



dave gurnell

⓪ untyped

# A Route to the Three 'R's: Reading, Writing, and the REST

<https://github.com/davegurnell/scalalol-2011-talk>

/add/123/to/234

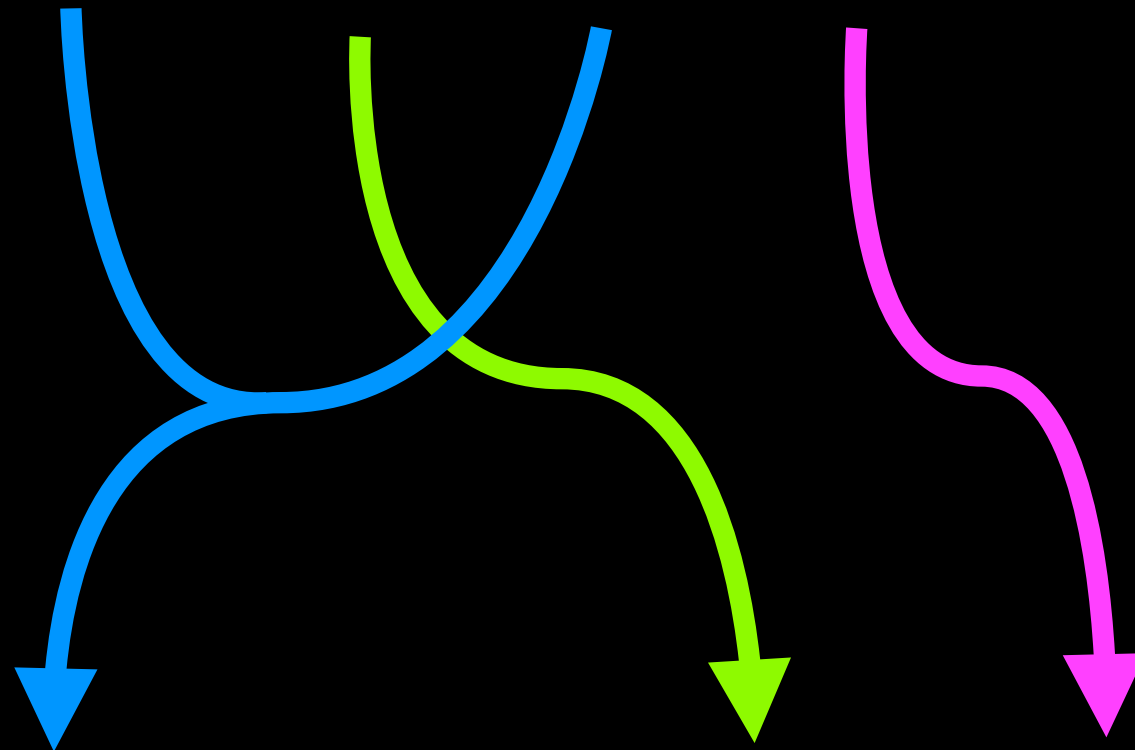
/add/123/to/234

Calculator.add(123, 234)

/add/123/to/234

Calculator.add(123, 234)

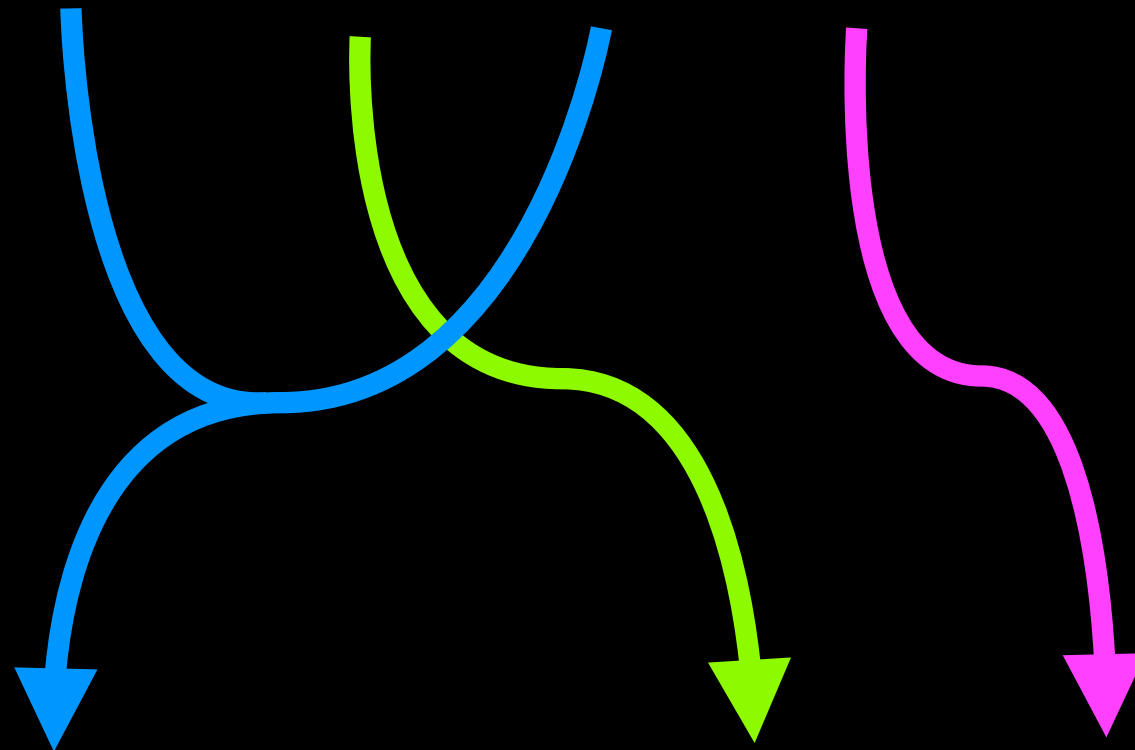
/add/123/to/234



Calculator.add(123, 234)

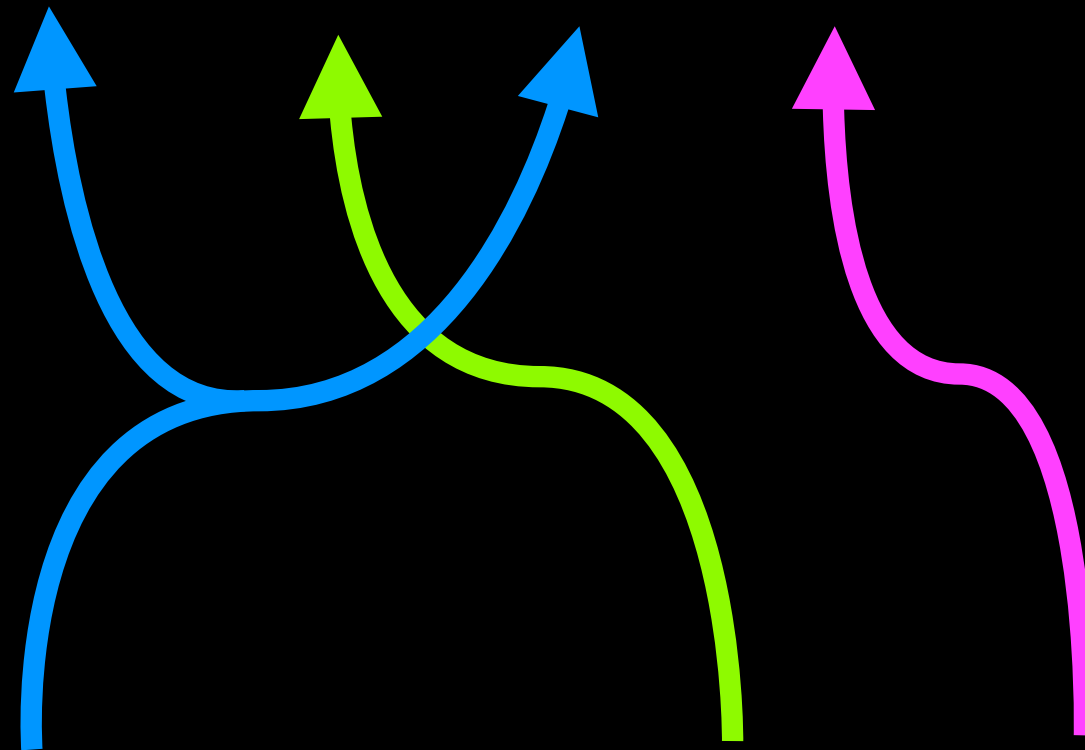


/add/123/to/234



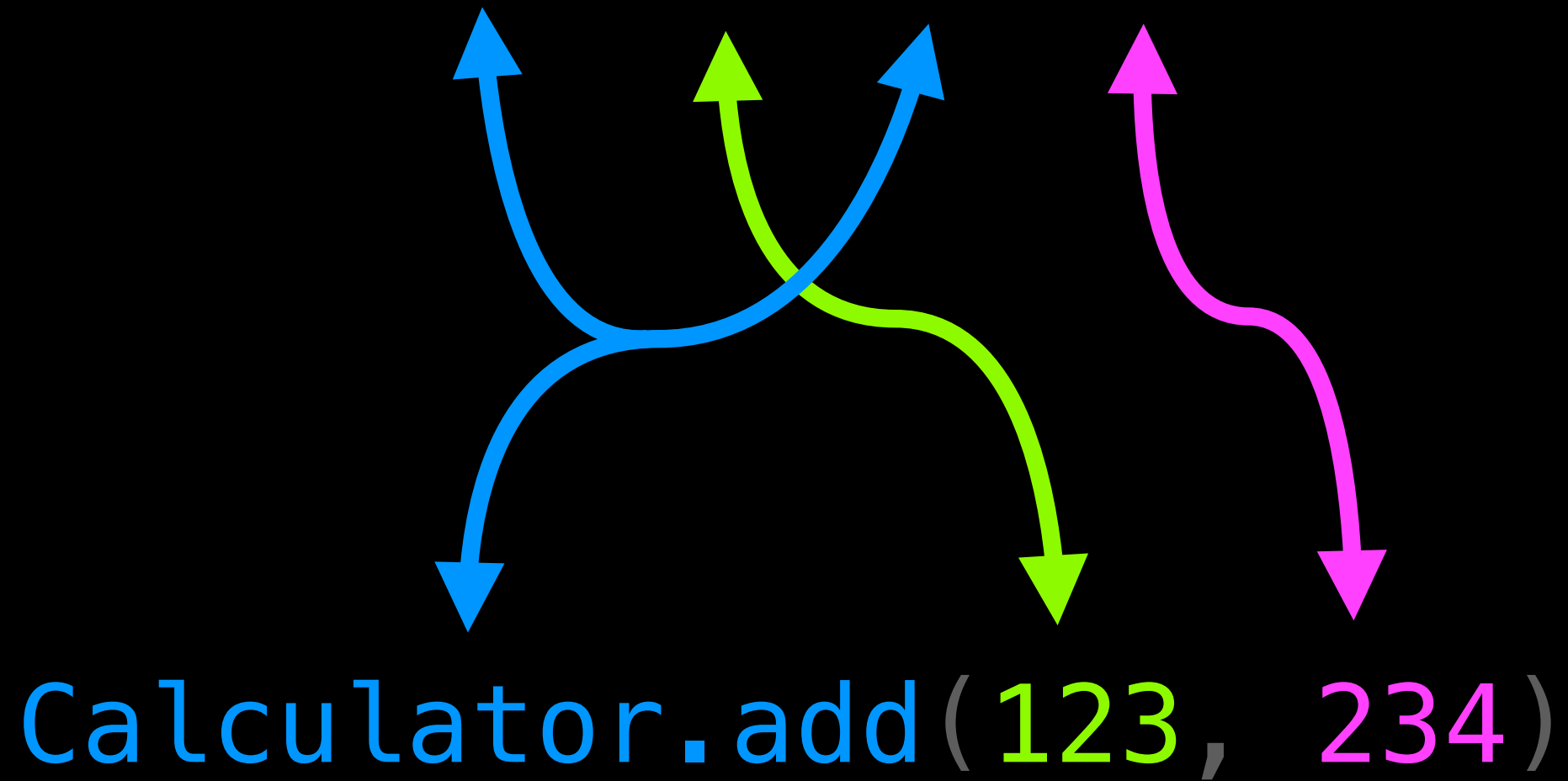
Calculator.add(123, 234)

