

Blocks and Lexical Scope

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Nested functions

It's good functional programming style to split up a task into many small functions.

But the names of functions like `sqrtIter`, `improve`, and `isGoodEnough` matter only for the *implementation* of `sqrt`, not for its *usage*.

Normally we would not like users to access these functions directly.

We can achieve this and at the same time avoid “name-space pollution” by putting the auxiliary functions inside `sqrt`.

The sqrt Function, Take 2

```
def sqrt(x: Double) = {  
  def sqrtIter(guess: Double, x: Double): Double =  
    if (isGoodEnough(guess, x)) guess  
    else sqrtIter(improve(guess, x), x)  
  
  def improve(guess: Double, x: Double) =  
    (guess + x / guess) / 2  
  
  def isGoodEnough(guess: Double, x: Double) =  
    abs(square(guess) - x) < 0.001  
  
  sqrtIter(1.0, x)  
}
```

Blocks in Scala

- ▶ A block is delimited by braces { ... }.

```
{ val x = f(3)
  x * x
}
```

- ▶ It contains a sequence of definitions or expressions.
- ▶ The last element of a block is an expression that defines its value.
- ▶ This return expression can be preceded by auxiliary definitions.
- ▶ Blocks are themselves expressions; a block may appear everywhere an expression can.

Blocks and Visibility

```
val x = 0
def f(y: Int) = y + 1
val result = {
  val x = f(3)
  x * x
}
```

- ▶ The definitions inside a block are only visible from within the block.
- ▶ The definitions inside a block *shadow* definitions of the same names outside the block.

Exercise: Scope Rules

Question: What is the value of result in the following program?

```
val x = 0
def f(y: Int) = y + 1
val result = {
  val x = f(3)
  x * x
} + x
```

X = 4
16

Possible answers:

- | | | |
|----------------------------------|------------------------------|---|
| <input type="radio"/> | 0 | 0 |
| <input checked="" type="radio"/> | 16 | |
| <input type="radio"/> | 32 | |
| <input type="radio"/> | reduction does not terminate | |

Lexical Scoping

Definitions of outer blocks are visible inside a block unless they are shadowed.

Therefore, we can simplify `sqrt` by eliminating redundant occurrences of the `x` parameter, which means everywhere the same thing:

The sqrt Function, Take 3

```
def sqrt(x: Double) = {  
  def sqrtIter(guess: Double): Double =  
    if (isGoodEnough(guess)) guess  
    else sqrtIter(improve(guess))  
  
  def improve(guess: Double) =  
    (guess + x / guess) / 2  
  
  def isGoodEnough(guess: Double) =  
    abs(square(guess) - x) < 0.001  
  
  sqrtIter(1.0)  
}
```


Semicolons

In Scala, semicolons at the end of lines are in most cases optional

You could write

```
val x = 1;
```

but most people would omit the semicolon.

On the other hand, if there are more than one statements on a line, they need to be separated by semicolons:

```
val y = x + 1; y * y
```

Semicolons and infix operators

One issue with Scala's semicolon convention is how to write expressions that span several lines. For instance

```
someLongExpression  
+ someOtherExpression
```

would be interpreted as *two* expressions:

```
someLongExpression;  
+ someOtherExpression
```

Semicolons and infix operators

There are two ways to overcome this problem.

You could write the multi-line expression in parentheses, because semicolons are never inserted inside (...):

```
(someLongExpression  
  + someOtherExpression)
```

Or you could write the operator on the first line, because this tells the Scala compiler that the expression is not yet finished:

```
someLongExpression +  
someOtherExpression
```

Summary

You have seen simple elements of functional programming in Scala.

- ▶ arithmetic and boolean expressions
- ▶ conditional expressions if-else
- ▶ functions with recursion
- ▶ nesting and lexical scope

You have learned the difference between the **call-by-name** and **call-by-value** evaluation strategies.

You have learned a way to reason about program execution: reduce expressions **using the substitution model.**

This model will be an important tool for the coming sessions.