



PEP Scala (1)

Email: christian.urban at kcl.ac.uk

Slides & Code: KEATS

Office Hour: Fridays 13:00 – 14:00

Location: N7.07 (North Wing, Bush House)

Pollev: <https://pollev.com/cfltutoratki576>

Why Scala?

LinkedIn

theguardian

Morgan Stanley

CREDIT SUISSE

Standard & Poor's

...



EDF
ENERGY

Novell

foursquare

HSBC

...



lichess engine (open source)
lichess.org

A former student working now at Quantexa:

"I am a former student. I graduated last year. I got my dream job as a backend Scala developer. Most of the Scala I know is from PEP 2018/19. My interviewers said they expect code of a lesser quality even from people with one year of experience."

"I am currently working as a software engineer at Morgan Stanley whilst doing my year-in-industry and am using Scala in the workplace. My team were impressed that I could already program in the language and even had knowledge of other functional languages. They told me that most university students are not taught such languages."

– Sumaiya Mohbubul 2021/22

"PEP was my favourite module so far during these 2 years. It motivated me to apply and get a summer internship offer at S&P Global as a Scala developer. The module content was more than enough for me to start working on the projects here at the company."

– Szabolcs Nagy 2021/22

Why Scala?

- compiles to the JVM
(also JavaScript, native X86 in the works)
- integrates seamlessly with Java
- combines **functional** and **object-oriented** programming
- no pointers, no null
- often one can write very concise and elegant code

Java vs Scala

```
public class Point { 1
    private final int x, y; 2
    3
    public Point(int x, int y) { 4
        this.x = x; 5
        this.y = y; 6
    } 7
    8
    public int x() { return x; } 9
    10
    public int y() { return y; } 11
} 12
```

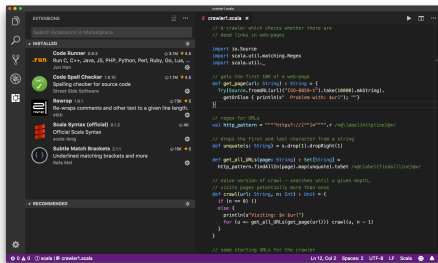
Java

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

Scala

First Steps: Scala 3 Tools

- contains a REPL \Rightarrow but this year we use `scala-cli`
- I use VS Codium and a Scala extension (M'place)



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

import io.Source
import scala.util.matching.Regex
import scala.util._

// gets the first URL of a webpage
def get_page(url: String) = {
  try {
    Source.fromURL(s"$url-000-01.html(000)").asString()
    .extract { printable } // deals with \n\r
  }
}

// regex for URLs
val http_pattern = """https?://(?:[a-zA-Z]+\.)?(?:localhost|)

// drops the first and last character from a string
def unquote(s: String) = s.drop(1).dropRight(1)

def get_all_urls(page: String) = {
  http_pattern.findAllIn(page).flatMap(unquote).toSet
}

// naive version of crawl -- searches until a given depth,
// visits pages potentially more than once
def crawl(url: String, n: Int) = {
  if (n == 0) ()
  else {
    println(s"visiting $n $url")
    for (a = get_all_urls(get_page(url))) crawl(a, n - 1)
  }
}

// see starting URLs for the crawler
```

- there is also a plugin for IntelliJ, but I do not recommend it

My personal keyboard shortcut for VS Code (in keybindings.json)

