Scalaz
Learn You Yet Another Real World Gentle Haskell (LYYARWGH) ((c) sproingie)

George Leontiev

deltamethod GmbH

April 17, 2013

(λx.folonexlambda-calcul.us)@
folone.info

Agenda

- Some hotness without context, to draw attention (Option, Boolean, Memo)
- Typeclasses
- Monoid
- Functor, Applicative, Monad
- Effects
- scalaz 6 vs seven
- typelevel.scala

What is scalaz

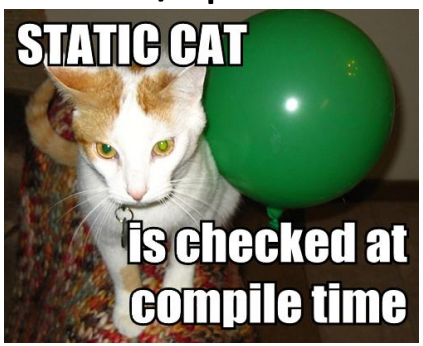
- Purely functional datatypes (Fingertree, HList, DList, Trees, Zippers, Nel, ImmutableArray)
- Typeclasses
- Effects
- Concurrency

Examples -- typesafe equals

```
s> "" == 5
res0: Boolean = false

s> "" === 5
<console>:14: error: type mismatch;
 found   : Int(5)
 required: java.lang.String
           "" === 5
                  ^
```

<spoiler>$\forall$ stuff $\in$ scalaz $\equiv$ scala.stdlib | stuff is typesafe $\vee$ stuff is strict</spoiler>



Examples -- options

```
s> some(5) getOrElse 0
res1: Int = 5
s> some(5) | 0
res2: Int = 5
s> some(1) getOrElse "ok"
res3: Any = 1
s> some(1) | "ok"
<console>:14: error: type mismatch;
 found   : java.lang.String("ok")
 required: Int
          some(1) | "ok"
                    ^
s> ~some(5) // Monoids
res4: Int = 5
s> ~none[Int] // NB: Beware of unary_~ on Validations (swap
res5: Int = 0
```

Examples -- options II

```
// Smart constructors
s> :t Some(1)                    s> :t None
Some[Int]                        None.type
s> :t some(1)                    s> :t none[Int]
Option[Int]                      Option[Int]

s> List(Some(1),None).foldLeft(None){(_, v) => v}
<console>:14: error: type mismatch;
 found   : v.type (with underlying type Option[Int])
 required: None.type
   List(Some(1),None).foldLeft(None){(_, v) => v}
                                               ^

s> List(Some(1),None).foldLeft(none[Int]){(_, v) => v}
res11: Option[Int] = None
```

Examples -- booleans

```
scala> true ? println("true") | println("false")
true
```

```
scala> true ?? 5
res14: Int = 5
```

```
scala> true !? 5
res15: Int = 0
```

```
scala> false ?? 5
res15: Int = 0
```

```
scala> false !? 5
res17: Int = 5
```

Examples -- function composition

```
val a = (_:Int) + 6
val b = (_:Int).toString
val c = (_:String).length

scala> 5 |> a |> b |> c
res18: Int = 2

scala> //(c ∙ b ∙ a) apply 5 // contramap
res19: Int = 2

scala> 5 |> //(a ∘ b ∘ c) // map
res20: Int = 2

// contramap === flip . map
```

Examples -- Memo

```
def func(s: String) = // Expensive computation
scala> Memo.immutableHashMapMemo(func)
res11: String => java.lang.String = <function1>

// Different strategies
mutableHashMapMemo
arrayMemo // sized
immutableListMemo
immutableTreeMapMemo
doubleArrayMemo // memoizing Double results != sentinel
weakHashMapMemo // GC
```

Examples -- Trampoline


```
def even(n: Int): Boolean =
  if (n == 0) true
  else odd(n - 1)
def odd(n: Int): Boolean =
  if (n == 0) false
  else even(n - 1)

scala> even(30000)
```

Examples -- Trampoline


```
def even(n: Int): Trampoline[Boolean] =
  if (n == 0) done(true)
  else suspend(odd(n - 1))
def odd(n: Int): Trampoline[Boolean] =
  if (n == 0) done(false)
  else suspend(even(n - 1))

scala> even(30000).run
```

Examples -- Trampoline

```scala
def fibRec(n: Int): Int =
  if (n < 2) n else fibRec(n - 1) + fibRec(n - 2)

def fibTailrec(n: Int) = {
  def loop(n: Int, next: Int, result: Int) = n match {
    case 0 => result
    case _ => loop(n - 1, next + result, next)
  }
  loop(n, 1, 0)
}
```

Examples -- Trampoline

```
def fibTramp(n: Int): Trampoline[Int] =
  if (n < 2) done(n) else suspend {
    for {
      i <- fibTramp(n - 1)
      j <- fibTramp(n - 2)
    } yield i + j
  }
// Continuation monad magic
```

Consult @runarorama's paper "Stackless Scala with Free Monads"

Typeclasses

Typeclasses

Typeclasses

http://www.haskell.org/haskellwiki/Typeclassopedia
http://typeclassopedia.bitbucket.org/

Typeclasses

- A monoid generalizes the (++) operation.
- A functor generalises the map operation.
- An applicative functor generalizes the zip (or zipWith) operation.
- A monad generalizes the concat operation.

