1024

x

768

Types Working For You

Richard Dallaway, @d6y

underscore.io

Modern type system with lots of power

Julio Capote
@capotej

scala career timeline:
year 1: dope, gonna write some terse code
year 2: hmm, maybe i shouldnt use every feature
year 3: java 8 looks nice

RETWEETS 114 LIKES 175

3:47 PM - 4 Feb 2016

Alessandro Zoffoli
@AL333Z

"[...] We write down the
type signature for an operation we want, then
"follow the types" to an
implementation."
#fpinscala #scala #fp

RETWEET 1 LIKES 4

10:22 AM - 15 Jan 2016

Two Themes

Straightforward Scala

Types Working for Us

Progression

Part 1 Straightforward Scala

Part 2 Functional Programming

Part 3 Typelevel Programming

— Part 1 —

Straightforward Scala

The only problem was we had no idea what the code was doing at first.

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The spaceship operator <|*|>

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We came across a strange symbol we hadn’t seen in our projects before

The spaceship operator <|*|>

Someone said out loud “what the hell is that?”

“It’s about having a maintainable code base where you can have people cross projects easily and get new hires up to speed rapidly”

Power!

Protect the team from it

and

Get the benefit of it

What can we do?

1. Expressions, types, & values
2. Objects and classes
3. Algebraic data types
4. Structural recursion
5. Sequencing computation
6. Type classes

1. Expressions, types, & values
2. Objects and classes
3. Algebraic data types
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Algebraic data types

Structural recursion

Algebraic data types

data into code

Structural recursion

transformation

Model data with logical *ors* and logical *ands*

A website visitor is:

- anonymous; *or*
- logged in

A logged in user has:

- an ID; *and*
- facts we know about them

Two Patterns

and (product types)
or (sum types)

Sum and product together
make algebraic data types

Structure of the code follows the structure of the data

A website visitor is:

- anonymous; *or*
- logged in

```scala
sealed trait Visitor

case class Anonymous()
  extends Visitor

case class User()
  extends Visitor
```

A logged in user has:

- an ID; *and*
- facts we know about them

An anonymous has:

- an ID

```scala
sealed trait Visitor

case class Anonymous()
  extends Visitor

case class User()
  extends Visitor
```

```scala
sealed trait Visitor

case class Anonymous(id: Id)
  extends Visitor

case class User(id: Id, facts: Set[Fact])
  extends Visitor
```

Structural recursion

```scala
def serveAd(v: Visitor): Advert = ???
```

Structure of the code follows the structure of the data

```scala
def serveAd(v: Visitor): Advert = ???
```

```scala
def serveAd(v: Visitor): Advert =
  v match {
    case User(_, info) =>
    case Anonymous(id) =>
  }
```

```scala
def serveAd(v: Visitor): Advert =
  v match {
    case User(_, info) => relevantAd(info)
    case Anonymous(id) => adRotation(id)
  }
```

```scala
def serveAd(v: Visitor): Advert =
  v match {
    case User(_, info) => relevantAd(info)
    case Anonymous(id) => adRotation(id)
  }
```

Structure

ADT & Structural Recursion

Straightforward part of Scala.

Clear, productive, occurs frequently.

Be opinionated in what you use.

Structure helps us.

— Part 2 —

Help from FP Ideas

Combining lists

Concatenating strings

Union of sets

Combining things in a loop

Chaining logical operations

Adding numbers

Building up a JavaScript expression

Showing errors in a UI

...

A combine function and an empty value

Addition

Empty	Combine
0	+

Set

Empty	Combine
Set.empty	union

For any T

Empty	Combine
A zero for T	A way to combine two Ts and give me back a T

A combine function and an empty value

Monoid

A combine function and
an empty value
...and laws

Monoids civil war - Doctor Who - The Ark - BBC

BBCClassicDoctorWho

Subscribe 4.7K

6,333

The boss asks…

What’s the total visits to the web site?

```
def report(vs: List[Int]): Int = ???
```

