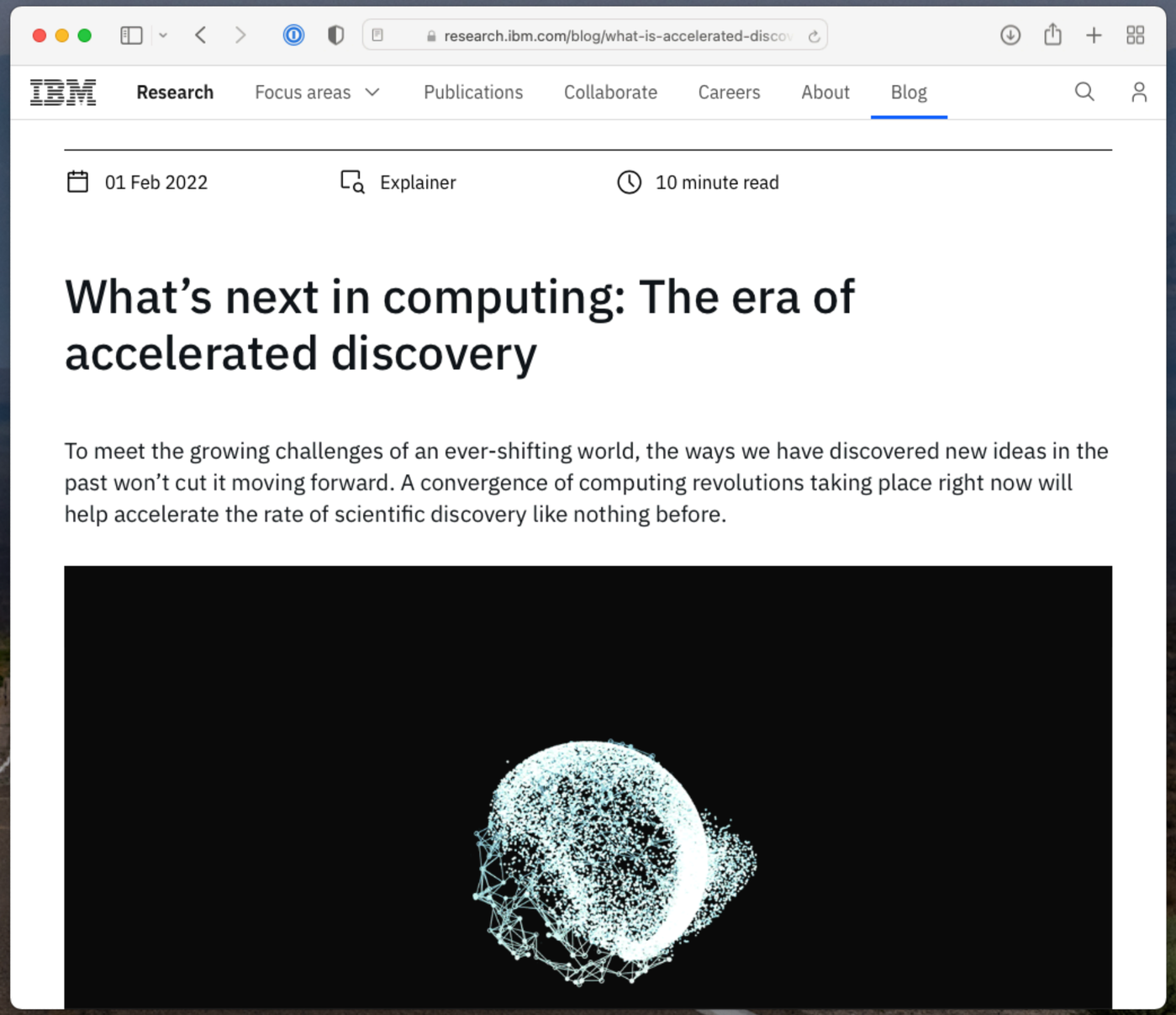
Lessons Learned from 15 Years of Scala in the Wild

