Week 1

Call by value first resolves the "values" before calling the function, while call by name first calls the function, gets the results and then resolves them.

Week 2

Take a function as a parameter:

```
def sum(f: Int => Int, a: Int, b: Int): Int =
  if a > b then 0
  else f(a) + sum(f, a + 1, b)
```

We can also generate functions using functions:

```
def sum(f: Int => Int): (Int, Int) => Int =
  def sumF(a: Int, b: Int): Int =
    if a > b then 0
    else f(a) + sumF(a + 1, b)
  sumF
```

```
def sumInts = sum(x => x)
def sumCubes = sum(x => x * x * x)
def sumFactorials = sum(fact)
```

```
sumCubes(1, 10) + sumFactorials(10, 20)
```

Generalization:

It's the same as creating a function that takes the `n-1` arguments, and one takes the last one:

```
def f(ps1)...(psn-1) = (psn ⇒ E)
```

Types

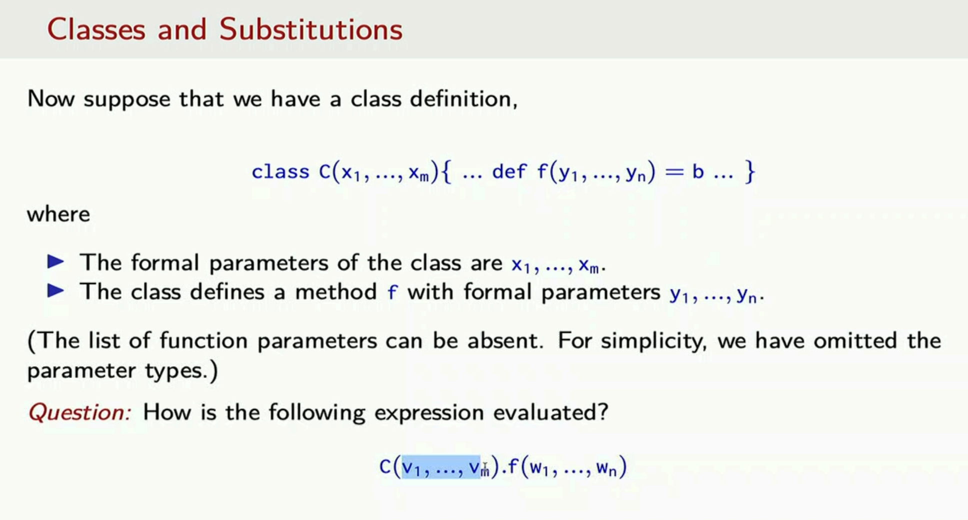
```
Type = SimpleType | FunctionType
FunctionType = SimpleType '=>' Type
| '( ' [ Types ] ') ' '= > ' Type
SimpleType = Ident
Types = Type { ' , ' Type }
```

Several ways of writing functions that return functions

```
def isGreaterThanBasic(x: Int, y: Int): Boolean =
  x > y
val isGreaterThanAnon: (Int, Int) => Boolean =
  (x, y) => x > y
val isGreaterThanCurried: Int => Int => Boolean =
  x => y => x > y // Same as `x => (y => x > y)`
def isGreaterThanCurriedDef(x: Int)(y: Int): Boolean =
  x > y
```

▷ Curried signifie que la fonction prend ses arguments un par un ! (en fait elle renvoie une nouvelle fonction à chaque fois) C'est utile si on veut appliquer des transformations partielles (fixer le premier argument et retarder l'application du second).

Week 3



Classes and Substitutions

Now suppose that we have a class definition,

$$\texttt{class } C(x_1, \ldots, x_m)\{ \ \ldots \ \texttt{def } f(y_1, \ldots, y_n) = b \ \ldots \ \}$$

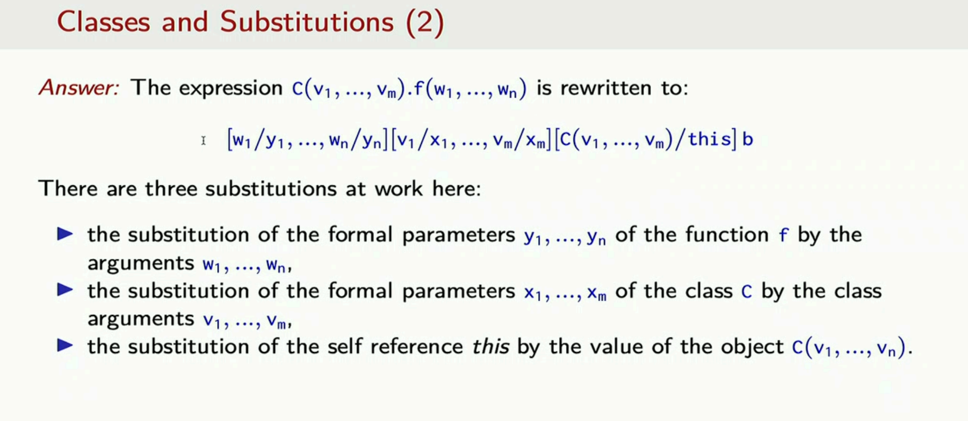
where

- The formal parameters of the class are $x_1, \ldots, x_m$.
- The class defines a method f with formal parameters $y_1, \ldots, y_n$.

