Functional Programming in HASKELL

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Functional Programming

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Sources

The slides used for this course strongly rely on the ones proposed by Graham Hutton as a support for the book

- Programming in Haskell - Graham Hutton, Cambridge University Press, 2016

Other references are available on the web page

1 - Introduction

What is a Functional Language?

Opinions differ, and it is difficult to give a precise definition, but generally speaking:

- Functional programming is a ***style*** of programming in which the basic method of computation is the application of functions to arguments

- A functional language is one that ***supports*** and ***encourages*** the functional style

Example

Summing the integers 1 to 10 in Java:

```
int total = 0;
for (int i = 1; i ≤ 10; i++)
    total = total + i;
```

The computation method is *variable assignment*.

Example

Summing the integers 1 to 10 in Haskell:

```
sum [1..10]
```

```
sum' m n = if m==n then m else
               if m<n then m + sum' (m+1) n
                   else n + sum' m (n+1)
```

```
sum'' m n   | m == n = n
            | m < n = m + sum'' (m+1) n
            | otherwise = n + sum'' m (n+1)
```

The computation method is ***function application***.

Example

Double a number:

```
double x = x + x
```

```
  double 3
= 3 + 3
= 6
```

```
  double (double  2)
= double (2 + 2)
= double 4
= 4 + 4
= 8
```

```
  double (double  2)
= (double 2) + (double 2)
= (2 +2) + (double 2)
= 4 + (double 2)
= 4 + (2 +2)
= 4 + 4
= 8
```

Historical Background

1930s:

Alonzo Church develops the **lambda calculus**, a simple but powerful theory of functions.

Historical Background

1950s:

John McCarthy develops **Lisp**, the first functional language, with some influences from the lambda calculus, but retaining variable assignments.

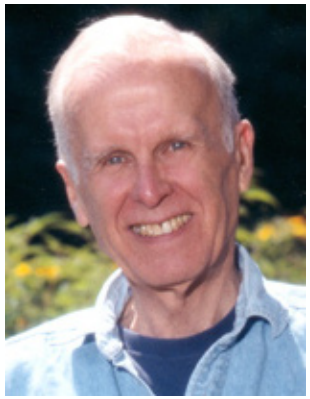
Historical Background

1960s:

Peter Landin develops **ISWIM**, the first pure functional language, based strongly on the lambda calculus, with no assignments.

Historical Background

1970s:



John Backus develops **FP**, a functional language that emphasizes higher-order functions and reasoning about programs.

Historical Background

1970s:

Robin Milner and others develop **ML**, the first modern functional language, which introduced type inference and polymorphic types.

Historical Background

1970s - 1980s:

David Turner develops a number of lazy functional languages, culminating in the **Miranda** system.

Historical Background

1987:

An international committee starts the development of **Haskell**, a standard lazy functional language.

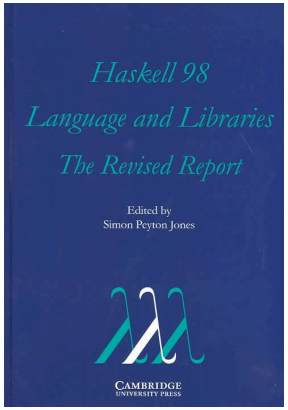
Historical Background

1990s:

Phil Wadler and others develop type classes and monads, two of the main innovations of Haskell.

Historical Background

2003:



The committee publishes the Haskell Report, defining a stable version of the language; an updated version was published in 2010.

Historical Background

2010-date:

Standard distribution, library support, new language features, development tools, use in industry, influence on other languages, etc.

A Taste of Haskell

```
f []     = []
f (x:xs) = f ys ++ [x] ++ f zs
           where
              ys = [a | a ← xs, a ≤ x]
              zs = [b | b ← xs, b > x]
```

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