```
[  
  {  
    "key": "ctrl+enter",  
    "command": "workbench.action.terminal.runSelectedText",  
    "when": "editorTextFocus && editorHasSelection"  
  }  
]
```

This year Scala 3/ scala-cli

scala-cli ⇒ <https://scala-cli.virtuslab.org/>

Installation problems:

- Oscar Sjostedt (oscar.sjostedt@kcl.ac.uk)
- Nicole Lehchevska (nicole.lehchevska@kcl.ac.uk)

Github problems:

- Quan Tran (anh.tran@kcl.ac.uk)

Discussion forum:

- Ruben Ticehurst-James (ruben.ticehurst-james@kcl.ac.uk)

Why Scala?

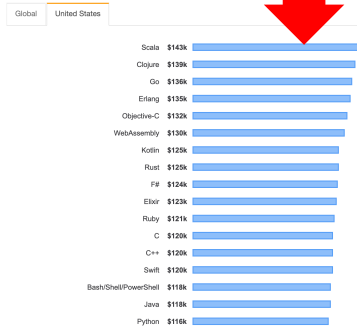
Why Scala?

Money?

What Languages Are Associated with the Highest Salaries Worldwide?



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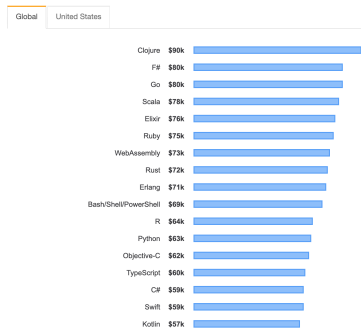
* source: Stackoverflow Developer Survey, 2019

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

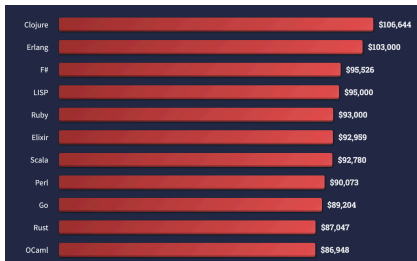
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Why Functional Programming?

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 Epic Games, used to work at Microsoft)
main developer of the Glasgow Haskell Compiler*

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

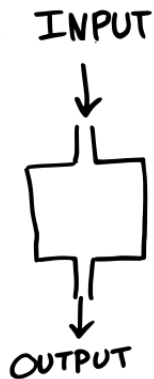
Why Functional Programming?



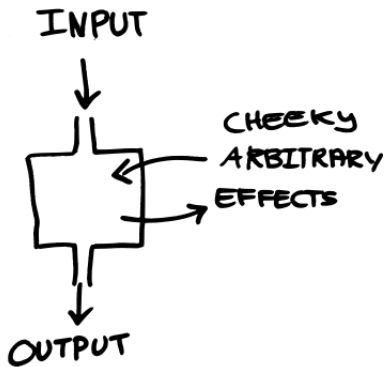
Immutability

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

Functions



Procedures



* from "What pure functional programming is all about?"

Why bother? or What is wrong with this?

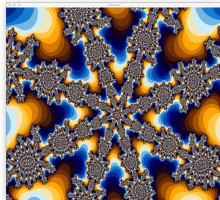
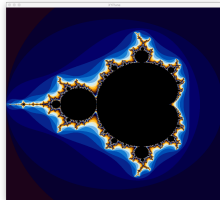
```
for (int i = 10; i < 20; i++) {  
  
    //...Do something interesting  
    //    with i...  
  
