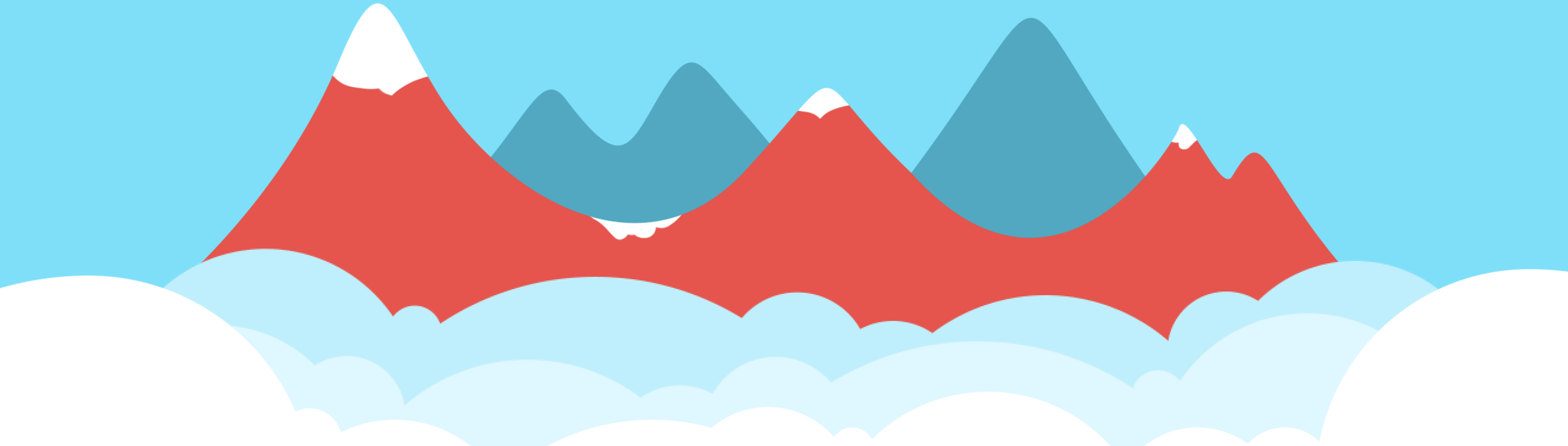
Scala **Enthusiasts** BS

Arne Brüsch – Philipp Wille

Pattern Matching Syntax



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Typesafe

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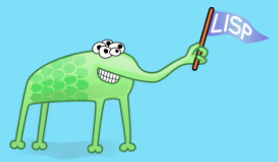
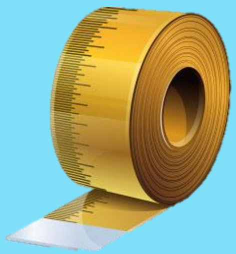
- Commercially marketed by Odersky‘s **Typesafe Inc.**

What do we talk about?



