Other Collections

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`.

$\log_{32}(N)$

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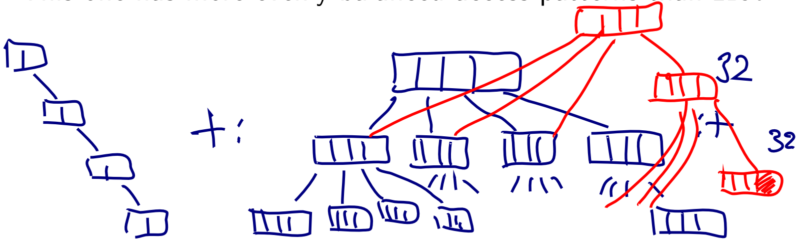


$32 * 32 = 2^{10}$

2^{15}

2^{20}

2^{25}

2^{30}

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

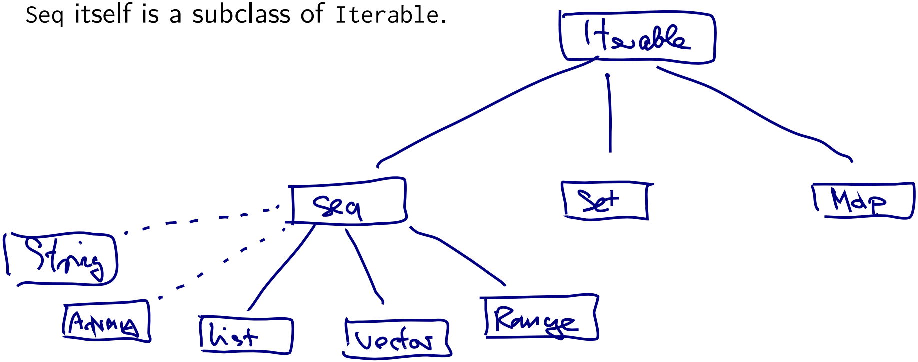
`x +: xs`	Create a new vector with leading element `x`, followed by all elements of `xs`.
`xs :+ x`	Create a new vector with trailing element `x`, preceded by all elements of `xs`.

(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    // 1, 2, 3, 4
val s: Range = 1 to 5       // 1, 2, 3, 4, 5
1 to 10 by 3                // 1, 4, 7, 10
6 to 1 by -2                // 6, 4, 2
```

Ranges a represented as single objects 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 => (1..N) map (y => (x, y))
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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
```

$$\sum_{i=1}^{n} x_i * y_i$$

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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 }
```

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:

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What is a high-level way to write a test for primality of numbers?
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```
def isPrime(n: Int): Boolean = (2 until n) forall (d => n % d != 0)
```