Dean Wampler
@deanwampler
https://deanwampler.medium.com
dean@deanwampler.com

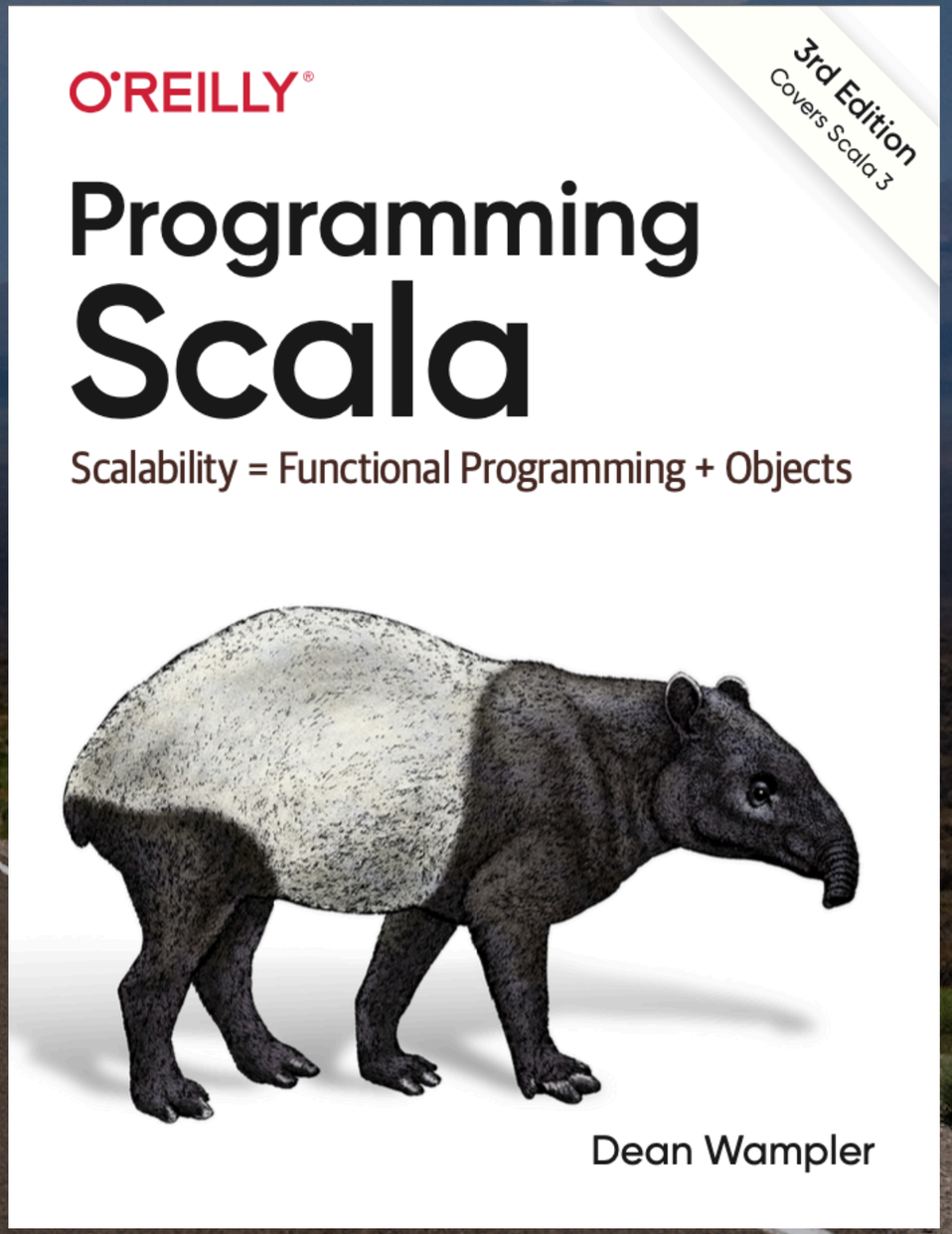
About me…

IBM Research



https://research.ibm.com/blog/what-is-accelerated-discovery

programming-scala.com



How Scala Has Evolved

- Greater Clarity
- From Implicits to Contextual Abstractions
- Improvements to the Type System


“Enterprise Scala”
FP Over OOP
Should *Everything* Be Typed?
Less Code Is More
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The Future??