/add/123/to/234



Calculator.add(123, 234)

/add/123/to/234



talk plan

# talk plan

1. path segments

# talk plan

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2. whole-path representations

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1. path segments
2. whole-path representations
3. whole-path transformations

# talk plan

1. path segments
2. whole-path representations
3. whole-path transformations
4. binding paths to code



# talk plan

1. path segments
2. whole-path representations
3. whole-path transformations
4. binding paths to code
5. making it pretty!

```
object Calculator extends Site {  
  
  val add =  
    ("add" :: IntArg :: "to" :: IntArg :: end) >> {  
      (a: Int, b: Int) =>  
        Response("%s + %s = %s".format(a, b, a + b))  
    }  
  
  val repeat =  
    ("repeat" :: StringArg :: IntArg :: "times" :: end) >> {  
      (a: String, b: Int) =>  
        Response("%s * %s = %s".format(a, b, a * b))  
    }  
  
}
```

```
object Calculator extends Site {  
  
  val add =  
    ("add" :: IntArg :: "to" :: IntArg :: end) >> {  
      (a: Int, b: Int) =>  
        Response("%s + %s = %s".format(a, b, a + b))  
    }  
  
  val repeat =  
    ("repeat" :: StringArg :: IntArg :: "times" :: end) >> {  
      (a: String, b: Int) =>  
        Response("%s * %s = %s".format(a, b, a * b))  
    }  
  
}
```

```
object Calculator extends Site {  
  
  val add =  
    ("add" :: IntArg :: "to" :: IntArg :: end) >> {  
      (a: Int, b: Int) =>  
        Response("%s + %s = %s".format(a, b, a + b))  
    }  
  
  val repeat =  
    ("repeat" :: StringArg :: IntArg :: "times" :: end) >> {  
      (a: String, b: Int) =>  
        Response("%s * %s = %s".format(a, b, a * b))  
    }  
  
}
```

```
object Calculator extends Site {  
  
  val add =  
    ("add" :: IntArg :: "to" :: IntArg :: end) >> {  
      (a: Int, b: Int) =>  
        Response("%s + %s = %s".format(a, b, a + b))  
    }  
  
  val repeat =  
    ("repeat" :: StringArg :: IntArg :: "times" :: end) >> {  
      (a: String, b: Int) =>  
        Response("%s * %s = %s".format(a, b, a * b))  
    }  
  
}
```

```
object Calculator extends Site {  
  
  val add =  
    ("add" :: IntArg :: "to" :: IntArg :: end) >> {  
      (a: Int, b: Int) =>  
        Response("%s + %s = %s".format(a, b, a + b))  
    }  
  
  val repeat =  
    ("repeat" :: StringArg :: IntArg :: "times" :: end) >> {  
      (a: String, b: Int) =>  
        Response("%s * %s = %s".format(a, b, a * b))  
    }  
  
}
```

**Calculator.add.url(1, 2)**      // => "/add/1/to/2"

```

object Calculator extends Site {

  val add =
    ("add" :: IntArg :: "to" :: IntArg :: end) >> {
      (a: Int, b: Int) =>
        Response("%s + %s = %s".format(a, b, a + b))
    }

  val repeat =
    ("repeat" :: StringArg :: IntArg :: "times" :: end) >> {
      (a: String, b: Int) =>
        Response("%s * %s = %s".format(a, b, a * b))
    }
}

```

`Calculator.add.url(1, 2)`      `// => "/add/1/to/2"`

`Calculator.repeat("abc", 4)`      `// => Response("abc * 2 = abcab")`

# talk plan

1. path segments

2. whole-path representations

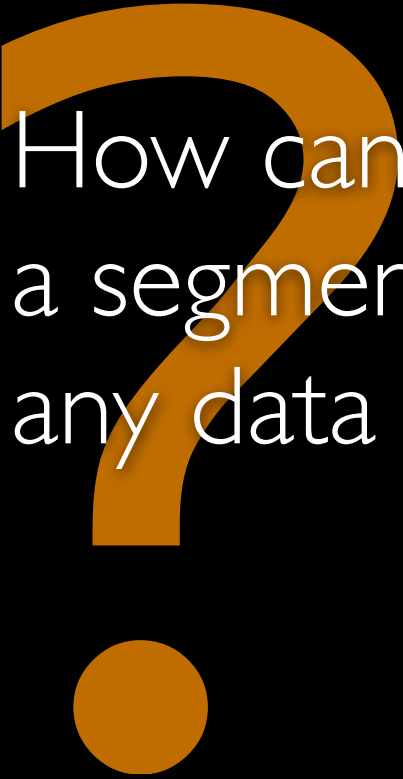
3. whole-path transformations

4. binding paths to code

5. making it pretty!







Q: How can we transform between  
a segment of a URL path and  
any data type we may need in our web app?

/add/123/to/234

/add/123/to/234

List("add", "123", "to", "234")

"add" :: "123" :: "to" :: "234" :: Nil

```
List("add", "123", "to", "234")
```

```
List("add", "123", "to", "234")
```



String

Int

123



234

"123"

"234"

String

Int

123

234



"123"

String

Option[Int]

123



"234"

String

Int

234





"123"

String

decode

Option[Int]



123

"234"

String

encode

Int



234

```
trait Arg[T] {  
  /**  
   * Attempt to decode a URL path segment.  
   *  
   * Return Some(value) if successful,  
   * or None if unsuccessful.  
   */  
  def decode(in: String): Option[T]  
  
  /** Encode a typed value as a URL path segment. */  
  def encode(in: T): String  
}
```

```
object IntArg extends Arg[Int] {  
  
  /**  
   * Attempt to decode a URL path segment.  
   *  
   * Return Some(value) if successful,  
   * or None if unsuccessful.  
   */  
  def decode(in: String): Option[Int] =  
    try {  
      Some(in.toInt)  
    } catch {  
      case exn: NumberFormatException => None  
    }  
  
  /** Encode a typed value as a URL path segment. */  
  def encode(in: Int): String =  
    in.toString  
  
}
```

```
object IntArg extends Arg[Int] {  
  
  /**  
   * Attempt to decode a URL path segment.  
   *  
   * Return Some(value) if successful,  
   * or None if unsuccessful.  
   */  
  def decode(in: String): Option[Int] =  
    try {  
      Some(in.toInt)  
    } catch {  
      case exn: NumberFormatException => None  
    }  
  
  /** Encode a typed value as a URL path segment. */  
  def encode(in: Int): String =  
    in.toString  
  
}
```

```
object IntArg extends Arg[Int]
```

```
object IntArg extends Arg[Int]
```

```
object StringArg extends Arg[String]
```

```
object DoubleArg extends Arg[Double]
```

```
object FooArg extends Arg[Foo]
```

```
object FooListArg extends Arg[List[Foo]]
```

```
// ...
```

```

object Calculator extends Site {

  val add =
    ("add" :: IntArg :: "to" :: IntArg :: end) >> {
      (a: Int, b: Int) =>
        Response("%s + %s = %s".format(a, b, a + b))
    }

  val repeat =
    ("repeat" :: StringArg :: IntArg :: "times" :: end) >> {
      (a: String, b: Int) =>
        Response("%s * %s = %s".format(a, b, a * b))
    }

}

```

```
Calculator.add.url(1, 2) // => "/add/1/to/2"
```

```
Calculator.repeat("abc", 2) // => Response("abc * 2 = abcabc")
```

```
bash$ cd 1-args  
bash$ ./sbt console
```

...

```
scala>
```



*Try it!*



```
bash$ cd 1-args  
bash$ ./sbt console
```

...

```
scala> IntArg.decode("123")
```



*Try it!*

```
bash$ cd 1-args  
bash$ ./sbt console
```

...

```
scala> IntArg.decode("123")  
res0: Option[Int] = Some(123)
```

```
scala>
```



*Try it!*

```
bash$ cd 1-args  
bash$ ./sbt console
```

...

```
scala> IntArg.decode("123")  
res0: Option[Int] = Some(123)
```

```
scala> IntArg.decode("abc")
```



*Try it!*



*Try it!*

```
bash$ cd 1-args  
bash$ ./sbt console
```

...

```
scala> IntArg.decode("123")  
res0: Option[Int] = Some(123)
```

```
scala> IntArg.decode("abc")  
res1: Option[Int] = None
```

```
scala>
```



*Try it!*

```
bash$ cd 1-args  
bash$ ./sbt console
```

...

```
scala> IntArg.decode("123")  
res0: Option[Int] = Some(123)
```

```
scala> IntArg.decode("abc")  
res1: Option[Int] = None
```

```
scala> IntArg.encode(123)
```



*Try it!*

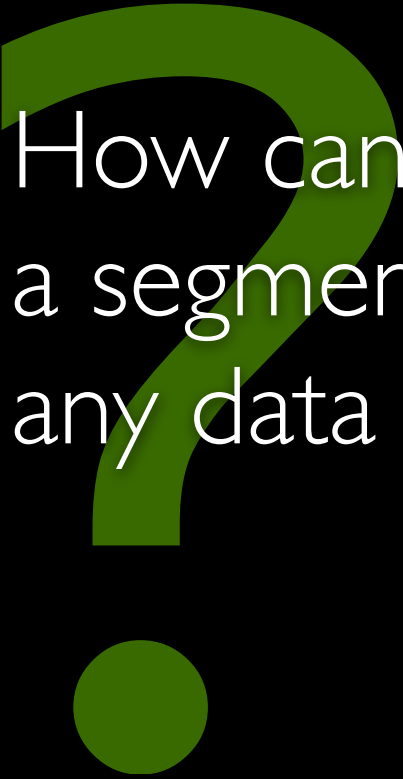
```
bash$ cd 1-args  
bash$ ./sbt console
```

...

