result:

```
C:/>scalac Test.scala
C:/>scala Test
1.9
2.9
3.4
3.5
Total is 11.7
Max is 3.5

C:/>
```

Multi-Dimensional Arrays:

There are many situations where you would need to define and use multi-dimensional arrays i.e., arrays whose elements are arrays. For example, matrices and tables are examples of structures that can be realized as two-dimensional arrays.

Scala does not directly support multi-dimensional arrays and provides various methods to process arrays in any dimension. Following is the example of defining a two-dimensional array:

```
var myMatrix = ofDim[Int](3,3)
```

This is an array that has three elements each being an array of integers that has three elements. The code that follows shows how one can process a multi-dimensional array:

```
import Array._

object Test {
   def main(args: Array[String]) {
      var myMatrix = ofDim[Int](3,3)

      // build a matrix
      for (i <- 0 to 2) {
         for ( j <- 0 to 2) {
            myMatrix(i)(j) = j;
         }
      }

      // Print two dimensional array
      for (i <- 0 to 2) {
         for ( j <- 0 to 2) {
            print(" " + myMatrix(i)(j));
         }
         println();
      }

   }
}
```

When the above code is compiled and executed, it produces the following result:

```
C:/>scalac Test.scala
C:/>scala Test
0 1 2
0 1 2
0 1 2

C:/>
```

Concatenate Arrays:

Following is the example which makes use of concat method to concatenate two arrays. You can pass more than one array as arguments to concat method.

```
import Array._

object Test {
   def main(args: Array[String]) {
      var myList1 = Array(1.9, 2.9, 3.4, 3.5)
      var myList2 = Array(8.9, 7.9, 0.4, 1.5)

      var myList3 =  concat( myList1, myList2)

      // Print all the array elements
      for ( x <- myList3 ) {
         println( x )
      }
   }
}
```

When the above code is compiled and executed, it produces the following result:

```
C:/>scalac Test.scala
```

```
C:/>scala Test
1.9
2.9
3.4
3.5
8.9
7.9
0.4
1.5

C:/>
```

Create Array with Range:

Following is the example, which makes use of range method to generate an array containing a sequence of increasing integers in a given range. You can use final argument as step to create the sequence; if you do not use final argument, then step would be assumed as 1.

```
import Array._

object Test {
   def main(args: Array[String]) {
      var myList1 = range(10, 20, 2)
      var myList2 = range(10,20)

      // Print all the array elements
      for ( x <- myList1 ) {
         print( " " + x )
      }
      println()
      for ( x <- myList2 ) {
         print( " " + x )
      }
   }
}
```

When the above code is compiled and executed, it produces the following result:

```
C:/>scalac Test.scala
C:/>scala Test
10 12 14 16 18
10 11 12 13 14 15 16 17 18 19

C:/>
```

Scala Arrays Methods:

Following are the important methods, which you can use while playing with array. As shown above, you would have to import **Array._** package before using any of the mentioned methods. For a complete list of methods available, please check official documentation of Scala.

SN	Methods with Description
1	**def apply** x: T, xs: T* **: Array[T]** Creates an array of T objects, where T can be Unit, Double, Float, Long, Int, Char, Short, Byte, Boolean.
2	**def concat[T]** xss: Array[T]* **: Array[T]** Concatenates all arrays into a single array.

3

def copy src: AnyRef, srcPos: Int, dest: AnyRef, destPos: Int, length: Int **: Unit**

Copy one array to another. Equivalent to Java's System.arraycopysrc, srcPos, dest, destPos, length.

4

def empty[T]: Array[T]

Returns an array of length 0

5

def iterate[T] start: T, len: Int f: (T **=> T): Array[T]**

Returns an array containing repeated applications of a function to a start value.

6

def fill[T] n: Int elem: => T**: Array[T]**

Returns an array that contains the results of some element computation a number of times.

7

def fill[T] n1: Int, n2: Int elem: => T **: Array[Array[T]]**

Returns a two-dimensional array that contains the results of some element computation a number of times.

8

def iterate[T] start: T, len: Int f: (T **=> T): Array[T]**

Returns an array containing repeated applications of a function to a start value.

9

def ofDim[T] n1: Int **: Array[T]**

Creates array with given dimensions.