- What current industry trends may mean for FP and Scala


Greater Clarity
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Python-esque Syntax in Scala 3

```scala
// Scala 2 braces
trait Monoid[A] {

  def add(a1: A, a2: A): A

  def zero: A
}

integer match {
  case 0 => println("zero")
  case _ => println("other value")
}
```

```scala
// Scala 3, no braces option
trait Monoid[A]:

  def add(a1: A, a2: A): A

  def zero: A

integer match
  case 0 => println("zero")
  case _ => println("other value")
```

More “Intentional” Constructs

```
// Implicit Type Conversions
implicit final class ArrowAssoc[A]
    private val self: A) extends AnyVal {
  @inline def ->[B](y: B): (A, B) = (self, y)

  @deprecated("Use `->` instead...", "2.13.0")
  def →[B](y: B): (A, B) = ->(y)
}
```

```
// True Extension Methods
import scala.annotation.targetName

extension [A] (a: A)
  @targetName("arrow2")
  inline def ~>[B](b: B): (A, B) = (a, b)
```

Used to write “a -> b” to return a tuple “(a, b)”


From Implicits to
Contextual Abstractions
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Implicits are a *mechanism* with idiomatic usage.
Givens and using clauses are more intentional.

```
trait Semigroup[T]:
  extension (t: T)
    infix def combine(other: T): T
    @targetName("plus")
    def <+>(other: T): T = t.combine(other)

trait Monoid[T] extends Semigroup[T]:
  def unit: T


given StringMonoid: Monoid[String] with
  def unit: String = ""
  extension (s: String)
    infix def combine(other: String): String =
      s + other
```

```
scala>"one" <+> ("two" <+> "three")
     | ("one" <+> "two") <+> "three"
val res1: String = onetwothree
val res2: String = onetwothree

scala> "one" <+> StringMonoid.unit
     | StringMonoid.unit <+> "one"
val res3: String = one
val res4: String = one
```

Implicits are a *mechanism* with idiomatic usage.
Givens and using clauses are more intentional.

```
trait Semigroup[T]:
  extension (t: T)
    infix def combine(other: T): T
    @targetName("plus")
    def <+>(other: T): T = t.combine(other)

trait Monoid[T] extends Semigroup[T]:
  def unit: T


given NumericMonoid[T: Numeric]: Monoid[T] with
  def unit: T = summon[Numeric[T]].zero
  extension (t: T)
    infix def combine(other: T): T =
      summon[Numeric[T]].plus(t, other)
```

```
scala> 2 <+> (3 <+> 4)
     | (2.2 <+> 3.3) <+> 4.4
     | (BigInt(2) combine BigInt(3))
     |   combine BigInt(4)
     |
val res5: Int = 9
val res6: Double = 9.9
val res7: BigInt = 9

scala> 2 <+> NumericMonoid[Int].unit
     | NumericMonoid[Double].unit <+> 3.3
val res8: Int = 2
val res9: Double = 3.3
```

Implicits are a *mechanism* with idiomatic usage.
Givens and using clauses are more intentional.

```
trait Context:
 def info: String
given Context = new Context:
 def info: String = "Cloud!"
```

```
def process(name: String)(using Context): String =
  s"$name-${summon[Context].info}"
```

```
scala> process(“AWS”)
val res0: String = “AWS-Cloud!”

scala> given ctx: Context = new Context:
     |   def info: String = "Also Cloud!"
     |
lazy val ctx: Context

scala> process("Azure")(using ctx)
val res1: String = Azure-Also Cloud!
```

Improvements to the Type System

Opaque type aliases:
Almost like regular types, but without the overhead.

```
object Log:
  opaque type Logarithm = Double

  // These are the two ways to lift to the Logarithm type
  def apply(d: Double): Logarithm = math.log(d)
  def safe(d: Double): Option[Logarithm] =
    if d > 0.0 then Some(math.log(d)) else None

  // Extension methods define an opaque type's public APIs
  extension (x: Logarithm)
    def toDouble: Double = math.exp(x)
    def + (y: Logarithm): Logarithm = Logarithm(math.exp(x) + math.exp(y))
    def * (y: Logarithm): Logarithm = x + y
```

Intersection Types

```
trait Resettable:
  override def toString: String = "Resettable:"+super.toString
  def reset(): Unit

trait Growable[T]:
  override def toString: String = "Growable:"+super.toString
  def add(t: T): Unit

def f(x: Resettable & Growable[String]): String =
  x.reset()
  x.add("first")
  x.add("second")
  x.toString
```

Only allowed values must be of **both** types Resettable **and** Growable.

