Gestion d’erreur fonctionnelle

AVEC SCALA ET CATS

Objectifs

Se simplifier l’existence avec la programmation fonctionnelle

En se basant sur des notions théoriques efficaces

Mais sans faire de la théorie

Pour le développement d’applications

En partant d’un niveau basique

Avec un cas réaliste et plutôt complexe à la fin

Scala en 3 slides (1)

```scala
abstract class Option[A]
case class Some[A](value: A) extends Option[A]
case class None[A]()         extends Option[A]

// data Option a = Some a | None

def maybeAnInt: Option[Int]    = ???
val something: Option[String] = Some("thing")

something match {
  case Some(x) => println(x)
  case None()  => println("nothing")
}
```

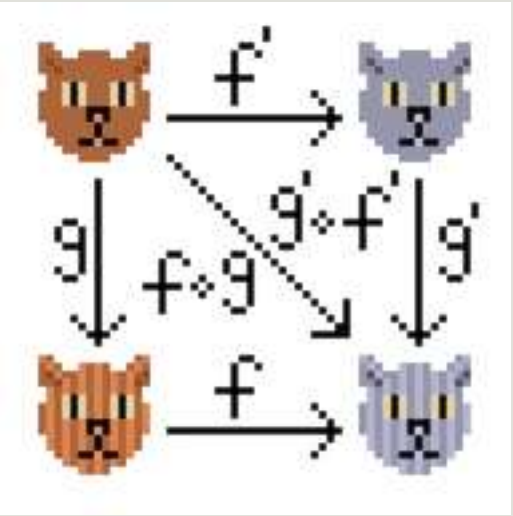
Scala en 3 slides (2)

```scala
def f(x: Int): String = ???

Some[Int](5).map(f) // => Some(f(5))
None.map(f)         // => None

def g(x: Int): Option[String] = ???

Some(3).map(g) : Option[Option[String]]

Some(4).flatMap(g) // => g(4)
None.flatMap(g)    // => None
```

Scala en 3 slides (3)

```scala
def f: Option[Int]              = ???
def g(x: Int): Option[String] = ???
def h(s: String): Double        = ???

val forComprehension: Option[Double] =
  for {
    x <- f
    y <- g(x)
  } yield h(y)

val desugared: Option[Double] =
  f.flatMap(x => g(x).map(y => h(y)))
```

cats



Projet Typelevel @ https://github.com/typelevel/cats

Abstractions « mathématiques »

Descend de Haskell

Ça fait un peu peur

On va le regarder comme un outil

```
import cats.data._
import cats.instances.all._
import cats.syntax.all._
```

Les erreurs dans une application

« Fail fast »

…Mais pas toujours 

Composition de plein de formats

- Exceptions
- null !
- Option
- Either
- Future

Option

```
case class User(name: String, address: Option[String])

def getUserById(id: Long): Option[User] = ???

def getUser1: Option[User] = Some(User("Thomas", Some("Lille")))

for {
  user    <- getUser1
  address <- user.address
} yield address

// Some("Lille")
```

Option (2)

```scala
case class User(name: String, address: Option[String])

def getUserById(id: Long): Option[User] = ???

def getUser2: Option[User] = Some(User("Other", None))

for {
  user    <- getUser2
  address <- user.address
} yield address

// None
```

Either

```scala
val anError: Either[String, Int]  = Left("OMG error!")
val aSuccess: Either[String, Int] = Right(1)

Some(12).toRight("Error message") // Right(12)
None.toRight("Error message")     // Left("error message")

Either.catchNonFatal(throw new Exception("!")) : Either[Throwable, Int]
```

Either

```scala
val anError: Either[String, Int]  = Left("OMG error!")
val aSuccess: Either[String, Int] = Right(1)

def f(x: Int): String = ???
aSuccess.map(f) // Right(f(1))        : Either[String, String]
anError.map(f)  // Left("OMG error!) : Either[String, String]

def g(x: Int): Either[String, String] = ???
aSuccess.flatMap(g) // g(1)
anError.flatMap(g)  // Left("OMG error!")
```

Either (fail-fast)

```scala
case class User(name: String, address: Option[String])

def getUser1: Option[User] = Some(User("Thomas", Some("Lille")))

for {
  user    <- getUser1.toRight("User 1 not found")
  address <- user.address.toRight("User 1 has no address")
} yield address

// Right("Lille")
```

