Functional Programming In Practice

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May 9th 2016

Agenda

- Functional Programming
- Haskell, Scala, Clojure
- Full stack example using Clojure

First, what is FP?

- First class functions
- Pure functions
- Immutable values
- No or few side effects

First class functions

Functions can be created on the fly

```
scala> val f = (x: String) => "Hello " + x
f: String => String = <function1>

scala> f("World")
res10: String = Hello World
```

First class functions

Functions can be passed around as values

```
List("Clojure","Scala","Haskell").map(f)
res: List(Hello Clojure, Hello Scala, Hello Haskell)
```

Pure functions

Function with same input always yields the output:

```
f(x) == y, always
```

Not a pure function

```
scala> val f = (i: Int) => Math.random() * i
f: Int => Double = <function1>

scala> f(1)
res14: Double = 0.13536266885499726

scala> f(1)
res15: Double = 0.4086671423543593
```

A pure function?

```
val add = (x: Int, y: Int) => x + y
add(1,2) // 3
```

A pure function?

```
class MutableInt(var i: Int) {
  override def toString = i.toString
}

val add = (x: MutableInt, y: MutableInt): MutableInt =>
  new MutableInt(x.i + y.i)

val x = new MutableInt(1)
val y = new MutableInt(2)

add(x,y) // MutableInt = 3
```

A pure function? No!

You cannot build pure functions with mutable objects.

```
add(x,y) // MutableInt = 3

x.i = 2

add(x,y) // MutableInt = 4
```

`add(x,y)` does not always yield the same result!
This is why we need **immutable values** in Functional Programming.

A pure function?

`List(1,2,3)` is immutable.

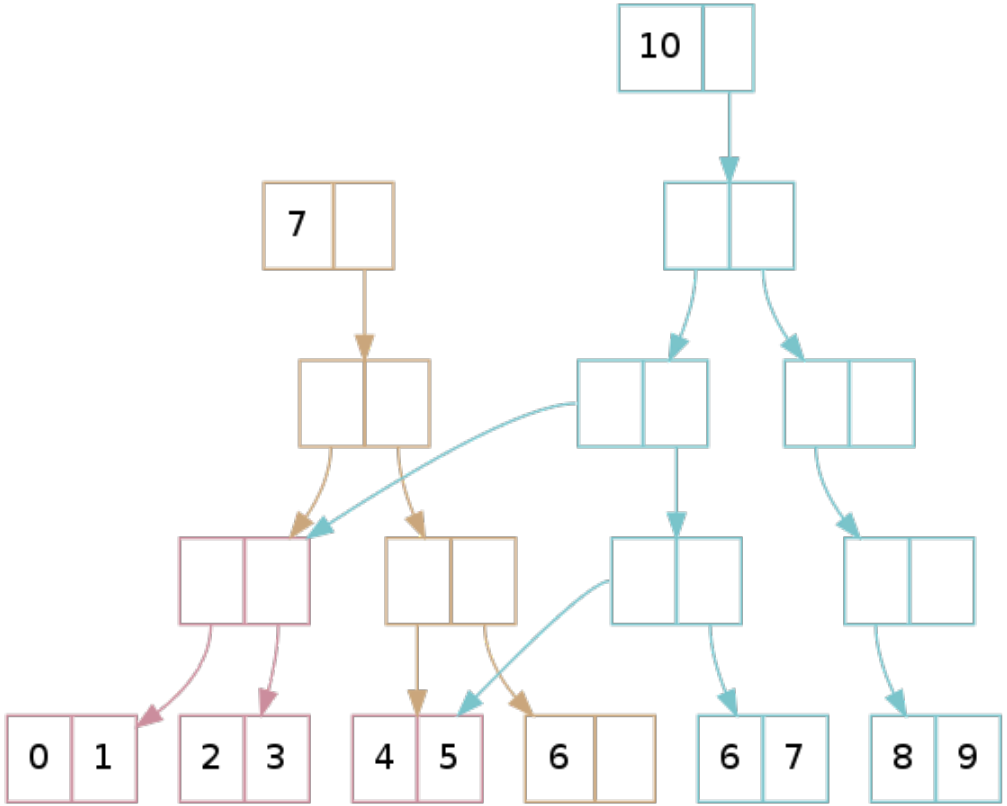
```
def addZero(l: List[Int]) = 0 :: l

addZero(List(1,2,3)) // List(0, 1, 2, 3)
```