Intersection Types

```
trait Resettable:
  override def toString: String = "Reset
  def reset(): Unit

trait Growable[T]:
  override def toString: String = "Growa
  def add(t: T): Unit

def f(x: Resettable & Growable[String]):
  x.reset()
  x.add("first")
  x.add("second")
  x.toString
```

```
val rg = new Resettable with Growable[String] {
  def reset(): Unit = value = ""
  def add(s: String): Unit = value + s
  var value: String = ""
}
val gr = new Growable[String] with Resettable {
  def reset(): Unit = value = ""
  def add(s: String): Unit = value + s
  var value: String = ""
}
rg.toString // "Growable:Resettable"
gr.toString // "Resettable:Growable"
```

Types commute: This equals Growable[String] & Resettable

BUT linearization isn't the same!!

Union Types

```
case class User(name: String, password: String)

def getUsers(id: String, dbc: DBConnection): String | User | Seq[User] =
  try
    val results = dbc.query(s"SELECT * FROM users WHERE id = $id")
    results.size match
      case 0 => s"No records found for id = $id"
      case 1 => results.head.as[User]
      case _ => results.map(_.as[User])
  catch
    case dbe: DBException => dbe.getMessage

getUsers("1234", myDBConnection) match
  case message: String => println(s"ERROR: $message")
  case User(name, _)   => println(s"Hello user: $name")
  case seq: Seq[User]  => println(s"Hello users: $seq")
```

Types also commute

Must use pattern matching to determine the actual type of the instance.

“Enterprise Scala”

Unlearning *Enterprise Java* habits


FP Over OOP
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Is anything more concise than SQL?

```
SELECT * FROM users WHERE id = “Dean Wampler”
```

Like SQL, functional code tends to be very concise and to the point, where composable operations enable fast, efficient programming

Object-Relational Mapping was a mistake, IMHO…

Parametric Polymorphism

```
def foo1[T](xs: Seq[T]): Int
def foo2(xs: Seq[Int]): Int
```

What can we deduce about these methods?? The first can have **only one** possible implementation. No ambiguity!

https://medium.com/scala-3/the-value-of-parametric-polymophism-e76bfb9a516b


Should *Everything*
Be Typed?
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When should we *avoid* static typing??

```
apiVersion: apps/v1
kind: Deployment
metadata:
  name: nginx-deployment
spec:
  selector:
    matchLabels:
      app: nginx
  replicas: 2 # tells deployment to run 2 pods matching the template
  template:
    metadata:
      labels:
        app: nginx
    spec:
      containers:
      - name: nginx
        image: nginx:1.14.2
        ports:
        - containerPort: 80
```

Should we faithfully **duplicate** this logic in our Scala code?? Can we use templates and minimize knowledge instead?

example from:
https://kubernetes.io/docs/concepts/overview/working-with-objects/kubernetes-objects/


Less (Code) Is More
Avoid Converting
Enterprise Java to
Enterprise Scala
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“Inverted Index” in Spark

```
import org.apache.spark.SparkContext
import org.apache.spark.SparkContext._

object InvertedIndex {
 def main(a: Array[String]) = {

  val sc = new SparkContext("local[*]", "Inverted Idx")

  sc.textFile("data/crawl").map { line =>
   val Array(path, text) =
     line.split("\t",2)
   (path, text)
  }.flatMap {
   case (path, text) =>
    text.split("""\W+""") map {
     word => (word, path)
    }
  }.map {
   case (w, p) => ((w, p), 1)
  }.reduceByKey {
   case (n1, n2) => n1 + n2
  }.map {
   case ((w, p), n) => (w, (p, n))
  }.groupByKey
  .mapValues { iter =>
   iter.toSeq.sortBy {
    case (path, n) => (-n, path)
   }.mkString(", ")
  }.saveAsTextFile("/path/out")
  sc.stop()
 }
}
```

- When your code is this concise, do you *really need:*
  - Dependency injection frameworks?
  - Fancy mocking libraries for testing?
  - Lots of design patterns?
    - Factories, Adapters…
  - Lots of micro services to partition the logic?