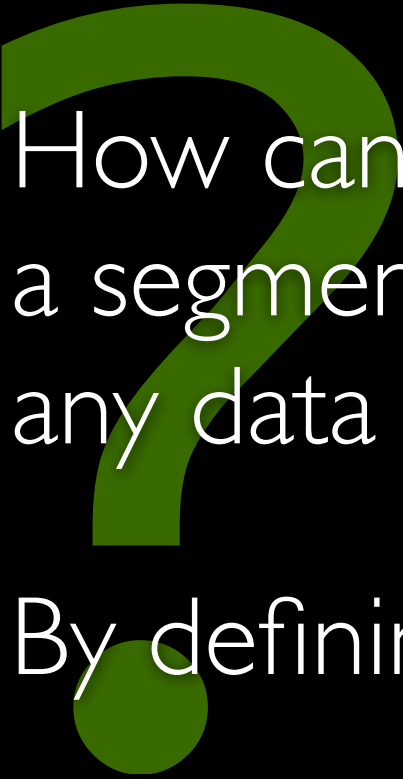
```
scala> IntArg.decode("123")  
res0: Option[Int] = Some(123)
```

```
scala> IntArg.decode("abc")  
res1: Option[Int] = None
```

```
scala> IntArg.encode(123)  
res2: String = 123
```



Q: How can we transform between  
a segment of a URL path and  
any data type we may need in our web app?



**Q:** How can we transform between a segment of a URL path and any data type we may need in our web app?

**A:** By defining an **Arg** for each type we need



# talk plan

1. path segments

2. whole-path representations

3. whole-path transformations

4. binding paths to code

5. making it pretty!

# talk plan

1. path segments

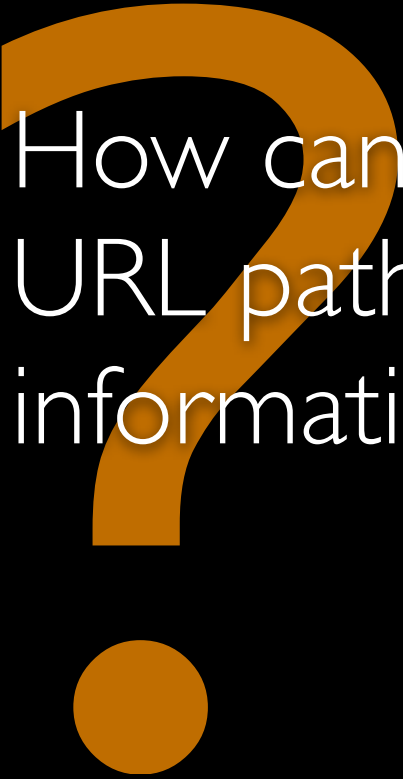
**2. whole-path representations**

3. whole-path transformations

4. binding paths to code

5. making it pretty!

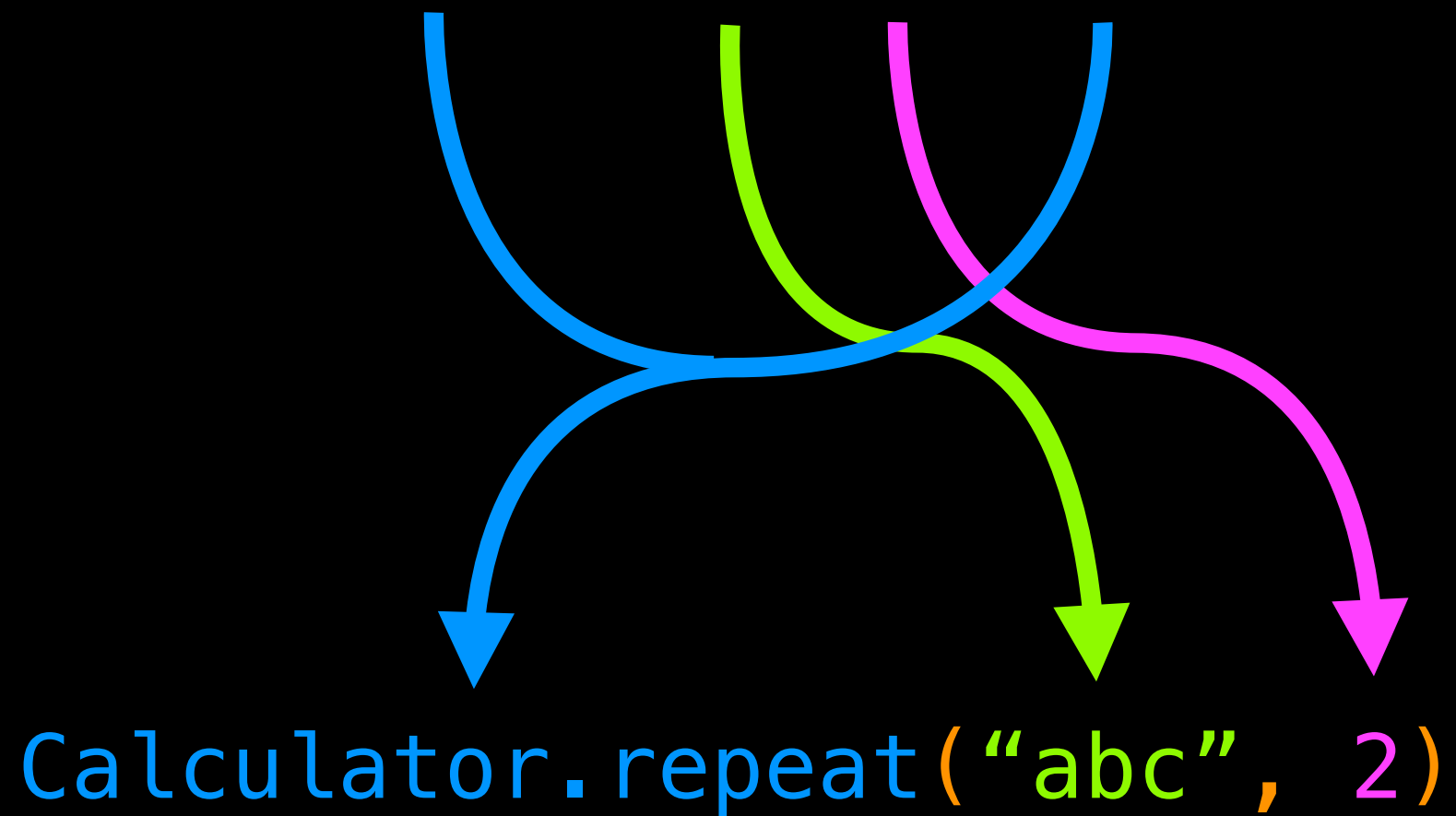




Q: How can we aggregate the transformed URL path segments, while maintaining type information?

/repeat/abc/2/times

/repeat/abc/2/times



/repeat/abc/2/times

List("repeat", "abc", "2", "times")

"repeat" :: "abc" :: "2" :: "times" :: Nil

“repeat” :: “abc” :: “2” :: “times” :: Nil



“repeat” :: “abc” :: “2” :: “times” :: Nil



“abc”

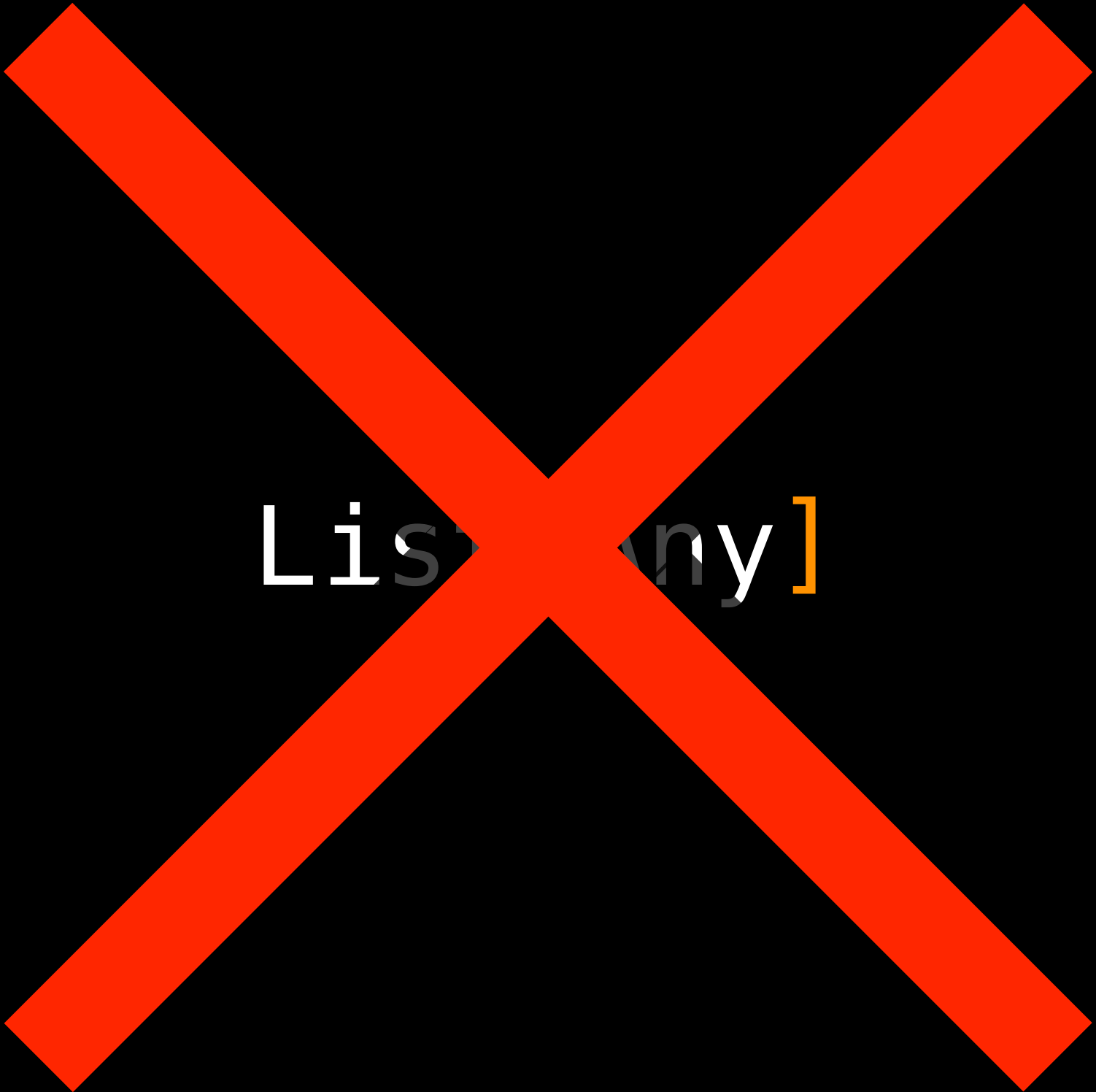
2

“repeat” :: “abc” :: “2” :: “times” :: Nil



“abc” :: 2 :: Nil

List [Any]