Immutable data structures

`Int, String`, etc are already immutable

```
0 :: List(1,2,3)   // List(0,1,2,3)
Vector(1,2,3) :+ 4 // Vector(1,2,3,4)
Set(1,2,3) + 4     // Set(1,2,3,4)
```

Efficient by re-using structure internally

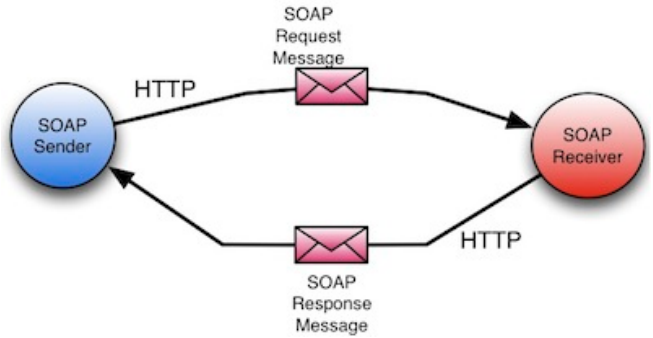


source: http://hypirion.com/musings/understanding-persistent-vector-pt-1

Systems and immutability

- Each system receives a message and/or sends a message
- Mutating a message does not affect other system
- In traditional OO references lead to uncontrolled mutation, also called spooky action at a distance

- You can protect yourself by using Value Objects or DTOs, but takes work
- Immutable data structures solve this problem



Side effects

- State modification
- Observable action

Examples:

- Modifying a variable
- Writing to a file

Side effects

- Pure functions have no side effects
- Side effects are difficult to test (without mocks)
- Pure FP languages make side effects explicit
- FP languages isolate/minimize side effects

Where are the side effects?

```
class Program extends App {
  var x: Int = 1
  def mutateX = {
    x = (Math.random * 100).toInt
  }
  mutateX
  println(x)
}
```

Where are the side effects?

```
class Program extends App {
  var x: Int = 1
  def mutateX = {
    x = (Math.random * 100).toInt
  }
  mutateX
  println(x)
}
```

Why Functional Programming?

- Makes codes easier to reason about
- Easier to test
- More expressive, less code = less bugs
- Better suited for parallellisation and concurrency