from:
https://deanwampler.github.io/polyglotprogramming/papers/Spark-TheNextTopComputeModel.pdf


Will FP Adoption Continue to Grow?
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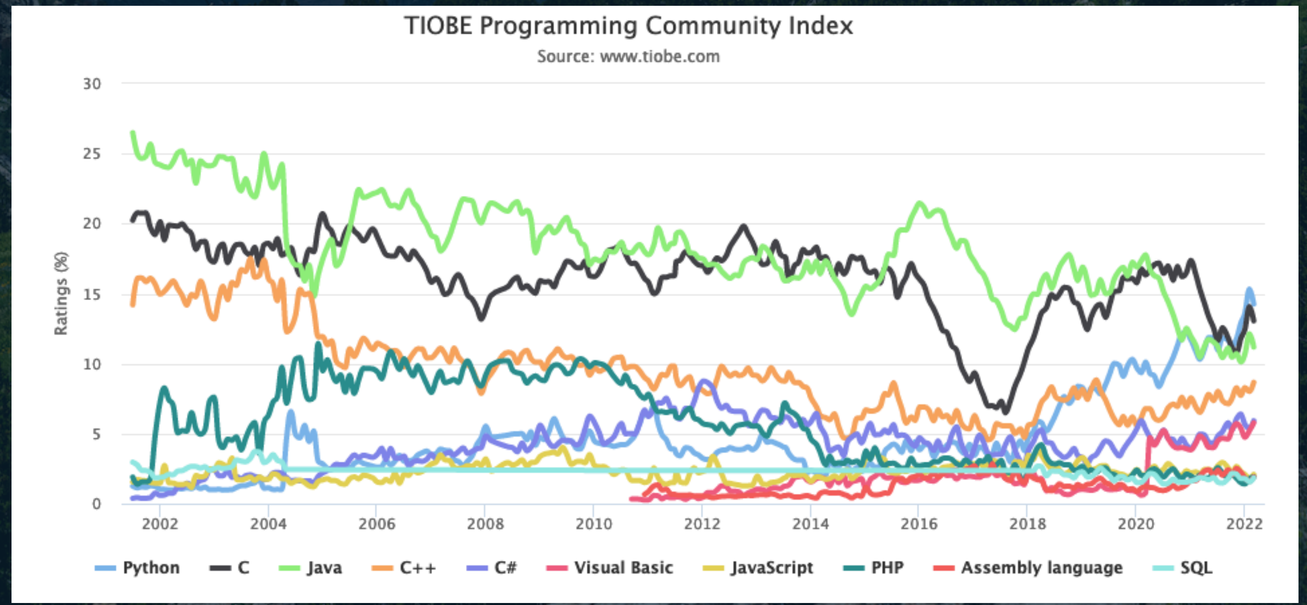
Will FP Adoption Continue to Grow?

Why are languages like Python, Go, Kotlin, etc. growing in popularity?

- None is particularly functional.
- FP fans like us might consider them “disabled”.



1) FP Is Too “Advanced”

- For most of the world’s developers, FP is either too hard or they lack the motivation to learn it.
- In contrast, OOP is “naively” intuitive and therefore seductive.

Second worst way OOP was abused: the belief we should faithfully represent the domain in code.

(The worst way was unconstrained, unprincipled mutability.)

