Optics Introduction

Lens => Product Type

```
trait Lens[S, A]{

  def get(s: S): A

  def set(a: A)(s: S): S

  def modify(f: A => A)(s: S): S

  def compose[B](other: Lens[A, B]): Lens[S, B]
}
```

Lens Laws

```
∀ s: S          => set(get(s))(s) == s

∀ s: S, a: A    => get(set(a)(s)) == a

∀ s: S, a: A    => set(s)(set(a)(s)) == set(a)(s)

∀ s: S          => modify(id)(s)  == s
```

Nested case class with std Scala

```
case class AppConfig(switches: Switches, client: ClientConfig)
case class Switches(useFeature1: Boolean, useFeature2: Boolean)
case class ClientConfig(endPoint: EndPointConfig, appId: String)
case class EndPointConfig(protocol: String, host: String, port: Int)

val config: AppConfig = ...

config.client.endpoint.port // 8080

config.copy(
  client = config.client.copy(
    endpoint = config.client.endpoint.copy(
      port = 5000
    )
  )
)
```

Nested case class with Monocle

```
import monocle.macro.Lenses
@Lenses case class AppConfig(client: ClientConfig, switches: Switches)
...

import AppConfig._, Switches._, ClientConfig._, EndPointConfig._
val newConfig = (client compose endPoint compose port).set(9999)(config)


(client compose endPoint compose port).get(newConfig) // 9999
```

More powerful Lens examples

```
def toggleFeature1(config: AppConfig): AppConfig =
  config.copy(
    switches = config.switches.copy(
      useFeature1 = ! config.swicthes.useFeature1
    )
  )

def toggle(feature: Lens[Switches, Boolean]): AppConfig => AppConfig =
  (switches compose feature).modify(b => ! b)

toggle(useFeature1)(config)

val toggleAllFeatures: AppConfig => AppConfig =
  toggle(useFeature1) . toggle(useFeature2)

toggleAllFeatures(config)
```

Lens Limitations

```
type Option[A] = Some[A](value: A) | None

def some[A]: Lens[Option[A], A] = ???

some.get(None) = ???
```

```
type Json = JsNumber(d: Double) | JsBool(b: Boolean) | ...
```

Prism => Sum Type

```
trait Prism[S, A]{

  def getOption(s: S): Option[A]

  def reverseGet(a: A): S

  def modify(f: A => A)(s: S): S

  def compose[B](other: Prism[A, B]): Prism[S, B]
}
```

Prism Laws

```
∀ a: A => getOption(reverseGet(a)) == Some(a)

∀ s: S => getOption(s).map{
    case Some(a) => reverseGet(a) == s
    case None    => true
 }

∀ s: S          => modify(id)(s)  == s
```

Laws => Automatic Testing

```
∀ s: S => getOption(s).map{
   case Some(a) => reverseGet(a) == s
   case None    => true
 }

val stringToInt = Prism[String, Int](s => Try(s.toInt).toOption)(_.toString)

stringToInt.getOption("12345")  == Some(12345)
stringToInt.getOption("-12345") == Some(-12345)
stringToInt.getOption("hello")  == None
stringToInt.getOption("99999999999999999") == None

stringToInt.modify(_ * 2)("1234") == "2468"
```

Laws => Automatic Testing

```
stringToInt.getOption("๙") == Some(9) // WTF???
```

Prism Examples

```
def cons[A] = Prism[List[A], (A, List[A])]{
  case Nil      => None
  case x :: xs => Some((x, xs))
}{ case (h, t) => h :: t }

cons.getOption(List(1,2,3)) == Some((1, List(2, 3)))
cons.getOption(Nil)          == None

cons.reverseGet((0, List(1, 2))) == List(0, 1, 2)
```

Prism Examples

```
def some[A] = Prism[Option[A], A](identity)(Some(_))

some.getOption(Some(3)) == Some(3)
some.getOption(None)    == None

some.reverseGet(3) == Some(3)

some.modify(_ + 1)(Some(3)) == Some(4)
some.modify(_ + 1)(None)    == None
```

Prism Limitations

```
val l: List[Char] = List('a', 'b', 'c')

def index[A](i: Int): Prism[List[A], A] = ???

index(1).getOption(l) == Some('b')
index(9).getOption(l) == None

index(2).set('l')(l) == List('a', 'b', 'l')

index(1).reverseGet('b') == ???
```

Optics Composition

```
 Lens[S, A] compose Prism[A, B] = ???[S, B]
Prism[S, A] compose  Lens[A, B] = ???[S, B]

val example = Person("John", 25, Some("john@gmail.com"))

val email: Lens[Person, Option[String]] = ...

(email compose some): ???[Person, String]
```