List any]

“repeat” :: “abc” :: “2” :: “times” :: Nil



“abc”

2

“repeat” :: “abc” :: “2” :: “times” :: Nil



“repeat” :: “abc” :: “2” :: “times” :: Nil

StringArg



IntArg



( “abc” , 2 )

Tuple2[String, Int]



Tuple2[String, Int]





`Tuple2[String, Int]`

“repeat” :: “abc” :: “2” :: “times” :: Nil

StringArg



IntArg



( “abc” , 2 )

“repeat” :: “abc” :: “2” :: “times” :: Nil



( “abc” , ( 2 , ??? ) )

```
Tuple2[String,  
        Tuple2[Int, ???]]
```

```
HCons[String,  
  HCons[Int, HNil]]
```

HCons [String, HCons [Int, HNil]]



```
trait List[+A] {  
    def ::(item: A): List[A] =  
        Cons(item, this)  
}  
  
class Cons[A](hd: A, tl: List[A])  
    extends List[A]  
  
object Nil extends List[Nothing]
```



```
trait List[+A] {
```

```
  def ::(item: A): List[A] =  
    Cons(item, this)
```

```
}
```

```
class Cons[A](hd: A, tl: List[A])  
  extends List[A]
```

```
object Nil extends List[Nothing]
```

```
trait List[+A] {
```

```
  def ::(item: A): List[A] =  
    Cons(item, this)
```

```
}
```

```
class Cons[A](hd: A, tl: List[A])  
  extends List[A]
```

```
object Nil extends List[Nothing]
```

```
trait List[+A] {
```

```
  def ::(item: A): List[A] =  
    Cons(item, this)
```

```
}
```

```
class Cons[A](hd: A, tl: List[A])  
  extends List[A]
```

```
object Nil extends List[Nothing]
```

```
trait HList
```

```
class HCons[H, T <: HList](hd: H, tl: T)  
  extends HList {
```

```
  def ::[X](item: X) =  
    HCons(item, this)
```

```
}
```

```
object HNil extends HList {
```

```
  def ::[X](item: X) =  
    HCons(item, this)
```

```
}
```

```
trait HList
```

```
class HCons[H, T <: HList](hd: H, tl: T)  
  extends HList {
```

```
  def ::[X](item: X) =  
    HCons(item, this)
```

```
}
```

```
object HNil extends HList {
```

```
  def ::[X](item: X) =  
    HCons(item, this)
```

```
}
```

```
trait HList
```

```
class HCons[H, T <: HList](hd: H, tl: T)  
  extends HList {  
  
  def ::[X](item: X) =  
    HCons(item, this)  
  
}
```

```
object HNil extends HList {  
  
  def ::[X](item: X) =  
    HCons(item, this)  
  
}
```

```
trait HList
```

```
class HCons[H, T <: HList](hd: H, tl: T)  
  extends HList {
```

```
  def ::[X](item: X) =  
    HCons(item, this)
```

```
}
```

```
object HNil extends HList {
```

```
  def ::[X](item: X) =  
    HCons(item, this)
```

```
}
```

```
bash$ cd 2-hlists  
bash$ ./sbt console
```

...

```
scala>
```



*Try it!*



```
bash$ cd 2-hlists  
bash$ ./sbt console
```

...

```
scala> "a" :: "b" :: "c" :: Nil
```



*Try it!*



*Try it!*

```
bash$ cd 2-hlists  
bash$ ./sbt console
```

...

```
scala> "a" :: "b" :: "c" :: Nil  
res0: List[String] =  
      List(a, b, c)
```

```
scala>
```



*Try it!*

```
bash$ cd 2-hlists  
bash$ ./sbt console
```

...

```
scala> "a" :: "b" :: "c" :: Nil  
res0: List[String] =  
      Cons(a, Cons(b, Cons(c, Nil)))
```

```
scala>
```



*Try it!*

```
bash$ cd 2-hlists  
bash$ ./sbt console
```

...

```
scala> "a" :: "b" :: "c" :: Nil  
res0: List[String] =  
      Cons(a, Cons(b, Cons(c, Nil)))
```

```
scala> "a" :: "b" :: "c" :: HNil
```



*Try it!*

```
bash$ cd 2-hlists
bash$ ./sbt console
```

...

```
scala> "a" :: "b" :: "c" :: Nil
res0: List[String] =
  Cons(a,Cons(b,Cons(c,Nil)))
```

```
scala> "a" :: "b" :: "c" :: HNil
res1: HCons[String,HCons[String,HCons[String,HNil]]] =
  HCons(a,HCons(b,HCons(c,HNil)))
```

```
scala>
```



*Try it!*

```
bash$ cd 2-hlists
bash$ ./sbt console
```

...

```
scala> "a" :: "b" :: "c" :: Nil
res0: List[String] =
  Cons(a,Cons(b,Cons(c,Nil)))
```

```
scala> "a" :: "b" :: "c" :: HNil
res1: HCons[String,HCons[String,HCons[String,HNil]]] =
  HCons(a,HCons(b,HCons(c,HNil)))
```

```
scala> "a" :: 2 :: 3.0 :: HNil
```



*Try it!*

```
bash$ cd 2-hlists
bash$ ./sbt console
```

...

```
scala> "a" :: "b" :: "c" :: Nil
```

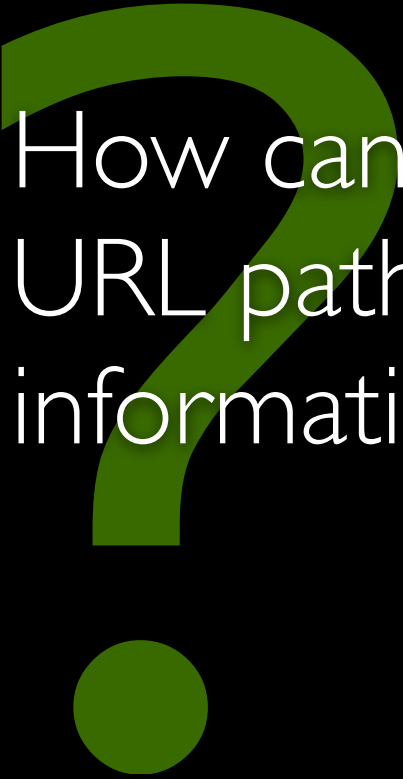
```
res0: List[String] =
  Cons(a,Cons(b,Cons(c,Nil)))
```

```
scala> "a" :: "b" :: "c" :: HNil
```

```
res1: HCons[String,HCons[String,HCons[String,HNil]]] =
  HCons(a,HCons(b,HCons(c,HNil)))
```

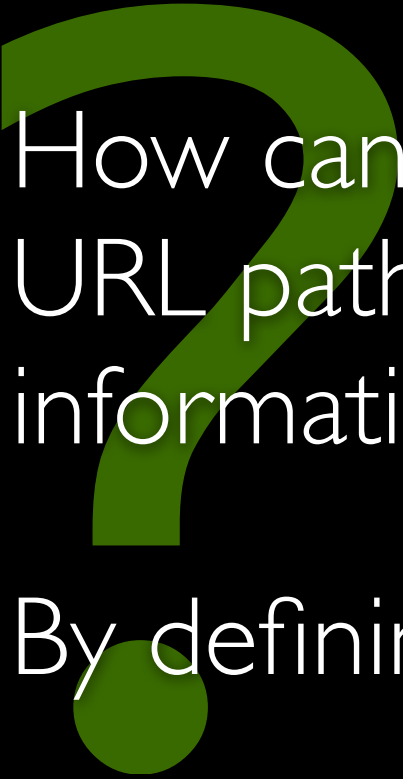
```
scala> "a" :: 2 :: 3.0 :: HNil
```

```
res2: HCons[String,HCons[Int,HCons[Double,HNil]]] =
  HCons(a,HCons(2,HCons(3.0,HNil)))
```



Q: How can we aggregate the transformed URL path segments, while maintaining type information?





**Q:** How can we aggregate the transformed URL path segments, while maintaining type information?

**A:** By defining an **HList** for each type we need

# talk plan

1. path segments

**2. whole-path representations**

3. whole-path transformations

4. binding paths to code

5. making it pretty!

# talk plan

1. path segments

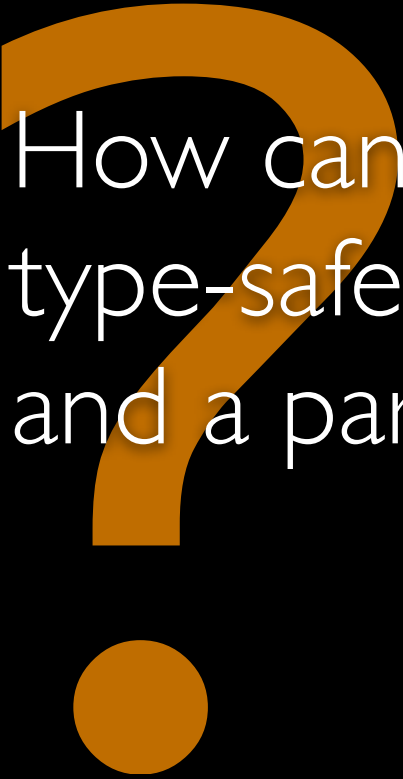
2. whole-path representations

**3. whole-path transformations**

4. binding paths to code

5. making it pretty!





Q: How can we create a bidirectional, type-safe mapping between a URL and a particular type of HList?

