

functors, monads, and you

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meet your foe

```
def flatMap[B](f: A => StateT[M, S, B])(implicit m: Bind[M]): StateT[M, S, B] =  
  stateT[M,S,B](s => apply(s) >>= ((x: (S, A)) => x match { case (sp, a) => f(a)(sp) }))  
  semigroup(_.list <::: _)  
CanBuildFrom[CC[A], B, CC[B]] forSome {type A; type B}  
implicit def Tuple2Traverse[X]: Traverse[({type λ[α]=(X, α)})#λ] =  
  new Traverse[({type λ[α]=(X, α)})#λ] {  
    def traverse[F[_] : Applicative, A, B](f: A => F[B], as: (X, A)): F[(X, B)] =  
      f(as._2) ∘ ((b: B) => (as._1, b))  
    implicit def ZipperTraverse: Traverse[Zipper] =  
      new Traverse[Zipper]semigroup(_.value * _.value ||)  
    def lift[F[_]](implicit f: Applicative[F]): (F[T1], F[T2]) => F[R] =  
      (a: F[T1], b: F[T2]) => (a <**> b)(this)  
    def promise(implicit s: Strategy): (T1, T2) => Promise[R] = (x: T1, y: T2) =>  
      x.pure[Promise].<**>(y.pure[Promise])(k)  
    implicit def Tuple4Semigroup[A, B, C, D](implicit as: Semigroup[A], bs: Semigroup[B], cs:  
      semigroup((a, b) => (a._1 |+| b._1, a._2 |+| b._2, a._3 |+| b._3, a._4 |+| b._4))  
    def traverse[F[_] : Applicative, A, B](f: A => F[B], za: Zipper[A]): F[Zipper[B]] = {  
      val z = (zipper(_: Stream[B], _: B, _: Stream[B])).curried  
      val a = implicitly[Applicative[F]]  
      a.apply(a.apply(a fmap(  
        a fmap(TraversableTraverse[Stream].traverse[F, A, B](f, za.lefts.reverse),  
          (_: Stream[B]).reverse),  
        z), f(za.focus)), TraversableTraverse[Stream].traverse[F, A, B](f, za.rights))  
    }  
  }
```

scalaz 7

- Scalaz (*scala-zed*, or *scala-zee*, depending on how cool you are) is a library bringing purely functional typeclasses and libraries to Scala. No compiler plugins, no language support.
- Scalaz 7 (to be released), drops unicode, increases modularity and discoverability.

scalaz isn't all scary ...

```
"1".toInt
"foo".toInt //uh oh

val iOpt: Option[Int] = "foo"".parseInt
iOpt err "not an int!" //compare with get
println(iOpt.isDefined ? "parsed" | "nada")
"i love o-o".println
```

scalaz fixes Java legacies

aka == considered harmful

```
val curUser: Option[RegisteredUser]
val admin: RegisteredUser
if (curUser == admin) {
    //fail, never entered
}
```

==== considered awesome

```
val curUser: Option[RegisteredUser]
val admin: RegisteredUser

implicit def userEqual = equalA[User]

if (curUser === admin) {
    //DOESN'T COMPILE
}
```

typeclasses

- Ad-hoc polymorphism
- You should all be experts ... Erik Osheim (Sep 20, 2011, PHASE, <http://plastic-idolatry.com/typcls>)
- What, you missed it? Here's a 3-slide review.

typeclass review I

Equal via subtyping

```
trait Equal[A] {  
    // A => A => Boolean  
    def ===(rhs: A): Boolean  
}  
  
case class Person(  
    name: String,  
    numCars: Int  
) extends Equal[Person] {  
    override def ===(rhs: A): Boolean = ...  
}  
  
Person("yuvi", 0) === Person("colleen", 1)
```

typeclass review II

Equal via typeclass pattern

```
trait Equal[A] {  
    // A => A => Boolean  
    def equals(lhs: A, rhs: A): Boolean  
}
```

```
case class Person(name: String, numCars: Int)  
def PersonHasEqual: Equal[Person] = new Person {  
    def equals(lhs: Person, rhs: Person): Boolean = ...  
}
```

```
personEqual.equals(  
    Person("yuvi", 0),  
    Person("colleen", 1)  
)
```

typeclass review III

type relationships

```
// A "is a" Equal
def myeq[A <: Equal](lhs: A, rhs: A) = lhs equal rhs
```

```
// A "can be a" Equal
def myeq[A <% Comparable](lhs: A, rhs: A) =
  lhs equal rhs
```

```
// A "has a" Equal
def myeq[A:Equal](lhs: A, rhs: A) = lhs equals rhs

def myeq[A](lhs: A, rhs: A)(ev: Equal[A]) =
  lhs equals rhs
```

functional programming



monoids

things you can add

//NOT SCALA SYNTAX

```
trait Semigroup[A] {  
    def |+| : A => A => A  
}
```

```
trait Monoid[A] extends Semigroup[A] {  
    def zero : A  
}
```

Int is a monoid

oops, Int *has a* monoid

```
def IntHasMonoid extends Monoid[Int] {  
    def |+| (lhs: Int, rhs: Int): Int =  
        lhs + rhs  
  
    def zero: Int = 0  
}  
  
1 |+| 1 === 2
```

what else is a monoid?

