EPFL

Other Collections

Principles of Functional Programming

Other Sequences

We have seen that lists are *linear*: Access to the first element is much faster than access to the middle or end of a list.

The Scala library also defines an alternative sequence implementation, `Vector`.

This one has more evenly balanced access patterns than `List`.

Operations on Vectors

Vectors are created analogously to lists:

```
val nums = Vector(1, 2, 3, -88)
val people = Vector("Bob", "James", "Peter")
```

They support the same operations as lists, with the exception of `::`

Instead of `x :: xs`, there is

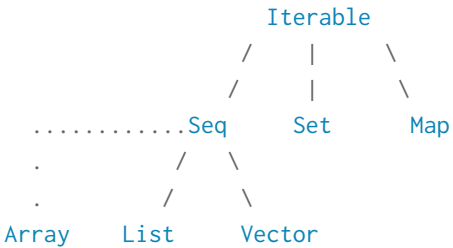
`x +: xs`	Create a new vector with leading element `x`, followed by all elements of `xs`.
`xs :+ x`	Create a new vector with trailing element `x`, preceded by all elements of `xs`.

(Note that the `:` always points to the sequence.)

Collection Hierarchy

A common base class of `List` and `Vector` is `Seq`, the class of all *sequences*.

`Seq` itself is a subclass of `Iterable`.



Arrays and Strings

Arrays and Strings support the same operations as `Seq` and can implicitly be converted to sequences where needed.

(They cannot be subclasses of `Seq` because they come from Java)

```
val xs: Array[Int] = Array(1, 2, 3)
xs.map(x => 2 * x)

val ys: String = "Hello world!"
ys.filter(_.isUpper)
```

Ranges

Another simple kind of sequence is the *range*.

It represents a sequence of evenly spaced integers.

Three operators:

`to` (inclusive), `until` (exclusive), `by` (to determine step value):

```
val r: Range = 1 until 5
val s: Range = 1 to 5
1 to 10 by 3
6 to 1 by -2
```

A `Range` is represented as a single object with three fields: lower bound, upper bound, step value.

Some more Sequence Operations:

`xs.exists(p)`	`true` if there is an element `x` of `xs` such that `p(x)` holds, `false` otherwise.
`xs.forall(p)`	`true` if `p(x)` holds for all elements `x` of `xs`, `false` otherwise.
`xs.zip(ys)`	A sequence of pairs drawn from corresponding elements of sequences `xs` and `ys`.
`xs.unzip`	Splits a sequence of pairs `xs` into two sequences consisting of the first, respectively second halves of all pairs.
`xs.flatMap(f)`	Applies collection-valued function `f` to all elements of `xs` and concatenates the results
`xs.sum`	The sum of all elements of this numeric collection.
`xs.product`	The product of all elements of this numeric collection
`xs.max`	The maximum of all elements of this collection (an `Ordering` must exist)
`xs.min`	The minimum of all elements of this collection

Example: Combinations

To list all combinations of numbers `x` and `y` where `x` is drawn from `1..M` and `y` is drawn from `1..N`:

```
(1 to M).flatMap(x =>
```

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```
(1 to M).flatMap(x => (1 to N).map(y => (x, y)))
```

Example: Scalar Product

To compute the scalar product of two vectors:

```
def scalarProduct(xs: Vector[Double], ys: Vector[Double]): Double =
  xs.zip(ys).map(xy => xy._1 * xy._2).sum
```

Example: Scalar Product

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```

An alternative way to write this is with a *pattern matching function value*.

```
def scalarProduct(xs: Vector[Double], ys: Vector[Double]): Double =
  xs.zip(ys).map { case (x, y) => x * y }.sum
```

Generally, the function value

```
{ case p1 => e1 ... case pn => en }
```

is equivalent to

```
x => x match { case p1 => e1 ... case pn => en }
```

Example: Scalar Product

For simple tuple decomposition, the `case` prefix in the pattern can be omitted.

So, the previous code can be simplified to:

```
def scalarProduct(xs: Vector[Double], ys: Vector[Double]): Double =
  xs.zip(ys).map((x, y) => x * y).sum
```

Or, even simpler

```
def scalarProduct(xs: Vector[Double], ys: Vector[Double]): Double =
  xs.zip(ys).map(_ * _).sum
```

Exercise:

A number `n` is *prime* if the only divisors of `n` are `1` and `n` itself.

What is a high-level way to write a test for primality of numbers? For once, value conciseness over efficiency.

```
def isPrime(n: Int): Boolean = ???
```

Exercise:

A number `n` is *prime* if the only divisors of `n` are `1` and `n` itself.

What is a high-level way to write a test for primality of numbers? For once, value conciseness over efficiency.

```
def isPrime(n: Int): Boolean =
  (2 to n - 1).forall(d => n % d == 0)
```