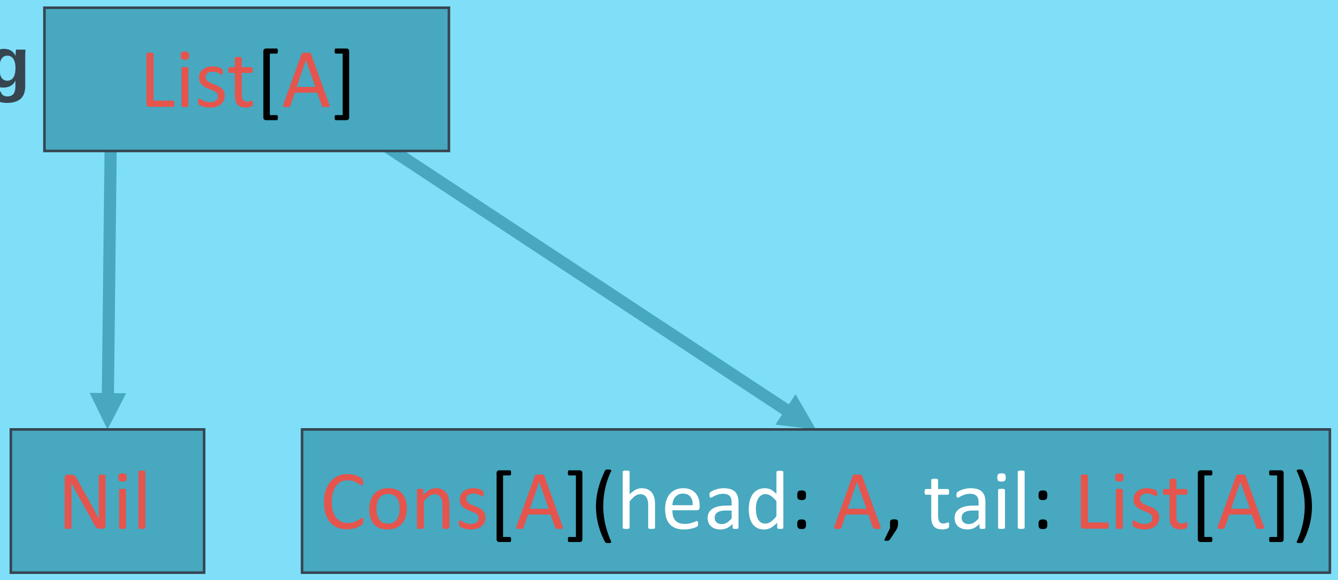
1. Algebraic Data Types & Pattern Matching
2. Implementing Algebraic Data Types



3. Pattern Matching Syntax
4. More Scala Features

(Generalized) Algebraic Data Types (ADTs)

- Most **functional programming** languages work with ADTs
- ADTs are types formed by a **combination of other types**
- The most common example is the **singly linked list**:



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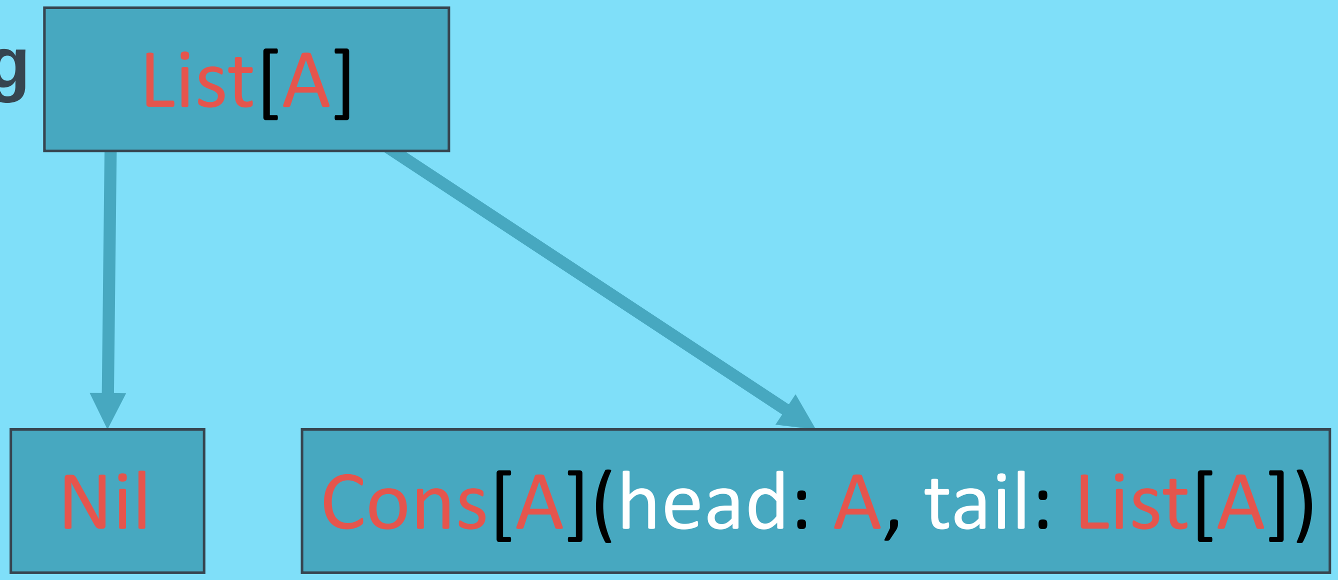


```
Cons(1, Cons(2, Cons(3, Nil)))
```

