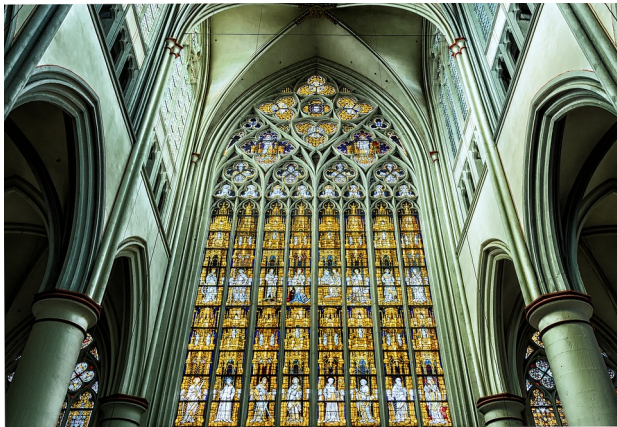


The Scala programming ecosystem

Leveraging functional, OO, libraries and frameworks

Markus Dale, 2016

Scala - The Good



The Scala Programming Language

- ▶ Martin Odersky, EPFL, Switzerland
 - ▶ Worked on javac (1.3)
 - ▶ Java Generics
- ▶ Lightbend (formerly Typesafe)
- ▶ Multi-paradigm language
 - ▶ Functional and Object-Oriented
- ▶ Statically typed
- ▶ Scalable language - script to large program
- ▶ Stretch your mind - functions and immutability

Sca(lable) la(nguage)

- ▶ Apache Kafka (LinkedIn)
- ▶ Apache Spark (Databricks)
- ▶ Finagle (Twitter)
- ▶ Akka (Lightbend)
- ▶ Lucid Software - scala.js presentation
- ▶ Play Web Framework
 - ▶ Lichess Online Chess
- ▶ Lightbend customers: Walmart, Verizon, Twitter, LinkedIn, Coursera, The Guardian, Airbnb...

Scala to Java bytecode

- ▶ Leverage Java Virtual Machine (JVM)
 - ▶ Over 20 years of optimizations
 - ▶ Java Interpreter and Just-in-time (JIT) compilers
 - ▶ Portability and Security
 - ▶ Ever-evolving garbage collectors
- ▶ Full interoperability with Java and Java libraries

Exploration - Scala Shell and Worksheet



Scala Tour

- ▶ Conciseness
- ▶ Mixed Paradigms
 - ▶ Object Oriented
 - ▶ Functional
- ▶ Options, Collections
- ▶ Functional Pattern Matching
- ▶ Implicits
- ▶ Spark

Vals and vars but no semicolons

```
val helloWorld = "Hello, Scala World!"
```

```
//vals are immutable
```

```
//helloWorld2 = "this is a different string"
```

```
val names = List("Markus", "Joe", "Jane")
```

```
//vars are mutable
```

```
var allHellos = ""
```

```
names.foreach(name =>  
    allHellos += s"Hello, ${name}! ")
```

```
println(allHellos)
```

```
> Hello, Markus! Hello, Joe! Hello, Jane!
```


Defining a function, higher-order functions

```
def hasAtLeastThreeLetters(input: String): Boolean = {  
  if ((input != null) && (!input.isEmpty)) {  
    val letters = input.filter(c => c.isLetter)  
    letters.size >= 3  
  } else {  
    false  
  }  
}
```

Calling a function - syntactic sugar

```
val testInputs = List(null, "", "lower", "Upper")
```

```
testInputs.map((input: String) =>  
    hasAtLeastThreeLetters(input))
```

```
testInputs.map(input =>  
    hasAtLeastThreeLetters(input))
```

```
testInputs.map(input => hasAtLeastThreeLetters(input))
```

```
testInputs.map(hasAtLeastThreeLetters(_))
```

```
testInputs.map(hasAtLeastThreeLetters)  
> res0: List[Boolean] = List(false, false, true, true)
```

Assigning functions/function literals to variables

```
val vowels = List('a','e','i','o','u')
```

```
val threeLs: String => Boolean = hasAtLeastThreeLetters
```

```
threeLs("abcd")
```

```
> res1: Boolean = true
```

```
val removeVowels: (String) => String = { (str) =>  
  str.filter(c => !vowels.contains(c))  
}
```

```
val removeNonLetters: String => String = { str =>  
  str.filter(c => c.isLetter)  
}
```

```
removeVowels("wabbit")
```

```
> res2: String = wbtt
```

