Parser combinators

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Avec des vrais morceaux de
functors, *applicative functors* et *monads*

Mais pas besoin de comprendre

Objectifs

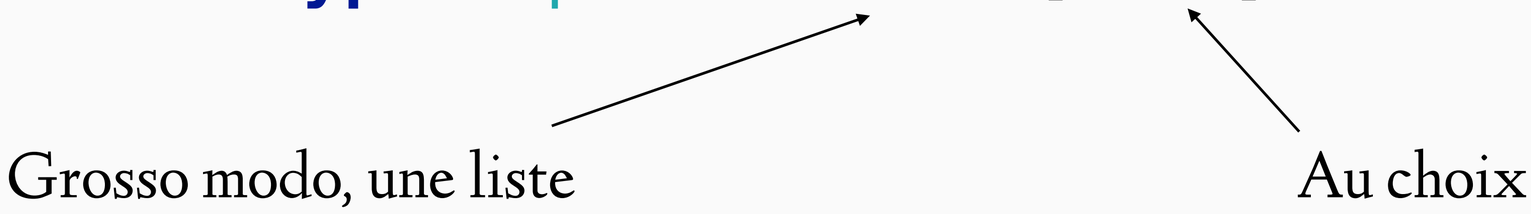
- Intro aux Parser Combinators
- Utilise *scala-parser-combinators*, mais pas spécifique
- Aller-retours explications/code
- Des ponts avec des concepts de théorie des catégories

`git clone` https://github.com/madjar/talk-scala-parser-combinators

So, what is a parser ?

```
abstract class Parser[+T] extends (Input => ParseResult[T])
```

```
type Input = Reader[Elem]
```



So, what is a parser ?

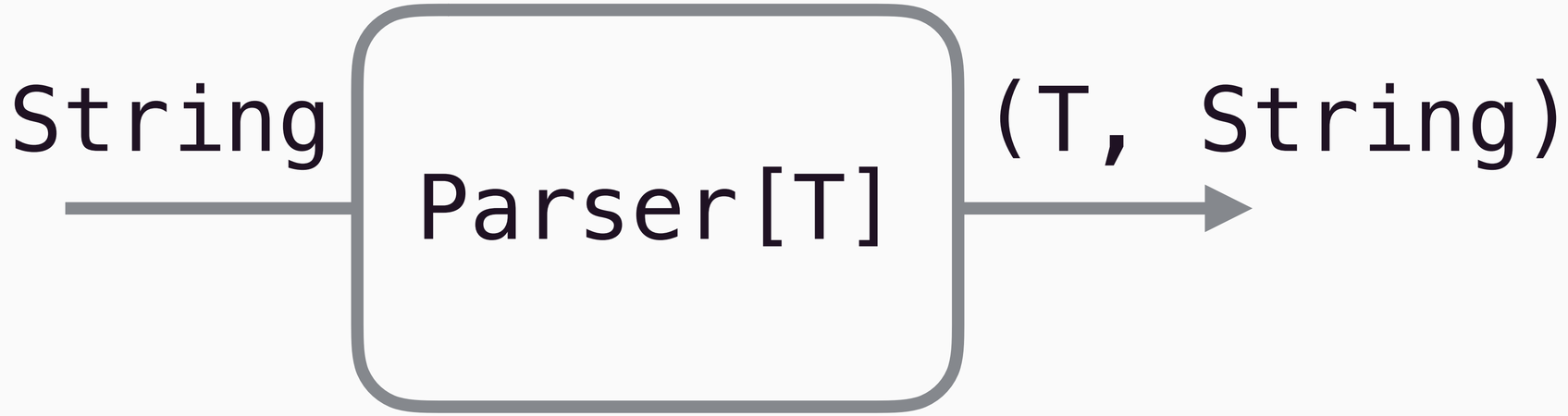
```
abstract class Parser[+T] extends (String => ParseResult[T])
```

Okay, so what is a parse result?

```
sealed abstract class ParseResult[+T]

case class Success[+T](result: T, override val next: Input)
  extends ParseResult[T]

case class Failure(val msg: String, override val next: Input)
  extends ParseResult[T]
```

When you remove the cruft

```
Parser[T] = String => Result[T]

Result[T] = Either[ ErrorMessage
                  , (T, String) ]
```



