الغلاف الخارجى للبحث

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Haskell and Scala, A brief comparison!

Introduction:

- Haskell is a statically typed programming language with strictly functional programming functionality with lazy evaluation and inference styles.
  - This was created and developed by Lennart Augustsson, John Hughes, Paul Hudak, John Launchbury, Philip Wadler, Simon Peyton Jones, and Erik Meijer.
  - The typing discipline is solid, static, assumed, and does not have strict Semantics.
  - It had been licensed under the BSD certificate of Clause 3. Its characteristics are lazy programming and is non-strict and flexible. The first release was in 2010.
- Scala is also a general-purpose programming language, provides the features of functional programming and had a strong static type system which had object-oriented features.
  - Scala was written and created using Java, and it uses Java virtual machine (JVM) to compile its source codes and it runs on the JVM.
  - So that it gives it a great advantage to run anywhere. It was licensed under Clause 3 BSD license.
  - It was designed by Martin Odersky, Lex Spoon, and Bill Venners. It was developed in "EPFL" in Switzerland.

So, we are going to discuss differences between Haskell and Scala to show up the differences between them.

In Haskell:

- Variables, Datatypes, and Functions: while the syntax is strong and static so every expression and function in Haskell has a *type*. For example, the value `True` has the type `Bool`, while the value `"foo"` has the type string.

  Static type system means that the compiler knows the type of every value and expression at compile time before any code is executed.

  Type inference means that compiler can automatically deduce the types of almost all expressions in a program.

  Some of basic datatypes in Haskell: `Char, Bool, Int, Integer, Double`
  and there is another useful composite data types like `lists` and `Tuples`

```
Prelude> :type “a”
"a" :: [Char]
```

```
Prelude> :type [1,2,3,4]
[5,2,4] :: Num a => [a]
Prelude> head [1,2,3,4]
1
```

```
Prelude> :type (99, 88)
(99, 88) :: (Num a, Num b) => (a, b)
Prelude> fst (99, 88)
99
```

To Define functions in Haskell it easy, we type first the type of the function and its arguments and body of function is written in that way:

```
square :: Integer -> Integer
square x = x * x
```

- Pattern matching: consists of specifying patterns to which some data should comply and checking to see whether they do, deconstructing the data according to these patterns and defining separate function bodies for different patterns. You can design any form of data starting with the numbers, characters, lists, tuples and so on, one of most useful examples in how to use pattern matching.

```
-- To sum vectors, it very easy to perform using patter matching
AddVectors :: (Num a) => (a, a) -> (a, a) -> (a, a)
AddVectors (a1, b1) (a2, b2) = (a1 + a2, b1 + b2)

-- Another example in how to use pattern matching
SumList :: [Int] -> [Int]
SumList (x:xs) = x + sumList xs
SumList []     = 0
```

Note: *Haskell programmers use the (x:xs) pattern often, especially with recursive functions. However, patterns that include the (:) character will match only against lists of length one or more.*

- List comprehension: means in general creating a list from another one or more other lists, list comprehension is a solution for the problem of no-loops in Haskell -because it is pure functional- so it’s the only way to loop in the data structure of lists, example:

```
Prelude> [(a, b) | a <- [1, 2], b <- "abc"]
[(1,'a'),(1,'b'),(1,'c'),(2,'a'),(2,'b'),(2,'c')]
```

- **Higher Order Functions:** Haskell functions may take functions as return values as parameters and functionality. The higher order function is a function that does one of these. More organized functions are not only a part of Haskell 's life, they are almost the reality of Haskell. If you choose to make equations by means on what stuff were, it turns out that higher order functions are invaluable, rather than specifying steps to alter any state and probably loop them. They are a very powerful way to solve problems and reflect on programs, examples on higher order functions:

```
multiplyThree :: Int -> (Int -> (Int -> Int))
multiplyThree x y z = x * y * z

Prelude> map (+3) [1,2,3,4]
[4,5,6,7]
```

- **Functions as values:** In an imperative language, appending two lists is cheap and easy, a simple C structure in which we maintain a pointer to the head and tail of a list.

```
struct list {
      struct node *head, *tail;
};
// This is example C structure to clarify the idea.
```

When we have one list and want to append another list onto its end, we modify the last node of the existing list to point to its head node, and then update its tail pointer to point to its tail node.