“repeat” :: “abc” :: “2” :: “times” :: Nil

“abc” :: 2 :: HNil

`“repeat” :: “abc” :: “2” :: “times” :: Nil`

`List[String]`

`HCons[String, HCons[Int, HNil]]`

`“abc” :: 2 :: HNil`

```

trait Path {
  type Result <: HList
  def decode(path: List[String]): Option[Result]
  def encode(args: Result): List[String]
}

class PLiteral[T <: Path](val head: String, val tail: T)
  extends Path {
  type Result = tail.Result
  def ::(head: String) = PLiteral(head, this)
  def ::[X](head: Arg[X]) = PMatch(head, this)
}

class PMatch[H, T <: Path](val head: Arg[H], val tail: T)
  extends Path {
  type Result = HCons[H, tail.Result]
  def ::(...) ...
}

object PNil extends Path {
  type Result = HNil
  def ::(...) ...
}

```



```
trait Path {  
  type Result <: HList  
  def decode(path: List[String]): Option[Result]  
  def encode(args: Result): List[String]  
}
```

```
class PLiteral[T <: Path](val head: String, val tail: T)  
  extends Path {  
    type Result = tail.Result  
    def ::(head: String) = PLiteral(head, this)  
    def ::[X](head: Arg[X]) = PMatch(head, this)  
  }
```

```
class PMatch[H, T <: Path](val head: Arg[H], val tail: T)  
  extends Path {  
    type Result = HCons[H, tail.Result]  
    def ::(...) ...  
  }
```

```
object PNil extends Path {  
  type Result = HNil  
  def ::(...) ...  
}
```

```
trait Path {  
  type Result <: HList  
  def decode(path: List[String]): Option[Result]  
  def encode(args: Result): List[String]  
}  
  
class PLiteral[T <: Path](val head: String, val tail: T)  
  extends Path {  
  type Result = tail.Result  
  def ::(head: String) = PLiteral(head, this)  
  def ::[X](head: Arg[X]) = PMatch(head, this)  
}  
  
class PMatch[H, T <: Path](val head: Arg[H], val tail: T)  
  extends Path {  
  type Result = HCons[H, tail.Result]  
  def ::(...) ...  
}  
  
object PNil extends Path {  
  type Result = HNil  
  def ::(...) ...  
}
```

```
trait Path {  
  type Result <: HList  
  def decode(path: List[String]): Option[Result]  
  def encode(args: Result): List[String]  
}  
  
class PLiteral[T <: Path](val head: String, val tail: T)  
  extends Path {  
    type Result = tail.Result  
    def ::(head: String) = PLiteral(head, this)  
    def ::[X](head: Arg[X]) = PMatch(head, this)  
  }  
  
class PMatch[H, T <: Path](val head: Arg[H], val tail: T)  
  extends Path {  
    type Result = HCons[H, tail.Result]  
    def ::(...) ...  
  }  
  
object PNil extends Path {  
  type Result = HNil  
  def ::(...) ...  
}
```

```
trait Path {
  type Result <: HList
  def decode(path: List[String]): Option[Result]
  def encode(args: Result): List[String]
}

class PLiteral[T <: Path](val head: String, val tail: T)
  extends Path {
  type Result = tail.Result
  def ::(head: String) = PLiteral(head, this)
  def ::[X](head: Arg[X]) = PMatch(head, this)
}

class PMatch[H, T <: Path](val head: Arg[H], val tail: T)
  extends Path {
  type Result = HCons[H, tail.Result]
  def ::(...) ...
}

object PNil extends Path {
  type Result = HNil
  def ::(...) ...
}
```

“repeat” :: “abc” :: “2” :: “times” :: Nil

“repeat” :: StringArg :: IntArg :: “times” :: PNil

“abc” :: 2 :: HNil

“repeat” :: “abc” :: “2” :: “times” :: Nil

“repeat” :: StringArg :: IntArg :: “times” :: PNil

“abc” :: 2 :: HNil



`“repeat” :: “abc” :: “2” :: “times” :: Nil`

`“repeat” :: StringArg :: IntArg :: “times” :: PNil`

`“abc” :: 2 :: HNil`

`type Result = HNil`

`"repeat" :: "abc" :: "2" :: "times" :: Nil`

`"repeat" :: StringArg :: IntArg :: "times" :: PNil`

`"abc" :: 2 :: HNil`

```
type Result = HNil
```

```
decode: (List[String]) => Option[HNil]
```

```
encode: HNil => List[String]
```



“repeat” :: “abc” :: “2” :: “times” :: Nil

“repeat” :: StringArg :: IntArg :: “times” :: PNil

“abc” :: 2 :: Nil

“repeat” :: “abc” :: “2” :: “times” :: Nil

“repeat” ::/ StringArg ::/ IntArg ::/ “times” ::/ PNil

String                      T

PLiteral[T <: Path]

“abc” :: 2 :: Nil

“repeat” :: “abc” :: “2” :: “times” :: Nil

“repeat” ::/ StringArg ::/ IntArg ::/ “times” ::/ PNil

String PNil

PLiteral[PNil]

“abc” :: 2 :: Nil

“repeat” :: “abc” :: “2” :: “times” :: Nil

“repeat” ::/:: StringArg ::/:: IntArg ::/:: “times” ::/:: PNil  
String PNil  
PLiteral[PNil]

“abc” :: 2 :: HNil

type Result = tail.Result

“repeat” :: “abc” :: “2” :: “times” :: Nil

“repeat” ::/:: StringArg ::/:: IntArg ::/:: “times” ::/:: PNil

String PNil

PLiteral[PNil]

“abc” :: 2 :: HNil

type Result = HNil

`"repeat" :: "abc" :: "2" :: "times" :: Nil`

`"repeat" ::/: StringArg ::/: IntArg ::/: "times" ::/: PNil`

String

PNil

PLiteral[PNil]

`"abc" :: 2 :: HNil`

```
type Result = HNil
```

```
decode: (List[String]) => Option[HNil]
```

```
encode: HNil => List[String]
```

“repeat” :: “abc” :: “2” :: “times” :: Nil

“repeat” :: StringArg :: IntArg :: “times” :: PNil

“abc” :: 2 :: HNil

“repeat” :: “abc” :: “2” :: “times” :: Nil

“repeat” :: StringArg :: IntArg :: “times” :: PNil

Arg[H] T

PMatch[H,T <: Path]

“abc” :: 2 :: HNil



“repeat” :: “abc” :: “2” :: “times” :: Nil

“repeat” ::/ StringArg ::/  $\frac{\text{Arg[Int]} \quad \text{PLiteral[PNil]}}{\text{IntArg ::/ “times” ::/ PNil}}$  PMatch[Int, PLiteral[PNil]]

“abc” :: 2 :: HNil

“repeat” :: “abc” :: “2” :: “times” :: Nil

“repeat” :: StringArg :: IntArg :: “times” :: PNil

Arg[Int]                      PLiteral[PNil]

PMatch[Int, PLiteral[PNil]]

“abc” :: 2 :: HNil

type Result = HCons[H, tail.Result]

“repeat” :: “abc” :: “2” :: “times” :: Nil

“repeat” :: StringArg :: IntArg :: “times” :: PNil

Arg[Int]                      PLiteral[PNil]

PMatch[Int, PLiteral[PNil]]

“abc” :: 2 :: HNil

type Result = HCons[Int, HNil]

“repeat” :: “abc” :: “2” :: “times” :: Nil

“repeat” :: StringArg :: IntArg :: “times” :: PNil

Arg[Int]                      PLiteral[PNil]

PMatch[Int, PLiteral[PNil]]

“abc” :: 2 :: HNil

```
type Result = HCons[Int, HNil]
```

```
decode: (List[String]) => Option[HCons[Int, HNil]]
```

```
encode: HCons[Int, HNil] => List[String]
```

“repeat” :: “abc” :: “2” :: “times” :: Nil

“repeat” ::/: StringArg ::/: IntArg ::/: “times” ::/: PNil

“abc” :: 2 :: HNil

“repeat” :: “abc” :: “2” :: “times” :: Nil

	$\frac{\text{Arg}[H]}{\text{StringArg}}$	$\frac{T}{\text{IntArg}}$	
“repeat” :::	StringArg :::	IntArg :::	“times” :::
	$\text{PMatch}[H, T <: \text{Path}]$		
			PNil

“abc” :: 2 :: HNil

“repeat” :: “abc” :: “2” :: “times” :: Nil

<u>Arg[String]</u>	<u>PMatch[Int, PLiteral[PNil]]</u>
“repeat” :::	StringArg :::
	IntArg :::
	“times” :::
	PNil
<u>PMatch[String, PMatch[Int, PLiteral[PNil]]]</u>	

“abc” :: 2 :: HNil

“repeat” :: “abc” :: “2” :: “times” :: Nil

“repeat” :: Arg[String] :: PMatch[Int, PLiteral[PNil]]  
StringArg :: IntArg :: “times” :: PNil  
PMatch[String, PMatch[Int, PLiteral[PNil]]]

“abc” :: 2 :: HNil

type Result = HCons[H, tail.Result]



`"repeat" :: "abc" :: "2" :: "times" :: Nil`

$$\frac{\text{Arg[String]} \quad \text{PMatch[Int, PLiteral[PNil]]}}{\text{"repeat" :: StringArg :: IntArg :: "times" :: PNil}} \quad \text{PMatch[String, PMatch[Int, PLiteral[PNil]]}]$$

`"abc" :: 2 :: HNil`

`type Result = HCons[String, HCons[Int, HNil]]`

`"repeat" :: "abc" :: "2" :: "times" :: Nil`

$$\frac{\frac{\text{Arg[String]}}{\text{"repeat" :: StringArg}} \quad \frac{\text{PMatch[Int, PLiteral[PNil]]}}{\text{"times" :: PNil}}}{\text{"repeat" :: StringArg :: IntArg :: "times" :: PNil}} \quad \text{PMatch[String, PMatch[Int, PLiteral[PNil]]]}$$

`"abc" :: 2 :: HNil`

```
type Result = HCons[String, HCons[Int, HNil]]
```

```
decode: (List[String]) => Option[HCons[String, HCons[Int, HNil]]]
```

```
encode: HCons[String, HCons[Int, HNil]] => List[String]
```

`"repeat" :: "abc" :: "2" :: "times" :: Nil`

`"repeat" :: StringArg :: IntArg :: "times" :: PNil`

`"abc" :: 2 :: HNil`

**“repeat” :: “abc” :: “2” :: “times” :: Nil**

String

T

**“repeat” :: StringArg :: IntArg :: “times” :: PNil**

PLiteral[T <: Path]

**“abc” :: 2 :: HNil**

**“repeat” :: “abc” :: “2” :: “times” :: Nil**

String

PMatch[String, PMatch[Int, PLiteral[PNil]]]

**“repeat” :: StringArg :: IntArg :: “times” :: PNil**

PLiteral[PMatch[String, PMatch[Int, PLiteral[PNil]]]]

**“abc” :: 2 :: HNil**

**“repeat” :: “abc” :: “2” :: “times” :: Nil**

String

PMatch[String, PMatch[Int, PLiteral[PNil]]]

**“repeat” :: StringArg :: IntArg :: “times” :: PNil**

PLiteral[PMatch[String, PMatch[Int, PLiteral[PNil]]]]

**“abc” :: 2 :: HNil**

type Result = tail.Result

**“repeat” :: “abc” :: “2” :: “times” :: Nil**

String

PMatch[String, PMatch[Int, PLiteral[PNil]]]

**“repeat” :: StringArg :: IntArg :: “times” :: PNil**

PLiteral[PMatch[String, PMatch[Int, PLiteral[PNil]]]]

**“abc” :: 2 :: HNil**

`type Result = HCons[String, HCons[Int, HNil]]`

**“repeat” :: “abc” :: “2” :: “times” :: Nil**

String

PMatch[String, PMatch[Int, PLiteral[PNil]]]

**“repeat” :: StringArg :: IntArg :: “times” :: PNil**

PLiteral[PMatch[String, PMatch[Int, PLiteral[PNil]]]]