Either (fail-fast)

```scala
case class User(name: String, address: Option[String])

def getUser2: Option[User] = Some(User("Other", None))

for {
  user    <- getUser2.toRight("User 2 not found")
  address <- user.address.toRight("User 2 has no address")
} yield address

// Left("User 2 has no address")
```

Either (formulaire)

```scala
case class Form(name: String, phone: String, email: String)

def validateName(name: String): Either[String, Unit]   = ???
def validatePhone(phone: String): Either[String, Unit] = ???
def validateEmail(email: String): Either[String, Unit] = ???

val form = Form("bad name", "bad phone", "bad email")

for {
  _ <- validateName(form.name)
  _ <- validatePhone(form.phone)
  _ <- validateEmail(form.email)
} yield form

// Left("bad name")
```

Validated

```scala
Validated.Valid("Some value")
Validated.Invalid("Some error")

"Some value".valid
"Some error".invalid

def f(x: Int): String = ???

13.valid.map(f)     // Valid(f(13))
"31".invalid.map(f) // Invalid("31")

// no flatMap

val anEither: Either[String, Int]       = Right(24)
val toValidated: Validated[String, Int] = anEither.toValidated
val backToEither: Either[String, Int]   = toValidated.toEither
```

Validated (formulaire)

```scala
case class Form(name: String, phone: String, email: String)

def validateName(name: String): Either[String, Unit]   = ???
def validatePhone(phone: String): Either[String, Unit] = ???
def validateEmail(email: String): Either[String, Unit] = ???

val form = Form("bad name", "bad phone", "bad email")

(validateName(form.name).toValidated |@|
  validateEmail(form.name).toValidated |@|
  validatePhone(form.phone).toValidated)
  .map((_, _, _) => form)
```

|@| - L'opérateur « cri »

```scala
def f : (Int, String) => Double = ???

(1.valid[String] |@| "foo".valid).map(f)      // Valid(f(1, "foo"))
("nope".invalid |@| "bar".valid).map(f)       // Invalid("nope")
(1.valid[String] |@| "nope".invalid).map(f)   // Invalid("nope")
("nope".invalid |@| "nope".invalid).map(f)    // Invalid("nopenope")

import cats.Cartesian._
map2(1.valid[String], "foo".valid)(f)
```

Validated (formulaire)

```scala
case class Form(name: String, phone: String, email: String)

def validateName(name: String): Either[String, Unit]   = ???
def validatePhone(phone: String): Either[String, Unit] = ???
def validateEmail(email: String): Either[String, Unit] = ???

val form = Form("bad name", "bad phone", "bad email")

(validateName(form.name).toValidated |@|
  validateEmail(form.name).toValidated |@|
  validatePhone(form.phone).toValidated)
  .map((_, _, _) => form)

// Invalid("bad namebad phonebad email")
```

Validated (formulaire bis)

```scala
val nonEmptyList = NonEmptyList("alice", List("bob"))

def anEither: Either[String, Int] = ???
anEither.toValidatedNel: Validated[NonEmptyList[String], Int]

val form = Form("bad name", "bad phone", "bad email")

(validateName(form.name).toValidatedNel |@|
  validateEmail(form.name).toValidatedNel |@|
  validatePhone(form.phone).toValidatedNel)
  .map((_, _, _) => form)

// Invalid(NonEmptyList("bad name", "bad phone", "bad email"))
```

Validated (formulaire ter)

```scala
val nonEmptyList = NonEmptyList("alice", List("bob"))

def anEither: Either[String, Int] = ???
anEither.toValidatedNel: Validated[NonEmptyList[String], Int]

val form = Form("bad name", "bad phone", "bad email")

validateName(form.name).toValidatedNel *>
  validateEmail(form.name).toValidatedNel *>
  validatePhone(form.phone).toValidatedNel *>
  form.validNel

// Invalid(NonEmptyList("bad name", "bad phone", "bad email"))
```

En pratique

Résultat : Either[Error, X]

- Error = String ou un type plus adapté

Enchaînement de

◦ Étapes pouvant échouer (X => Either[Error, Y])	flatMap
◦ Étapes « normales » (X => Y)	map