(The list of function parameters can be absent. For simplicity, we have omitted the parameter types.)

Question: How is the following expression evaluated?

$$C(v_1, \ldots, v_m).f(w_1, \ldots, w_n)$$



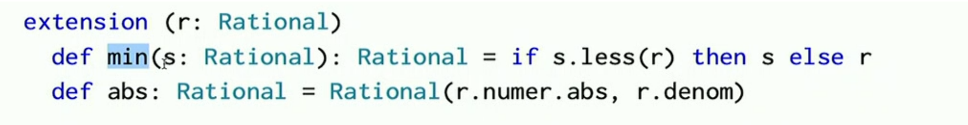
Classes and Substitutions (2)

Answer: The expression $C(v_1, \ldots, v_m).f(w_1, \ldots, w_n)$ is rewritten to:

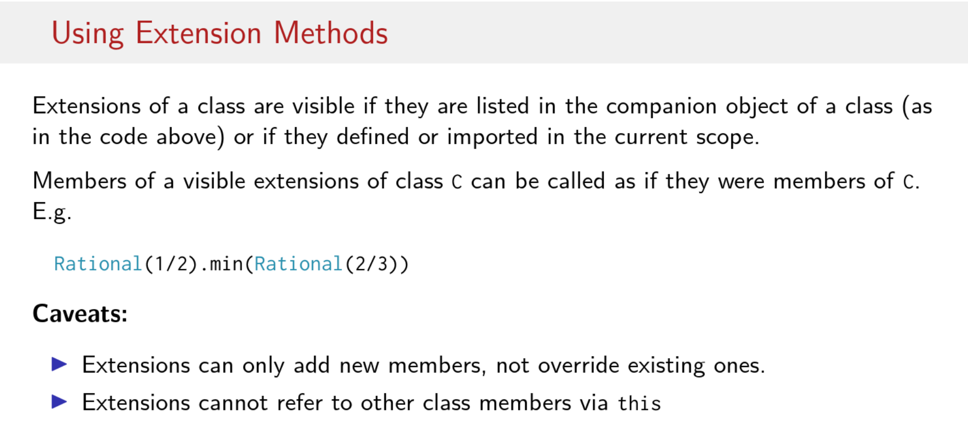
$$[w_1/y_1, \ldots, w_n/y_n][v_1/x_1, \ldots, v_m/x_m][C(v_1, \ldots, v_m)/\texttt{this}]\, b$$

There are three substitutions at work here:

- the substitution of the formal parameters $y_1, \ldots, y_n$ of the function f by the arguments $w_1, \ldots, w_n$,
- the substitution of the formal parameters $x_1, \ldots, x_m$ of the class C by the class arguments $v_1, \ldots, v_m$,
- the substitution of the self reference *this* by the value of the object $C(v_1, \ldots, v_n)$.



```
extension (r: Rational)
  def min(s: Rational): Rational = if s.less(r) then s else r
  def abs: Rational = Rational(r.numer.abs, r.denom)
```



Using Extension Methods

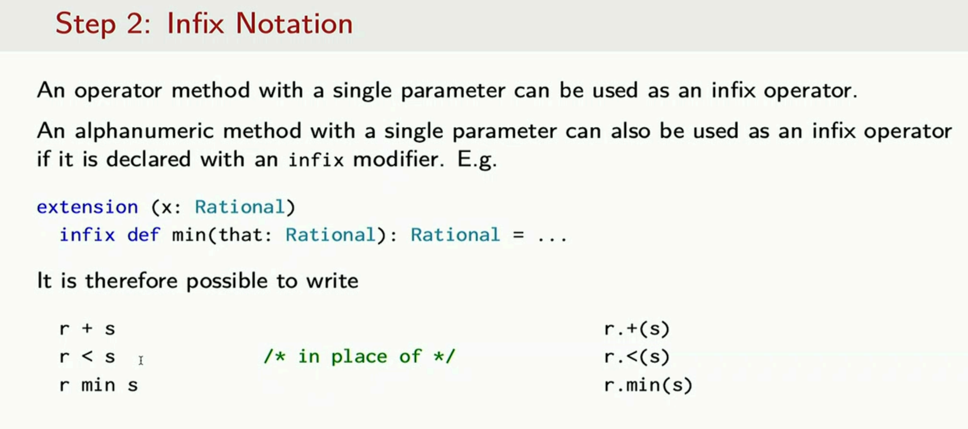
Extensions of a class are visible if they are listed in the companion object of a class (as in the code above) or if they defined or imported in the current scope.

Members of a visible extensions of class `C` can be called as if they were members of `C`. E.g.

```
Rational(1/2).min(Rational(2/3))
```

Caveats:

- Extensions can only add new members, not override existing ones.
- Extensions cannot refer to other class members via `this`



Step 2: Infix Notation

An operator method with a single parameter can be used as an infix operator.