**“abc” :: 2 :: HNil**

```
type Result = HCons[String, HCons[Int, HNil]]
```

```
decode: (List[String]) => Option[HCons[String, HCons[Int, HNil]]]
```

```
encode: HCons[String, HCons[Int, HNil]] => List[String]
```



```
bash$ cd 3-paths  
bash$ ./sbt console
```

...

```
scala>
```



*Try it!*

```
bash$ cd 3-paths
bash$ ./sbt console
```

...

```
scala> val p = "repeat" :/: StringArg :/:  
              IntArg :/: "times" :/: PNil
```



*Try it!*



*Try it!*

```
bash$ cd 3-paths
bash$ ./sbt console
```

...

```
scala> val p = "repeat" ::: StringArg :::
           IntArg ::: "times" ::: PNil
p: PLiteral[PMatch[String,PMatch[Int,PLiteral[PNil]]]] =
  PLiteral(repeat,PMatch(StringArg,
    PMatch(IntArg, PLiteral(times,PNil))))

scala>
```



*Try it!*

```
bash$ cd 3-paths
bash$ ./sbt console
```

...

```
scala> val p = "repeat" ::: StringArg :::
              IntArg ::: "times" ::: PNil
p: PLiteral[PMatch[String, PMatch[Int, PLiteral[PNil]]]] =
  PLiteral(repeat, PMatch(StringArg,
    PMatch(IntArg, PLiteral(times, PNil))))

scala> p.decode("repeat" ::: "abc" ::: "2" ::: "times" ::: Nil)
```



*Try it!*

```
bash$ cd 3-paths
bash$ ./sbt console
```

...

```
scala> val p = "repeat" ::: StringArg :::
              IntArg ::: "times" ::: PNil
p: PLiteral[PMatch[String, PMatch[Int, PLiteral[PNil]]]] =
  PLiteral(repeat, PMatch(StringArg,
    PMatch(IntArg, PLiteral(times, PNil))))

scala> p.decode("repeat" ::: "abc" ::: "2" ::: "times" ::: Nil)
res0: Option[p.Result] =
  Some(HCons(abc, HCons(2, HNil)))

scala>
```



*Try it!*

```
bash$ cd 3-paths
bash$ ./sbt console
```

...

```
scala> val p = "repeat" ::: StringArg :::
              IntArg ::: "times" ::: PNil
p: PLiteral[PMatch[String, PMatch[Int, PLiteral[PNil]]]] =
  PLiteral(repeat, PMatch(StringArg,
    PMatch(IntArg, PLiteral(times, PNil))))

scala> p.decode("repeat" ::: "abc" ::: "2" ::: "times" ::: Nil)
res0: Option[p.Result] =
  Some(HCons(abc, HCons(2, HNil)))

scala> p.encode("abc" ::: 2 ::: HNil)
```



*Try it!*

```
bash$ cd 3-paths
bash$ ./sbt console
```

...

```
scala> val p = "repeat" ::: StringArg :::
              IntArg ::: "times" ::: PNil
p: PLiteral[PMatch[String, PMatch[Int, PLiteral[PNil]]]] =
  PLiteral(repeat, PMatch(StringArg,
    PMatch(IntArg, PLiteral(times, PNil))))

scala> p.decode("repeat" ::: "abc" ::: "2" ::: "times" ::: Nil)
res0: Option[p.Result] =
  Some(HCons(abc, HCons(2, HNil)))

scala> p.encode("abc" ::: 2 ::: HNil)
res1: List[String] = List(repeat, abc, 2, times)
```

```
bash$ cd 3-paths  
bash$ ./sbt console
```

...

```
scala>
```



*Try it!*



```
bash$ cd 3-paths  
bash$ ./sbt console
```

...

```
scala> p.encode("abc" :: "2" :: HNil)
```



*Try it!*



*Try it!*

```
bash$ cd 3-paths
bash$ ./sbt console
```

...

```
scala> p.encode("abc" :: "2" :: HNil)
<console>:9: error: type mismatch;
 found   : HCons[String,HCons[String,HNil]]
 required: p.Result
           p.encode("abc" :: "2" :: HNil)
                        ^
```

```

object Calculator extends Site {

  val add =
    ("add" :: IntArg :: "to" :: IntArg :: PNil) >> {
      (a: Int, b: Int) =>
        Response("%s + %s = %s".format(a, b, a + b))
    }

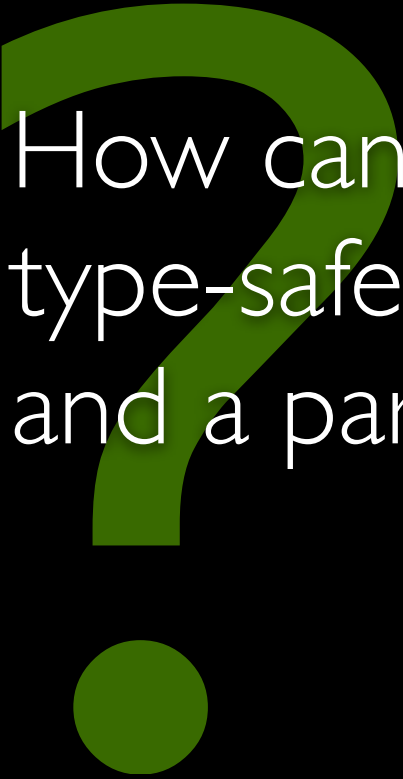
  val repeat =
    ("repeat" :: StringArg :: IntArg :: "times" :: PNil) >> {
      (a: String, b: Int) =>
        Response("%s * %s = %s".format(a, b, a * b))
    }

}


```

```
Calculator.add.url(1, 2)      // => "/add/1/to/2"
```

```
Calculator.multiply(3, 4)    // => Response("3 * 4 = 12")
```



Q: How can we create a bidirectional, type-safe mapping between a URL and a particular type of HList?



**Q:** How can we create a bidirectional, type-safe mapping between a URL and a particular type of HList?

**A:** By defining a **Path** with the correct **Result** type

# talk plan

1. path segments

2. whole-path representations

**3. whole-path transformations**

4. binding paths to code


5. making it pretty!

# talk plan

1. path segments
2. whole-path representations
3. whole-path transformations
- 4. binding paths to code**
5. making it pretty!







Q: How can we call a function and pass it the typed data we have extracted from a URL?

```
trait Path {  
    type Result <: HList  
  
    def decode(path: List[String]): Option[Result]  
    def encode(args: Result): List[String]  
  
}
```

```
trait Path {  
  type Result <: HList  
  
  def decode(path: List[String]): Option[Result]  
  def encode(args: Result): List[String]  
  
}
```

```
trait Path {  
  type Result <: HList  
  
  def decode(path: List[String]): Option[Result]  
  def encode(args: Result): List[String]  
  
  def >>(fn: (Result) => Response): Route[Result] =  
    new Route(this, fn)  
}
```

```
import java.net.URLEncoder.{encode => urlEncode}

class Route[Res <: HList](
  val path: Path { type Result = Res },
  val fn: (Res) => Response
) {

  def dispatch(req: Request): Option[Response] =
    path.decode(req.path).map(fn)

  def url(arg: Res) =
    path.encode(arg).
      map(urlEncode(_, "utf-8")).
      mkString("/", "/", "")

  def apply(arg: Res) =
    fn.apply(arg)

}
```

```
import java.net.URLEncoder.{encode => urlEncode}

class Route[Res <: HList](
  val path: Path { type Result = Res },
  val fn: (Res) => Response
) {

  def dispatch(req: Request): Option[Response] =
    path.decode(req.path).map(fn)

  def url(arg: Res) =
    path.encode(arg).
      map(urlEncode(_, "utf-8")).
      mkString("/", "/", "")

  def apply(arg: Res) =
    fn.apply(arg)
}
```

```
import java.net.URLEncoder.{encode => urlEncode}

class Route[Res <: HList](
  val path: Path { type Result = Res },
  val fn: (Res) => Response
) {

  def dispatch(req: Request): Option[Response] =
    path.decode(req.path).map(fn)

  def url(arg: Res) =
    path.encode(arg).
      map(urlEncode(_, "utf-8")).
      mkString("/", "/", "")

  def apply(arg: Res) =
    fn.apply(arg)
}
```

```
import java.net.URLEncoder.{encode => urlEncode}

class Route[Res <: HList](
  val path: Path { type Result = Res },
  val fn: (Res) => Response
) {

  def dispatch(req: Request): Option[Response] =
    path.decode(req.path).map(fn)

  def url(arg: Res) =
    path.encode(arg).
      map(urlEncode(_, "utf-8")).
      mkString("/", "/", "")

  def apply(arg: Res) =
    fn.apply(arg)

}
```



```
import java.net.URLEncoder.{encode => urlEncode}

class Route[Res <: HList](
  val path: Path { type Result = Res },
  val fn: (Res) => Response
) {

  def dispatch(req: Request): Option[Response] =
    path.decode(req.path).map(fn)

  def url(arg: Res) =
    path.encode(arg).
      map(urlEncode(_, "utf-8")).
      mkString("/", "/", "")

  def apply(arg: Res) =
    fn.apply(arg)
}
```

```
import java.net.URLEncoder.{encode => urlEncode}

class Route[Res <: HList](
  val path: Path { type Result = Res },
  val fn: (Res) => Response
) {

  def dispatch(req: Request): Option[Response] =
    path.decode(req.path).map(fn)

  def url(arg: Res) =
    path.encode(arg).
      map(urlEncode(_, "utf-8")).
      mkString("/", "/", "")

  def apply(arg: Res) =
    fn.apply(arg)

}
```

```
bash$ cd 4-routes  
bash$ ./sbt console
```

...

```
scala>
```



*Try it!*

```
bash$ cd 4-routes
bash$ ./sbt console
```

...

```
scala> val path = "add" :: IntArg ::
              "to"  :: IntArg :: PNil
```



*Try it!*



*Try it!*

```
bash$ cd 4-routes
bash$ ./sbt console
```

...

```
scala> val path = "add" :: IntArg ::
              "to" :: IntArg :: PNil
path: PLiteral[PArg[Int, PLiteral[PArg[Int, PNil]]]] =
  PLiteral(add, PArg(IntArg, PLiteral(to,
    PArg(IntArg, PNil))))

scala>
```



*Try it!*

```
bash$ cd 4-routes
bash$ ./sbt console
```

...

```
scala> val path = "add" :: IntArg ::
              "to"  :: IntArg :: PNil
path: PLiteral[PArg[Int, PLiteral[PArg[Int, PNil]]]] =
  PLiteral(add, PArg(IntArg, PLiteral(to,
    PArg(IntArg, PNil))))

scala> def fn(res: HCons[Int, HCons[Int, HNil]]) = {
  val a = res.head
  val b = res.tail.head
  val ans = a + b
  Response("%s + %s = %s".format(a, b, a + b))
}
```



