Scala Polymorphism: Object-oriented vs Implicit

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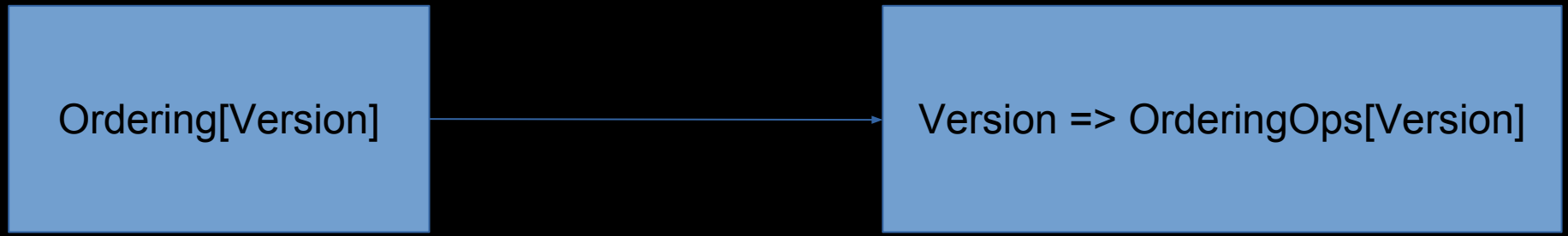
```
trait Ordering[T] {
  def compare(a: T, b: T): Int
}
```

```
case class Version( major: Int, minor: Int, patch: Int ) {
  override def toString: String = s”v$major.$minor.$patch”
}
```

```
object Version {
  implicit val ord = new Ordering[Version] {

    def compare(a: Instant, b: Instant): Int = {
      val diff1 = a.major – b.major

      if( diff1.isZero ) {
        val diff2 = a.minor – b.minor