10

def ofDim[T] n1: Int, n2: Int **: Array[Array[T]]**

Creates a 2-dimensional array

11

def ofDim[T] n1: Int, n2: Int, n3: Int **: Array[Array[Array[T]]]**

Creates a 3-dimensional array

12

def range start: Int, end: Int, step: Int **: Array[Int]**

Returns an array containing equally spaced values in some integer interval.

13

def range start: Int, end: Int **: Array[Int]**

Returns an array containing a sequence of increasing integers in a range.

14

def tabulate[T] n: Int f: (Int**=> T): Array[T]**

Returns an array containing values of a given function over a range of integer values starting from 0.

15

def tabulate[T] n1: Int, n2: Int f: (Int, Int **=> T): Array[Array[T]]**

Returns a two-dimensional array containing values of a given function over ranges of integer values starting from 0.

SCALA COLLECTIONS

Scala has a rich set of collection library. Collections are containers of things. Those containers can be sequenced, linear sets of items like List, Tuple, Option, Map, etc. The collections may have an arbitrary number of elements or be bounded to zero or one element e.g., Option.

Collections may be **strict** or **lazy**. Lazy collections have elements that may not consume memory until they are accessed, like **Ranges**. Additionally, collections may be **mutable** the contents of the reference can change or **immutable** the thing that a reference refers to is never changed. Note that immutable collections may contain mutable items.

For some problems, mutable collections work better, and for others, immutable collections work better. When in doubt, it is better to start with an immutable collection and change it later if you need mutable ones.

This chapter gives details of the most commonly used collection types and most frequently used operations over those collections.

SN	Collections with Description
1	Scala Lists Scala's List[T] is a linked list of type T.
2	Scala Sets A set is a collection of pairwise different elements of the same type.
3	Scala Maps A Map is a collection of key/value pairs. Any value can be retrieved based on its key.
4	Scala Tuples Unlike an array or list, a tuple can hold objects with different types.
5	Scala Options Option[T] provides a container for zero or one element of a given type.
6	Scala Iterators An iterator is not a collection, but rather a way to access the elements of a collection one by one.

Example:

Following code snippet is a simple example to define all the above type of collections:

```
// Define List of integers.
val x = List(1,2,3,4)

// Define a set.
var x = Set(1,3,5,7)

// Define a map.
val x = Map("one" -> 1, "two" -> 2, "three" -> 3)

// Create a tuple of two elements.
val x = (10, "Scala")

// Define an option
val x:Option[Int] = Some(5)
```

SCALA CLASSES & OBJECTS

A class is a blueprint for objects. Once you define a class, you can create objects from the class blueprint with the keyword **new**. Following is a simple syntax to define a class in Scala:

```
class Point(xc: Int, yc: Int) {
   var x: Int = xc
   var y: Int = yc

   def move(dx: Int, dy: Int) {
      x = x + dx
      y = y + dy
      println ("Point x location : " + x);
      println ("Point y location : " + y);
   }
}
```

This class defines two variables **x** and **y** and a method: **move**, which does not return a value. Class variables are called, fields of the class and methods are called class methods.

The class name works as a class constructor which can take a number of parameters. The above code defines two constructor arguments, **xc** and **yc**; they are both visible in the whole body of the class.

As mentioned earlier, you can create objects using a keyword **new** and then you can access class fields and methods as shown below in the example:

```
import java.io._

class Point(val xc: Int, val yc: Int) {
   var x: Int = xc
   var y: Int = yc
   def move(dx: Int, dy: Int) {
      x = x + dx
      y = y + dy
      println ("Point x location : " + x);
      println ("Point y location : " + y);
   }
}

object Test {
   def main(args: Array[String]) {
      val pt = new Point(10, 20);

      // Move to a new location
      pt.move(10, 10);
   }
}
```

When the above code is compiled and executed, it produces the following result:

```
C:/>scalac Test.scala
C:/>scala Test
Point x location : 20
Point y location : 30

C:/>
```

Extending a Class:

You can extend a base scala class in similar way you can do it in Java but there are two restrictions: method overriding requires the **override** keyword, and only the **primary** constructor can pass parameters to the base constructor. Let us extend our above class and add one more class method:

```
class Point(val xc: Int, val yc: Int) {
   var x: Int = xc
   var y: Int = yc
   def move(dx: Int, dy: Int) {
      x = x + dx
      y = y + dy
      println ("Point x location : " + x);
      println ("Point y location : " + y);
   }
}

class Location(override val xc: Int, override val yc: Int,
   val zc :Int) extends Point(xc, yc){
   var z: Int = zc

   def move(dx: Int, dy: Int, dz: Int) {
      x = x + dx
      y = y + dy
      z = z + dz
      println ("Point x location : " + x);
      println ("Point y location : " + y);
      println ("Point z location : " + z);
   }
}
```

Such an **extends** clause has two effects: it makes class Location inherit all non-private members from class Point, and it makes the type *Location* a subtype of the type *Point* class. So here the *Point* class is called **superclass** and the class *Location* is called **subclass**. Extending a class and inheriting all the features of a parent class is called **inheritance** but scala allows the inheritance from just one class only. Let us take complete example showing inheirtance:

```
import java.io._

class Point(val xc: Int, val yc: Int) {
   var x: Int = xc
   var y: Int = yc
   def move(dx: Int, dy: Int) {
      x = x + dx
      y = y + dy
      println ("Point x location : " + x);
      println ("Point y location : " + y);
   }
}

class Location(override val xc: Int, override val yc: Int,
   val zc :Int) extends Point(xc, yc){
   var z: Int = zc

   def move(dx: Int, dy: Int, dz: Int) {
      x = x + dx
      y = y + dy
```

```
      z = z + dz
      println ("Point x location : " + x);
      println ("Point y location : " + y);
      println ("Point z location : " + z);
   }
}

object Test {
   def main(args: Array[String]) {
      val loc = new Location(10, 20, 15);

      // Move to a new location
      loc.move(10, 10, 5);
   }
}
```

Note that methods move and **move** do not override the corresponding definitions of move since they are different definitions for example, the former take two arguments while the latter take three arguments. When the above code is compiled and executed, it produces the following result:

```
C:/>scalac Test.scala
C:/>scala Test
Point x location : 20
Point y location : 30
Point z location : 20

C:/>
```

Singleton objects:

Scala is more object-oriented than Java because in Scala we cannot have static members. Instead, Scala has **singleton objects**. A singleton is a class that can have only one instance, i.e., object. You create singleton using the keyword **object** instead of class keyword. Since you can't instantiate a singleton object, you can't pass parameters to the primary constructor. You already have seen all the examples using singleton objects where you called Scala's main method. Following is the same example of showing singleton:

```
import java.io._

class Point(val xc: Int, val yc: Int) {
   var x: Int = xc
   var y: Int = yc
   def move(dx: Int, dy: Int) {
      x = x + dx
      y = y + dy
   }
}

object Test {
   def main(args: Array[String]) {
      val point = new Point(10, 20)
      printPoint

      def printPoint{
         println ("Point x location : " + point.x);
         println ("Point y location : " + point.y);
      }
   }
}
```

When the above code is compiled and executed, it produces the following result:

```
C:/>scalac Test.scala
C:/>scala Test
Point x location : 10
Point y location : 20
```

```
C:/>
```

SCALA TRAITS

A trait encapsulates method and field definitions, which can then be reused by mixing them into classes. Unlike class inheritance, in which each class must inherit from just one superclass, a class can mix in any number of traits.

Traits are used to define object types by specifying the signature of the supported methods. Scala also allows traits to be partially implemented but traits may not have constructor parameters.

A trait definition looks just like a class definition except that it uses the keyword **trait** as follows:

```
trait Equal {
  def isEqual(x: Any): Boolean
  def isNotEqual(x: Any): Boolean = !isEqual(x)
}
```

This trait consists of two methods **isEqual** and **isNotEqual**. Here, we have not given any implementation for isEqual where as another method has its implementation. Child classes extending a trait can give implementation for the un-implemented methods. So a trait is very similar to what we have **abstract classes** in Java. Below is a complete example to show the concept of traits:

```
trait Equal {
  def isEqual(x: Any): Boolean
  def isNotEqual(x: Any): Boolean = !isEqual(x)
}

class Point(xc: Int, yc: Int) extends Equal {
  var x: Int = xc
  var y: Int = yc
  def isEqual(obj: Any) =
    obj.isInstanceOf[Point] &&
    obj.asInstanceOf[Point].x == x
}

object Test {
   def main(args: Array[String]) {
      val p1 = new Point(2, 3)
      val p2 = new Point(2, 4)
      val p3 = new Point(3, 3)

      println(p1.isNotEqual(p2))
      println(p1.isNotEqual(p3))
      println(p1.isNotEqual(2))
   }
}
```

When the above code is compiled and executed, it produces the following result:

```
C:/>scalac Test.scala
C:/>scala Test
false
true
true

C:/>
```

When to use traits?