Pattern Matching

- **Check** a given ADT for an **exact pattern**

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```

Pattern Matching

- **Check** a given ADT for an **exact pattern**
- Similar to Java‘s Switch/Case statement

```
Cons(1, Cons(2, Cons(3, Nil))) match {
  case Cons(1, tail) => println(“one”)
  case Cons(2, tail) => println(“two”)
}
```

Pattern Matching

- Most functional languages use a special notation for lists:

Pattern Matching

- Most functional languages use a special notation for lists:
  - Expresses the right-associativity of singly linked lists

```
1 :: 2 :: 3 :: Nil match {
  case 1 :: tail => println(“one”)
  case 2 :: tail => println(“two”)
}
```

List Notation

ML

List Notation

```
(cons 1 (cons 2 (cons 3 (cons 4 (cons 5 nil)))))
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ML

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ML

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`(1 2 3 4 5)`

ML

List Notation

(1 2 3 4 5)

ML `1 :: 2 :: 3 :: 4 :: 5 :: nil`

List Notation

```
(1 2 3 4 5)
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ML
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List Notation

```
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```
(1 2 3 4 5)
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ML
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1 : 2 : 3 : 4 : 5 : Nil
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List Notation

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```
(list 1 2 3 4 5)
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ML

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```
(list 1 2 3 4 5)
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ML `[1; 2; 3; 4; 5]`

List Notation

(list 1 2 3 4 5)

ML [1; 2; 3; 4; 5]

[1, 2, 3, 4, 5]

List Notation

```
List(1, 2, 3, 4, 5)
```

```
(list 1 2 3 4 5)
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ML

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[1; 2; 3; 4; 5]
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I love LISTS.

Reimplementing `List`

- `Cons` and `Nil` are *Data Constructors* for List

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- Basic class structure:

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sealed trait List[+A]
case object Nil extends List[Nothing]
case class Cons[+A](head: A, tail: List[A]) extends List[A]
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sealed trait List[+A]
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- This gives us the following notation:

```
val list = Cons(1, Cons(2, Cons(3, Cons(4, Cons(5, Nil)))))
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Reimplementing List

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- Pattern matching the list:

```scala
list match {
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val list = List(1, 2, 3, 4, 5)
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- The first notation hides the implementation details from the user
  - The user does not need to know about `Cons` or `Nil`

Alternate List Notation

```scala
object List {
  def apply[A](as: A*): List[A] =
    if(as.isEmpty) Nil
    else Cons(as.head, apply(as.tail: _*))
}
```

Alternate `List` Notation

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- The `List` companion objects enables the following notations:

```
val list = List.apply(1, 2, 3, 4, 5)
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val list = List.apply(1, 2, 3, 4, 5)
val list = List(1, 2, 3, 4, 5)
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Better DSL for `Lists`

- We have two ways to define `Lists` now:

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val list = Cons(1, Cons(2, Cons(3, Cons(4, Cons(5, Nil)))))
val list = List(1, 2, 3, 4, 5)
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RIGHT!

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- But how can we implement the last one?

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val list = 1 :: 2 :: 3 :: 4 :: 5 :: Nil
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- Overloaded **operator**

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- Overloaded **operator**
- **Right-associative**

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Nicer DSL for `Lists`

- Let us first look at a similar DSL:

```
val list = Nil.after(5).after(4).after(3).after(2).after(1)
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- But `after` is still **left-associative**…

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- But how to define right-associative functions?