Parser[*T*] est un parseur qui renvoie un *T*

T est un paramètre de type

Parser est un type paramétrique

My first parser

```
object Hello extends Parsers {
  type Elem = Char
  def oneA = elem('a')
}
```

```
>>> val result = Hello.oneA(new CharSequenceReader("axa"))
>>> result.get
‘a’
>>> result.next
"xa"
```

My first parser (less tedious version)

```
object HelloRegex extends RegexParsers {
  def oneA = "a"
}
```

```
>>> val result = HelloRegex.parse(oneA, "axa")
>>> result.get
‘a’
>>> result.next
"xa"
```

So, how do I get a (primitive) parser?

```
implicit def accept  (e: Elem)   : Parser[Elem]
implicit def literal (s: String) : Parser[String]
implicit def regex   (r: Regex)  : Parser[String]
```

```
def acceptIf       (p: (Elem) ⇒ Boolean)         : Parser[Elem]
def acceptMatch[U] (f: PartialFunction[Elem, U]): Parser[U]
def acceptSeq      (es: Iterable[Elem])          : Parser[List[Elem]]
```

My first combinators

A combinator combines parsers to make parsers

```
Parser[T] ~> Parser[U]  =>  Parser[U]
Parser[T] <~ Parser[U]  =>  Parser[T]
```

```
def inParens = "[" ~> "[a-z]*".r <~ "]"
```

```
inParens("[lala]") == "lala"
```

Diviser pour mieux régner

Faire des petits parseurs

Les combiner pour en faire des plus gros

Exercice 1

```
Hello World   => World
Hello Georges => Georges
Goodbye World => FAIL
```

```
sbt "~testOnly Step1Spec"
```

Some nice combinators

Repetition

```
rep(Parser[T])   =>   Parser[List[T]]
```

```
   rep("l.".r).parse("lalalilo")
== List("la", "la", "li", "lo")
```

```
Variantes :   parser.* (ou parser*)
```

Some nice combinators

Repetition with a separator

```
repsep(Parser[T], Parser[Any])  =>  Parser[List[T]]
```

```
    repsep("l.".r, "->").parse("la->la->li->lo")
 == List("la", "la", "li", "lo")
```

Some nice combinators

Non-empty repetition

```
rep1(Parser[T])   =>   Parser[List[T]]
```

```
rep1sep(Parser[T], Parser[Any])  =>  Parser[List[T]]
```

Some nice combinators

Repeat N times

```
repN(Int, Parser[T])   =>   Parser[List[T]]
```

Exercice 2

csv parser !

```
sbt "~testOnly Step2Spec"
```

And if I don’t want a string ?

```
def number = """\d+""".r
```

```
scala> number("12345")
res0: String = 12345
```

That is not a number !

And if I don’t want a string ?

Apply a function to a Parser

```
Parser[T].map[U](f: (T) ⇒ U)    =>    Parser[U]
```

And if I don’t want a string ?

```
def number = """\d+""".r.map { x => x.toInt }

def number = """\d+""".r ^^ { x => x.toInt }
```

```
scala> number("12345")
res0: Int = 12345
```

map means *Functor*

map means *Functor*

Functor[A]
A => B

=> Functor[B]

map means *Functor*

Functor[A]
A => B
=> Functor[B]

Parser is a *Functor*

Choosing

Elevator instructions

```
((((()))))()(((((((((())))()(())))(()((((()(()((((()((()((((()(()()()()()
```

```
sealed trait Instruction
object Up extends Instruction
object Down extends Instruction
```

Choosing

```
def up   = "(".map(x => Up)
def down = ")" ^^^ Down
```

```
scala> up.parse("(")
res0: Instruction = Up
```

Choosing

```
Parser[T] | Parser[T]    =>    Parser[T]
```

```
def instruction = up | down
```

Choosing

```
def instruction = up | down
```

```
rep(instruction).parse("(((())))()(((((((()")
 == Seq(Up, Up, Up, Up, Down, Down, …)
```

Let's be recursive

Matching parenthesis

`(((toto)))` should be parsed as `toto`

`(toto` should fail

```
def matching: Parser[String] =
  "[a-z]*" | ("(" ~> matching <~ ")")
```

