Haskell and Circuit Design

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1 What's Haskell

2 Type in Haskell

3 Function in Haskell

4 Type Class

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What's Haskell

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  - lazy
  - purely functional language

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- Haskell is functional language. In particular, it is a
  - polymorphically
  - statically typed
  - lazy
  - purely functional language
- Haskell is based on the lambda calculus.

1. What’s Haskell
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Type in Haskell

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Type in Haskell

- Type inference
  - Automatically deduce the types of expressions
- Basic types
  - Char, Bool, Int, Integer, []...
- Define a new type
  - data BookInfo = Book Int String [String] deriving (show)

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Function in Haskell

Function in Haskell

- Basic funtions
  - lines
  - map
  - ...
  - odd $3- > $ True

Function in Haskell

- Basic funtions
  - lines
  - map
  - ...
  - odd $3- >$ True
- Type of function

```
:t {function_name}
```

Function in Haskell

- Define a funtion

```
upperCase :: String -> String
upperCase (x:xs) = toUpper x : upperCase xs
upperCase [ ]  [ ]
```

Function in Haskell

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```
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```

- Anonymous (lambda functions)

```
unsafeHead = \(x:_) -> x
```

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Type Class

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What are type classes?

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- Define a set of functions that can have different implementations depending on the type of data they are given.

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What are type classes?

- Define a set of functions that can have different implementations depending on the type of data they are given.
- Without type classes

```
stringEq :: [Char] -> [Char] -> Bool
intEq      ::    Int  -> Int -> Bool
```

Type Class

- Definition of typeclass

```
class  BasicEq a where
       isEqual  ::  a -> a -> Bool
```

```
class  Monad m where
       >>= :: Monad m => m a -> (a -> m b) -> m b
```

Type Class

- Definition of typeclass

```
class BasicEq a where
      isEqual :: a -> a -> Bool
```

```
class Monad m where
      >>= :: Monad m => m a -> (a -> m b) -> m b
```

- Instance of typeclass

```
instance BasicEq Bool where
         isEqual True True = True
         isEqual False False = True
         isEqual _ _ False
```

Type Class

- Typeclass inheritance

```
class Monad m => Circuit m where
      and2, or2 :: (Bit, Bit) -> m Bit
```

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5. **Monad**
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Monad

Monad

Why monad?

Monad

Why monad?

- Actions & Sequencing

```
main = do    putStrLn Greetings! What is your name?
             inpStr <- getLine
             putStrLn & Welcome to Haskell, ++ inpStr
        ++ !
```

```
main  = putStrLn Greetings! What is your name? >>
        getLine >>=
        (\inpStr -> putStrLn $ Welcome to Haskell, ++
        inpStr ++ !)
```

Monad

Monad type class

```
class  Monad m where
```

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class Monad m where
```

- >>=

```
>>= :: m a -> (a -> m b) -> m b
print foo >>= \_ -> print bar
```

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Monad type class

```
class Monad m where
```

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```
>>= :: m a -> (a -> m b) -> m b
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```

- return

```
return  ::  a -> m a
return 9
```

Monad

- >>

```
>>  ::   m a -> m b -> m b
print foo >> print bar
```

Monad

- >>

```
>>   ::   m a -> m b -> m b
print  foo >> print bar
```

- fail

```
fail   String  -> m a
fail   error
```

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Lava – build circuit with Haskell

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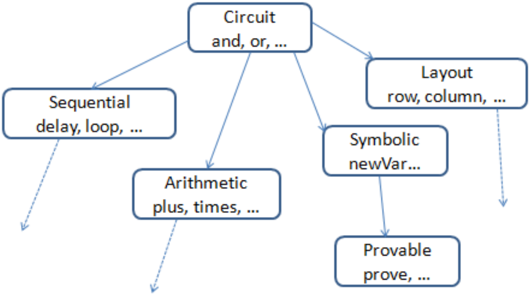
- Types
  - Bit (low,high)
  - NumSig
  - CmplxSig

Lava – build circuit with Haskell

- Types
  - Bit (low,high)
  - NumSig
  - CmplxSig

- Type class
  - Circuit
  - Sequential
  - Layout
  - Symbolic
  - Arithmetic
  - Provable



Lava – build circuit with Haskell

Lava – build circuit with Haskell

- Build in funtions

```
(>->) :: Circuit m => (a -> m b) -> (b -> m c) -> (a -> m c)
    compose :: Circuit m => [a -> m a] -> (a -> m a)
    one :: Circuit m => ([a] -> m [a]) -> ([a] -> m [a])
    two :: Circuit m => ([a] -> m [b]) -> ([a] -> m [b])
```

Thank you!

Q & A