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- Which gives us our last notation

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list match { case head :: tail => ... }
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- Let‘s have a closer look at how pattern matching in Scala works…

Example 1: Sum of a List

- For a start we implement the sum of a list using Pattern Matching:

```scala
def sum(list: List[Int]): Int = list match {
  case Cons(head, tail) => head + sum(tail)
  case Nil => 0
}

sum(1 :: 2 :: 3 :: 4 :: 5 :: Nil)
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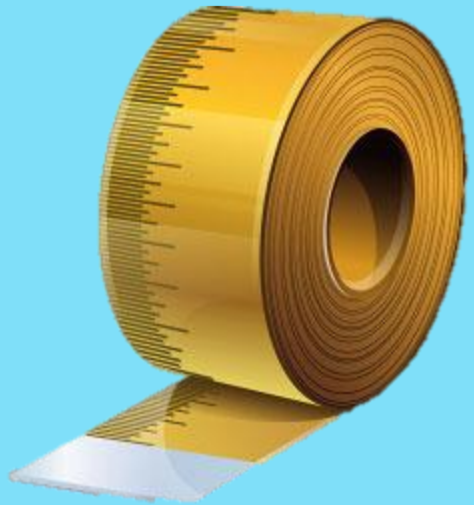

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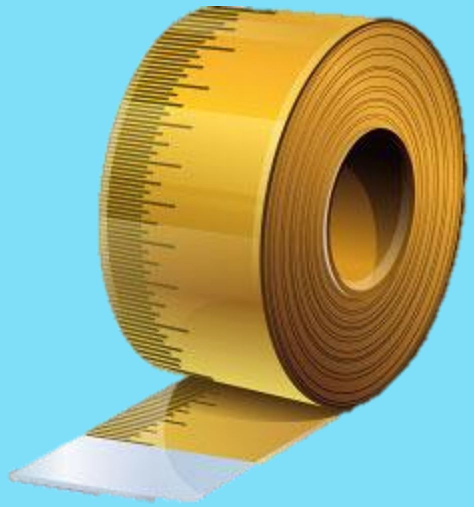