        if( diff2.isZero ) a.patch – b.patch
        else diff2
      } else diff1
    }
  }
}
```

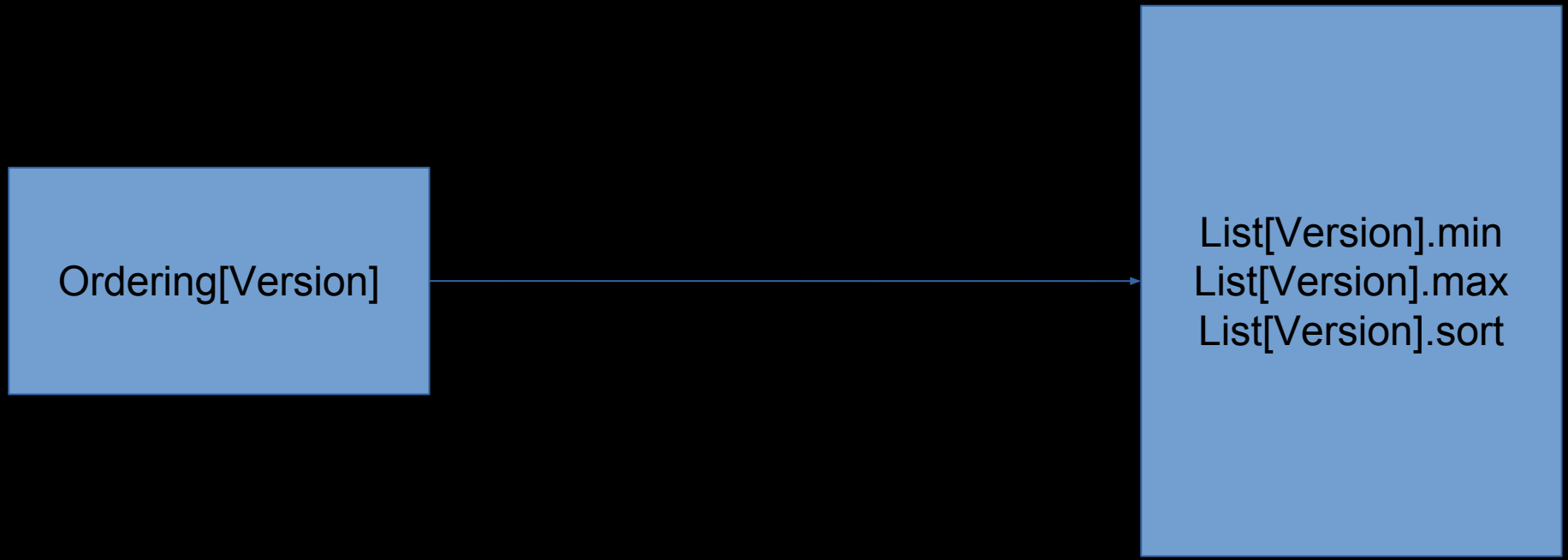
```
implicit class OrderingOps[T](a: T)(implicit ord: Ordering[T]) {

  def >(b: T): Boolean = ord.compare(a, b).isPositive

  def <(b: T): Boolean = ord.compare(a, b).isNegative

  def >=(b: T): Boolean = !ord.compare(a, b).isNegative

  def <=(b: T): Boolean = !ord.compare(a, b).isPositive

  def max(b: T): T = if( >(b) ) a else b

  def min(b: T): T = if( <(b) ) a else b
}
```