}
```

1986



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

3 days



1986



1988, C



1986



1988, C



1992, Linux



1986



1988, C



1992, Linux



1996

1986



1988, C



1992, Linux



1996

2000



1986



1988, C



1992, Linux



1996

2012?



2000



1986



1988, C



1992, Linux



1996

2012?



2000



2017



1986



1988, C



1992, Linux



2012?



2000



1996



2017



1986: no Internet

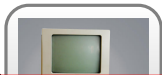
no Amazon

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?



2017

Every two years, computers got twice as powerful.

no Amazon

no FB, no mobiles,...

1986



1988, C



1992, Linux



2012?



2000



1996



2017

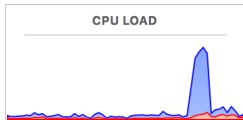
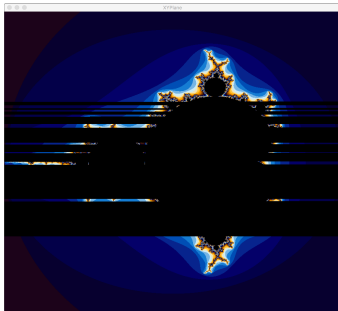
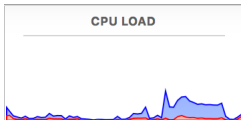
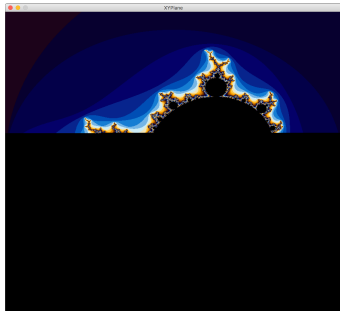


1986: no Internet

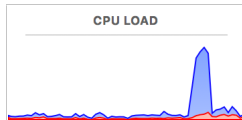
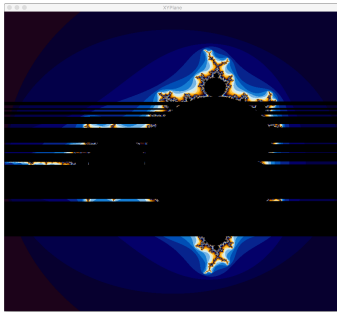
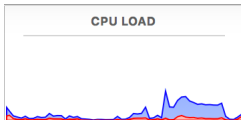
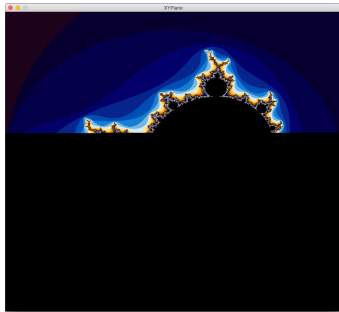
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Seq vs Par



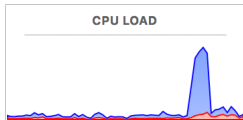
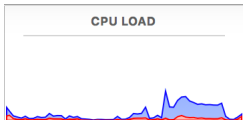
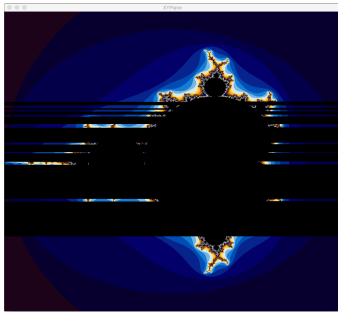
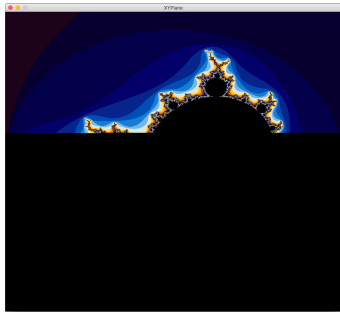
Seq vs Par



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 needed

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

Option[Int]

options of Int's

```
def fname(arg1: ty1, arg2: ty2,..., argn: tyn): rty = {  
    ....  
}
```



```
def average(xs: List[Int]) : Int = {  
  val s = xs.sum  
  val n = xs.length  
  s / n  
}
```

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
// -> List(0, 1, 2, 3, 4, 5)
```

- You do not have to be defensive about who can access the data.
- You can look at your code in isolation.

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  
          }  
        }  
      }  
    }  
  }  
  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?

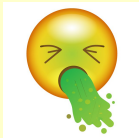
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      if(path == Nil) { boolReturn = true }  
      else { for(i <- 0 until path.length) {  
        if(breakLoop == false) {  
          if(path(i) == x) {  
            boolReturn = true  
            breakLoop = true  
          }  
        }  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

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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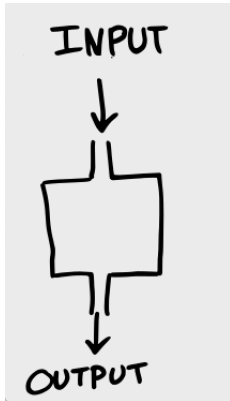


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— Szabolcs Daniel Nagi (PEP 2021)

Conclusion for Today

- This year we will be using Scala 3 with the `scala-cli` REPL!
- <https://scala-cli.virtuslab.org/>
- Scala can be 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 an imperative way, it is hard to change.
- Hope you have fun with Scala and the assignments.



???

