



PEP Scala (1)

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Office Hours: Mondays 12:00 – 14:00
except next week: Tuesday

Why Scala?

twitter 

Linked 

theguardian

Morgan Stanley

CREDIT SUISSE 

...



edf
ENERGY

Novell.

foursquare™

HSBC 

...

developed since 2004 by Martin Odersky
(he was behind Generic Scala which was included
in Java 5)

Why Scala?

- compiles to the JVM
(also JavaScript, native X86 in the works)
- integrates seamlessly with Java
- combines **functional** and **object-oriented** programming
- it is a bit on the “mathematical” side
(no pointers, no null, but expressions)
- often one can write very concise and elegant code

alternatives:

Elm, Haskell, Ocaml, F#, Erlang, ML, Lisp (Racket), ...

Java vs Scala

Java

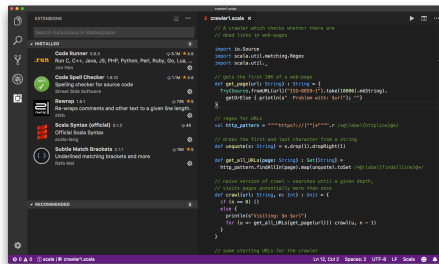
```
public class Point {  
    private final int x, y;  
  
    public Point(int x, int y) {  
        this.x = x;  
        this.y = y;  
    }  
  
    public int x() { return x; }  
  
    public int y() { return y; }  
}
```

```
class Point(val x: Int, val y: Int)
```

Scala

First Steps: Scala Tools

- I use VS Code and a Scala extension



```
// A crawler which checks whether there are
// dead links in web-pages

import io.Source
import scala.io.{Matching, Regex}
import scala.util._

// gets the first url of a webpage
def get_pageUrl( String ) : String = {
  try {
    val url = new java.net.URL( "http://www.scala-lang.org" )
    url.openConnection().getHeaderField( "link" )
  } catch {
    case _ => ""
  }
}

// regex for urls
val http_pattern = """http://[^\s]*\.[^\s]*\.[^\s]*"""

// strips the first and last character from a string
def stripOuter( String ) = s.stripPrefix( " " ).stripSuffix( " " )

def get_all_urls( page : String ) : Set[String] =
  http_pattern.findAllIn( page ).map( stripOuter ).toSet

// main version of crawl - searches until a given depth,
// visits pages potentially more than once
def crawl( url : String, n : Int ) : Set[String] = {
  if ( n == 0 ) {
    else {
      println( "visiting: " + url )
      for {
        url2 <- get_all_urls( get_pageUrl( url ) )
        crawl( url2, n - 1 )
      }
    }
  }
}

// some starting URLs for the crawler
```

- there is a plugin for Eclipse (called Scala IDE)
- there is also a plugin for IntelliJ

Why Scala?

Scala, Elm, Haskell, Ocaml, F#, Erlang, ML, Lisp (Racket), ...

Why Functional Programming?

Scala, Elm, Haskell, Ocaml, F#, Erlang, ML, Lisp (Racket), ...

Why Functional Programming?

“If you want to see which features will be in mainstream programming languages tomorrow, then take a look at functional programming languages today.”

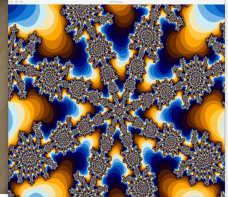
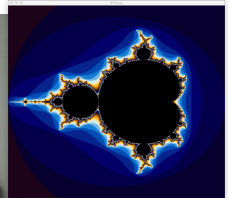
—Simon Peyton Jones (works at Microsoft)
main developer of the Glasgow Haskell Compiler

Scala, Elm, Haskell, Ocaml, F#, Erlang, ML, Lisp (Racket), ...

1986



3 days



64K RAM, no HD, no monitor, lots of cables

1986



1988, C



1986



1988, C



1992, Linux



1986



1988, C



1992, Linux



1996

1986



1988, C



1992, Linux



2000



1996



1986



1988, C



1992, Linux



2012?