- String
- List[A]
- Option[A:Monoid]
- Any semigroups that aren't monoids?

What did an explicit Monoid representation get us?

Just one random example ...

```
def orZero(opt: Option[A:Monoid]): A =  
  opt match {  
    case Nil      => zero[A]  
    case Some(a)  => a  
  }
```

```
orZero(Some(5)) === 5  
val nopt: Option[Int] = None  
orZero(nopt) === 0  
~ nopt === 0
```

functors

things that can map

//NOT SCALA SYNTAX

```
trait Functor[A] {  
    def map[A, B] : F[A] => (A => B) => F[B]  
}  
  
def map(opt: Option[A], fun: A => B): Option[B] =  
    opt match {  
        case Some(a) => Some(fun(a))  
        case None     => None  
    }
```

monads



quickmeme.com

monoids

things that can flatMap

//NOT SCALA SYNTAX

```
trait Monad[A] extends Functor[A] {  
  
  def map[A, B] :  
    F[A] => (A => B) => F[B]  
  
  def flatMap[A, B] :  
    F[A] => (A => F[B]) => F[B]  
}
```

Option is a monad

```
def OptionHasMonad extends Monad[Option] {  
  
    //F[A] => (A => F[B]) => F[B]  
    def flatMap(  
        opt: Option[A],  
        fun: A => Option[B]): Option[B]  
    ) = opt match {  
        case None      => None  
        case Some(a)   => fun(a)  
    }  
}
```

Aside: stop matching on Option, damnit

```
// Option[A] => (A => B) => Option[B]
Some(5) map { _.toString } === Some("5")
```

```
// Option[A] => A, passing default
Some(5) getOrElse 13 === 5
None getOrElse 13 === 13
```

```
// Option[A] => B, passing default, from scalaz
Some(5) ? "inty" | "none" === "inty"
None ? "inty" | "none" === "none"
```

```
// Option[A] => Option[A], passing default
Some(5) orElse Some(13) === Some(5)
None orElse Some(13) === None
```

```
// Option[A] => (A => B) => B => B, catamorphism, scalaz
Some(5) cata (_ + 1, 13) === 6
None cata (_ + 1, 13) === 13
```

Aside: stop matching on Option, damnit

```
// Option[A] => (A => Option[B]) => Option[B]
Some(100).flatMap { safeLog10(_) } === Some(2)
```

```
// Option[A] => Boolean, checking for emptiness
Some(5).isDefined === true
Some(5).isEmpty === false
None.isDefined === false
None.isEmpty === true
```

```
// Option[A] => Boolean, using a predicate
Some(5).exists { _ > 0 } === true
```

```
// Option[A:Monoid] => A, from scalaz
~ Some(5) === 5
~ None     === 0
```

List is a monad

```
def ListHasMonad extends Monad[List[_]] {  
  
    //F[A] => (A => F[B]) => F[B]  
    def flatMap(  
        opt: List[A],  
        fun: A => List[B]): List[B]  
    ) = opt match {  
        case Nil      => Nil  
        case h :: t   => fun(h) :: flatMap(opt, t)  
    }  
}
```

why can't you handle an A?



given A, what problems do ...

- Option [A]
 - List [A]
- ... protect you from?

IO

a monad you may not know ... or want to know

- What can go wrong with i/o computations?
- Why don't i/o functions fit into functional programming well?

referential transparency

```
def now: Long = System.currentTimeMillis
```

```
val n1 = now  
val n2 = now
```

```
n2 - n1
```

IO typeclass

```
trait IO[A] {  
    // "don't call until the end of the universe"  
    def unsafePerformIO: A  
}
```

See, not all monads can be thought of as collections!



```
object CatsWithHatsApp {
  def addHat(p: Picture): Picture = ...

  def pmain(args: Vector[String]): IO[Unit] = {
    val Vector(path) = args
    for {
      files <- listDir(path) // List[File] <- IO[List[File]]
      file <- files          // File <- List[File]
      pic <- readPic(file)   // Picture <- IO[Picture]
      _    <- writeFile(       // () <- IO[Unit]
        file,
        addHat(pic)
      )
    } yield ()
  }

  def main(args: Array[String]) = {
    val program = pmain.(Vector.empty ++ args).except {
      case e => putStrLn("failing with: " e.toString)
    }
    program.unsafePerformIO // end of the universe!
  }
}
```

README.md

Puritan: Referentially Transparent IO for Scala

"There are many things in this world that a child must not ask about ... When an uninstructed multitude attempts to see with its eyes, it is exceedingly apt to be deceived."

- *The Scarlet Letter*, Nathaniel Hawthorne



Puritan lets you do IO with [Scalaz 7](#) without compromising on functional purity. It's also a great way to annoy everyone.

Thank you! Questions?