Ordering[Version]
Version => OrderingOps[Version]

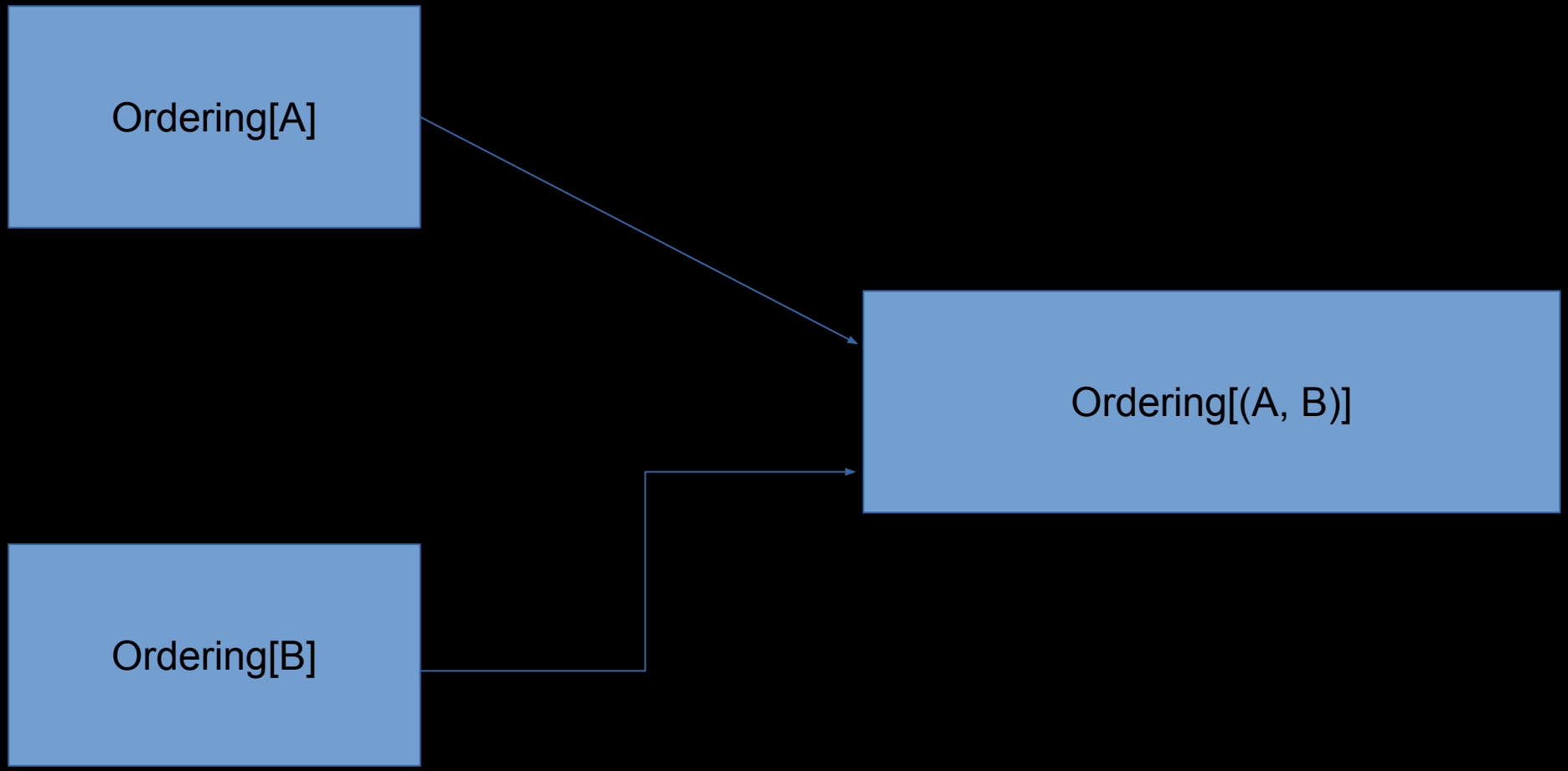
```
> Version(11,2,3) > Version(3,2,1)
true

> Version(3,2,3) < Version(3,2,1)
false

> Version(11,2,3) >= Version(3,2,1)
false

> Version(11,2,3) <= Version(3,2,1)
true

> Version(11,2,3) max Version(3,2,1)
”v11.2.3”

> Version(11,2,3) min Version(3,2,1)
”v3.2.1”
```

```
sealed abstract class List[T] {
  def min(implicit ord: Ordering[T]): T
  def max(implicit ord: Ordering[T]): T

  def sort(implicit ord: Ordering[T]): List[T]
}
```