Everything's an object, more syntactic sugar, == equality

```
3 * 10
```

```
3.*(10)
```

```
1 to 10
```

```
1.to(10)
```

```
> res2: scala.collection.immutable.Range.Inclusive =  
  Range(1, 2, 3, 4, 5, 6, 7, 8, 9, 10)
```

```
val foo = "foo"
```

```
val bar = new String("foo")
```

```
foo == bar
```

Built-in tuples

```
val tuple = ("hello", 42)
```

```
val tuple2: (String, Int) = ("hello", 42)
```

```
val tuple3: Tuple2[String, Int] = ("hello", 42)
```

```
val triple = ("123-22-2111", "Joe", "443.998.8899")
```

```
tuple._1
```

```
tuple._2
```

```
val (word, count) = tuple
```

```
> word: String = hello
```

```
> count: Int = 5
```

Options - no more NullPointerExceptions!

```
val portOpt: Option[Int] = Some(5123)
```

```
val port2Opt: Option[Int] = None
```

```
portOpt.get
```

```
> res0: Int = 5123
```

```
port2Opt.get -
```

```
> java.util.NoSuchElementException: None.get
```

```
port2Opt.getOrElse(3306)
```

```
> res1: Int = 3306
```

```
portOpt.foreach(port => println(s"opening port ${port}"))
```

```
> res2: Unit = ()
```

```
Option(null)
```

```
> res3: Option[Null] = None
```

Collections - Arrays (with syntactic sugar)

```
val a : Array[Int] = Array(1,3,7,9)  
//val b = Array.apply(1,3,7,9)
```

```
a(0)  
//b.apply(0)
```

```
a(0) = 5  
//b.update(0, 5)
```

```
a.mkString(",")  
> res1: String = 5,3,7,9
```

Collections - Lists

```
val ws = List("When", "shall", "we", "three")
```

```
val ws2 = "When" :: "shall" :: Nil
```

```
val longWords = ws.filter(s => s.length > 4)
```

```
val lowers = ws.map(_.toLowerCase)
```

```
lowers.flatMap(_.permutations)
```

```
> res3: List[String] = List(when, whne, wehn...
```

```
//how many letters in our list?
```

```
val lengths = ws.map(_.length)
```

```
lengths.reduce(_ + _)
```

```
lengths.sum
```


Collections - Maps 1

```
var transMap = Map("when" -> "wann",  
    "shall" -> "sollen", "we" -> "wir")
```

```
val entryTuple1 = ("three" -> "drei")
```

```
val entryTuple2 = ("meet", "treffen")
```

```
transMap = transMap + entryTuple1
```

```
transMap = transMap + entryTuple2
```

```
transMap("when")
```

```
//transMap("who") //java.util.NoSuchElementException
```

```
transMap.get("when")
```

```
> res10: Option[String] = Some(wann)
```

```
transMap.get("who")
```

```
res11: Option[String] = None
```

Collections - Maps 1

```
val whenGerman = if (transMap.contains("when")) {  
    transMap("when")  
} else {  
    "unbekannt"  
}
```

```
val whenGerman2 = transMap.getOrElse("when", "unbekannt")
```

```
val transMap2 = transMap.withDefaultValue("unbekannt")
```

```
transMap2("when")
```

```
> res12: String = wann
```

```
transMap2("who")
```

```
> res13: String = unbekannt
```

Collections - higher-order functions

```
val wordLengthTuples = ws.map(s => (s, s.length))

val lengthMap =
  wordLengthTuples.groupBy { case (word, length) =>
    length }
> lengthMap: immutable.Map[Int,List[(String, Int)]]

lengthMap(5)
>res14: List[(String, Int)] = List((shall,5), (three,5))
```

For Comprehensions, yield, guards

```
val input = "afed-123-ghi-45-67"
```

```
//if we did not have RichChar.isDigit...
```

```
def isDigit(c : Char): Boolean = {  
    ('0' to '9').contains(c)  
}
```

```
var digits = ""  
for (c <- input) {  
    if (isDigit(c)) digits += c  
}  
digits  
> res1: String = 1234567
```

```
val digits2 = for(c <- input if isDigit(c)) yield c  
> digits2: String = 1234567
```

Scala Docs

Scala Standard x

← → ↻ ⓘ www.scala-lang.org/api/2.11.8/#scala.collection.immutable.Vector

Apps Asymmetrik Wildfire GeneralDev Scala

Vector

#ABCDEFGHIJKLMNOPQRSTUVWXYZ – deprecated


display packages only

scala.collection.immutable hide focus

- Vector
- VectorBuilder
- VectorIterator

scala.collection.parallel.immutable hide focus

- ParVector

 scala.collection.immutable

Vector

final class **Vector**[+A] extends [AbstractSeq](#)[A] with [IndexedSeq](#)[A] with [GenVectorPointer](#)[A] with [Serializable](#) with [CustomParallelizable](#)[A, [ParVector](#)

Vector is a general-purpose, immutable data structure. It provides random access and updates in effectively constant time. For random functional updates, they are currently the default implementation of immutable indexed sequences. It is best suited for very large sequences.