For any T

Empty	Combine
A zero for T	A way to combine two Ts and give me back a T

For any T

```
trait Monoid[T] {
  def empty: T
  def combine(x: T, y: T): T
}
```

```scala
val addition = new Monoid[Int] {
  def empty = 0
  def combine(x: Int, y: Int) = x+y
}
```

fold

```scala
def fold(vs: List[Int]): Int =
  vs match {
    case Nil          => 0
    case v :: rest => v + fold(rest)
  }

fold(List(1,2,3))
// 6
```

```
fold(1,2,3)
```

```
fold(1,2,3)
    1
```

```
fold(1,2,3)
      1 + fold(2,3)
```

```
fold(1,2,3)
      1 + fold(2,3)
                2
```

```
fold(1,2,3)
      1 + fold(2,3)
                2 + fold(3)
```

```
fold(1,2,3)
      1 + fold(2,3)
                2 + fold(3)
                           3 + fold()
                                      0
```

0 + 3 + 2 + 1 = 6

```scala
def fold(vs: List[Int]): Int =
  vs match {
   case Nil          => 0
   case v :: rest => v + fold(rest)
  }

  fold(List(1,2,3))
  // 6
```

```scala
def fold(vs: List[Int], m: Monoid[Int]): Int =
  vs match {
   case Nil          => 0
   case v :: rest => v + fold(rest)
  }

  fold(List(1,2,3), addition)
  // 6
```

```scala
def fold(vs: List[Int], m: Monoid[Int]): Int =
  vs match {
   case Nil          => m.empty
   case v :: rest => m.combine(v, fold(rest,m))
  }

  fold(List(1,2,3), addition)
  // 6
```

```scala
def fold[T](vs: List[T], m: Monoid[T]): T =
  vs match {
   case Nil          => m.empty
   case v :: rest => m.combine(v, fold(rest,m))
  }

  fold(List(1,2,3), addition)
  // 6
```

Split on cases,
inspect values you have

```scala
def fold[T](vs: List[T], m: Monoid[T]): T =
  vs match {
   case Nil          => ???
   case v :: rest => ???
  }

  fold(List(1,2,3), addition)
  // 6
```

```scala
def fold[T](vs: List[T], m: Monoid[T]): T =
  vs match {
   case Nil          => m.empty
   case v :: rest => ???
  }

  fold(List(1,2,3), addition)
  // 6
```

But back to Monoids...

The boss asks…

What’s the total visits to the web site?

```
def report(vs: List[Int]): Int =
  fold(vs, addition)
```

Benefits

Composition

Flexibility

Problem Solving

The boss asks...

How many distinct visitors?

```
def report(vs: List[Visitor]): Int = ???
```

Set

Empty	Combine
Set.empty	union

The boss says...

Argh!
The servers are OutOfMemory

HyperLogLog

Empty	Combine
new HLL()	HLL.plus

Armon Dadgar (Papers We Love, 2015)
“Bloom Filters and HyperLogLog”

The boss asks...

Who are the really keen visitors to the site?

Count-Min Sketch

Empty	Combine
new CMS()	CMS.plus

Laura Bledaite (Scala eXchange 2015)
“Count-Min Sketch in Real Data Applications”