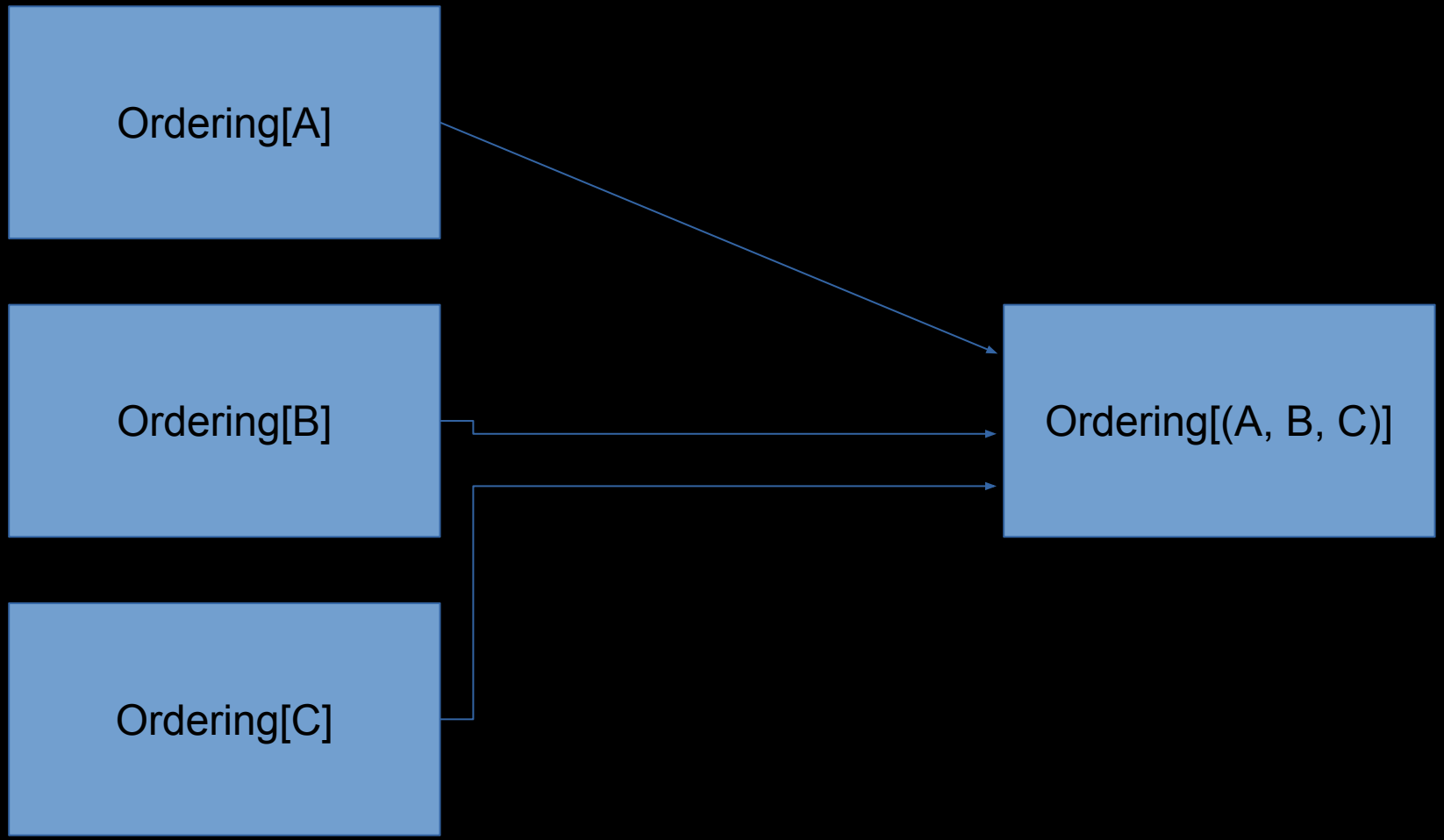
```
case class Cons[T](head: T, tail: List[T]) extends List[T] {
  def min(implicit ord: Ordering[Nothing]): T =
    tail.fold(head)(_ min _)

  def max(implicit ord: Ordering[Nothing]): T =
    tail.fold(head)(_ max _)

  def sort(implicit ord: Ordering[T]): List[T] = {
    val (smalls, bigs) = tail.partition(_ < head)
    smalls.sort ++ List(head) ++ bigs.sort
  }
}

case object Nil extends List[Nothing] {
  def min(implicit ord: Ordering[Nothing]): Nothing =
    throw new NoSuchElementException("Cannot find minimum of empty List.")
  def max(implicit ord: Ordering[Nothing]): Nothing =
    throw new NoSuchElementException("Cannot find maximum of empty List.")

  def sort(implicit ord: Ordering[Nothing]): List[Nothing] = Nil
}
```