A the element type

Self Type [Vector](#)[A]
Source [Vector.scala](#)
See also ["Scala's Collection Library overview"](#) section on Vectors for more information.

► Linear Supertypes

q

Ordering Alphabetic By Inheritance

Inherited

- Vector
- CustomParallelizable
- Serializable
- Serializable
- VectorPointer
- IndexedSeq
- GenSeq
- GenSeqLike
- PartialFunction
- Function1
- AbstractIterable
- Iterable
- Iterable
- GenericTraversableTemplate
- TraversableLike
- GenTraversableLike
- Parallelizable
- Traversable

Multiline strings and interpolations

```
val multi = """It was the best of times,  
             |it was the worst of times""".stripMargin
```

```
val d = 100
```

```
val s = f"${d}%05d"
```

```
> s: String = 00100
```

Functional Pattern Matching - constant, type & variable

```
val result: Long = myObj match {  
  case 1234 => {  
    println("Constant pattern 1234")  
    1234  
  }  
  case i: Int => {  
    println(s"Typed pattern int: ${i}")  
    i  
  }  
  case d: Double => {  
    println(s"Typed pattern Double: ${d}")  
    math.round(d)  
  }  
  case default => //or wildcard _ (can't reference)  
    println(s"Variable pattern: ${default.getClass}")  
    0  
}
```

Functional Pattern Matching - sequence patterns

```
1 match {  
  case List(1, x, y) => {  
    println(s"1, then ${x}, ${y}")  
  }  
  case List(1, x, _*) => {  
    println(s"second element ${x}")  
  }  
  case 1 :: x :: xs => {  
    println(s"head 1, ${x} and tail ${xs}")  
  }  
  case x :: xs => {  
    println(s"Head ${x}, tail ${xs}")  
  }  
  case Nil => println("List was empty")  
}
```


Regex Pattern

```
val HostPortRegex =  
    """http://([\w.]+):(\d+)""".r  
  
val url = "http://es.host.com:9200"  
val HostPortRegex(host,port) = url  
  
val hostPortOpt = url match {  
    case HostPortRegex(host, port) =>  
        Some((host, port.toInt))  
    case _ => None  
}
```

Classes

```
class Person(var name: String) {  
    if (name.isEmpty) throw new  
        IllegalArgumentException("Empty name")  
}
```

```
val p1 = new Person("John Doe")
```

```
p1.name
```

```
> res1: String = John Doe
```

```
p1.name = "Joe Doe"
```

Class inheritance

```
class Employee(name: String,  
               val id: String = "009")  
    extends Person(name)  
  
val e1 = new Employee("Jennifer Huston")  
  
e1.name  
e1.id
```

Traits

```
trait Audit {  
  var auditLevel = "low"  
  def audit(action: String): Unit = {  
    val user = getUser()  
    val message = getLogMessage(user, action)  
    writeAudit(message)  
  }  
  
  def writeAudit(message: String): Unit  
  
  def getUser(): String = {  
    "alice"  
  }  
  def getLogMessage(user: String,  
                     action: String): String = {  
    s"${user} - ${action}"  
  }  
}
```

LogAudit Trait

```
trait LogAudit extends Audit {  
  
    var logFile = "/var/log/audit"  
  
    override def writeAudit(message: String): Unit = {  
        //use log4j or Files to append to logFile  
        println(message)  
    }  
  
    override def getLogMessage(user: String,  
                                action: String): String = {  
        val basicMessage =  
            super.getLogMessage(action, user)  
        s"${basicMessage} to ${logFile}"  
    }  
}
```

CloudAudit Trait

```
trait CloudAudit extends Audit {  
  var remoteHost = "host1:2121"  
  
  override def writeAudit(message: String): Unit = {  
    //write to remote host  
    println(message)  
  }  
  
  override def getLogMessage(action: String,  
                               user: String): String = {  
    val basicMessage =  
      super.getLogMessage(action, user)  
    s"${basicMessage} to ${remoteHost}"  
  }  
}
```

Audited Service class

```
abstract class MyService extends Audit {  
  def execute(): Unit = {  
    audit("MyService.execute")  
    //execute...  
  }  
}
```