We can safely run

a parallel version

of fold

Laws

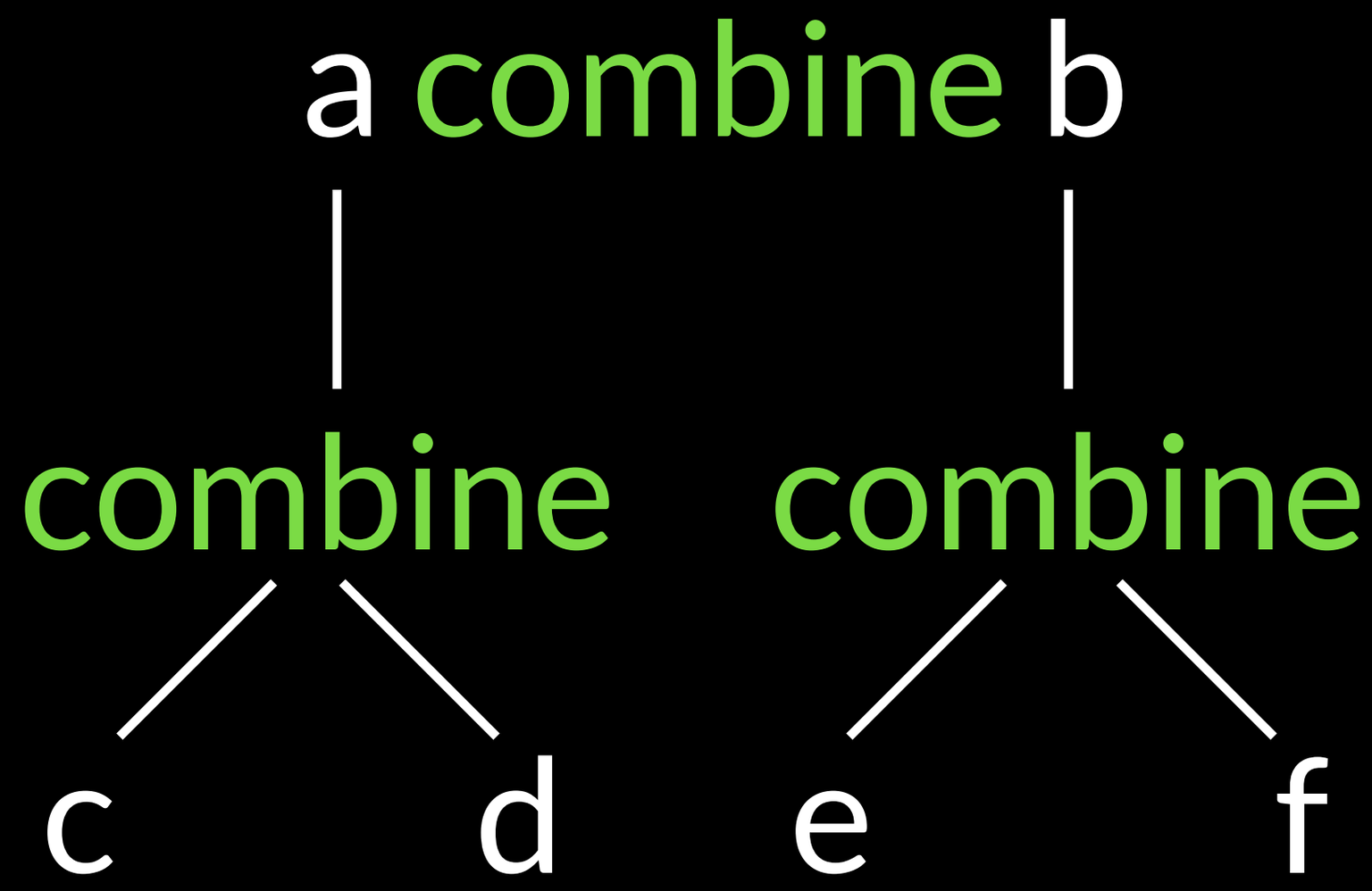
$$a + 0 = a$$

$$(a + b) + c = a + (b + c)$$

Identity & Associativity

a combine empty = a

(a combine b) combine c
= a combine (b combine c)


a combine b
combine
combine
c
d
e
f

users.scala — /Users/richard/Desktop/QCon-London-2016/code

users.scala

```scala
sealed trait Visitor {
  def id: Id
}

final case class Anonymous(id: Id) extends Visitor
final case class User(id: Id, email: Email) extends Visitor

```

Ensime Errors: 10 Warnings: 0

File 0 Project 0 No Issues src/main/scala/users.scala 7:1 LF UTF-8 Scala

users.scala — /Users/richard/Desktop/QCon-London-2016/code

users.scala

```scala
sealed trait Visitor {
  def id: Id
}

final case class Anonymous(id: Id) extends Visitor
final case class User(id: Id, email: Email) extends Visitor
```

Ensime Errors: 10 Warnings: 0

File 0 Project 0 No issues src/main/scala/users.scala 7:1 LF UTF-8 Scala

Errors: 10 Warnings: 0

Its a monoid

I know this

...so we fold

Summary

Types and laws give us flexibility & help lead us to solutions.

They help us every day.

— Part 3 —

A Taste of Typelevel

```
csv(
 List(“Date”, “Metric”),
 List(
  List(“Mon”, “Low”),
  List(“Tue”, “High”) )
 )
```

Date	Metric
Mon	Low
Tue	High

```
csv(
 List(“Date”),
 List(
  List(“Mon”, “Low”),
  List(“Tue”, “High”) )
 )
```

Date	
Mon	Low
Tue	High

How can we prevent that error happening again?

```scala
def csv(
  hdrs: List[String],
  rows: List[List[String]]
): String = ???
```

```scala
import shapeless._
import syntax.sized._

def csv[N <: Nat](
  hdrs: List[String],
  rows: List[List[String]]
): String = ???
```

```scala
import shapeless._
import syntax.sized._


def csv[N <: Nat](
 hdrs: Sized[List[String], N],
 rows: List[Sized[List[String], N]]
): String = ???
```

```
csv(
 Sized(“Date”),
 List(
  Sized(“Mon”, “Low”),
  Sized(“Tue”, “High”) )
)
```

Sized[List, 1]

```
csv(
 Sized("Date"),
 List(
  Sized("Mon", "Low"),
  Sized("Tue", "High") )
)
```

Sized[List, 2]

How?