Ordering[Version]
List[Version].min
List[Version].max
List[Version].sort

```
> val versions = List( Version(11,2,3), Version(3,2,1), Version(1,22,3) )

> versions.min
v1.22.3

> versions.max
v11.2.3

> versions.sort
List(v1.22.3, v3.2.1, v11.2.3)
```


Ordering[A]
Ordering[B]
Ordering[(A, B)]

```
implicit def orderingPair[A, B](implicit
  ordA: Ordering[A],
  ordB: Ordering[B]
): Ordering[(A, B)] = new Ordering {

  def compare(lhs: (A, B), rhs: (A,B)): Int = {
    val diff = ordA.compare( lhs._1, rhs._1 )

    if( diff.isZero ) ordB.compare( lhs._2, rhs._2 )
    else diff
  }
}
```


Ordering[A]
Ordering[B]
Ordering[C]
Ordering[(A, B, C)]

```
object Ordering {
  def by[A, B](f: A => B)(implicit ord: Ordering[B]): Ordering[A] =
    new Ordering {
      def compare(lhs: A, rhs: A): Int =
        ord.compare( f(lhs), f(rhs) )
    }
}
```

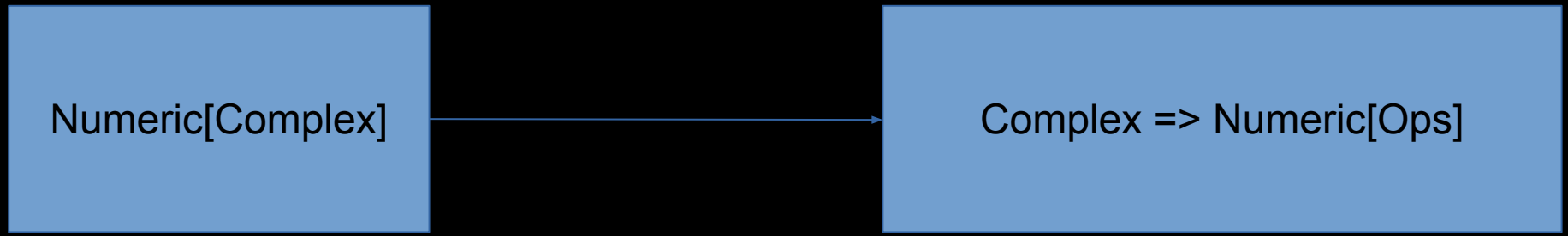
```
object Version {
  implicit val ord = Ordering by unapply
}
```

```
trait Numeric[N] {
  def add(a: N, b: N): N
  def substract(a: N, b: N): N
  def multiply(a: N, b: N): N
  def divide(a: N, b: N): N

  def zero: N
  def unit: N
}
```

```
case class Complex( re: Double, im: Double ) {

  override def toString: String = {
    val sign = if (im.isNegative) “” else “+”
    s”$re$sign{$im}i”
  }
}
```

```
object Complex {
  implicit num = new Numeric {

    def add(a: Complex, b: Complex): Complex = Complex( a.re + b.re, a.im + b.im)

    def substract(a: Complex, b: Complex): Complex = Complex( a.re - b.re, a.im - b.im)

    def multiply(a: Complex, b: Complex): Complex = Complex(
      re = a.re * b.re - a.im * b.im,
      im = a.re * b.im + a.im * b.re
    )

    def divide(a: Complex, b: Complex): Complex = {
      val abs = b.re * b.re + b.im * b.im
      Complex(
        (a.im * b.im - a.re * b.re) / abs,
        (a.re * b.im + a.im * b.re) / abs
      )
    }

    def zero: Complex = Complex(0, 0)
    def unit: Complex = Complex(1, 0)
  }
}
```

```
implicit class NumericOps[N](a: N)(implicit num: Ordering[N]) {

  def +(b: N): Boolean = num.add(a, b)

  def -(b: N): Boolean = num.subtract(a, b)

  def *(b: N): Boolean = num.multiply(a, b)

  def /(b: N): Boolean = num.divide(a, b)
}
```