*Try it!*

```
bash$ cd 4-routes
bash$ ./sbt console
```

...

```
scala> val path = "add" :: IntArg ::
              "to" :: IntArg :: PNil
path: PLiteral[PArg[Int, PLiteral[PArg[Int, PNil]]]] =
  PLiteral(add, PArg(IntArg, PLiteral(to,
    PArg(IntArg, PNil))))
```

```
scala> def fn(res: HCons[Int, HCons[Int, HNil]]) = {
  val a = res.head
  val b = res.tail.head
  val ans = a + b
  Response("%s + %s = %s".format(a, b, a + b))
}
fn: (res: HCons[Int, HCons[Int, HNil]])Response
```

```
bash$ cd 4-routes  
bash$ ./sbt console
```

...

```
scala>
```



*Try it!*



```
bash$ cd 4-routes  
bash$ ./sbt console
```

...

```
scala> val route = path >> fn
```



*Try it!*



*Try it!*

```
bash$ cd 4-routes
bash$ ./sbt console
```

...

```
scala> val route = path >> fn
route: Route[path.Result] =
  Route(PLiteral(add, PArg(IntArg, PLiteral(to,
    PArg(IntArg, PNil)))) , <function1>)
```

```
scala>
```



*Try it!*

```
bash$ cd 4-routes
bash$ ./sbt console
```

...

```
scala> val route = path >> fn
route: Route[path.Result] =
  Route(PLiteral(add, PArg(IntArg, PLiteral(to,
    PArg(IntArg, PNil)))) , <function1>)
```

```
scala> route.dispatch(Request("/add/123/to/234"))
```



*Try it!*

```
bash$ cd 4-routes
bash$ ./sbt console
```

...

```
scala> val route = path >> fn
route: Route[path.Result] =
  Route(PLiteral(add,PArg(IntArg,PLiteral(to,
    PArg(IntArg,PNil)))),<function1>)
```

```
scala> route.dispatch(Request("/add/123/to/234"))
res0: Option[Response] = Some(Response("123 + 234 = 357"))
```

```
scala>
```



*Try it!*

```
bash$ cd 4-routes
bash$ ./sbt console
```

...

```
scala> val route = path >> fn
route: Route[path.Result] =
  Route(PLiteral(add, PArg(IntArg, PLiteral(to,
    PArg(IntArg, PNil))))), <function1>)
```

```
scala> route.dispatch(Request("/add/123/to/234"))
res0: Option[Response] = Some(Response("123 + 234 = 357"))
```

```
scala> route.dispatch(Request("/add/abc/to/234"))
```



*Try it!*

```
bash$ cd 4-routes
bash$ ./sbt console
```

...

```
scala> val route = path >> fn
route: Route[path.Result] =
  Route(PLiteral(add, PArg(IntArg, PLiteral(to,
    PArg(IntArg, PNil)))) , <function1>)
```

```
scala> route.dispatch(Request("/add/123/to/234"))
res0: Option[Response] = Some(Response("123 + 234 = 357"))
```

```
scala> route.dispatch(Request("/add/abc/to/234"))
res1: Option[Response] = None
```

```
bash$ cd 4-routes  
bash$ ./sbt console
```

...

```
scala>
```



*Try it!*

```
bash$ cd 4-routes  
bash$ ./sbt console
```

...

```
scala> route.url(HCons(123, HCons(234, HNil)))
```



*Try it!*





*Try it!*

```
bash$ cd 4-routes  
bash$ ./sbt console
```

...

```
scala> route.url(HCons(123, HCons(234, HNil)))  
res2: String = "/add/123/to/234"
```

```
scala>
```



*Try it!*

```
bash$ cd 4-routes
bash$ ./sbt console
```

...

```
scala> route.url(HCons(123, HCons(234, HNil)))
res2: String = "/add/123/to/234"
```

```
scala> route.apply(HCons(123, HCons(234, HNil)))
```



*Try it!*

```
bash$ cd 4-routes
bash$ ./sbt console
```

...

```
scala> route.url(HCons(123, HCons(234, HNil)))
res2: String = "/add/123/to/234"
```

```
scala> route.apply(HCons(123, HCons(234, HNil)))
res3: Response = Response("123 + 234 = 357")
```

```
scala>
```



*Try it!*

```
bash$ cd 4-routes
bash$ ./sbt console
```

...

```
scala> route.url(HCons(123, HCons(234, HNil)))
res2: String = "/add/123/to/234"
```

```
scala> route.apply(HCons(123, HCons(234, HNil)))
res3: Response = Response("123 + 234 = 357")
```

```
scala> route.url(HCons("123", HCons(234, HNil)))
```



*Try it!*

```
bash$ cd 4-routes
bash$ ./sbt console
```

...

```
scala> route.url(HCons(123, HCons(234, HNil)))
res2: String = "/add/123/to/234"
```

```
scala> route.apply(HCons(123, HCons(234, HNil)))
res3: Response = Response("123 + 234 = 357")
```

```
scala> route.url(HCons("123", HCons(234, HNil)))
<console>:13: error: type mismatch;
 found   : String("123")
 required: Int
      route.url(HCons("123", HCons(234, HNil)))
                        ^
```



Q: How can we call a function and pass it the typed data we have extracted from a URL?




**Q:** How can we call a function and pass it the typed data we have extracted from a URL?

**A:** By constructing a **Route** that combines a Path and a Function of corresponding types







Q: How can we use the contents of a URL to choose which Route we should take?

```
trait Site {  
  
  var routes: List[Route[_]] = Nil  
  
  def addRoute(route: Route[_]): Unit =  
    routes = routes :+ route  
  
  def dispatch(req: Request): Option[Response] =  
    dispatch(req, routes)  
  
  private def dispatch(req: Request, routes: List[Route[_]]) =  
    routes match {  
      case Nil => None  
      case head :: tail =>  
        head.dispatch(req).orElse(dispatch(req, tail))  
    }  
  
}
```

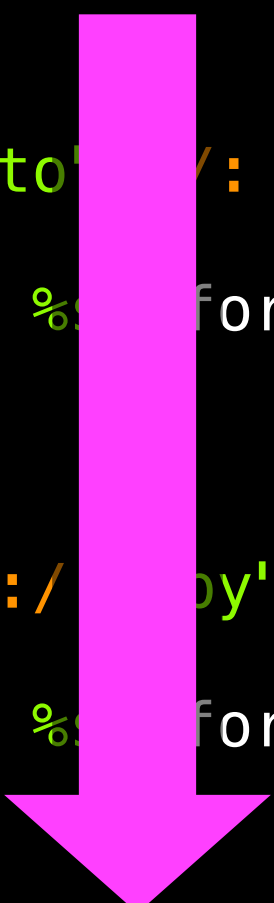
```
trait Site {  
  
  var routes: List[Route[_]] = Nil  
  
  def addRoute(route: Route[_]): Unit =  
    routes = routes :+ route  
  
  def dispatch(req: Request): Option[Response] =  
    dispatch(req, routes)  
  
  private def dispatch(req: Request, routes: List[Route[_]]) =  
    routes match {  
      case Nil => None  
      case head :: tail =>  
        head.dispatch(req).orElse(dispatch(req, tail))  
    }  
  
}
```

```
trait Site {  
  
  var routes: List[Route[_]] = Nil  
  
  def addRoute(route: Route[_]): Unit =  
    routes = routes :+ route  
  
  def dispatch(req: Request): Option[Response] =  
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      case head :: tail =>  
        head.dispatch(req).orElse(dispatch(req, tail))  
    }  
  
}
```

```
object Calculator extends Site {  
  
  val add =  
    ("add" :: IntArg :: "to" :: IntArg :: PNil) >> {  
      (a: Int, b: Int) =>  
        Response("%s + %s = %s".format(a, b, a + b))  
    }  
  
  val multiply =  
    ("multiply" :: IntArg :: "by" :: IntArg :: PNil) >> {  
      (a: Int, b: Int) =>  
        Response("%s * %s = %s".format(a, b, a * b))  
    }  
  
}
```

```
object Calculator extends Site {  
  val add =  
    ("add" :: IntArg :: "total" :: IntArg :: PNil) >> {  
      (a: Int, b: Int) =>  
        Response("%s + %s = %s" format(a, b, a + b))  
    }  
  
  val multiply =  
    ("multiply" :: IntArg :: "multiply" :: IntArg :: PNil) >> {  
      (a: Int, b: Int) =>  
        Response("%s * %s = %s" format(a, b, a * b))  
    }  
}
```



```
trait Site {  
  
  var routes: List[Route[_]] = Nil  
  
  def addRoute(route: Route[_]): Unit =  
    routes = routes :+ route  
  
  def dispatch(req: Request): Option[Response] =  
    dispatch(req, routes)  
  
  private def dispatch(req: Request, routes: List[Route[_]]) =  
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        dispatch(req, routes)  
  
    private def dispatch(req: Request, routes: List[Route[_]]) =  
        routes match {  
            case Nil => None  
            case head :: tail =>  
                head.dispatch(req).orElse(dispatch(req, tail))  
        }  
}
```

```
class Route[Res <: HList](  
  val path: Path { type Result = Res },  
  val fn: (Res) => Response  
) {  
  
  def dispatch(req: Request): Option[Response] =  
    path.decode(req.path).map(fn)  
  
  def url(arg: Res) =  
    path.encode(arg).mkString("/", "/", "")  
  
  def apply(arg: Res) =  
    fn.apply(arg)  
  
}
```

```
class Route[Res <: HList](  
    val path: Path { type Result = Res },  
    val fn: (Res) => Response  
) {  
  
    def dispatch(req: Request): Option[Response] =  
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class Route[Res <: HList](  
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  val path: Path { type Result = Res },  
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) {  
  
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    path.decode(req.path).map(fn)  
  
  def url(arg: Res) =  
    path.encode(arg).mkString("/", "/", "")  
  
  def apply(arg: Res) =  
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) {  
  
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  def url(arg: Res) =  
    path.encode(arg).mkString("/", "/", "")  
  
  def apply(arg: Res) =  
    fn.apply(arg)  
  
}
```

```
class Route[Res <: HList](  
  val site: Site,  
  val path: Path { type Result = Res },  
  val fn: (Res) => Response  
) {  
  
  site.addRoute(this)  
  
  def dispatch(req: Request): Option[Response] =  
    path.decode(req.path).map(fn)  
  
  def url(arg: Res) =  
    path.encode(arg).mkString("/", "/", "")  
  
  def apply(arg: Res) =  
    fn.apply(arg)  
  
}
```

```
trait Path {  
  type Result <: HList  
  
  def decode(path: List[String]): Option[Result]  
  def encode(args: Result): List[String]  
  
  def >>(fn: (Result) => Response): Route[Result] =  
    new Route(this, fn)  
}
```

```
trait Path {  
  type Result <: HList  
  
  def decode(path: List[String]): Option[Result]  
  def encode(args: Result): List[String]  
  
  def >>(fn: (Result) => Response) :  
    Route[Result] =  
    new Route(this, fn)  
}
```



```
trait Path {  
    type Result <: HList  
  
    def decode(path: List[String]): Option[Result]  
    def encode(args: Result): List[String]  
  
    def >>(fn: (Result) => Response)(implicit site: Site):  
        Route[Result] =  
        new Route(this, fn)  
  
}
```

```
trait Site {  
  
  var routes: List[Route[_]] = Nil  
  
  def addRoute(route: Route[_]): Unit =  
    routes = routes :+ route  
  
  def dispatch(req: Request): Option[Response] =  
    dispatch(req, routes)  
  
  private def dispatch(req: Request, routes: List[Route[_]]) =  
    routes match {  
      case Nil => None  
      case head :: tail =>  
        head.dispatch(req).orElse(dispatch(req, tail))  
    }  
  
}
```

```
trait Site {  
    implicit val site: Site = this  
  
    var routes: List[Route[_]] = Nil  
  
    def addRoute(route: Route[_]): Unit =  
        routes = routes :+ route  
  
    def dispatch(req: Request): Option[Response] =  
        dispatch(req, routes)  
  
    private def dispatch(req: Request, routes: List[Route[_]]) =  
        routes match {  
            case Nil => None  
            case head :: tail =>  
                head.dispatch(req).orElse(dispatch(req, tail))  
        }  
}
```

```

object Calculator extends Site {

  val add =
    ("add" :: IntArg :: "to" :: IntArg :: PNil) >> {
      (args: HCons[Int, HCons[Int, HNil]]) =>
        val a = args.head
        val b = args.tail.head
        Response("%s + %s = %s".format(a, b, a + b))
    }

  val repeat =
    ("repeat" :: StringArg :: IntArg :: "times" :: PNil) >> {
      (args: HCons[String, HCons[Int, HNil]]) =>
        val a = args.head
        val b = args.tail.head
        Response("%s * %s = %s".format(a, b, a * b))
    }

}