Making complex parsers

A date

```
2015-02-03   =>   LocalDate(2015, 2, 3)
```

Making complex parsers

```
Parser[T].tuple(Parser[U])    =>    Parser[(T, U)]
```

Warning: does not exist

Making complex parsers

```
"""\d{4}""".r.tuple("""\d{2}""".r.tuple("""\d{2}""".r))
  .map { case (y, (m, d)) => new LocalDate(y, m, d) }
```

Warning: does not exist

Applicative Functor

Applicative functors are *functors* for which there is also a *natural transformation* that preserve the *Cartesian product*

Applicative Functor, translated

Applicative functor

=

functor

+

some function that merges values in the functor

(Functor[A], Functor[B]) => Functor[(A, B)]

Some sugar on top

`(y, (m, d))` is ugly

Let's make a type `~[T, U]` with values `t ~ u`

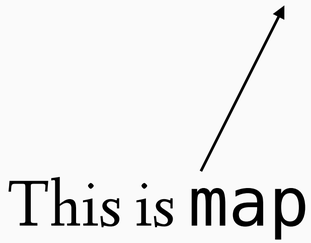
Now we can write `y ~ m ~ d`, and pattern match on it

Some sugar on top

```
Parser[T] ~ Parser[U]    =>    Parser[~[T, U]]
```

Some sugar on top

```
"""\d{4}""".r ~ """\d{2}""".r ~ """\d{2}""".r
  ^^ { case y ~ m ~ d => new LocalDate(y, m, d) }
```



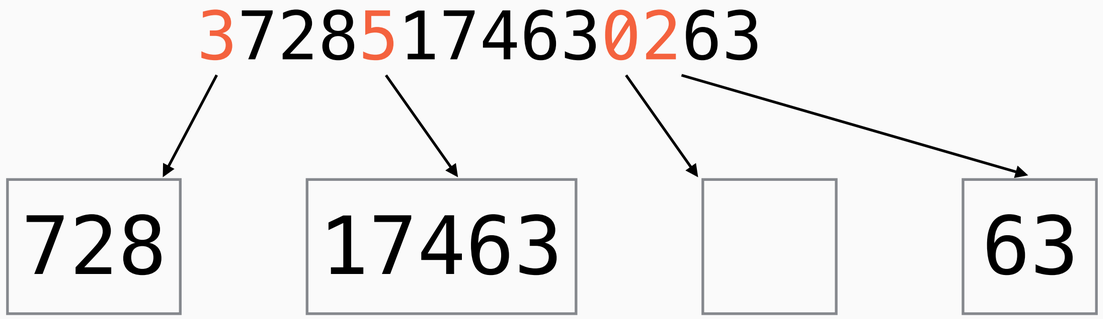
Exercice 3

Expression parser !

```
sbt "~testOnly Step3Spec"
```

Parsers depending on previous parsers

Format alacon : un chiffre annonce le nombre de chiffres à lire



Parsers depending on previous parsers

```
Parser[T].into(T => Parser[U])  =>  Parser[U]
```

Parsers depending on previous parsers

```
def digit = """\d""".r ^^ (_.toInt)
def cell = digit.into { n => repN(n, digit)}
def cells = rep(cell)


    parse(cells, "3728517463026 3")
== List(List(7, 2, 8),
         List(1, 7, 4, 6, 3),
         List(),
         List(6, 3))
```

Parsers depending on previous parsers

Variantes

```
digit.into { n => repN(n, digit)}

digit >> { n => repN(n, digit)}

digit.flatMap { n => repN(n, digit)}
```

Monads

Monads

Functors that you can chain

Monad[A] + A => Monad[B]

=

Monad[B]

Syntactic sugar!

```
digit.into { n => repN(n, digit)}
```

```
for { n <- digit
      result <- repN(n, digit)
} yield result
```

Syntactic sugar!

```
def product = "(" ~> (expr <~ "*") ~ expr <~ ")"
              ^^ { case l ~ r => Product(l, r)}
```

```
for { _ <- "("
      l <- expr
      _ <- "*"
      r <- expr
      _ <- ")"
} yield Product(l, r)
```

Final exercise

JSON !

```
sbt "~testOnly Step4Spec"
```

Pour finir

- Perfs
- https://github.com/madjar/talk-scala-parser-combinators
- Questions ?