Obviously, this method is kind of not available in Haskell. As, the data is immutable, so, we can not modify the lists declaration like this, so we will use (++) sign which concatenate two lists together.
Lambda expression is important appliance on functions as values and it could be defined as, examples:

```
Prelude> :type (++)
(++) :: [a] -> [a] -> [a]

-- concatenation sign redeclaration.
(++) :: [a] -> [a] -> [a]
(x:xs) ++ ys = x : xs ++ ys
_ ++ ys = ys

Prelude> map (\(a,b) -> a * b) [(1,2), (3,4), (5,6), (3, 8)]
[2,12,30,24]
```

- **Tail Recursion:** In an imperative language, a loop executes in constant space. Lacking loops, we use tail recursive functions in Haskell instead. Normally, a recursive function allocates some space each time it applies itself, so it knows where to return to, example:

```
factTR :: (Integral a) => a -> a
factTR x = fact' x 1 where
  fact' 0 y = y
  fact' x y = fact' (x-1) $! (x * y)
```

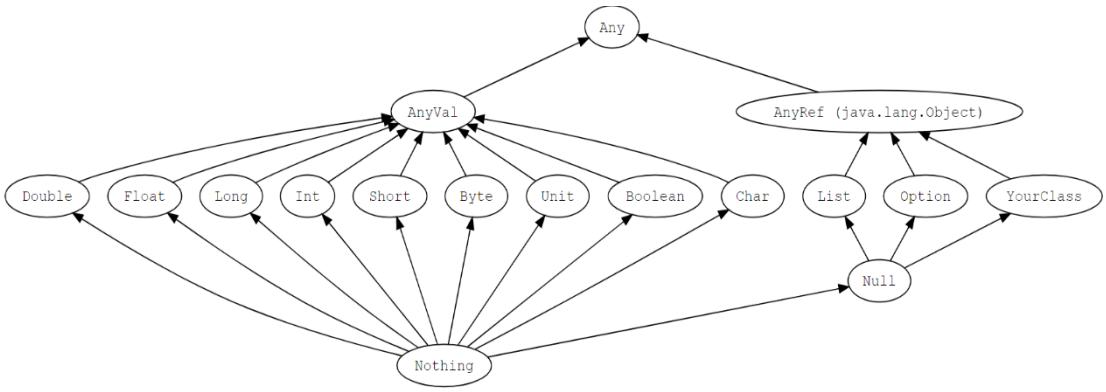
- I/O in Haskell: The basic I/O wasn't added to Haskell in first release, So they wanted a good system to manage input and output of data to make the full use of any system was made in this language, and Haskell I/O system is very expressive and easy to work with it, and while Haskell is pure functional, that's makes it so simple, example of basic I/O:

```
main :: IO
main = do
      putStrLn "Hello, Tell us your name?"
      inpStr <- getLine
      putStrLn $ "Welcome Basic I/O example, " ++ inpStr ++ "!"
```

In Scala:

- Variables, Datatypes, and Functions: While Scala is a blend of object-oriented and functional programming concepts and a statically typed language, so that is making Scala's functional programming construct make it easy to build interesting things quickly from simple parts, and makes it easy to structure larger systems and to adapt the new demands.

  Scala datatypes are the same with Haskell like:
  `Nothing, Double, Float, Long, Int, Short, Byte, Unit, Boolean, Char, Null, Lists, Options, Classes, Any`



Scala-lang.org

Variables are made in Scala into that way:

```
scala> var sayhi = "Hello World!!"
val sayhi:String = "Hello World!!"
scala> val PI:Double = 22/7.0
val PI: Double = 3.142857142857143
```

Note: the number 7 is typed 7.0 to cast it into Double datatype and all datatypes in both languages are capitalized.

And to define functions in Scala we will type, in example to find maximum number between two numbers:

```
scala> def max(x: Int, y: Int): Int = {
     | if (x > y) x
     | else y }
def max(x: Int, y: Int): Int
scala> max(5, 7)
val res0: Int = 7
```

- Pattern matching: is like that one in Haskell, but we will show that by examples to see what differs from one to another and we will use the same examples in Haskell section.

```
// To find sum of using pattern matching
scala> val vectors = List(((1,2), (3,4)))
val obj: List[((Int, Int), (Int, Int))] = List(((1,2),(3,4)))
scala> vectors.map { case ((a, b),(c, d)) => (a+c, b+d)}
val res1: List[(Int, Int)] = List((4,6))

// To find sum of list using pattern matching
scala> def sumList(xs: List[Int]): Int = {
     | if (xs.isEmpty) 0
     | else xs.head + sumList(xs.tail) }
def sumList(xs: List[Int]): Int
```