`Sized("Date")` constructs `Sized[Nat]`

`Nat` implements numbers as types

```scala
sealed trait Nat
trait Succ[P <: Nat] extends Nat
trait Zero extends Nat
```

```
Zero 0
Succ[Zero] 1
Succ[Succ[Zero]] 2
Succ[Succ[Succ[Zero]]] 3
```

```scala
sealed trait Nat
trait Succ[P <: Nat] extends Nat
trait Zero extends Nat
```

```scala
sealed trait Nat
trait Succ[P <: Nat] extends Nat
trait Zero extends Nat

type One = Succ[Zero]
type Two = Succ[One]
```

```scala
sealed trait Nat
trait Succ[P <: Nat] extends Nat
trait Zero extends Nat

type One = Succ[Zero]
type Two = Succ[One]

implicitly[Succ[Zero] =:= One]
```

```scala
sealed trait Nat
trait Succ[P <: Nat] extends Nat
trait Zero extends Nat

type One = Succ[Zero]
type Two = Succ[One]

implicitly[Succ[Zero] =:= One]
implicitly[Succ[One] =:= Succ[Succ[Zero]]]
```

```scala
sealed trait Nat
trait Succ[P <: Nat] extends Nat
trait Zero extends Nat

type One = Succ[Zero]
type Two = Succ[One]

implicitly[Succ[Zero] =:= Two]
error:
 Cannot prove that Succ[Zero] =:= Two.
```

Merging Fields

```scala
case class User(
  id    : Long,
  name  : String,
  email : Option[String])
```

```scala
val user = User(
  123L,
  “Bruce Wayne”,
  Some(“bruce@example.org”))
```

```
PATCH /user/123

{
  “name” : “Batman”
}
```

```scala
case class User(
  id    : Long,
  name  : String,
  email : Option[String])


case class Update(
  name  : Option[String],
  email : Option[Option[String]])
```

```
val user = User(
  123L,
  “Bruce Wayne”,
  Some(“bruce@example.org”))

val update = Update(
  Some(“Batman”),
  None)
```

How do we get to…

```
User(
  123L,
  “Batman”,
  Some(“bruce@example.org”))
```

Bulletin

https://github.com/davegurnell/bulletin

How?

User	String	Option[String]	…
Update	Option[String]	Option[Option[String]]	…

How?

User	String	Option[String]	…
Update	Option[String]	Option[Option[String]]	…

Head

How?

User	String	Option[String]	…
Update	Option[String]	Option[Option[String]]	…

Head

The Rest…

How?

Type constraints

Implicit methods

HLists

Labelled generic

Macros

...

```scala
val user = User(
  123L,
  "Bruce Wayne”,
  Some(“bruce@example.org”))

val update = Update(
  Some(“Batman”),
  None)

import bulletin._

val updated = user.merge(update)

// User(
//   123L,
//   “Batman”,
//   Some(“bruce@example.org”))
```

```scala
val user = User(
  123L,
  "Bruce Wayne”,
  Some(“bruce@example.org”))

val update = Update(
  Some(“Batman”),
  None)
```

```scala
import bulletin._

val updated = user.merge(update)
```

```scala
// User(
//   123L,
//   “Batman”,
//   Some(“bruce@example.org”))
```

Summary

The compiler can help (maybe more than you thought).

Reduce boilerplate code.

