

### Composition and application

`(.) :: (b -> c) -> (a -> b) -> a -> c` function composition

`(\$) :: (a -> b) -> a -> b` application operator, has low, right-associative binding precedence, for example  
`f \$ g \$ h x = f (g (h x))`

### Monoid

typeclass where empty/append are defined

`mempty :: Monoid a => a` identity of mappend (mappend mempty x = x)

`mappend :: Monoid a => a -> a -> a` append two monoids (associative: brackets does not matter)  
`mappend x (mappend y z) = mappend (mappend x y) z`

`<> :: Monoid m => m -> m -> m` infix synonym for mappend ("he" <> "llo")

`mconcat :: [a] -> a` fold list using mappend and mempty

### Functor

typeclass where `fmap` (`map/<$>`) is defined

should satisfy laws

`fmap id == id`  
`fmap (f . g) == fmap f . fmap g`

`fmap :: Functor f => (a -> b) -> f a -> f b`

map function over functor  
`fmap (+1) (Just 3) is Just 4`

`<$> :: Functor f => (a -> b) -> f a -> f b`

function mapped over functor  
 infix synonym for `fmap`  
`(+1) <$> (Just 3) is Just 4`

### Applicative

typeclass where `pure/<*>` are defined

have `Functor` as super class

every instance of `Applicative` must have instance of `Functor`  
 so `fmap` (`map/<$>`) can be used

`pure :: Applicative f => a -> f a`

create an instance of `Applicative`  
`pure 3 :: [Int] is [3]`  
`pure 3 :: Maybe Int is Just 3`  
`pure (+3) :: Maybe (Int -> Int) is Just a function from Int to Int`  
`pure (+3) :: [Int -> Int] is list of function`  
`pure 1 :: IO Int is how it is printed in ghci`

`(<*>) :: Applicative f => f (a -> b) -> f a -> f b`

sequential application / apply  
`Just (+1) <*> Just 1 :: Maybe Int is Just 2`  
`[(+1), (+2)] <*> [0] :: [Int] is [1, 2]`



### Monad

typeclass

have `Applicative` as super class

every instance of `Monad` must have instance of `Applicative` and `Functor`  
so `fmap (map/<$>)` and `<*>/pure` can be used

`return :: Monad m => a -> m a`

is `pure`

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

sequentially compose two monads, first is usually

`Just 2 >> Just 3` is `Just 3`

`Nothing >> Just 3` is `Nothing`

`[9, 9] >> [0, 0, 0]` is `[0,0,0,0,0,0]`

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

bind, sequentially compose two monads, value of first passed as argument to the second

`Just 3 >>= \x -> Just (x + 1)` is `Just 4`

`Nothing >>= \x -> Just (x + 1)` is `Nothing`

`[0, 0] >>= \x -> [x + 1]` is `[1, 1]`

`[0, 0] >>= \x -> [x + 1, 2]` is `[1,2,1,2]`

`[] >>= \x -> [x + 1]` is `[]`



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