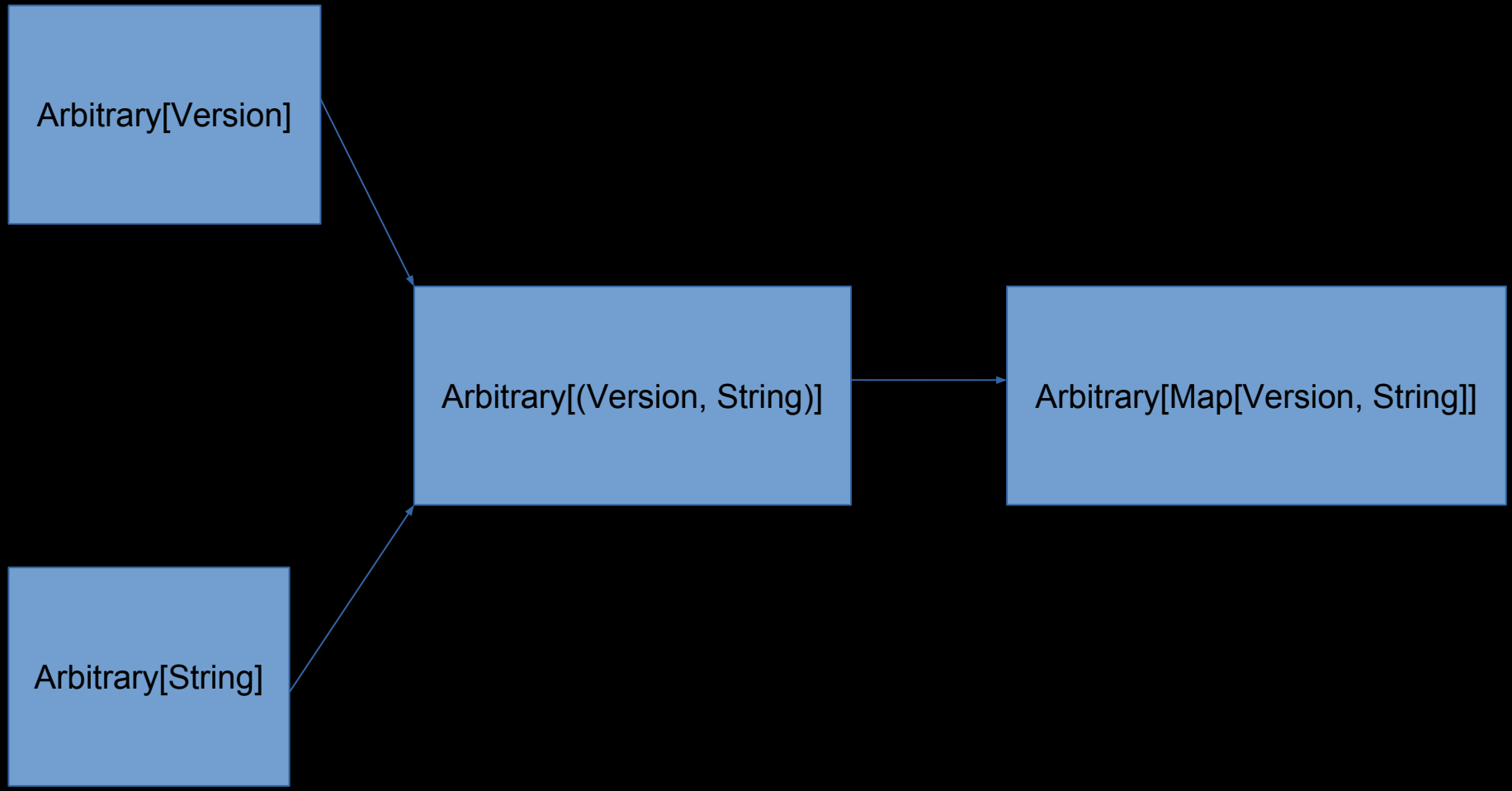

Numeric[Complex]
Complex => Numeric[Ops]

```
> Complex(11,2) + Complex(3,2)
14+4i

> Complex(3,2) - Complex(3,2)
0+0i

> Complex(3,4) * Complex(4,3)
25+0i

> Complex(4,-3) / Complex(3,4)
0-1i
```

```
sealed abstract class List[T] {

  def sum(implicit num: Numeric[T]): T = fold(num.zero)(_ + _)

  def prod(implicit num: Numeric[T]): T = fold(num.unit)(_ * _)
}
```

```
> val nums = List( Complex(3,4), Complex(4,3), Complex(0,0.2) )

> nums.sum
7+7.2i

> nums.prod
0+5i
```

```
trait Arbitrary[T] {
  val gen: Gen[T]
}
```


Arbitrary[Version]
Arbitrary[String]
Arbitrary[(Version, String)]
Arbitrary[Map[Version, String]]