

Lambda Cases

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1 Introduction

Haskell is a delightful language. Yet, for some reason, it doesn't seem to have its rightful place in terms of popularity in industry. Why is it so? Is it inherently hard to learn and therefore only the brave enough students and corporations dare to use it, or could it be that the syntax is perplexing to the amateur eye? It is my belief that with some syntax changes that give a greater familiarity to the new user, there would be no language more compelling than (the new) Haskell. In an attempt to achieve that familiarity, I present some new syntax, of which some is closer to the imperative/OOP style (to attract more already experienced programmers from these languages), some is closer to mathematics (in which most programmers should be experienced) and some is closer to natural language (in which we are all already experienced). Ofcourse, I could not rewrite Haskell from scratch by my self, so I will try to keep the language as small and to the point as possible for now, as well as use as much as I can from Haskell itself, as the new language (Lambda Cases) is compiled to Haskell.

2 Language Description

2.1 Values

As with Haskell a program is a set of values, with the "main" value determining the program's behaviour.

2.1.1 Literals

Literals are the same as Haskell

Examples	Type
1, 2, 17, 42, -100	Int
1.61, 2.71, 3.14, -1234.567	Real
'a', 'b', 'c', 'x', 'y', 'z', '.', ',', '\n'	Char
[1, 2, 3], ['a', 'b', 'c'], [1.61, 2.71, 3.14]	List

2.1.2 Identifiers

lower case or underscore

2.1.3 Operators

Operator	Type	Description
<code>==></code>	$(A, A \rightarrow B) \rightarrow B$	Right function application
<code><==</code>	$(A \rightarrow B, A) \rightarrow B$	Left function application
<code>o></code>	$(A \rightarrow B, B \rightarrow C) \rightarrow (A \rightarrow C)$	Right function composition
<code><o</code>	$(B \rightarrow C, A \rightarrow B) \rightarrow (A \rightarrow C)$	Left function composition
<code>^</code>	$(A)ToThe(B)Gives(C) \Rightarrow (A, B) \rightarrow C$	General exponentiation
<code>*</code>	$(A)And(B)MultiplyTo(C) \Rightarrow (A, B) \rightarrow C$	General multiplication
<code>/</code>	$(A)Divides(B)To(C) \Rightarrow (A, B) \rightarrow C$	General division
<code>+</code>	$(A)And(B)AddTo(C) \Rightarrow (A, B) \rightarrow C$	General addition
<code>-</code>	$(A)SubtractsFrom(B)To(C) \Rightarrow (B, A) \rightarrow C$	General subtraction
<code>= /=</code>	$(A)HasEquality \Rightarrow (A, A) \rightarrow Bool$	Equality operators
<code>> < >= <=</code>	$(A)HasOrder \Rightarrow (A, A) \rightarrow Bool$	Order operators
<code>& </code>	$(Bool, Bool) \rightarrow Bool$	Boolean operators
<code>>>=</code>	$(M)IsAMonad \Rightarrow (M(A), A \rightarrow M(B)) \rightarrow M(B)$	Monad application (right bind)
<code>=<<</code>	$(M)IsAMonad \Rightarrow (A \rightarrow M(B), M(A)) \rightarrow M(B)$	Monad application (left bind)

2.1.4 Functions

2.1.4.1 Abstractions

```
x -> body
(x, y, z) -> body
cases -> body
(x, cases, z) -> body
```

2.1.5 Value Definitions

2.1.5.1 Examples

```
foo: Int
  = 42

val1, val2, val3: Int, Bool, Char
  = 42, true, 'a'

int1, int2, int3: all Int
  = 1, 2, 3

succ: Int -> Int
  = x -> x + 1

f: (Int, Int, Int) -> Int
  = (a, b, c) -> a + b * c
```

2.1.5.2 Description

To define a new value you give it a name, a type and an expression. It is possible to group value definitions by separating the names, the types and the expressions with commas. It is also possible to use the keyword "all" to give the same type to all the values.

Examples in Haskell

```
foo :: Int
foo = 42

val1 :: Int
val1 = 42
val2 :: Bool
val2 = true
val3 :: Char
val3 = 'a'

int1 :: Int
int1 = 1
int2 :: Int
int2 = 2
int3 :: Int
int3 = 3

succ :: Int -> Int
succ = \x -> x + 1

f :: Int -> Int -> Int -> Int
f = \a b c -> a + b * c
```

2.2 Types

2.2.1 Type annotations

2.2.1.1 Differences with Haskell

2.2.2 Type definitions

2.2.2.1 Or Types

Examples

```
or_type Bool
values true | false

or_type Possibly<==A
values indeed<==(value: A) | nothing

or_type ListOf(A)s
values non_empty<==(value: NonEmptyListOf(A)s) | empty

tuple_type NonEmptyListOf(A)s
value (head: T, tail: ListOf(A)s)
```

```

is_empty: ListOf(A)s -> Bool
  = cases ->
    empty -> true
    non_empty -> false

get_head: ListOf(A)s -> Possibly<==A
  = cases ->
    empty -> nothing
    non_empty -> head==>indeed

```

Description

Values of an Or Type are one of many cases that possibly have values of other types inside. Or Types together with Int and Char are the only types on which the "cases" syntax can be used.

