第一章： 概论

函数，函数式程序设计，
历史回顾，Haskell的特点和例子

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函数

- In Haskell, a function is a mapping that takes one or more arguments and produces a single result.

double x = x + x

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- Computation by function application

```
   double 3
=  { applying double }
   3 + 3
=  { applying + }
   6
```

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- Computation by function application

```
   double (double 2)
=    { applying the inner double }
   double (2 + 2)
=    { applying + }
   double 4
=    { applying double }
   4 + 4
=    { applying + }
   8
```

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- Computation by function application

```
    double (double 2)
=    { applying the outer double }
    double 2 + double 2
=    { applying the first double }
    (2 + 2) + double 2
=    { applying the first + }
    4 + double 2
=    { applying double }
    4 + (2 + 2)
=    { applying the second + }
    4 + 4
=    { applying + }
    8
```

函数式程序设计

- Functional programming is <u>style</u> of programming in which the basic method of computation is the application of functions to arguments;

- A functional language is one that <u>supports</u> and <u>encourages</u> the functional style.

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例子

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 <u>variable assignment</u>.

Summing the integers 1 to 10 in Haskell:

```haskell
sum [] = 0
sum (x:xs) = x + sum xs

sum [1..10]
```

The computation method is <u>function application</u>.

历史回顾

1930s:

Alonzo Church develops the <u>lambda calculus</u>, a simple but powerful theory of functions.

历史回顾

1950s:

John McCarthy develops <u>Lisp</u>, the first functional language, with some influences from the lambda calculus, but retaining variable assignments.
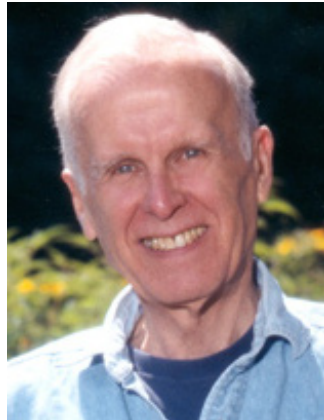
历史回顾

1960s:

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

历史回顾

1970s:

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

历史回顾

1970s:

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

历史回顾

1970s - 1980s:

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

历史回顾

1987:

An advanced, purely functional programming language

An international committee starts the development of <u>Haskell</u>, a standard lazy functional language.
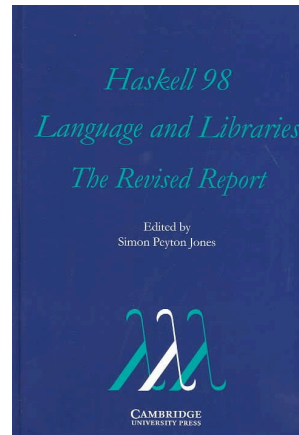
历史回顾

1990s:

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

历史回顾

2003:

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

历史回顾

2010-date:

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

Haskell的特点

- 简洁（声明式）：第2章，第4章
- 强有力的类型系统：第3章，第8章
- List comprehensions: 第5章
- 递归函数：第6章
- 高阶函数：第7章
- 表达副作用的函数：第10章，第12章
- Generic函数：第12章，第14章
- 惰性计算：第15章
- 程序推理：第16章，第17章

例1: 序列求和

```
sum []        = 0
sum (n:ns)   = n + sum ns
```

```
     sum [1,2,3]
=      { applying sum }"
     1 + sum [2,3]
=      { applying sum }
     1 + (2 + sum [3])
=      { applying sum }
     1 + (2 + (3 + sum []))
=      { applying sum }
     1 + (2 + (3 + 0))
=      { applying + }
     6
```

例2: 快速排序

```
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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作业：

【1-1】 Define a function product that produces the product of a list of numbers, and show using your definition that product [2,3,4] = 24.

【1-2】 How should the definition of the function qsort be modified so that it produces a reverse sorted version of a list?

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