Mixins

```
val myService0 = new MyService with LogAudit
myService0.execute()
> MyService.execute - alice to /var/log/audit
```

```
val myService1 =
  new MyService with LogAudit with CloudAudit
myService1.execute()
> MyService.execute - alice to /var/log/audit to host1
```

```
val myService2 =
  new MyService with CloudAudit with LogAudit
myService2.execute()
> MyService.execute - alice to host1 to /var/log/audit
```


Case Classes

```
case class Person(name: String, age: Int)
```

```
val p1 = Person("John Doe", 42)
```

```
p1.name //val
```

```
p1.age
```

```
val p2 = Person("Jane Doe", 39)
```

```
val p3 = Person("Jane Doe", 39)
```

```
val areTheyEqual = p2 == p3
```

```
> areTheyEqual: Boolean = true
```

Constructor pattern with pattern guard

```
val people: List[Person] =  
  List(p1,p2,p3)  
  
val (youngerPeople, youngPeople) =  
  people.partition { person =>  
    person match {  
      case Person(_, age) if age < 40 => true  
      case _ => false  
    }  
  }  
  
val Person(name, age) = p3
```

Scala in the small - scripting

```
import scala.sys.process._
import scala.sys.env
import scala.sys.props
import scala.language.postfixOps

val externalCommand = "tokenGenerator"

//run command and get its status code
s"chmod +x ${externalCommand}"!

//run command and get its output
val myToken = s"./${externalCommand}"!!

env("PATH")
> res2: String = /usr/local/bin:/usr/sbin:...
props("user.name")
> res3: String = medale
```

Import Aliasing, Java Interoperability

```
import scala.collection._  
import scala.collection.JavaConverters._  
import java.util.ArrayList  
import java.util.{List => JavaList}
```

```
val myJavaList = new ArrayList[String]()  
myJavaList.add("hello")  
myJavaList.add("world")
```

```
val buffer: mutable.Buffer[String] = myJavaList.asScala  
val myScalaList: List[String] = buffer.toList
```

```
val capStrings = myScalaList.map { str =>  
    str.capitalize  
}
```

```
val javaCapStrings: JavaList[String] = capStrings.asJava  
> javaCapStrings: java.util.List[String] = [Hello, World]
```

Implicits - Predef - StringOps

```
"abcdef".diff("abef")
```

```
> res0: String = cd
```

```
"abc".permutations.toList
```

```
> res1: List[String] = List(abc, acb, bac, bca, cab, cba)
```

```
"bi-grams".sliding(2).toList
```

```
> res2: List[String] = List(bi, i-, -g, gr, ra, am, ms)
```

```
"No earth without art".slice(4,7)
```

```
> res3: String = art
```

From: Predef

```
implicit def augmentString(x: String): StringOps  
  = new StringOps(x)
```

Writing your own Implicit - Map with getOpt

```
import java.util.{Map => JavaMap}
import java.util.HashMap
import scala.language.implicitConversions

val map = new HashMap[String,String]()
map.put("foo","bar")

map.get("baz")
> res5: String = null
```

Implicit: Augmenting Map with getOpt

```
class JavaMapOps[K,V](map: JavaMap[K,V]) {  
  def getOpt(key: K): Option[V] = {  
    if (map.containsKey(key)) {  
      Some(map.get(key))  
    } else {  
      None  
    }  
  }  
}  
  
implicit def augmentJavaMap[K,V](map: JavaMap[K,V]):  
  JavaMapOps[K,V] = {  
    new JavaMapOps(map)  
  }  
  
map.getOpt("foo")  
> res5: Option[String] = Some(bar)  
fooMap.getOpt("baz")  
> res6: Option[String] = None
```

Scala in action - Spark big data processing

```
val spark = SparkSession.builder()
    .master("local")
    .appName("combined-age")
    .getOrCreate()
import spark.implicits._
val peopleDs = spark.createDataset(people)
val youngerDs = peopleDs.filter(p => p.age < 40)

val resultRows = peopleDs.
    groupBy($"name").
    avg("age").collect()

resultRows.foreach { row =>
    println(s"Name: ${row.get(0)} Avg. age: ${row.get(1)}")
}
> Name: John Avg. age: 30.0
> Name: Jane Avg. age: 25.0
```


Learn by doing - Scala exercises

- ▶ See `scalatour_exercises` and `scalatour_solutions`

Resources

- ▶ Coursera/EPFL Functional Programming in Scala Specialization
- ▶ Horstmann, Scala for the Impatient Video
- ▶ Odersky et al., Programming in Scala, 3rd Edition
- ▶ Payne, Wampler, Programming Scala, 2nd Edition
- ▶ Alexander, Scala Cookbook
- ▶ Chiusano, Bjarnason, Functional Programming in Scala
- ▶ Twitter Scala School