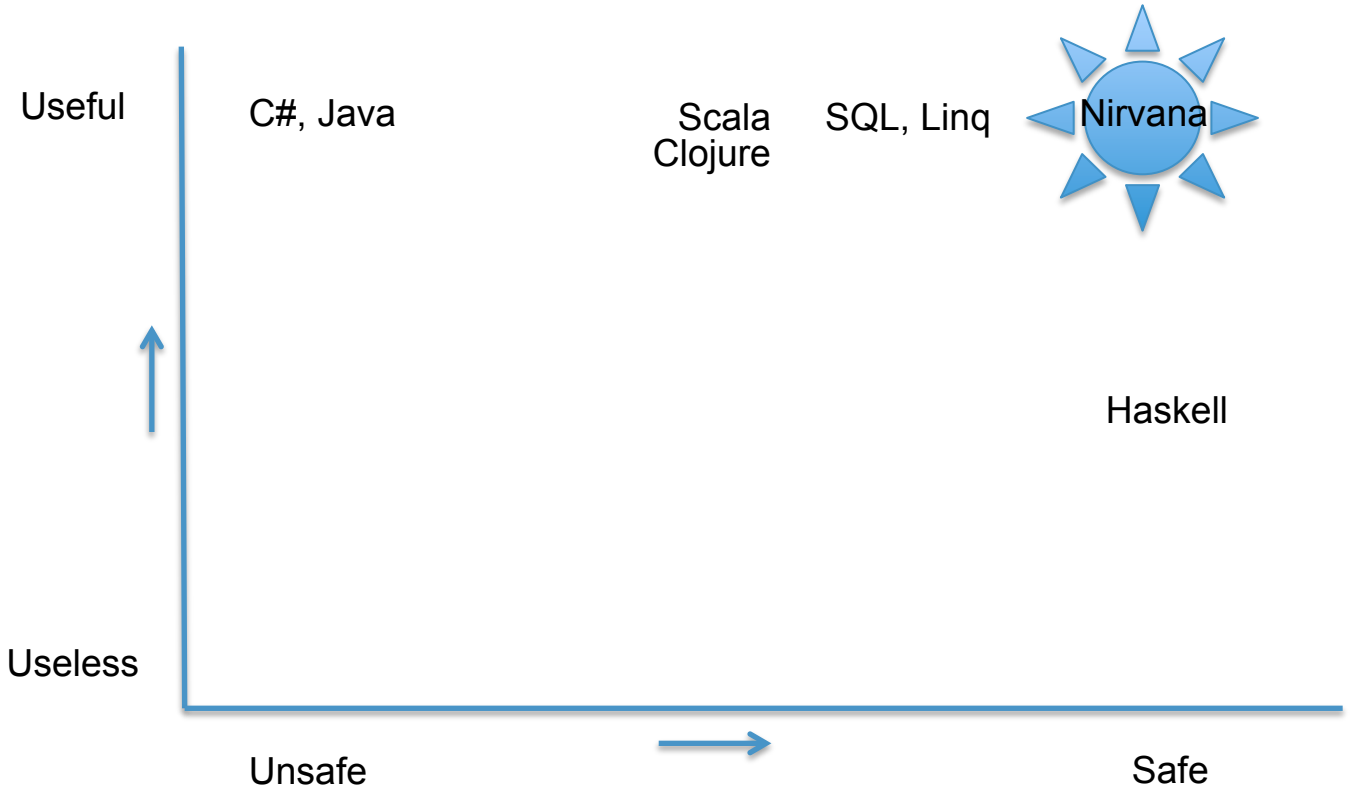
Examples in Haskell, Scala and Clojure

- Define a new type Person
- Create a list of Persons
- Count total length of first names with length greater than 4

https://github.com/borkdude/fp-hu-may-2016/blob/master/code

Degrees of FP

Simon Peyton Jones, FP researcher



Learning FP

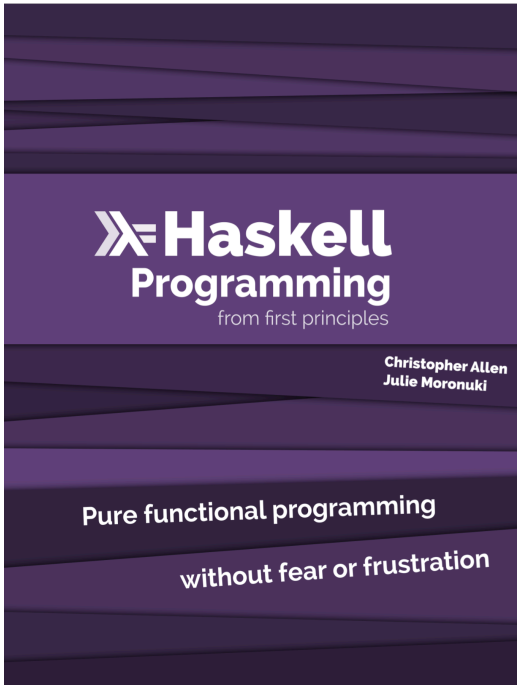
Choose a language that encourages FP

Haskell	Pure, lazy, statically typed
Clojure	Not pure. FP + Lisp on JVM, dynamically typed
Scala	Not pure. FP + (immutable) OO on JVM, statically typed