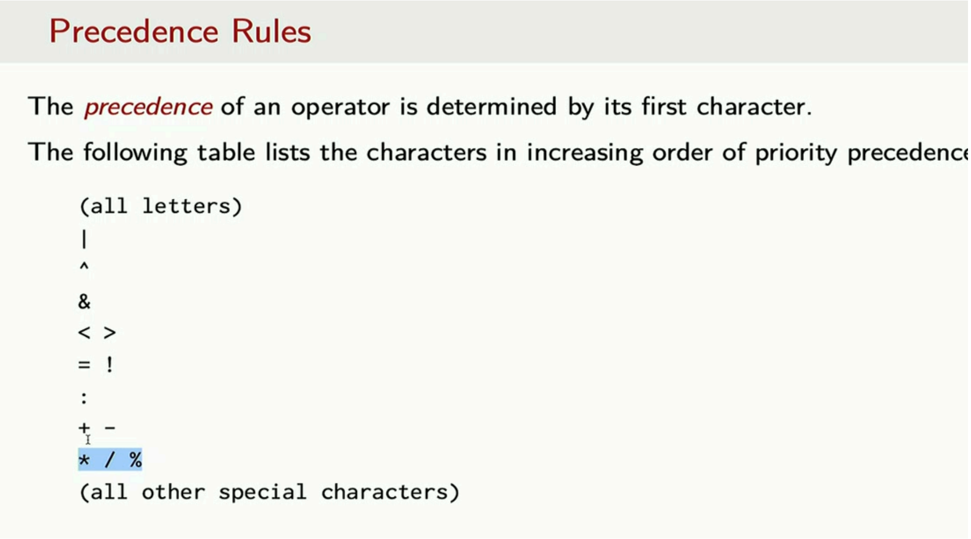
An alphanumeric method with a single parameter can also be used as an infix operator if it is declared with an `infix` modifier. E.g.

```
extension (x: Rational)
  infix def min(that: Rational): Rational = ...
```

It is therefore possible to write

```
  r + s                                     r.+(s)
  r < s              /* in place of */      r.<(s)
  r min s                                   r.min(s)
```

Déterminée en fonction du caractère qui démarre l'opérateur:

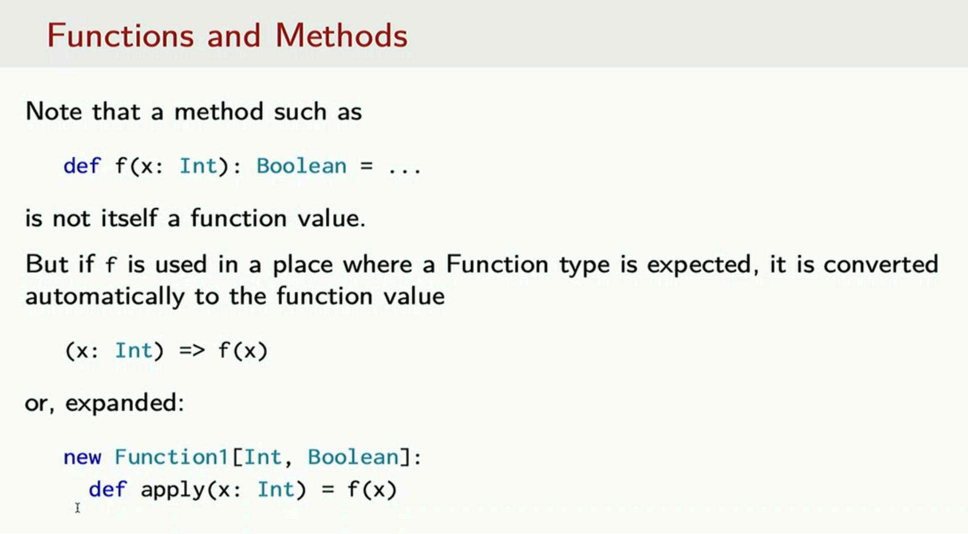


Precedence Rules

The *precedence* of an operator is determined by its first character.

The following table lists the characters in increasing order of priority precedence

```
(all letters)
|
^
&
< >
= !
:
+ -
* / %
(all other special characters)
```



Functions and Methods

Note that a method such as

```
def f(x: Int): Boolean = ...
```

is not itself a function value.

But if `f` is used in a place where a Function type is expected, it is converted automatically to the function value

```
(x: Int) => f(x)
```

or, expanded:

```
new Function1[Int, Boolean]:
  def apply(x: Int) = f(x)
```

Types

Contravariance : quand un type plus général est utilisé pour un autre type Covariance : quand un type plus précis est utilisé pour un autre type

```
trait Printer[-A] {
  def print(value: A): Unit
```

```scala
}

val animalPrinter: Printer[Animal] = (animal: Animal) => println(s"Printing an animal: $animal")
val dogPrinter: Printer[Dog] = animalPrinter // ok, Printer[Animal] is a supertype of Printer[Dog]
```