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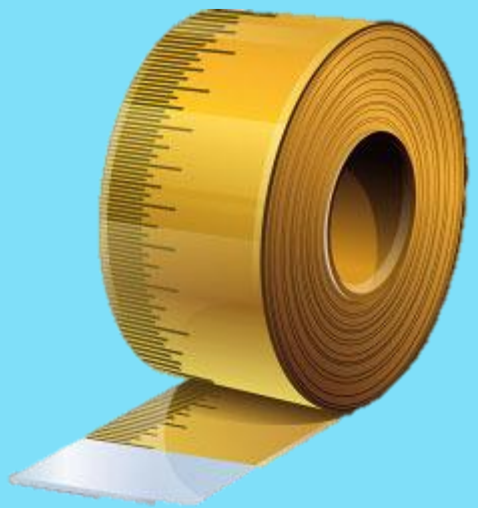

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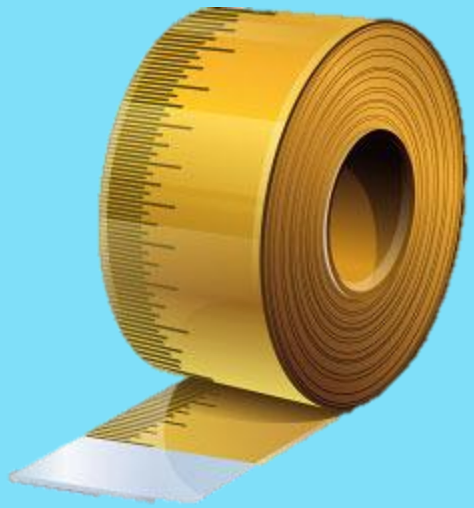

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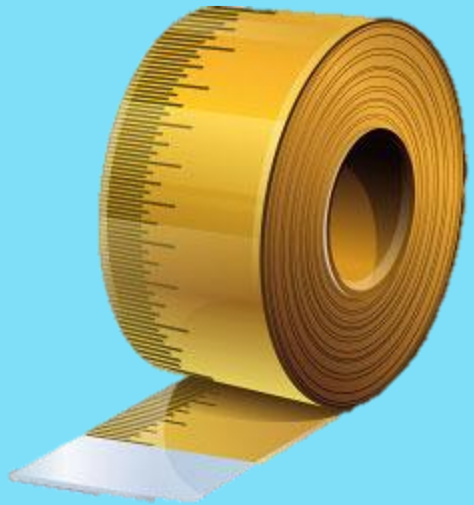

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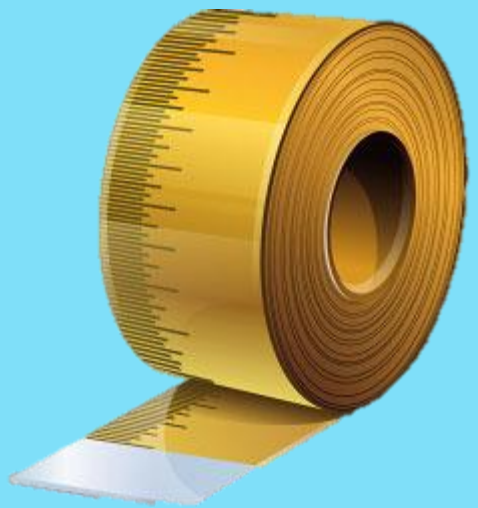

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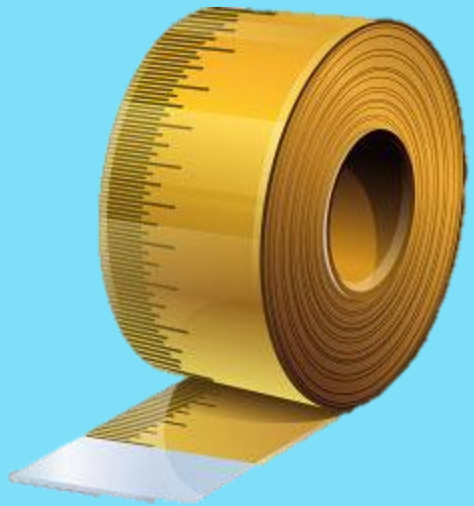

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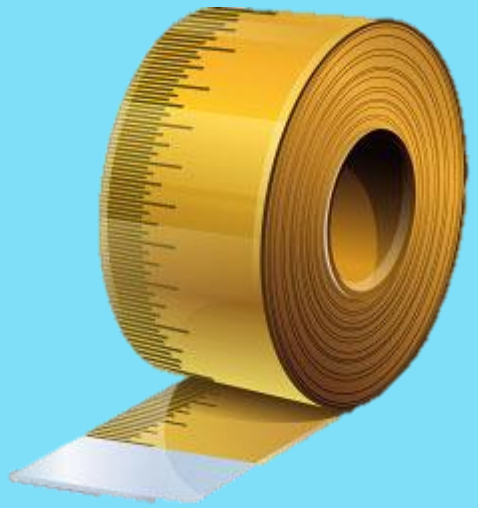
5



Example 3: Take n first Elements

- Pattern Matching also allows us to select Elements from a list

