



Loops

Principles of Functional Programming

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Loops

Proposition: Variables are enough to model all imperative programs.

But what about control statements like loops?

We can model them using functions.

Example: Here is a Scala program that uses a while loop:

```
def power(x: Double, exp: Int): Double =  
  var r = 1.0  
  var i = exp  
  while i > 0 do { r = r * x; i = i - 1 }  
  r
```

In Scala, while-do is a built-in control construct

But how could we define while using a function (call it whileDo)?

Definition of whileDo

The function whileDo can be defined as follows:

```
def whileDo(condition: => Boolean)(command: => Unit): Unit =  
  if condition then  
    command  
    whileDo(condition)(command)  
  else ()
```

Note: The condition and the command must be passed by name so that they're reevaluated in each iteration.

Note: whileDo is tail recursive, so it can operate with a constant stack size.

Exercise

Write a function implementing a repeat loop that is used as follows:

```
repeatUntil {  
  command  
} ( condition )
```

It should execute command one or more times, until condition is true.

Exercise

Write a function implementing a repeat loop that is used as follows:

```
repeatUntil {  
  command  
} ( condition )
```

It should execute command one or more times, until condition is true.

The repeatUntil function starts like this:

```
def repeatUntil(command: => Unit)(condition: => Boolean) =
```



Exercise (open-ended)

Is it also possible to obtain the following syntax?

```
repeat {  
  command  
} until ( condition )
```

?



For-Loops

The classical for loop in Java can *not* be modeled simply by a higher-order function.

The reason is that in a Java program like

```
for (int i = 1; i < 3; i = i + 1) { System.out.print(i + " "); }
```

the arguments of for contain the *declaration* of the variable `i`, which is visible in other arguments and in the body.

However, in Scala there is a kind of for loop similar to Java's extended for loop:

```
for i <- 1 until 3 do System.out.print(s"$i ")
```

This displays 1 2.

Translation of For-Loops

For-loops translate similarly to for-expressions, but using the `foreach` combinator instead of `map` and `flatMap`.

`foreach` is defined on collections with elements of type `T` as follows:

```
def foreach(f: T => Unit): Unit =  
  // apply 'f' to each element of the collection
```

Example

```
for i <- 1 until 3; j <- "abc" do println(s"$i $j")
```

translates to:

```
(1 until 3).foreach(i => "abc".foreach(j => println(s"$i $j")))
```