  `http://stackoverflow.com/a/15727162/163423`

Monoids

$$(S, \otimes, 1)$$
$$\forall a, b \in S : a \otimes b \in S$$
$$\forall a, b, c \in S : (a \otimes b) \otimes c = a \otimes (b \otimes c)$$
$$\forall a \in S : 1 \otimes a = a \otimes 1 = a$$

```
trait Semigroup[F] {
  def append(a1: F, a2: F): F
}
trait Monoid[F] extends Semigroup[F] {
  def zero: F
}
// scalacheck-binding
import scalaz.scalacheck.ScalazProperties._
semigroup.laws[Int]
monoid.laws[String]
```

Monoids

```
scala> 1 |+| 5
res2: Int = 6

scala> Multiplication(2) |+| Multiplication(3)
res4: Int @@ Multiplication = 6

scala> some(1) |+| some(5)
res5: Option[Int] = Some(6)

// Monoids beget monoids
scala> some(some((1, "OH ", 1 + (_:Int)))) |+|
       some(some((4, "HAI", 2 * (_:Int))))
res6: Option[Option[(Int, java.lang.String,
      Int => Int)]] = Some(Some((5, OH HAI,
                                <function1>)))
```

Monoids

```
scala> List(1,2,3).suml
res16: Int = 6

scala> List("OH ", "HAI", "!").suml
res17: java.lang.String = OH HAI!
```

Functors


```
trait Functor[F[_]] {
  def fmap[A, B](f: A => B): F[A] => F[B]
}

scala> some(3) map(_.toString)
res13: Option[java.lang.String] = Some(3)
```

Applicatives

```
trait Applicative[T[_]] extends Functor[T] {
  def pure[A](a: A): T[A]
  def <*>[A, B](tf: T[A => B])(ta: T[A]): T[B]
}
```

```
scala> some(1) <*> some((_:Int) + 2) <*> some((_:Int) * 5
res10: Option[Int] = Some(15)

scala> List(1,2) <*> List((_:Int) * 5, (_: Int) + 2)
res12: List[Int] = List(5, 10, 3, 4)
```

Applicatives

```
scala> List(some(1), some(2), some(3))
res21: List[Option[Int]] = List(Some(1), Some(2),
                                 Some(3))

scala> .sequence
res22: Option[List[Int]] = Some(List(1, 2, 3))

scala> res21.traverse(x => some(x))
res23: Option[List[Int]] = Some(List(1, 2, 3))
```

Monads

```
trait Monad[M[_]] extends Applicative[M]{
  def >>=[A, B](ma: M[A])(f: A => M[B]): M[B]
}
```

```
scala> for {
  | i <- List(1,2,3)
  | j <- List(4,5,6)
  | } yield i*j
res15: List[Int] = List(4, 5, 6, 8, 10, 12, 12, 15, 18)
```

DEMO

Scalaz 6 vs seven

- a-la-carte imports
- typeclass instances separated from instances
- tags
- law checking via scalacheck
- Isomorphisms
- etc.

Consult examples and tests.

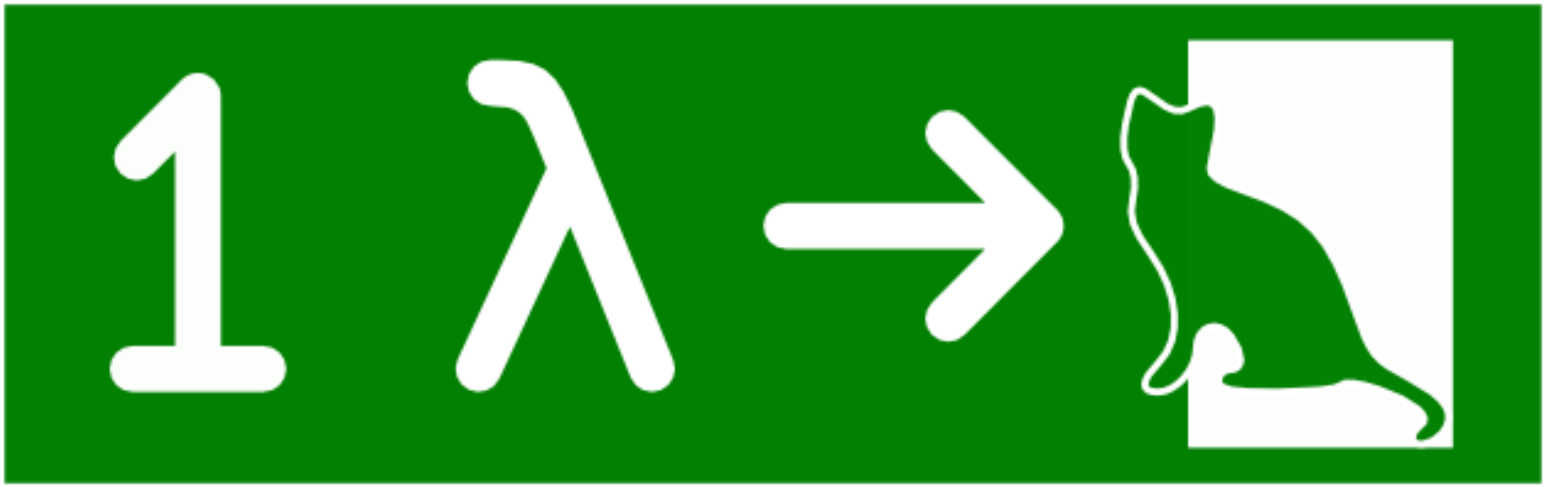
`http://www.folone.info/blog/Scalaz-sevenMigration/`

typelevel.scala

- scalaz
- spire
- shapeless

http://typelevel.org/

That's it



Questions?