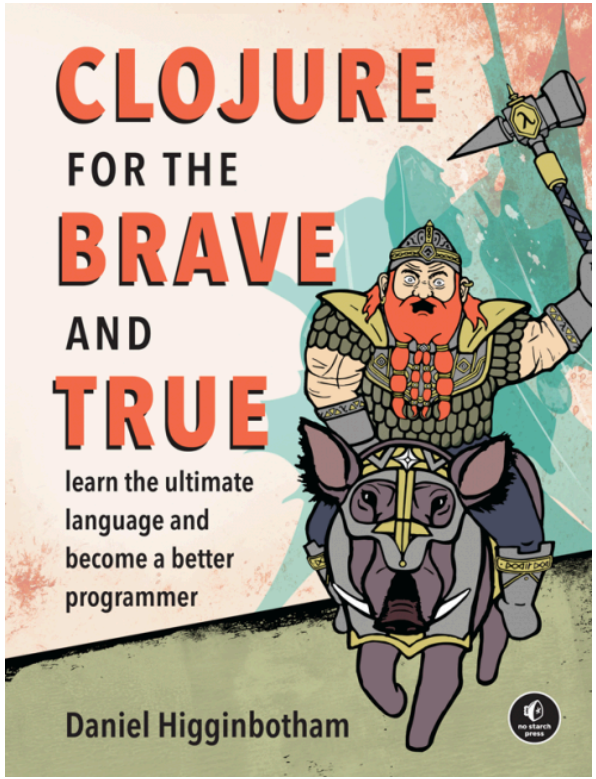
Apply the concepts in your favorite language