2) SW Development Itself Is Changing

Two Kinds of Programming

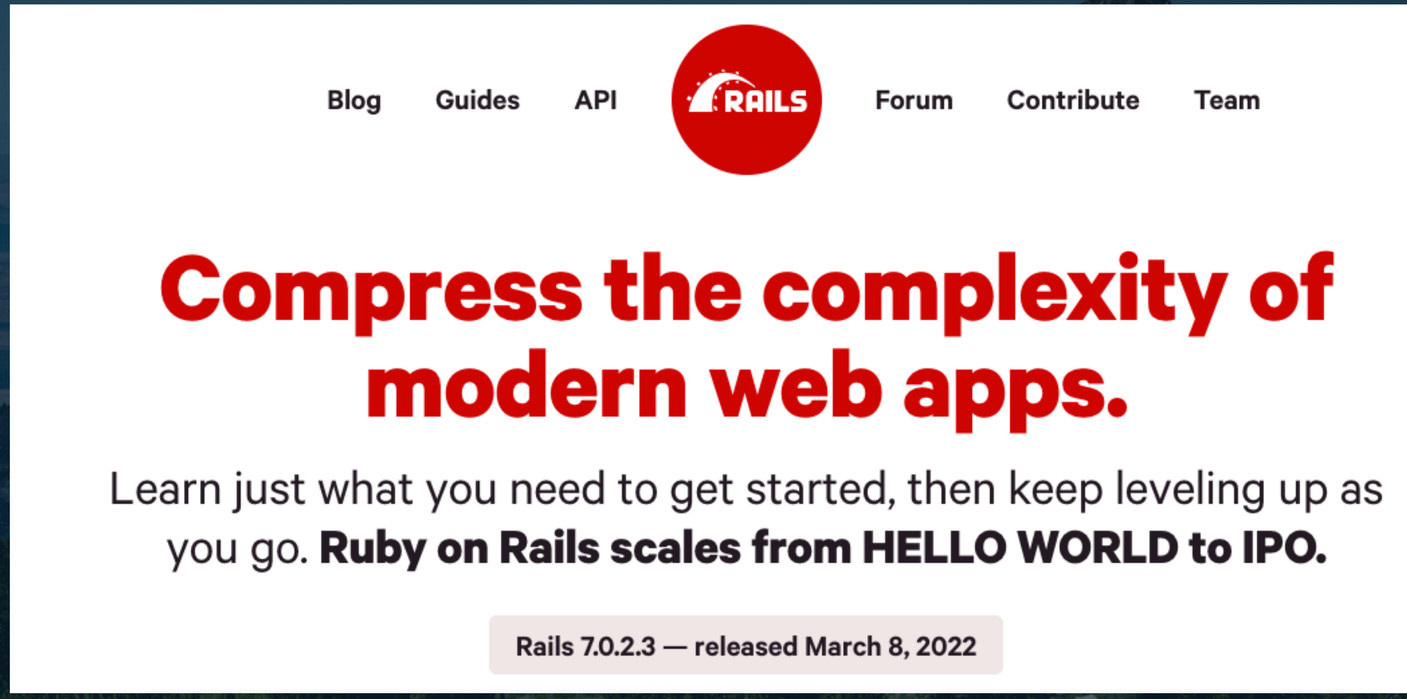
- Applications
- Services

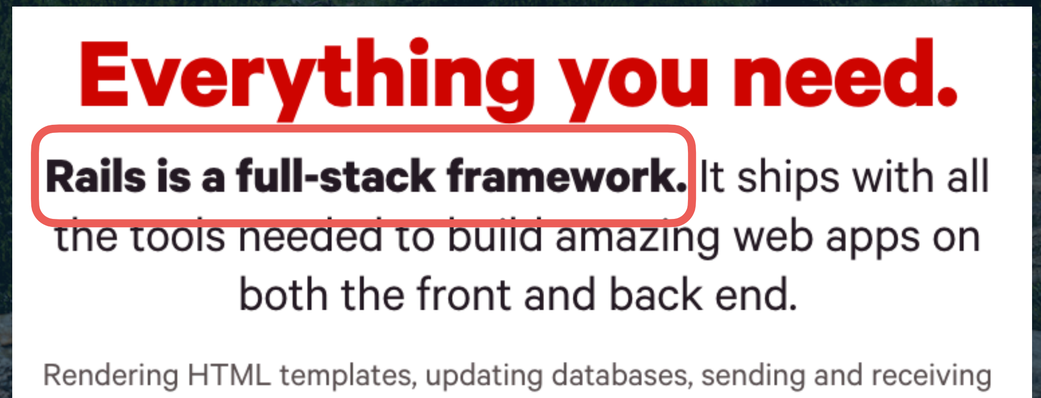
Both can exist in the same environment.

“Applications”

- You write a significant amount of the program logic yourself.
- The domain logic is complex.
- Deployment is a secondary concern.

FP and “real” FP languages are the best tool here!