Optional

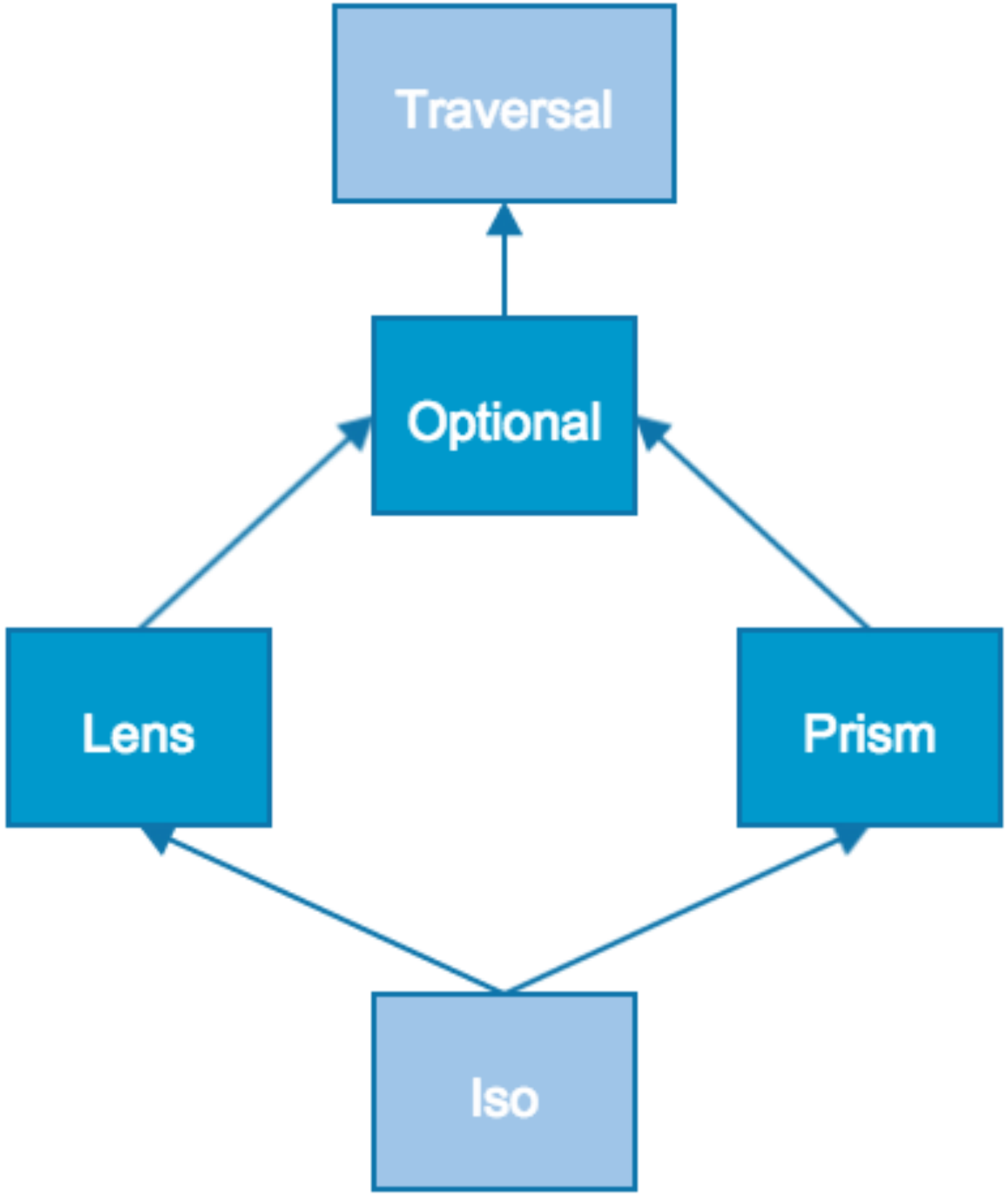
```
trait Optional[S, A]{

  def getOption(s: S): Option[A]

  def set(a: A)(s: S): S

  def modify(f: A => A)(s: S): S

  def compose[B](other: Optional[A, B]): Optional[S, B]
  def compose[B](other:     Lens[A, B]): Optional[S, B]
  def compose[B](other:    Prism[A, B]): Optional[S, B]
}
```


Traversal
Optional
Lens
Prism
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Optional Laws

```
∀ s: S => getOption(s).map{
   case Some(a) => set(a)(s) == s
   case None    => true
 }
∀ s: S => getOption(set(a)(s)) == getOption(s).map(_ => a)

∀ s: S, a: A  => set(set(a)(s), s) == set a s
∀ s: S        => modify(id)(s)  == s
```

Json Example

```
sealed trait Json
case class JsNumber(value: Double)                extends Json
case class JsString(value: String)                extends Json
case class JsArray(value: List[Json])             extends Json
case class JsObject(value: Map[String, Json]) extends Json

val jsNumber: Prism[Json, Double] = ...
val jsArray : Prism[Json, List[Json]] = ...
```

Json Example

```
val json: Json = JsObject(Map(
  "first_name" -> JsString("John"),
  "last_name"  -> JsString("Doe"),
  "age"        -> JsNumber(26),
  "siblings"   -> JsArray(List(
    JsObject(Map(
      "first_name" -> JsString("Zoe"),
      "age"        -> JsNumber(21)
    )),
    JsObject(Map(
      "first_name" -> JsString("Bill"),
      "age"        -> JsNumber(23)
    ))
  ))
))
```

Json Example

```
import monocle.function._

(jsObject compose index("first_name") compose jsString).getOption(json) == Some("John")

(jsObject
  compose index("siblings") compose jsArray
  compose index(1)          compose jsObject
  compose index("age")      compose jsNumber
).modify(_ + 1)(json)

(jsObject compose filterIndex(_.contains("name"))
          compose jsString
).modify(_.toLowerCase)(json)
```

Erratum

- Most Optics have 4 type parameters instead of 2 with "simple" type alias: Lens[S, A] == PLens[S, S, A, A]
- Type inference issues with compose forced us to create non overloaded compose versions: composeLens, composePrism, composeOptional ...
- Macros are awesome but IDE support is limited

Links

[1] Monocle github project

[2] Blog post explaining Lens implementation in Monocle

[3] Simon Peyton Jones presentation of Lens library at the London Scala exchange 2013

[4] Tony Morris history of Lenses history

[5] Edward Kmett video of how to use Lenses with State Monad