

Programming Language Concepts Notes

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18-1-24

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1 Introduction to Haskell

Functional programming: Functions are central

Garbage collection came first with FP, and recursion is used over loops.

Avoid side effects

Side effects include changing some hidden state. Functions should return the same values when given the same input ideally.

Haskell enforces purity, no side effects

Haskell is statically typed, lazy semantics

FP also used to make compilers and interpreters

Learning Haskell is good for you, a new paradigm and way to think

2 Higher-order functions in Haskell

In FP, functions are first-class

- Can be outputs
- Can be inputs

To call a function f with argument a , $f\ a$

$(f \cdot g)\ x = f\ (g\ x)$

Consider:

$f :: (a \rightarrow b) \rightarrow (a, a) \rightarrow (b, b)$

$f\ g\ (x, y) = (g\ x, g\ y)$

Anonymous function:

$\backslash x \rightarrow x * x$

In definitions:

$id = \backslash x \rightarrow x$

As arguments to higher order functions:

$\text{applyTwice}(\backslash x \rightarrow x * x)$

2.1 Partial Applications and Sections

Suppose we have $f :: \text{Int} \rightarrow \text{Int} \rightarrow \text{Int}$

Then we can write $f\ 3 :: \text{Int} \rightarrow \text{Int}$

$\text{Int} \rightarrow \text{Int} \rightarrow \text{Int}$ is the same as $\text{Int} \rightarrow (\text{Int} \rightarrow \text{Int})$

If we have something like $(+10)$, that is a section

2.2 List Combinators

Consider $\text{map} :: (a \rightarrow b) \rightarrow [a] \rightarrow [b]$

$f :: a \rightarrow b$

$\text{map } f \text{ xs}$ applies f to all elements of xs

$\text{filter} :: (a \rightarrow \text{Bool}) \rightarrow [a] \rightarrow [a]$

$\text{filter } p \text{ xs}$ keeps every element of xs where $p\ x$ is `True`

$\text{zipWith} :: (a \rightarrow b \rightarrow c) \rightarrow [a] \rightarrow [b] \rightarrow [c]$

$\text{zipWith } f [x_1, \dots, x_n][y_1, \dots, y_{(n+k)}] = [f\ x_1\ y_1, \dots, f\ x_n\ y_n]$

$\text{foldr } f\ z\ \text{xs} = f\ x_1\ (f\ x_2\ (\dots\ (f\ x_n\ z)))$

3 Data Types and Recursion

```
data BinTree = Leaf | Node Char BinTree BinTree
```

We can write a function on this data type like

```
height :: BinTree a → Int
```

```
height Leaf = 0
```

```
height (Node x t1 t2) = 1 + max (height t1) (height t2)
```

4 Stuff I didn't take notes on

5 Introduction to Agda