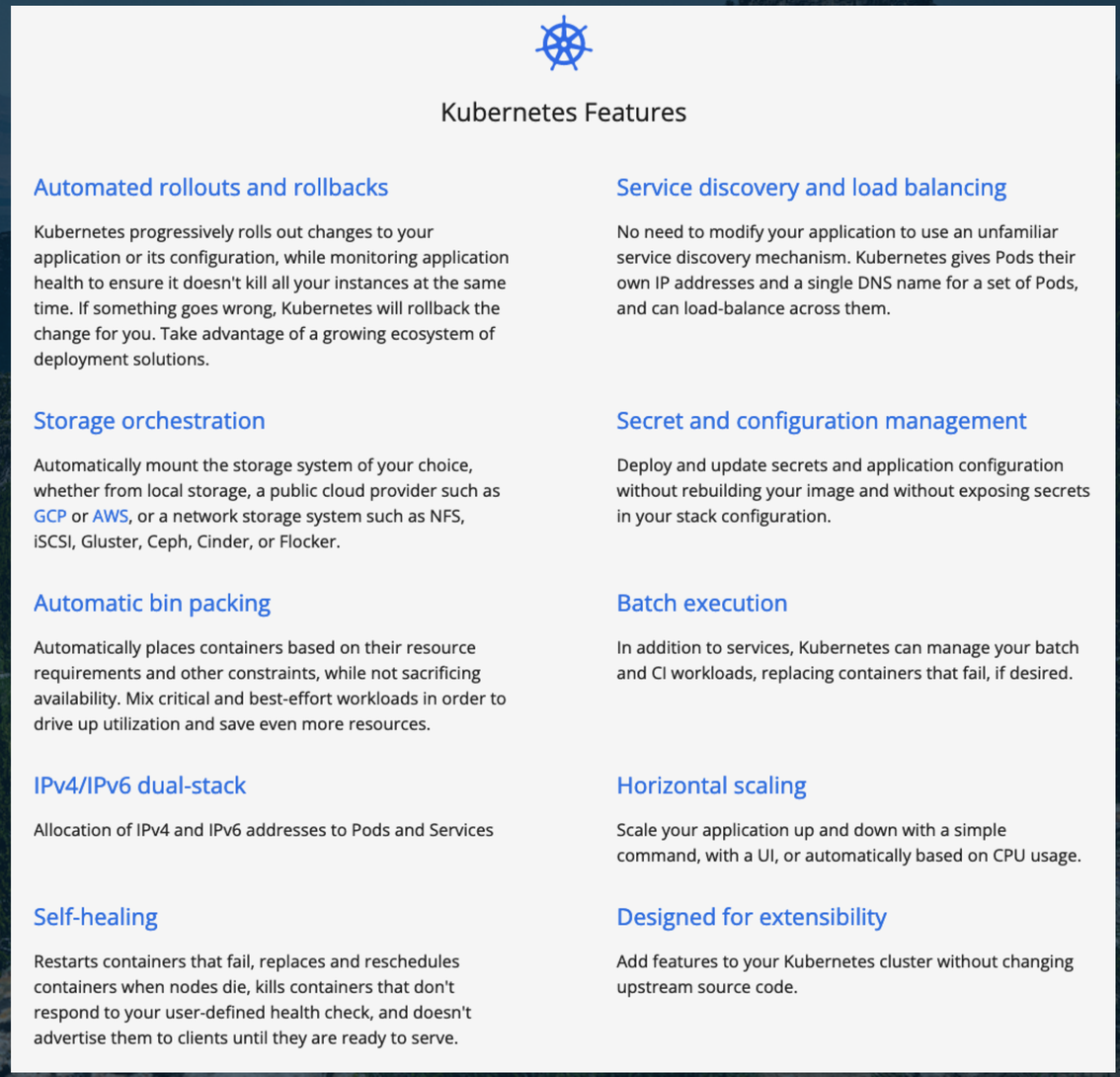




“Services”

- E.g., services in a Kubernetes cluster.
  - Integration, wiring, scripting the biggest challenges.
  - Code you write is relatively small and focused.

Go, Bash, Python, and … YAML.
FP isn’t as important.