2000



1996



1986



1988, C



1992, Linux



2012?



2000



1996



2017



1986



1988, C



1992, Linux



2012?



2000



1996



2017



1986: no Internet

no Amazon

no FB, no mobiles,...

1986



1988, C



1992, Linux



Speedup by Moore's Law

1986:	3 days	1996:	135 mins
1988:	1.5 days	1998:	67 mins
1990:	18 hs	2000:	33 mins
1992:	9 hs	2002:	16 mins
1994:	4.5 hs		???

2012?



Every two years, computers got twice as powerful.

2017



no Amazon

no FB, no mobiles,...

1986



1988, C



1992, Linux



2012?



2000



1996



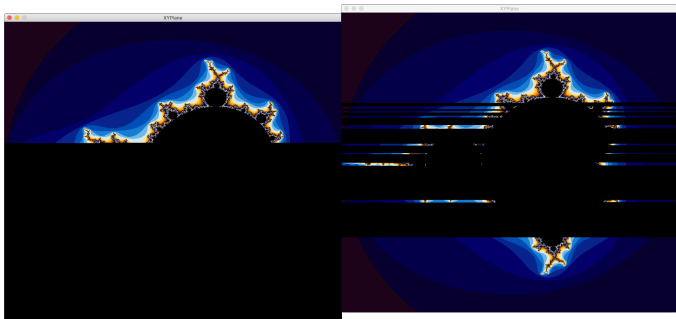
2017

1986: no Internet

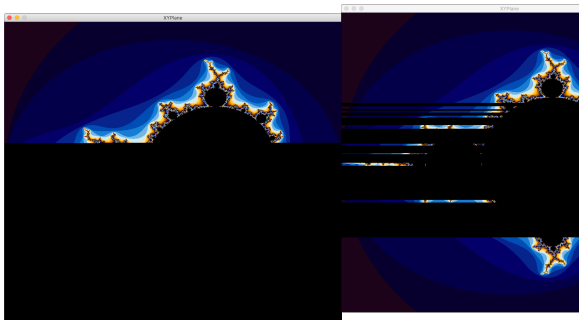
no Amazon

no FB, no mobiles,...

Seq vs Par



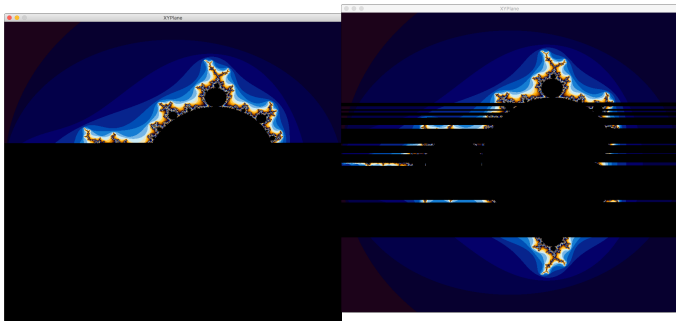
Seq vs Par



in Java or C++



Seq vs Par



In FP: Once a variable is created, it is assigned a value and then never changed again \Rightarrow no synchronisation
(Andrew's second favourite feature of C++)

Types

- Base types

Int, Long, BigInt, Float, Double
String, Char
Boolean

- Compound types

List[Int]

lists of Int's

Set[Double]

sets of Double's

(Int, String)

Int-String pair

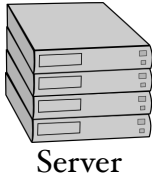
List[(BigInt, String)]

lists of BigInt-String
pairs

List[List[Int]]

list of lists of Int's

An Http Request



GET request



webpage



Browser



POST data



```
import java.io.IOException;
import java.net.MalformedURLException;
import java.net.URL;
import java.util.Scanner;

public class URLReader {

    public static String readURL(String sUrl) {
        StringBuilder buf = new StringBuilder();
        Scanner in = null;

        try {
            URL url = new URL(sUrl);
            in = new Scanner(url.openStream());

            while (in.hasNextLine()) {
                buf.append(in.nextLine() + "\n");
            }
            return buf.toString();

        } catch (MalformedURLException e) {
            System.err.println(e);
        } catch (IOException e) {
            System.err.println(e);
        } finally {
            if (in != null) {
                in.close();
            }
        }
        return null;
    }
}
```