There is no firm rule, but here are few guidelines to consider:

- If the behavior will not be reused, then make it a concrete class. It is not reusable behavior after all.

- If it might be reused in multiple, unrelated classes, make it a trait. Only traits can be mixed into different parts of the class hierarchy.
- If you want to inherit from it in Java code, use an abstract class.
- If you plan to distribute it in compiled form, and you expect outside groups to write classes inheriting from it, you might lean towards using an abstract class.
- If efficiency is very important, lean towards using a class.

SCALA PATTERN MATCHING

Pattern matching is the second most widely used feature of Scala, after function values and closures. Scala provides great support for pattern matching for processing the messages.

A pattern match includes a sequence of alternatives, each starting with the keyword **case**. Each alternative includes a **pattern** and one or more **expressions**, which will be evaluated if the pattern matches. An arrow symbol => separates the pattern from the expressions. Here is a small example, which shows how to match against an integer value:

```
object Test {
   def main(args: Array[String]) {
      println(matchTest(3))

   }
   def matchTest(x: Int): String = x match {
      case 1 => "one"
      case 2 => "two"
      case _ => "many"
   }
}
```

When the above code is compiled and executed, it produces the following result:

```
C:/>scalac Test.scala
C:/>scala Test
many

C:/>
```

The block with the case statements defines a function, which maps integers to strings. The match keyword provides a convenient way of applying a function like the pattern matching function above to an object. Following is a second example, which matches a value against patterns of different types:

```
object Test {
   def main(args: Array[String]) {
      println(matchTest("two"))
      println(matchTest("test"))
      println(matchTest(1))

   }
   def matchTest(x: Any): Any = x match {
      case 1 => "one"
      case "two" => 2
      case y: Int => "scala.Int"
      case _ => "many"
   }
}
```

When the above code is compiled and executed, it produces the following result:

```
C:/>scalac Test.scala
C:/>scala Test
2
```

```
many
one

C:/>
```

The first case matches if x refers to the integer value 1. The second case matches if x is equal to the string"two". The third case consists of a typed pattern; it matches against any integer and binds the selector value xto the variable y of type integer. Following is another form of writing same match...case expressions with the help of braces {...}:

```
object Test {
   def main(args: Array[String]) {
      println(matchTest("two"))
      println(matchTest("test"))
      println(matchTest(1))

   }
   def matchTest(x: Any){
      x match {
         case 1 => "one"
         case "two" => 2
         case y: Int => "scala.Int"
         case _ => "many"
      }
   }
}
```

Matching Using case Classes:

The **case classes** are special classes that are used in pattern matching with case expressions. Syntactically, these are standard classes with a special modifier: **case**. Following is a simple pattern matching example using case class:

```
object Test {
   def main(args: Array[String]) {
    val alice = new Person("Alice", 25)
    val bob = new Person("Bob", 32)
    val charlie = new Person("Charlie", 32)

      for (person <- List(alice, bob, charlie)) {
         person match {
            case Person("Alice", 25) => println("Hi Alice!")
            case Person("Bob", 32) => println("Hi Bob!")
            case Person(name, age) =>
               println("Age: " + age + " year, name: " + name + "?")
         }
      }
   }
   // case class, empty one.
   case class Person(name: String, age: Int)
}
```

When the above code is compiled and executed, it produces the following result:

```
C:/>scalac Test.scala
C:/>scala Test
Hi Alice!
Hi Bob!
Age: 32 year, name: Charlie?

C:/>
```

Adding the case keyword causes the compiler to add a number of useful features automatically. The keyword suggests an association with case expressions in pattern matching.

First, the compiler automatically converts the constructor arguments into immutable fields vals.

The val keyword is optional. If you want mutable fields, use the var keyword. So, our constructor argument lists are now shorter.