Examples in Haskell

```

{-# language LambdaCase #-}

data Bool =
  Ctrue | Cfalse

data Possibly a =
  Cwrapper a | Cnothing

data ListOf_s a =
  Cnon_empty (NonEmptyListOf_s a) | Cempty

data NonEmptyListOf_s a =
  CNonEmptyListOf_s a (ListOf_s a)

is_empty :: ListOf_s a -> Bool
is_empty = \case
  Cempty -> Ctrue
  Cnon_empty (CNonEmptyListOf_s head tail) -> Cfalse

get_head :: ListOf_s a -> Possibly a
get_head = \case
  Cempty -> Cnothing
  Cnon_empty (CNonEmptyListOf_s head tail) -> Cwrapper head

```

2.2.2.2 Autogenerated Functions

Or Types the following have automatically generated functions:

```
is_case:
```

2.2.2.3 Tuple Types

Examples

```

tuple_type ClientInfo
value (name: String, age: Int, nationality: String)

```

```

tuple_type ExprT==>WithPosition
value (expr: ExprT, line: Int, column: Int)

tuple_type (FirstT, SecondT)==>Pair
value (first: FirstT, second: SecondT)

```

Description

Tuple types group many values into a single value.

Examples in Haskell

```

data ClientInfo =
  ClientInfoC String Int String

data WithPosition a =
  WithPositionC a Int Int

data Pair a b =
  PairC a b

```

Autogenerated Functions

2.3 Type Logic

2.3.0.1 Type Predicate

2.3.0.2 Type Theorem

2.4 Grammar

2.4.1 Tokens

2.4.1.1 Keywords

cases use_fields tuple_type or_type

2.4.1.2 Value names

$\langle \text{value-name} \rangle ::= \langle \text{lower-case-letter} \rangle (\langle \text{lower-case-letter} \rangle \mid \text{'_'})^*$

2.4.1.3 Type names

$\langle \text{type-name} \rangle ::= \langle \text{upper-case-letter} \rangle (\langle \text{upper-case-letter} \rangle \mid \langle \text{lower-case-letter} \rangle)^*$

2.4.2 Core Grammar

2.4.2.1 Program

$\langle \text{program} \rangle ::= (\langle \text{value-defs} \rangle \mid \langle \text{type-def} \rangle)^+$

$\langle value-defs \rangle ::= \langle value-names \rangle \text{'::'} (\langle types \rangle \mid \text{'all'} \langle type \rangle) \text{'\n_{\square\square}='} \langle value-exprs \rangle$

$\langle value-names \rangle ::= \langle value-name \rangle (\text{' , ' } \langle value-name \rangle)^*$

$\langle types \rangle ::= \langle type \rangle (\text{' , ' } \langle type \rangle)^*$

$\langle value-exprs \rangle ::= \langle value-expr \rangle (\text{' , ' } \langle value-expr \rangle)^*$

2.4.2.2 Types

$\langle type \rangle ::= \langle func-type \rangle \mid \langle prod-type \rangle \mid \langle type-app \rangle$

$\langle func-type \rangle ::= \langle input-types-expr \rangle \text{'\square->\square'} \langle output-type \rangle$

$\langle prod-type \rangle ::= \langle prod-sub-type \rangle (\text{'\square x \square'} \langle prod-sub-type \rangle)^+$

$\langle type-app \rangle ::= [\langle t-inputs \rangle \text{'==>'}] \langle type-name \rangle [\text{'<=='} \langle t-inputs \rangle]$

$\langle input-types-expr \rangle ::= \langle many-ts-in-paren \rangle \mid \langle one-type \rangle$

$\langle output-type \rangle ::= \langle prod-type \rangle \mid \langle type-app \rangle$

$\langle prod-sub-type \rangle ::= \text{'('} (\langle func-type \rangle \mid \langle prod-type \rangle) \text{') ' } \mid \langle type-app \rangle$

$\langle one-type \rangle ::= \text{'('} \langle func-type \rangle \text{') ' } \mid \langle prod-type \rangle \mid \langle type-app \rangle$

$\langle t-inputs \rangle ::= \langle many-ts-in-paren \rangle \mid \text{'('} \langle type \rangle \text{') ' } \mid \langle type-name \rangle$

$\langle many-ts-in-paren \rangle ::= \text{'('} \langle type \rangle (\text{' , ' } \langle type \rangle)^+ \text{') '}$

2.4.2.3 Value Expressions

$\langle value-expr \rangle ::= [\langle input-expr \rangle] \langle cases-or-where \rangle \mid \langle op-expr \rangle$

$\langle \text{cases-or-where} \rangle \quad ::= \langle \text{cases-expr} \rangle \mid \langle \text{where-expr} \rangle$

$\langle \text{where-expr} \rangle \quad ::= \text{'let'} \langle \text{spicy-nl} \rangle (\langle \text{value-defs} \rangle \langle \text{spicy-nls} \rangle) + \text{'in'} \langle \text{value-expr} \rangle \langle \text{spicy-nl} \rangle$

$\langle \text{cases-expr} \rangle \quad ::= \text{'cases'} (\langle \text{case} \rangle) + [\langle \text{default-case} \rangle]$

3 Parser implimentation

The parser was implemented using the parsec library.

3.1 AST Types

3.2 Parsers

4 Translation to Haskell

5 Running examples

6 Conclusion

7 To be removed or incorporated

Addition/Subtraction:

```
+ : (A)HasAddition => (A, A) -> A
- : (A)HasSubtraction => (A, A) -> A
```

Equality and ordering:

```
= : (A)HasEquality => (A, A) -> Bool
<= : (A)HasOrder => (A, A) -> Bool
>= : (A)HasOrder => (A, A) -> Bool
```

```
(fmap)<inside> — (W)IsAWrapper => (A -> B, W(A)) -> W(B) — Apply inside operator
(<*>)<wrapped_inside> — (W)IsAWrapper => (W(A -> B), W(A)) -> W(B) — Order operators
```

better as postfix functions