Coursework

- sorry, I might have been a bit wordy:
CW description is 7 pages, but I only needed < 150 loc for all the CW
- there is email feedback when pushing code to github
- we want you to learn FP: **no vars**, no mutable datastructures, e.g. ListBuffer

The Joy of Immutability

- If you need to manipulate some data in a list say, then you make a new list with the updated values, rather than revise the original list. Easy!

```
val old_list = List(1, 2, 3, 5)
val new_list = 0 :: old_list
```

- You do not have to be defensive about who can access the data (concurrency, laziness).

Email: Hate 'val'

Subject: **Hate 'val'**

01:00 AM

Hello Mr Urban,

I just wanted to ask, how are we suppose to work with the completely useless **val**, that can't be changed ever? Why is this rule active at all? I've spent 4 hours not thinking on the coursework, but how to bypass this annoying rule. What's the whole point of all these coursework, when we can't use everything Scala gives us?!?

Regards.

«deleted»

Subject: **Re: Hate 'val'**

01:02 AM

*«my usual rant about fp...
concurrency bla bla... better programs yada»*

PS: What are you trying to do where you
desperately want to use var?

Subject: **Re: Re: Hate 'val'**

01:04 AM

Right now my is_legal function works fine:

```
def is_legal(dim: Int, path: Path)(x: Pos): Boolean = {  
  var boolReturn = false  
  if(x._1 > dim || x._2 > dim || x._1 < 0 || x._2 < 0) {  
    else { var breakLoop = false  
      if(path == Nil) { boolReturn = true }  
      else { for(i <- 0 until path.length) {  
        if(breakLoop == false) {  
          if(path(i) == x) {  
            boolReturn = true  
            breakLoop = true  
          }  
        }  
      } else { boolReturn = false }  
    } else breakLoop = true  
  }  
  boolReturn  
}
```

...but I can't make it work with boolReturn being val. What approach would you recommend in this case, and is using var in this case justified?

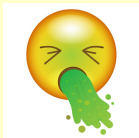
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    else { var breakLoop = false  
      if(path == Nil) { boolReturn = true }  
      else { for(i <- 0 until path.length) {  
        if(breakLoop == false) {  
          if(path(i) == x) {  
            boolReturn = true  
            breakLoop = true  
          }  
        }  
      } else { boolReturn = false }  
    } else breakLoop = true  
  }  
}
```

Me:



...but I can't make it work with boolReturn being val. What approach would you recommend in this case, and is using var in this case justified?

Subject: **Re: Re: Re: Hate 'val'**

01:06 AM

OK. So you want to make sure that the x-position is not outside the board...and furthermore you want to make sure that the x-position is not yet in the path list. How about something like

```
def is_legal(dim: Int, path: Path)(x: Pos): Boolean =  
  ...<<some board conditions>>... && !path.contains(x)
```

Does not even contain a `val`.

(This is all on one line)

Subject: **Re: Re: Re: Re: Hate 'val'** 11:02 AM

THANK YOU! You made me change my coding perspective. Because of you, I figured out the next one...

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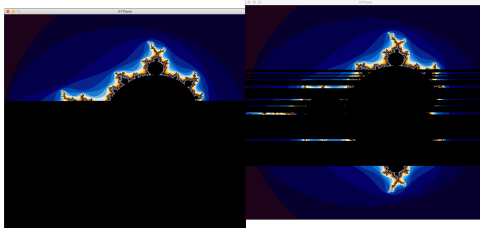
Me:



Conclusion

- Scala is still under heavy development (the compiler is terribly slow)
- <http://www.scala-lang.org/>
- it is a rather **deep** language...i.e. gives you a lot of rope to shoot yourself
- learning functional programming is not easy...when you have spent all of your career thinking in a procedural way it is hard to change
- hope you have fun with the coursework

Questions?



My Scala Office Hours: Thursdays 11 – 13