‘Think like a fundamentalist, code like a hacker’ – Erik Meijer

Haskell resources



Clojure resources



http://michielborkent.nl/clojurecursus

Inleiding Functioneel Programmeren met Clojure

Auteur: Michiel Borkent

Cursusjaar: 2012-2013

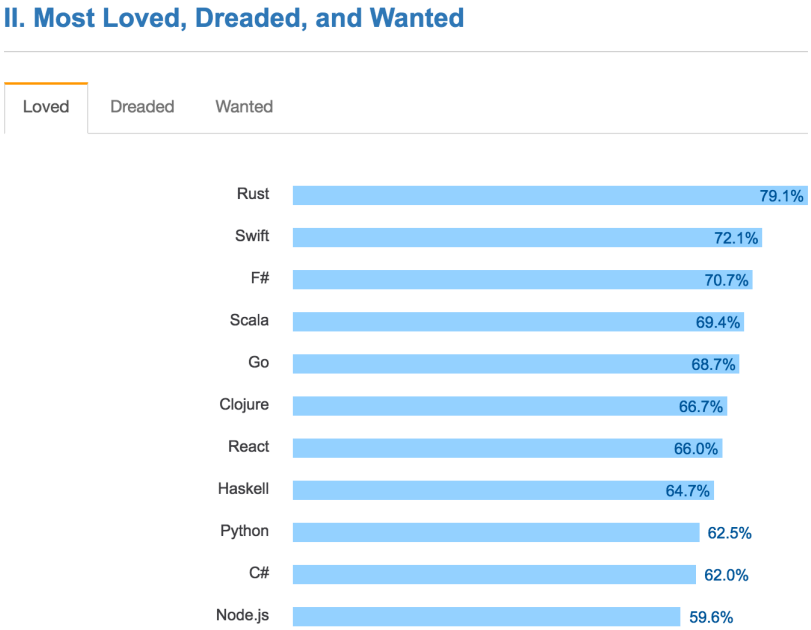
- studiewijzer
- dictaat
- practicum

Scala resources

Functional Programming in Scala

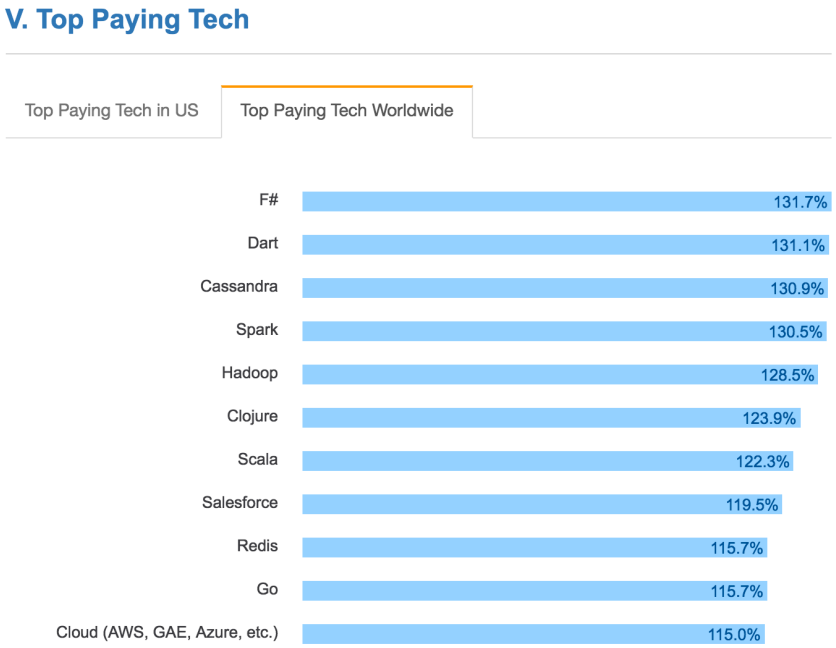
Coursera MOOC

Developers love FP



Source: http://stackoverflow.com/research/developer-survey-2016

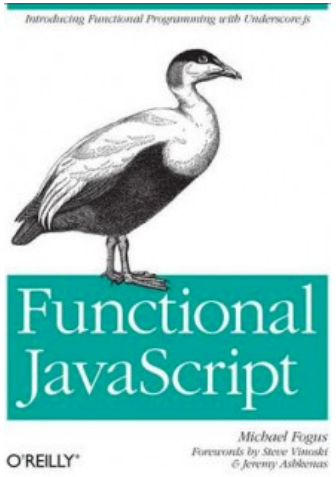
Companies want FP devs

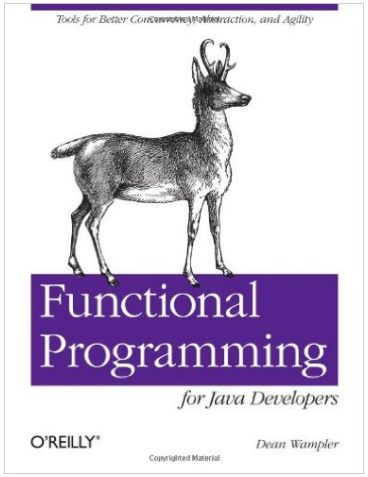


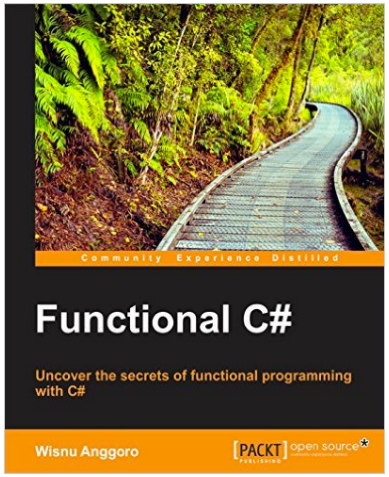
Source: http://stackoverflow.com/research/developer-survey-2016

