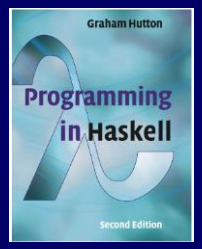
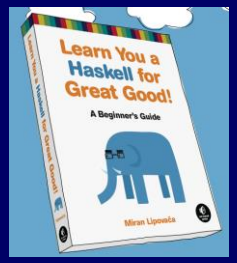
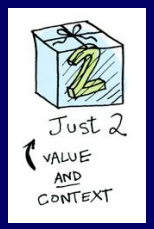
# State Monads

Monads




Based on lecture notes by Graham Hutton, the book "Learn You a Haskell for Great Good", pictures from Aditya Bhargava, and https://wiki.haskell.org/State_Monad

# Monads

We have seen how Monads work.

There is a nice introduction to Writer, Reader and State Monads here (Aditya Bhargava)

We will look at the State Monad most closely.

# State Monad

```
import Control.Monad.State
--will include
newtype State s a = State { runState :: (s -> (a,s)) }
```

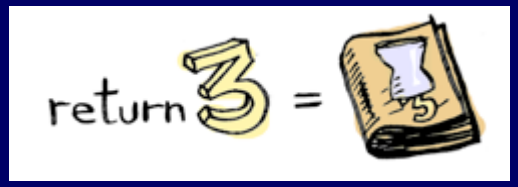
There are a few things going on here

- *newtype* is a lot like *data*, except for some details
- what's "in" our data type? It's a function! And we're implicitly defining a function to extract our inner function from the data type: that function is called runState
- It's type is *s -> (a,s)*. Essentially, it's a type for any function that takes some initial state and then returns a tuple of *(regular return value, new state)*.

# State Monad – primitives return, runState

```
> runState (return 'X') 1
('X', 1)
```

return --set the result value but leave the state unchanged.




```
return a = State $ \s -> (a, s)
```

# State Monad - put

**put** -- set the result value to () and set the state value.

```
-- ie: (put 5) 1 -> ((),5)
put :: s -> State s
put x s = ( () ,x)
```

# State Monad - get

**get** - set the result value to the state and leave the state unchanged

```
>runState get 1
(1, 1)
```

# State Monad - helpers

**evalState** and **execState** just select one of the two values returned by runState.
EvalState returns the final result while execState returns the final state:

```
evalState :: State s a -> s -> a
evalState act = fst . runState act


execState :: State s a -> s -> s
execState act = snd . runState act
```

# State Monad –simple example

```
import Control.Monad.State

greeter :: State String String
greeter = do
        name <- get
        put "Some State"
        return ("hello, " ++ name ++ "!")


>runState greeter “Mairead”
("hello, Mairead!","Some State")
```

# State Monad - parse example

```
import Control.Monad.State
-- Example use of State monad
- Passes a string of dictionary {a,b,c}
-- Game is to produce a number from the string.
-- By default the game is off, a c toggles the
-- game on and off. A 'a' gives +1 and a b gives -1.
-- E.g -- 'ab' = 0 -- 'ca' = 1 -- 'cabca' = 0
-- State = game is on or off & current score
--       = (Bool, Int)
```

# State Monad - parse example

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-- State = game is on or off & current score
--       = (Bool, Int)
```

# State Monad - parse example

```
type GameValue = Int
type GameState = (Bool, Int)
playGame :: String -> State GameState GameValue playGame []
= do
      (_, score) <- get
       return score
playGame (x:xs) = do
       (on, score) <- get
       case x of
              'a' | on -> put (on, score + 1)
              'b' | on -> put (on, score - 1)
              'c' -> put (not on, score)
              _ -> put (on, score)
       playGame xs
startState = (False, 0)
main = print $ evalState (playGame "abcaaacbbcabbab") startState
```

# State Monad – stack example

```
import Control.Monad.State
type Stack = []

pop :: State Stack Int
pop = state $ \(x:xs) -> (x, xs)

push :: Int -> State Stack ()
push a = state $ \xs -> ((), a:xs)
```

# State Monad – stack example

```
stackManip :: State Stack Int
stackManip = do
        push 3
        a <- pop
        pop
```

Run as

```
>runState stackManip [1,2,3]
(1,[2,3])
```

# State Monad – stack example

```
stackStuff :: State Stack ()
stackStuff = do
        a <- pop
        if a == 5
                then push 5
                else do
                        push 3
                        push 8
```

Run as

```
>runState stackStuff [9,0,2,1,0]
(1,[2,3])
```