Using Power Tools

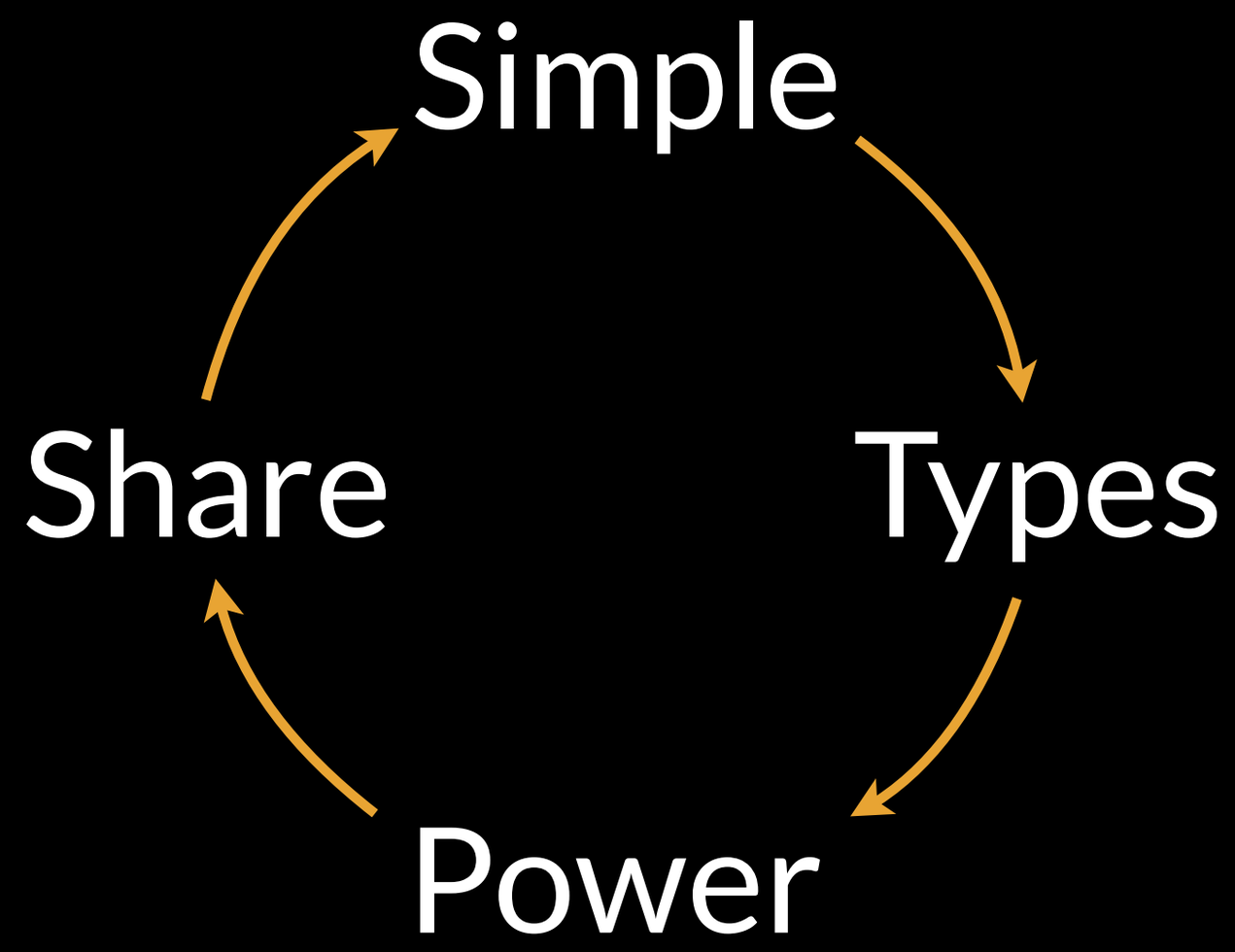
Can go one of two ways...

Using Power Tools

Can go one of two ways...

What the hell is that?

It's a monoid! I know this


Simple
Types
Power
Share

2008

‘The name Scala stands for “scalable language.”

The language is so named because it was designed to grow with the demands of its users.’

What have we seen?

Some straightforward parts of Scala
—Clear, maintainable, helpful

Encoding ideas in types
—flexibility, leads us to solutions

Let the compiler do it
—when it make sense for your demands

Summary

Scala scaling with your needs
—be opinionated in what you use, more when needed

Types working for us, not stopping us
—functional programming, share what you learn

Thanks!

Richard Dallaway, @d6y

Thanks!

Richard Dallaway, @d6y

Amanda Laucher
Wesley Reisz
Noel Welsh
Dave Gurnell
Miles Sabin
Jono Ferguson
Julio Capote
Alessandro Zoffoli

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