Adapted from Graham's lecture slides.

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

函数

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

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

- Computation by function application

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

- Computation by function application

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

- 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 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.

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 variable assignment.

Summing the integers 1 to 10 in Haskell:

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

sum [1..10]
```

The computation method is function application.

历史回顾

1930s:

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

历史回顾

1950s:

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

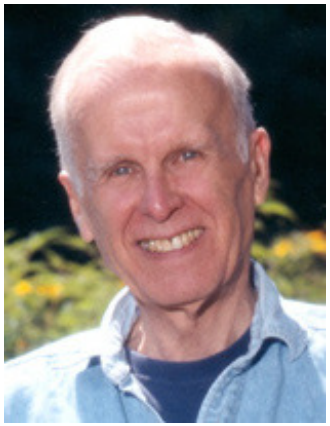
历史回顾

1960s:

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

历史回顾

1970s:



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

历史回顾

1970s:

Robin Milner and others develop ML, 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 Miranda system.

历史回顾

1987:

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

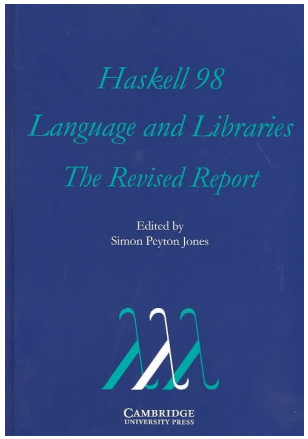
历史回顾

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 Haskell Report, 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

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

例3: 序列求"和"一般化: 高阶函数

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

```
foldr plus zero []        = zero
foldr plus zero  (n:ns)   = plus n (foldr plus zero ns)

sum = foldr (+) 0
```

练习：用foldr定义（1）计算数字列表的乘积；（2）计算列表的长度。

例4: 生成无限序列

```
cyclic = let x = 0 : y
             y = 1 : x
         in x

ns = 0 : foldr f 0 ns
     where  f n r = (1+n) : r
```

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】Define list reverse function using foldr.

【1-3】How should the definition of the function qsort be modified so that it produces a reverse sorted version of a list?