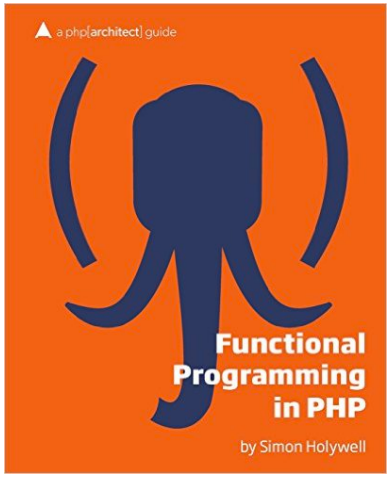
Once you know FP

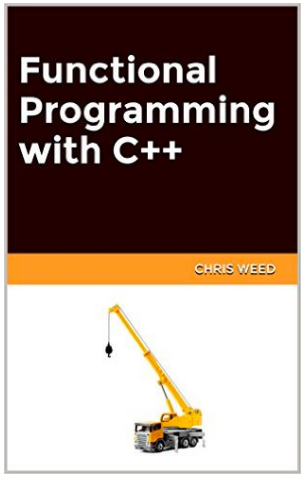
… you can apply and see it everywhere







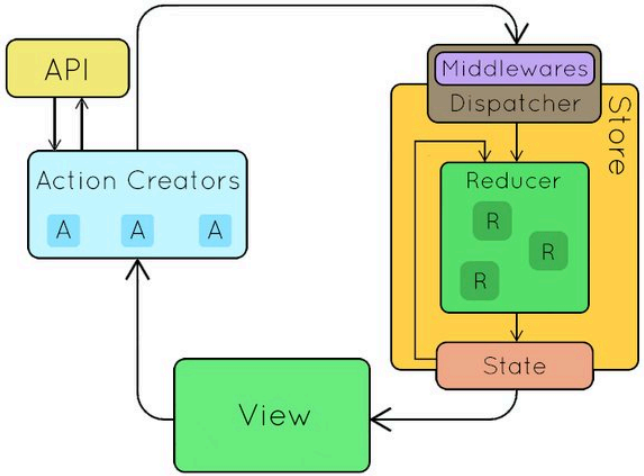


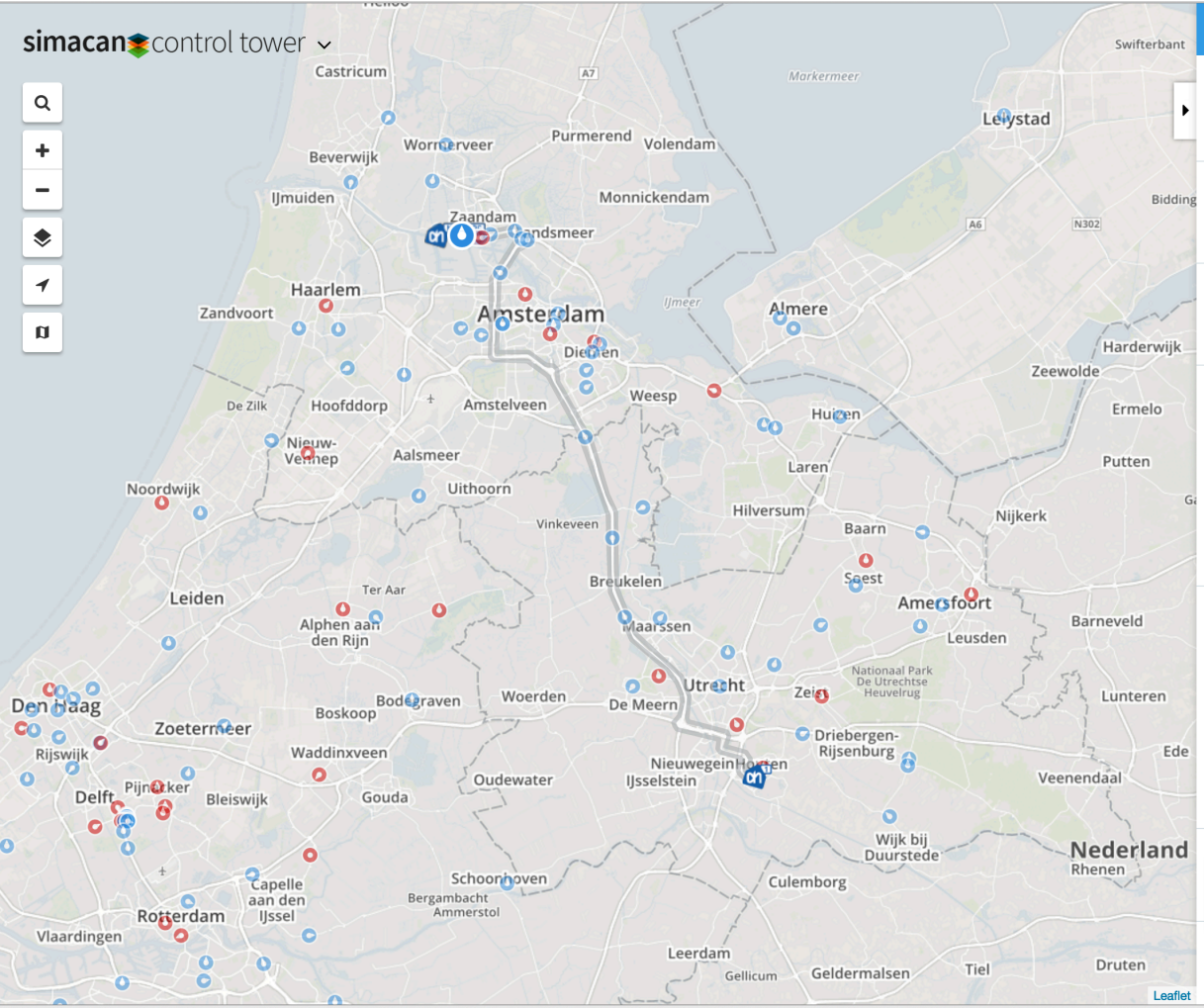


FP at my job

simacan

- Microservices in Scala
- UI in JavaScript using React, ImmutableJS and Redux





6-5-2016

Simacan Developer

DCZ|2016|18-5-232 (Simon Loos B.V. (Wognum))

12:20 - 16:25

AFWIJKINGEN

Deze rit heeft geen afwijkingen

GESCHIEDENIS

Nog geen berichten...

REALISATIE

PLANNING

12:21 - 12:41 DCZ Dock: 110 (HB)

14:14 - 14:50 8559 Houten (HB)

16:05 - 16:25 MCZ

RIT DETAILS

Laatste update:

Telefoonnummer:

Voertuig:

Kenteken:

Trailers:

Toon kruimelpad

Clojure

- dynamic language
- Lisp
- functional programming
- immutable data structures
- strong concurrency support
- embraces host platform (JVM, js)
- EDN

Clojure in industry

https://www.youtube.com/watch?v=av9Xi6CNqq4

https://www.youtube.com/watch?v=iUC7noGU1mQ

http://dev.clojure.org/display/community/Clojure+Success+Stories

Data literals

```
Keyword:      :a
Vector:       [1 2 3 4]
Hash map:     {:a 1, :b 2}
Set:          #{1 2 3 4}
List:         '(1 2 3 4)
```

Extensible Data Notation

```
{:key1"Bar"
 :key2 [1 2 3]
 "key3", #{1.0 2.0 \c}
 :key4,{:foo {:bar {:baz 'hello}}}}

(pr-str {:foo "bar"})
(read-string "{:foo \"bar\"}")
```