Second, the compiler automatically implements **equals, hashCode,** and **toString** methods to the class, which use the fields specified as constructor arguments. So, we no longer need our own toString methods.

Finally, also, the body of **Person** class is gone because there are no methods that we need to define!

SCALA REGULAR EXPRESSIONS

Scala supports regular expressions through **Regex** class available in the scala.util.matching package. Let us check an example where we will try to find out word **Scala** from a statement:

```
import scala.util.matching.Regex

object Test {
   def main(args: Array[String]) {
      val pattern = "Scala".r
      val str = "Scala is Scalable and cool"

      println(pattern findFirstIn str)
   }
}
```

When the above code is compiled and executed, it produces the following result:

```
C:/>scalac Test.scala
C:/>scala Test
Some(Scala)

C:/>
```

We create a String and call the **r** method on it. Scala implicitly converts the String to a RichString and invokes that method to get an instance of Regex. To find a first match of the regular expression, simply call the **findFirstIn** method. If instead of finding only the first occurrence we would like to find all occurrences of the matching word, we can use the **findAllIn** method and in case there are multiple Scala words available in the target string, this will return a collection of all matching words.

You can make use of the mkString method to concatenate the resulting list and you can use a pipe | to search small and capital case of Scala and you can use **Regex** constructor instead or **r** method to create a pattern as follows:

```
import scala.util.matching.Regex

object Test {
   def main(args: Array[String]) {
      val pattern = new Regex("(S|s)cala")
      val str = "Scala is scalable and cool"

      println((pattern findAllIn str).mkString(","))
   }
}
```

When the above code is compiled and executed, it produces the following result:

```
C:/>scalac Test.scala
C:/>scala Test
Scala,scala

C:/>
```

If you would like to replace matching text, we can use **replaceFirstIn** to replace the first match or

replaceAllIn to replace all occurrences as follows:

```
object Test {
   def main(args: Array[String]) {
      val pattern = "(S|s)cala".r
      val str = "Scala is scalable and cool"

      println(pattern replaceFirstIn(str, "Java"))
   }
}
```

When the above code is compiled and executed, it produces the following result:

```
C:/>scalac Test.scala
C:/>scala Test
Java is scalable and cool

C:/>
```

Forming regular expressions:

Scala inherits its regular expression syntax from Java, which in turn inherits most of the features of Perl. Here are just some examples that should be enough as refreshers:

Here is the table listing down all the regular expression metacharacter syntax available in Java:

Subexpression	Matches
^	Matches beginning of line.
$	Matches end of line.
.	Matches any single character except newline. Using m option allows it to match newline as well.
[...]	Matches any single character in brackets.
[^...]	Matches any single character not in brackets
\\A	Beginning of entire string
\\z	End of entire string
\\Z	End of entire string except allowable final line terminator.
re*	Matches 0 or more occurrences of preceding expression.
re+	Matches 1 or more of the previous thing
re?	Matches 0 or 1 occurrence of preceding expression.
re{ n}	Matches exactly n number of occurrences of preceding expression.
re{ n,}	Matches n or more occurrences of preceding expression.
re{ n, m}	Matches at least n and at most m occurrences of preceding expression.
a|b	Matches either a or b.
re	Groups regular expressions and remembers matched text.
?: re	Groups regular expressions without remembering matched text.
?> re	Matches independent pattern without backtracking.
\\w	Matches word characters.

\\W	Matches nonword characters.
\\s	Matches whitespace. Equivalent to [\t\n\r\f].
\\S	Matches nonwhitespace.
\\d	Matches digits. Equivalent to [0-9].
\\D	Matches nondigits.
\\A	Matches beginning of string.
\\Z	Matches end of string. If a newline exists, it matches just before newline.
\\z	Matches end of string.
\\G	Matches point where last match finished.
\\n	Back-reference to capture group number "n"
\\b	Matches word boundaries when outside brackets. Matches backspace 0x08 when inside brackets.
\\B	Matches nonword boundaries.
\\n, \\t, etc.	Matches newlines, carriage returns, tabs, etc.
\\Q	Escape quote all characters up to \\E
\\E	Ends quoting begun with \\Q

Regular-expression Examples:

Example	Description
.	Match any character except newline
[Rr]uby	Match "Ruby" or "ruby"
rub[ye]	Match "ruby" or "rube"
[aeiou]	Match any one lowercase vowel
[0-9]	Match any digit; same as [0123456789]
[a-z]	Match any lowercase ASCII letter
[A-Z]	Match any uppercase ASCII letter
[a-zA-Z0-9]	Match any of the above
[^aeiou]	Match anything other than a lowercase vowel
[^0-9]	Match anything other than a digit
\\d	Match a digit: [0-9]
\\D	Match a nondigit: [^0-9]
\\s	Match a whitespace character: [\t\r\n\f]
\\S	Match nonwhitespace: [^ \t\r\n\f]
\\w	Match a single word character: [A-Za-z0-9_]

\\W	Match a nonword character: [^A-Za-z0-9_]
ruby?	Match "rub" or "ruby": the y is optional
ruby*	Match "rub" plus 0 or more ys
ruby+	Match "rub" plus 1 or more ys
\\d{3}	Match exactly 3 digits
\\d{3,}	Match 3 or more digits
\\d{3,5}	Match 3, 4, or 5 digits
\\D\\d+	No group: + repeats \\d
\\D\\d+/	Grouped: + repeats \\D\d pair
[Rr]uby(, ?)+	Match "Ruby", "Ruby, ruby, ruby", etc.

Note that every backslash appears twice in the string above. This is because in Java and Scala a single backslash is an escape character in a string literal, not a regular character that shows up in the string. So instead of .\. you need to write .\\. to get a single backslash in the string. Check the following example:

```
import scala.util.matching.Regex

object Test {
   def main(args: Array[String]) {
      val pattern = new Regex("abl[ae]\\d+")
      val str = "ablaw is able1 and cool"

      println((pattern findAllIn str).mkString(","))
   }
}
```

When the above code is compiled and executed, it produces the following result:

```
C:/>scalac Test.scala
C:/>scala Test
able1

C:/>
```

SCALA EXCEPTION HANDLING

Scala's exceptions work like exceptions in many other languages like Java. Instead of returning a value in the normal way, a method can terminate by throwing an exception. However, Scala doesn't actually have checked exceptions.

When you want to handle exceptions, you use a try{...}catch{...} block like you would in Java except that the catch block uses matching to identify and handle the exceptions.

Throwing exceptions:

Throwing an exception looks the same as in Java. You create an exception object and then you throw it with the **throw** keyword:

```
throw new IllegalArgumentException
```

Catching exceptions:

Scala allows you to **try/catch** any exception in a single block and then perform pattern matching against it using **case** blocks as shown below:

```
import java.io.FileReader
import java.io.FileNotFoundException
import java.io.IOException

object Test {
   def main(args: Array[String]) {
      try {
         val f = new FileReader("input.txt")
      } catch {
         case ex: FileNotFoundException =>{
            println("Missing file exception")
         }
         case ex: IOException => {
            println("IO Exception")
         }
      }
   }
}
```

When the above code is compiled and executed, it produces the following result:

```
C:/>scalac Test.scala
C:/>scala Test
Missing file exception

C:/>
```

The behavior of this **try-catch** expression is the same as in other languages with exceptions. The body is executed, and if it throws an exception, each **catch** clause is tried in turn.

The finally clause:

You can wrap an expression with a **finally** clause if you want to cause some code to execute no matter how the expression terminates.

```
import java.io.FileReader
import java.io.FileNotFoundException
import java.io.IOException

object Test {
   def main(args: Array[String]) {
      try {
         val f = new FileReader("input.txt")
      } catch {
         case ex: FileNotFoundException => {
            println("Missing file exception")
         }
         case ex: IOException => {
            println("IO Exception")
         }
      } finally {
         println("Exiting finally...")
      }
   }
}
```

When the above code is compiled and executed, it produces the following result:

```
C:/>scalac Test.scala
C:/>scala Test
Missing file exception
Exiting finally...

C:/>
```

SCALA EXTRACTORS

An extractor in Scala is an object that has a method called **unapply** as one of its members. The purpose of that unapply method is to match a value and take it apart. Often, the extractor object also defines a dual method **apply** for building values, but this is not required.