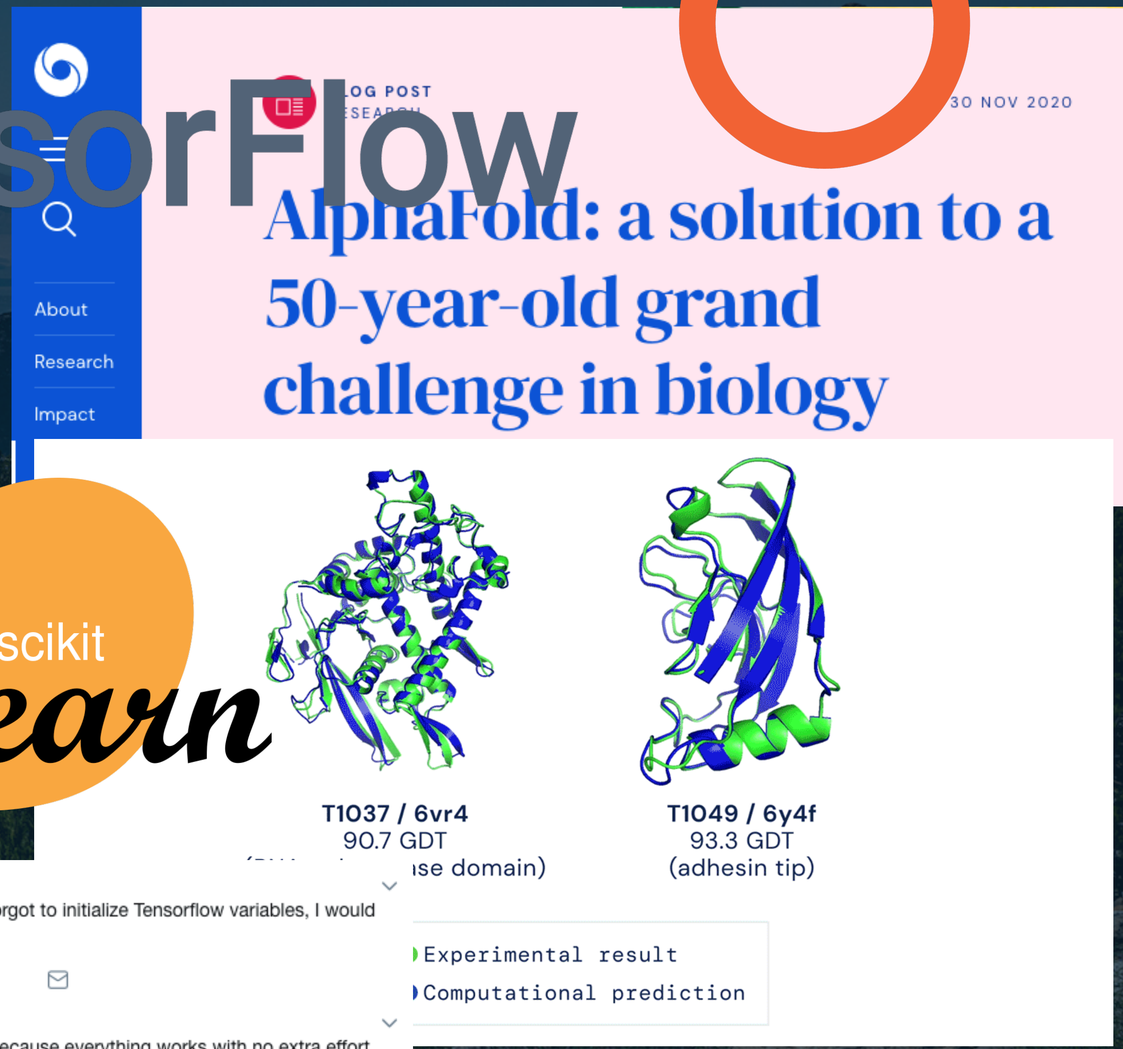
“Services”

- Data Science, ML/AI applications
  - Integration, wiring, scripting of big libraries.
  - Code you write is relatively small and focused.

Mostly scripting:
Python and R

TensorFlow

scikit learn



Two Kinds of Programming

- As more and more software problems get standardized into frameworks and libraries, we'll write less and less code.
  - That's a good thing…
  - … but I claim it is a threat to FP.

Thank You

deanwampler.com/talks
https://deanwampler.medium.com
dean@deanwampler.com
@deanwampler