Mais aussi

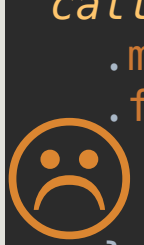
◦ Transformation de l'erreur (Error => String)	leftMap
◦ Récupération d'erreur (Error => X)	handleError
◦ … Pouvant à son tour échouer (Error => Either[Error, X])	handleErrorWith
◦ Appels asynchrones	…

Future (intro)

```scala
import scala.concurrent.Future
import scala.concurrent.ExecutionContext.Implicits.global

def f : Future[Int] = ??? // un Int, un jour, peut-être

f.map(x => x + 1) : Future[Int]

def g : Int => Future[String] = ???
f.flatMap(g) : Future[String]

f.onComplete(???)
import scala.concurrent.Await
import scala.concurrent.duration.Duration
Await.result(f, Duration.Inf)
```

Future et Either

```scala
import scala.concurrent.Future
import scala.concurrent.ExecutionContext.Implicits.global

def callHttpApi: Future[String]                          = ???
def uncertainComputation(s: String): Either[String, Int] = ???
def callOtherApi(x: Int): Future[Int]                    = ???
def composeUserMessage(x: Int): String                   = ???

callHttpApi
  .map(uncertainComputation)
  .flatMap {
    case Left(error)  => Future.successful(Left(error))
    case Right(value) => callOtherApi(value).map(Right(_))
  }
  .map(x => x.map(composeUserMessage))
```





EitherT

```scala
type Result[X] = Future[Either[String, X]]

// EitherT[Future, String, X]

val fromResult = EitherT(??? : Result[Int])
fromResult.value : Result[Int]

val successNow = EitherT.pure[Future, String, Int](4)
val eitherNow  = EitherT.fromEither[Future](Either.left("error"))

val successLater = EitherT.liftT[Future, String, Int](Future(5))
val errorAsLeft = Future.failed(new Exception("!")).attemptT.leftMap(_.toString)
// Left("java.lang.Exception: !") – succès immédiat
```

EitherT

```
def callHttpApi: Future[String]                          = ???
def uncertainComputation(s: String): Either[String, Int] = ???
def callOtherApi(x: Int): Future[Int]                    = ???
def composeUserMessage(x: Int): String                   = ???

for {
  step1 <- callHttpApi.attemptT.leftMap(_.toString)
  step2 <- EitherT.fromEither[Future](uncertainComputation(step1))
  step3 <- callOtherApi(step2).attemptT.leftMap(_.toString)
  step4 = composeUserMessage(step3)
} yield step4
```

Combinateurs

EitherT[Future, MyError, A]

Récupération d’erreurs

- attemptT : EitherT[Future, MyError, A]
- handleError(f : MyError => A)
- handleErrorWith(f : MyError => EitherT[Future, MyError, A])
- leftMap(f : MyError => String)

Transformations

- transform(Either[MyError, A] => Either[String, B]) : EitherT[Future, String, B]

Combinateurs

EitherT[Future, MyError, A]

Chainage

- flatMap(f : A => EitherT[Future, MyError, B])
- flatMapF(f : A => Future[Either[MyError, B]])
- subflatMap(f : A => Either[MyError, B])
- semiflatMap(f : A => Future[B])
- map(f: A => B)

Séquences :

- sequence : List[EitherT[Future, MyError, A]] => EitherT[Future, MyError, List[A]]
- traverse : List[A] => (A => EitherT[Future, MyError, B]) => EitherT[Future, MyError, List[B]]

Récap

On peut mixer gestion d’erreur et asynchronie et c’est à peu près confortable

Recommandations

Tout représenter comme EitherT

Toujours attemptT

Utiliser son propre type pour les erreurs

Références

Scala https://www.scala-lang.org

Cats https://github.com/typelevel/cats

Sources https://github.com/chwthewke/lillefp5

Inspirations <3

Eugene Yokota – herding cats, stacking Future and Either

http://eed3si9n.com/herding-cats/stacking-future-and-either.html

Brendan McAdams – A Skeptic's look into scalaz's gateway drugs

https://www.youtube.com/watch?v=BPYz19z_3s8

Daniela Sfregola – Easy and efficient data validation with cats

https://www.youtube.com/watch?v=OkTfcyFohS0