



Conditionals and Value Definitions

Principles of Functional Programming

Conditional Expressions

To express choosing between two alternatives, Scala has a conditional expression `if-then-else`.

It resembles an `if-else` in Java, but is used for expressions, not statements.

Example:

```
def abs(x: Int) = if x >= 0 then x else -x
```

`x >= 0` is a *predicate*, of type `Boolean`.

Boolean Expressions

Boolean expressions b can be composed of

```
true  false    // Constants
!b      // Negation
b && b   // Conjunction
b || b   // Disjunction
```

and of the usual comparison operations:

$e \leq e$, $e \geq e$, $e < e$, $e > e$, $e == e$, $e != e$

Rewrite rules for Booleans

Here are reduction rules for Boolean expressions (e is an arbitrary expression):

```
!true      -->  false
!false     -->  true
true && e   -->  e
false && e  -->  false
true || e  -->  true
false || e -->  e
```

Note that && and || do not always need their right operand to be evaluated.

We say, these expressions use “short-circuit evaluation”.

Exercise: Formulate rewrite rules for if-then-else

Value Definitions

We have seen that function parameters can be passed by value or be passed by name.

The same distinction applies to definitions.

The `def` form is “by-name”, its right hand side is evaluated on each use.

There is also a `val` form, which is “by-value”. Example:

```
val x = 2
val y = square(x)
```

The right-hand side of a `val` definition is evaluated at the point of the definition itself.

Afterwards, the name refers to the value.

For instance, `y` above refers to 4, not `square(2)`.

Value Definitions and Termination

The difference between `val` and `def` becomes apparent when the right hand side does not terminate. Given

```
def loop: Boolean = loop
```

A definition

```
def x = loop
```

is OK, but a definition

```
val x = loop
```

will lead to an infinite loop.

Exercise

Write functions `and` and `or` such that for all argument expressions `x` and `y`:

`and(x, y) == x && y`

`or(x, y) == x || y`

(do not use `||` and `&&` in your implementation)

What are good operands to test that the equalities hold?