```
def take[A](n: Int, ls: List[A]): List[A] = ls match {
  case Cons(hd, tl) if n > 0 => hd :: take(n-1, tl)
  case _ => Nil
}

take(2, 1 :: 2 :: 3 :: 4 :: 5 :: Nil)
```

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1 :: take(1, 2 :: 3 :: 4 :: 5 :: Nil)
```

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1 :: 2 :: take(0, 3 :: 4 :: 5 :: Nil)
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def take[A](n: Int, ls: List[A]): List[A] = ls match {
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  case _ => Nil
}
```

```
1 :: 2 :: Nil
```

Pattern Matching Syntactically

- Pattern Matching is a very self-contained part of the Scala programming language. This is where Pattern Matching lives:

```
Expr ::= PostfixExpr `match' `{' CaseClauses `}'
CaseClauses ::= CaseClause {CaseClause}
CaseClause ::= `case' Pattern [Guard] `=>' Block
```

- A more abstract syntax

```
e match { case p1 => b1 … case pn => bn }
```

Guard Syntax

- Remember take?

```
def take[A](n: Int, ls: List[A]): List[A] = ls match {
  case Cons(hd, tl) if n > 0 => hd :: take(n - 1, tl)
  case _ => Nil
}
```

```
Guard ::=  `if' BExpr
```

```
Guarded Patterns are applied iff
The Pattern matches and
The Guard yields true
```

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Pattern Syntax

```
Pattern ::= Pattern1 { ‘|’ Pattern1 }
Pattern1 ::= varid ‘:’ TypePat | ‘_’ ‘:’ TypePat | Pattern2
Pattern2 ::= varid [‘@’ Pattern3] | Pattern3
Pattern3 ::= SimplePattern | SimplePattern {id [nl] SimplePattern}
SimplePattern ::= ‘_’ |
                  varid |
                  Literal |
                  StableId |
                  StableId ‘(’ [Patterns] ‘)’ |
                  StableId ‘(’ [Patterns ‘,’] [varid ‘@’] ‘_’ ‘*’ ‘)’ |
                  ‘(’ [Patterns] ‘)’ |
                  XmlPattern
```

Typed Pattern

```
Pattern1 ::= varid ‘:’ TypePat |
             ‘_’ ‘:’ TypePat | Pattern2
```

```scala
def length[A](l: List[A]): Int = l match {
  case Nil => 0
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                  ‘(’ [Patterns] ‘)’ |
                  XmlPattern
```

Pattern Binders

```
Pattern2 ::= varid [‘@’ Pattern3] | Pattern3

def length[A](list: List[A]): Int = list match {
  case Nil => 0
  case c @ Cons(head, tail) => 1 + length(c.tail)
}
```

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                  StableId ‘(’ [Patterns ‘,’] [varid ‘@’] ‘_’ ‘*’ ‘)’ |
                  ‘(’ [Patterns] ‘)’ |
                  XmlPattern
```

Extractor Pattern

```
SimplePattern ::= StableId '(' [Patterns] ')' |
```

```scala
def take[A](n: Int, ls: List[A]): List[A] = ls match {
  case Cons(head, tail) if n > 0 => {
    head :: take(n - 1, tail)
  }
  case _ => Nil
}
```

```
Pattern ::= Pattern1 { '|' Pattern1 }
Pattern1 ::= varid ':' TypePat | '_' ':' TypePat | Pattern2
Pattern2 ::= varid ['@' Pattern3] | Pattern3
Pattern3 ::= SimplePattern | SimplePattern {id [nl] SimplePattern}
SimplePattern ::= '_' |
                  varid |
                  Literal |
                  StableId |
                  StableId '(' [Patterns] ')' |
                  StableId '(' [Patterns ','] [varid '@'] '_' '*' ')' |
                  '(' [Patterns] ')' |
                  XmlPattern
```

Custom Extractors

- Remember? We wanted to use the following extractor syntax:

```
val list = 1 :: 2 :: 3 :: 4 :: 5 :: Nil
list match { case head :: tail => ... }
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```

- We can do this by defining a custom extractor!

Pattern Matching with `unapply`

- Remember? We wanted to use the following extractor syntax:

```
list match { case head :: tail => ... }
```

- We need to define an `unapply` method

```
object :: {
  def unapply[A](cons: Cons[A]): Option[(A, List[A])] =
    Some((cons.head, cons.tail))
}
```

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    - Build-in **Dependency Injection**

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- We **meet** every **2nd month**, every **2nd Tuesday** and **talk** about Scala, its libraries, and programming concepts in general
  - Normally we have **two 30 minutes talks** and open discussions afterwards