```

```
Calculator.add.url(1 :: 2 :: HNil) // => "/add/1/to/2"
```

```
Calculator.repeat("abc" :: 2 :: HNil) // => Response("...")
```

```

object Calculator extends Site {

  val add =
    ("add" :: IntArg :: "to" :: IntArg :: PNil) >> {
      (args: HCons[Int, HCons[Int, HNil]]) =>
        val a = args.head
        val b = args.tail.head
        Response("%s + %s = %s".format(a, b, a + b))
    }(site)

  val repeat =
    ("repeat" :: StringArg :: IntArg :: "times" :: PNil) >> {
      (args: HCons[String, HCons[Int, HNil]]) =>
        val a = args.head
        val b = args.tail.head
        Response("%s * %s = %s".format(a, b, a * b))
    }(site)

}

```

```

Calculator.add.url(1 :: 2 :: HNil) // => "/add/1/to/2"

```

```

Calculator.repeat("abc" :: 2 :: HNil) // => Response("...")

```

```

object Calculator extends Site {

  val add =
    ("add" :: IntArg :: "to" :: IntArg :: PNil) >> {
      (args: HCons[Int, HCons[Int, HNil]]) =>
        val a = args.head
        val b = args.tail.head
        Response("%s + %s = %s".format(a, b, a + b))
    }

  val repeat =
    ("repeat" :: StringArg :: IntArg :: "times" :: PNil) >> {
      (args: HCons[String, HCons[Int, HNil]]) =>
        val a = args.head
        val b = args.tail.head
        Response("%s * %s = %s".format(a, b, a * b))
    }

}

```

```
Calculator.add.url(1 :: 2 :: HNil) // => "/add/1/to/2"
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```
Calculator.repeat("abc" :: 2 :: HNil) // => Response("...")
```

```

object Calculator extends Site {

  val add =
    ("add" :: IntArg :: "to" :: IntArg :: PNil) >> {
      (args: HCons[Int, HCons[Int, HNil]]) =>
        val a = args.head
        val b = args.tail.head
        Response("%s + %s = %s".format(a, b, a + b))
    }

  val repeat =
    ("repeat" :: StringArg :: IntArg :: "times" :: PNil) >> {
      (args: HCons[String, HCons[Int, HNil]]) =>
        val a = args.head
        val b = args.tail.head
        Response("%s * %s = %s".format(a, b, a * b))
    }

}

```

```


Calculator.add.url(1 :: 2 :: HNil) // => "/add/1/to/2"

```

```

Calculator.repeat("abc" :: 2 :: HNil) // => Response("...")

```



Q: How can we use the contents of a URL to choose which Route we should take?





**Q:** How can we use the contents of a URL to choose which Route we should take?

**A:** By registering several Route with a **Site**  
(and using implicits to paper over the cracks)


# talk plan

1. path segments
2. whole-path representations
3. whole-path transformations
- 4. binding paths to code**
5. making it pretty!

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Q: How can we save the application programmer from dealing with HLists?

```

object Calculator extends Site {

  val add =
    ("add" :: IntArg :: "to" :: IntArg :: PNil) >> {
      (args: HCons[Int, HCons[Int, HNil]]) =>
        val a = args.head
        val b = args.tail.head
        Response("%s + %s = %s".format(a, b, a + b))
    }

  val repeat =
    ("repeat" :: StringArg :: IntArg :: "times" :: PNil) >> {
      (args: HCons[String, HCons[Int, HNil]]) =>
        val a = args.head
        val b = args.tail.head
        Response("%s * %s = %s".format(a, b, a * b))
    }

}

```

Calculator.add.url(1 :: 2 :: HNil) // => "/add/1/to/2"

Calculator.repeat("abc" :: 2 :: HNil) // => Response("...")

```

object Calculator extends Site {

  val add =
    ("add" :: IntArg :: "to" :: IntArg :: PNil) >> {
      (a: Int, b: Int) =>
        Response("%s + %s = %s".format(a, b, a + b))
    }

  val repeat =
    ("repeat" :: StringArg :: IntArg :: "times" :: PNil) >> {
      (a: String, b: Int) =>
        Response("%s * %s = %s".format(a, b, a * b))
    }

}

```

```
Calculator.add.url(1, 2)           // => "/add/1/to/2"
```

```
Calculator.repeat("abc", 2)       // => Response("...")
```



Q: How can we save the application programmer from dealing with HLists?





**Q:** How can we save the application programmer from dealing with HLists?

**A:** Through judicious use of pimping and implicits...  
(check the example *6-implicits* for details)

```
class RouteN[A, B, ...] extends Route {  
  def url(a: A, b: B, ...) =  
    path.encode(a :: b :: HNil).mkString("/", "/", "")  
  
  def apply(a: A, b: B, ...) =  
    fn.apply(arg)  
}
```

```
class RouteN[A, B, ...] extends Route {  
  def url(a: A, b: B, ...) =  
    path.encode(a :: b :: HNil).mkString("/", "/", "")  
  
  def apply(a: A, b: B, ...) =  
    fn.apply(arg)  
}
```

```
case class Route0 // ...
```

```
case class Route1[A] // ...
```

```
case class Route2[A, B] // ...
```

```
case class Route3[A, B, C] // ...
```

```
case class Route4[A, B, C, D] // ...
```

```
case class Route5[A, B, C, D, E] // ...
```

```
case class Route6[A, B, C, D, E, F] // ...
```

```
case class Route7[A, B, C, D, E, F, G] // ...
```

```
case class Route8[A, B, C, D, E, F, G, H] //
```

```
trait PimpedPath {  
  type Rt <: Route  
  def >>(fn: FunctionN)(implicit site: Site): Rt  
}
```

```
trait PimpedPath {  
  type Rt <: Route  
  def >>(fn: FunctionN)(implicit site: Site): Rt  
}  
  
implicit def pimpPath0[... ] // ...  
implicit def pimpPath1[A](... ) // ...  
implicit def pimpPath2[A, B](... ) // ...  
implicit def pimpPath3[A, B, C](... ) // ...  
implicit def pimpPath4[A, B, C, D](... ) // ...  
implicit def pimpPath5[A, B, C, D, E](... ) // ...  
implicit def pimpPath6[A, B, C, D, E, F](... ) // ...  
implicit def pimpPath7[A, B, C, D, E, F, G](... ) // ...  
implicit def pimpPath8[A, B, C, D, E, F, G, H](... ) // ...  
implicit def pimpPath9[A, B, C, D, E, F, G, H, I](... ) //
```

```

object Calculator extends Site {

  val add =
    ("add" :: IntArg :: "to" :: IntArg :: end) >> {
      (a: Int, b: Int) =>
        Response("%s + %s = %s".format(a, b, a + b))
    }

  val repeat =
    ("repeat" :: StringArg :: IntArg :: "times" :: end) >> {
      (a: String, b: Int) =>
        Response("%s * %s = %s".format(a, b, a * b))
    }

}

```

Calculator.add.url(1, 2) // => "/add/1/to/2"

Calculator.repeat("abc", 2) // => Response("...")

```
bash$ cd 6-implicits  
bash$ ./sbt test
```

...



*Try it!*

```
bash$ cd 7-lift-app
```

```
bash$ ./sbt jetty-run ~prepare-webapp
```



*Try it!*



```
bash$ cd 7-lift-app
bash$ ./sbt jetty-run ~prepare-webapp
```

*Try it!*



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extensions

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l.rest arguments     /append/a/b/c/...

# extensions

1. rest arguments      /append/a/b/c/...

2. request parameters      ?a=b

# extensions

1. rest arguments     `/append/a/b/c/...`

2. request parameters     `?a=b`

3. generating full links to routes

```
<a href="/foo" title="">...</a>
```

# extensions

1. rest arguments     `/append/a/b/c/...`

2. request parameters     `?a=b`

3. generating full links to routes

```
<a href="/foo" title="">...</a>
```

4. route-level access control



references

# references

## **Original paper on HLists in Haskell:**

Oleg Kiselyov, Ralf Lämmel, and Kean Schupke

*Strongly Typed Heterogenous Collections*

<http://homepages.cwi.nl/~ralf/HList/>

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## **Awesome blog posts on Type-Level Programming and HLists in Scala:**

Mark Harrah

*Type-level programming in Scala*

<http://apocalisp.wordpress.com/2010/06/08/type-level-programming-in-scala>

# references

The delectable term “pimping” (applied to Scala):

Martin Odersky

*Pimp my Library*

<http://www.artima.com/weblogs/viewpost.jsp?thread=179766>

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<http://www.artima.com/weblogs/viewpost.jsp?thread=179766>

**Everything we’ve covered here (and more) but written in Racket:**

Dave Gurnell

*Dispatch.PLT: Binding URLs to Procedures*

[http://planet.racket-lang.org/package-source/untyped/dispatch.plt/2/1/ ...](http://planet.racket-lang.org/package-source/untyped/dispatch.plt/2/1/...)  
... planet-docs/dispatch/index.html

# get in touch

Slides, nodes, and code samples

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