Following example shows an extractor object for email addresses:

```
object Test {
   def main(args: Array[String]) {

      println ("Apply method : " + apply("Zara", "gmail.com"));
      println ("Unapply method : " + unapply("Zara@gmail.com"));
      println ("Unapply method : " + unapply("Zara Ali"));

   }
   // The injection method (optional)
   def apply(user: String, domain: String) = {
      user +"@"+ domain
   }

   // The extraction method (mandatory)
   def unapply(str: String): Option[(String, String)] = {
      val parts = str split "@"
      if (parts.length == 2){
         Some(parts(0), parts(1))
      }else{
         None
      }
   }
}
```

This object defines both **apply** and **unapply** methods. The apply method has the same meaning as always: it turns Test into an object that can be applied to arguments in parentheses in the same way a method is applied. So you can write Test"Zara", "gmail.com" to construct the string "Zara@gmail.com".

The **unapply** method is what turns Test class into an **extractor** and it reverses the construction process of **apply**. Where apply takes two strings and forms an email address string out of them, unapply takes an email address and returns potentially two strings: the **user** and the **domain** of the address.

The **unapply** must also handle the case where the given string is not an email address. That's why unapply returns an Option-type over pairs of strings. Its result is either **Someuser, domain** if the string str is an email address with the given user and domain parts, or None, if str is not an email address. Here are some examples:

```
unapply("Zara@gmail.com") equals Some("Zara", "gmail.com")
unapply("Zara Ali") equals None
```

When the above code is compiled and executed, it produces the following result:

```
C:/>scalac Test.scala
C:/>scala Test
Apply method : Zara@gmail.com
Unapply method : Some((Zara,gmail.com))
Unapply method : None

C:/>
```

Pattern Matching with Extractors:

When an instance of a class is followed by parentheses with a list of zero or more parameters, the compiler invokes the **apply** method on that instance. We can define apply both in objects and in classes.

As mentioned above, the purpose of the **unapply** method is to extract a specific value we are looking for. It does the opposite operation **apply** does. When comparing an extractor object using the **match** statement the **unapply** method will be automatically executed as shown below:

```
object Test {
   def main(args: Array[String]) {

      val x = Test(5)
      println(x)

      x match
      {
         case Test(num) => println(x+" is bigger two times than "+num)
         //unapply is invoked
         case _ => println("i cannot calculate")
      }

   }
   def apply(x: Int) = x*2
   def unapply(z: Int): Option[Int] = if (z%2==0) Some(z/2) else None
}
```

When the above code is compiled and executed, it produces the following result:

```
C:/>scalac Test.scala
C:/>scala Test
10
10 is bigger two times than 5

C:/>
```

SCALA FILES I/O

Scala is open to make use of any Java objects and **java.io.File** is one of the objects which can be used in Scala programming to read and write files. Following is an example of writing to a file:

```
import java.io._

object Test {
   def main(args: Array[String]) {
      val writer = new PrintWriter(new File("test.txt" ))

      writer.write("Hello Scala")
      writer.close()
   }
}
```

When the above code is compiled and executed, it creates a file with "Hello Scala" content which you can check yourself.

```
C:/>scalac Test.scala
C:/>scala Test

C:/>
```

Reading line from Screen:

Sometime you need to read user input from the screen and then proceed for some further processing. Following example shows you how to read input from the screen:

```
object Test {
   def main(args: Array[String]) {
      print("Please enter your input : " )
      val line = Console.readLine
```

```
      println("Thanks, you just typed: " + line)
   }
}
```

When the above code is compiled and executed, it prompts you to enter your input and it continues until you press ENTER key.

```
C:/>scalac Test.scala
C:/>scala Test
scala Test
Please enter your input : Scala is great
Thanks, you just typed: Scala is great

C:/>
```

Reading File Content:

Reading from files is really simple. You can use Scala's **Source** class and its companion object to read files. Following is the example which shows you how to read from "test.txt" file which we created earlier:

```
import scala.io.Source

object Test {
   def main(args: Array[String]) {
      println("Following is the content read:" )

      Source.fromFile("test.txt" ).foreach{
         print
      }
   }
}
```

When the above code is compiled and executed, it will read test.txt file and display the content on the screen:

```
C:/>scalac Test.scala
C:/>scala Test
scala Test
Following is the content read:
Hello Scala

C:/>
```

Processing math: 10%