Syntax

```
f(x) -> (f x)
```

Syntax

```
if (...) {
  ...
} else {
  ...
}
```

->

```
(if ...
    ...
    ...)
```

Syntax

```
var foo = "bar";
```

```
(def foo "bar")
```

JavaScript - ClojureScript

```
if (bugs.length > 0) {
  return 'Not ready for release';
} else {
  return 'Ready for release';
}
```

```
(if (pos? (count bugs))
  "Not ready for release"
  "Ready for release")
```

source: http://himera.herokuapp.com/synonym.html

JavaScript - ClojureScript

`var foo = {bar: "baz"};`
`foo.bar = "baz";`
`foo["abc"] = 17;`
 	
`alert('foo')`
`new Date().getTime()`
`new`
`Date().getTime().toString()`
	`(def foo (js-obj "bar" "baz"))`
	`(set! (.-bar foo) "baz")`
	`(aset foo "abc" 17)`
	
	`(js/alert "foo")`
	`(.getTime (js/Date.))`
	`(.. (js/Date.) (getTime)`
	`(toString))`

source: http://himera.herokuapp.com/synonym.html

Persistent data structures

```
(def v [1 2 3])
(conj v 4) ;; => [1 2 3 4]
(get v 0) ;; => 1
(v 0) ;; => 1
```

Persistent data structures

```
(def m {:foo 1 :bar 2})
(assoc m :foo 2) ;; => {:foo 2 :bar 2}
(get m :foo) ;;=> 1
(m :foo) ;;=> 1
(:foo m) ;;=> 1
(dissoc m :foo) ;;=> {:bar 2}
```

Functional programming

```
(def r (->>
         (range 10)     ;; (0 1 2 .. 9)
         (filter odd?) ;; (1 3 5 7 9)
         (map inc)))    ;; (2 4 6 8 10)
;; r is (2 4 6 8 10)
```

Functional programming

```
;; r is (2 4 6 8 10)
(reduce + r)
;; => 30
(reductions + r)
;; => (2 6 12 20 30)
```

```
var sum = _.reduce(r, function(memo, num){ return memo + num; });
```

Sequence abstraction

Data structures as seqs

```
(first [1 2 3]) ;;=> 1
(rest [1 2 3]) ;;=> (2 3)
```

General seq functions: `map`, `reduce`, `filter`, …

```
(distinct [1 1 2 3]) ;;=> (1 2 3)
(take 2 (range 10)) ;;=> (0 1)
```

See http://clojure.org/cheatsheet for more

Sequence abstraction

Most seq functions return lazy sequences:

```
(take 2 (map
          (fn [n] (js/alert n) n)
            (range)))
```

side effect

infinite lazy sequence of numbers

Mutable state: atoms

```
(def my-atom (atom 0))
@my-atom ;; 0
(reset! my-atom 1)
(reset! my-atom (inc @my-atom)) ;; bad idiom
(swap! my-atom (fn [old-value]
                 (inc old-value)))
(swap! my-atom inc) ;; same
@my-atom ;; 4
```

Lisp: macros

```
(map inc
  (filter odd?
    (range 10)))

(->>
  (range 10)
  (filter odd?)
  (map inc))
```

thread last macro

Lisp: macros

```
(macroexpand
  '(->> (range 10) (filter odd?)))

;; => (filter odd? (range 10))

(macroexpand
  '(->> (range 10) (filter odd?) (map inc)))

;; => (map inc (filter odd? (range 10)))
```

Lisp: macros

JVM Clojure:

```
(defmacro defonce [x init]
 `(when-not (exists? ~x)
    (def ~x ~init)))
```

ClojureScript:

```
(defonce foo 1)
(defonce foo 2) ;; no effect
```

notes:

- macros must be written in JVM Clojure
- are expanded at compile time
- generated code gets executes in ClojureScript

Artikel in Java Magazine over Clojure

http://michielborkent.nl/nljug/18_21_Clojure.pdf

Demo time!

https://github.com/borkdude/fp-hu-may-2016