- List comprehension: in Scala, there is no list comprehensions like Haskell, unlike Haskell, Scala is bind between Functional programming and imperative Programming so there is loops as known: While, For, and Do While loops, That's makes a good point to Scala, because the time complexity and dealing with a lot of problems, GCD example:

```
scala> def gcd(x: Long, y: Long): Long = {
     | var a = x
     | var b = y
     | while (a != 0)
     | {
     |      val temp = a
     |      a = b % a
     |      b = temp
     | }
     | b}
def gcd(x: Long, y: Long): Long
```

- Higher Order Functions: All functions are separated into common parts, which are the same in every invocation of the function, and non-common parts, which may vary from

```
scala> val salaries = Seq(Functions as values:
20000, 70000, 40000)
val salaries: Seq[Int] = List(20000, 70000, 40000)

scala> val doubleSalary = (x: Int) => x * 2
val doubleSalary: Int => Int = $Lambda$1075/1329589315@38dbeb39

scala> val newSalaries = salaries.map(doubleSalary)
val newSalaries: Seq[Int] = List(40000, 140000, 80000)
```

- Functions as value: has the meaning on the Haskell the different is the syntax of the code because it is a concept of Functional programming:

```
scala> val l = List(1, 1, 2, 3, 5, 8)
val l: List[Int] = List(1, 1, 2, 3, 5, 8)

scala> val res = l.map( (x:Int) => x * x )
val res: List[Int] = List(1, 1, 4, 9, 25, 64)
```

- Tail Recursion: this concept is general concept could be applied in Functional and Imperative paradigms, but in Scala specially its compiler detects the tail recursion and replaces it with a jump start back to the beginning of the function after updating the function parameters with the new values.

- the thing is that we can use recursion algorithm in Scala in the cases that we need to do it like when we are dealing with infinite data structure as example, but in some cases a recursive algorithm is more concise and elegant than loop one, but the point is that tail recursion will not have time to move backwards to find the final solution, let's take an example

```
// Calculate the factorial summation using tail recursion.
import scala.annotation.tailrec
import scala.annotation.tailrec

def factTR(x:Long): Long = {
     @tailrec
     def factHelper(y:Long, x:Long): Long = {
           if (x == 0) y
           else factHelper (x * y, x - 1)
      }
      factHelper(1, x)
      }

/*
Results after compiling
scala> factTR(5)
val res0: Long = 120
*/
```

- Power of 'OO' in Scala: Now, we came to the one of most important features that makes Scala more powerful which is the ability of creating objects and class.

  As Scala was written using java. So, the power of object oriented has been inherited to Scala and that is giving the ability to apply Architecture and Design Patterns, in comparison to java, Scala is a programming language pure object oriented. Example:

```
public class JPerson {
      private String name;
      private int age;
      public JPerson(String name, int age) {
            this.name = name;
            this.age = age;
      }
      public void setName(String name) { this.name = name; }
      public String getName() { return this.name; }
      public void setAge(int age) { this.age = age; }
      public int getAge() { return this.age; }
}
```

- Final say:
  At the end what is the conditions and kind of problems that could make me choose Haskell or Scala?
  The answer is it depends in a lot of cases and conditions, here we will assume that we know how to code, solve problems, and make products from both languages.

  In case we wanted to:
  - Build General purpose language to build reliable software use, Haskell.
  - Build Big system built to manage huge data and not be messy, use Scala.
  - Build Pure functional, easy fix, and trace errors, use Haskell.
  - Build System use-in Java and want to integrate with it, with more features, and OO, use Scala.
  - Good language in learning curve to train engineers or to teach concepts use Haskell.
  - A language that is faster, concise, and secure both languages are useful.
  - A language can use in Big Data to analytics Scala is prefect!

Conclusion:

Haskell and Scala both are functional programming languages but at last they are tools, the idea of having different programming languages to choose the best tool to finish tasks and improve productivity.

As we see, Scala is very powerful when it become in the field of creating huge systems, cluster computing, testing.in big data.

And Haskell is very powerful when it become to use in solving parallel programming problem and building efficient algorithms.

Finally, the selection of the programming language depends on the capabilities and characteristics necessary for the application to work efficiently by making an efficient choice. Haskell has Haskell prototype, and Scala uses Macros.

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