

Functor (1A)

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Based on

<http://learnyouahaskell.com/making-our-own-types-and-typeclasses#the-functor-typeclass>

Haskell in 5 steps

https://wiki.haskell.org/Haskell_in_5_steps

Typeclasses

Typeclasses are like **interfaces**

defines some **behavior**

- comparing for equality
- comparing for ordering
- enumeration

Instances of that typeclass

types possessing such behavior

Such behavior is defined by

function definition

type declaration to be implemented

a type is an instance of a typeclass implies

the functions defined by the typeclass with that type can be used

No relation with classes in Java or Python

<http://learnyouahaskell.com/making-our-own-types-and-typeclasses#the-functor-typeclass>

A Typeclass Example

the Eq typeclass

defines the functions `==` and `/=`

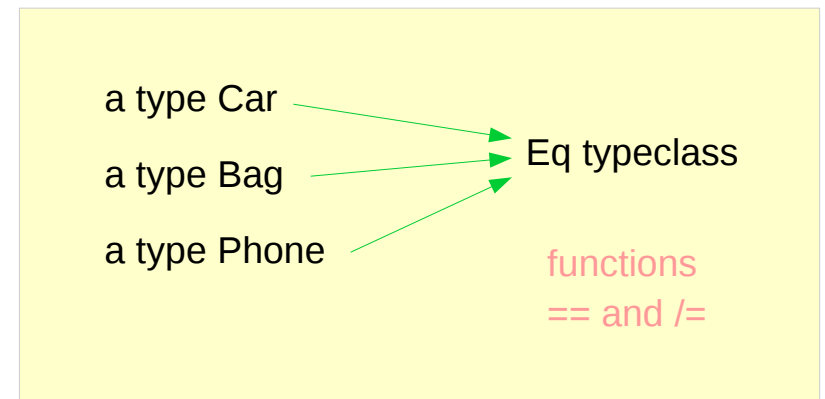
a type Car

comparing two cars `c1` and `c2` with the equality function `==`

The Car type is an instance of Eq typeclass

Instances : various types

Typeclass : a group or a class of these similar types



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Eq Typeclass Example

class Eq a **where**

<code>(==) :: a -> a -> Bool</code>	- a type declaration
<code>(/=) :: a -> a -> Bool</code>	- a type declaration
<code>x == y = not (x /= y)</code>	- a function definition
<code>x /= y = not (x == y)</code>	- a function definition

data TrafficLight = Red | Yellow | Green

instance Eq TrafficLight **where**

```
Red == Red = True
Green == Green = True
Yellow == Yellow = True
_ == _ = False
```

```
ghci> Red == Red
True
ghci> Red == Yellow
False
ghci> Red `elem` [Red, Yellow, Green]
True
```

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Show Typeclass Example

```
class Show a where  
  show :: a -> String      - a type declaration  
  * * *
```

```
data TrafficLight = Red | Yellow | Green
```

```
instance Show TrafficLight where  
  show Red = "Red light"  
  show Yellow = "Yellow light"  
  show Green = "Green light"
```

```
ghci> [Red, Yellow, Green]  
[Red light, Yellow light, Green light]
```

<http://learnyouahaskell.com/making-our-own-types-and-typeclasses#the-functor-typeclass>

Show Typeclass Example

```
class (Eq a) => Num a where
```

```
...
```

```
class Num a where
```

```
...
```

class constraint on a class declaration

only we state that our type `a` must be an instance of `Eq`

an instance of `Eq`

before being an instance of `Num`

When defining the required function bodies

in the **class declaration** or

in **instance declarations**,

we can safely use `==` because `a` is a part of `Eq`

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Show Typeclass Example

class constraints in **class declarations**

to make a typeclass a **subclass** of another typeclass

class constraints in **instance declarations**

to express **requirements** about the contents of some type.

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Show Typeclass Example

the **a** : a concrete type

Maybe : not a concrete type
: a type constructor that takes one parameter
produces a concrete type.

Maybe a : a concrete type

instance (Eq m) => Eq (Maybe m) where
Just x == **Just** y = x == y
Nothing == **Nothing** = True
_ == _ = False

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Functor typeclass

the Functor typeclass is basically for things that can be mapped over

ex) mapping over lists

the list type is part of the Functor typeclass

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Functor typeclass

class **Functor** **f** where

fmap :: (a -> b) -> **f** a -> **f** b

The Functor typeclass

defines one function, **fmap**,
no default implementation

the type variable **f**

not a concrete type (a concrete type can hold a value)

a **type constructor** taking one **type parameter**

Maybe Int : a concrete type

Maybe : a type constructor that takes one type as the parameter

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Functor typeclass

class **Functor** **f** where

fmap :: (a -> b) -> **f** a -> **f** b

fmap takes

- a **function** from one type to another (a -> b)
- a **functor** **f** applied with one type
- returns a **functor** **f** applied with another type.

map :: (a -> b) -> [a] -> [b]

map takes

- a **function** from one type to another
- a **list** of one type
- returns a **list** of another type

map is just a fmap that works only on lists. Here's how the list is an instance of the Functor typeclass.

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Functor typeclass

class **Functor** **f** where

fmap :: (a -> b) -> **f** a -> **f** b

map :: (a -> b) -> **[a]** -> **[b]**

map is just a fmap that works only on lists

Here's how the list is an instance of the Functor typeclass.

instance **Functor** **[]** where

fmap = **map**

f : a type constructor that takes one type

[] : a type constructor that takes one type

[a] : a concrete type ([Int], [String] or [[String]])

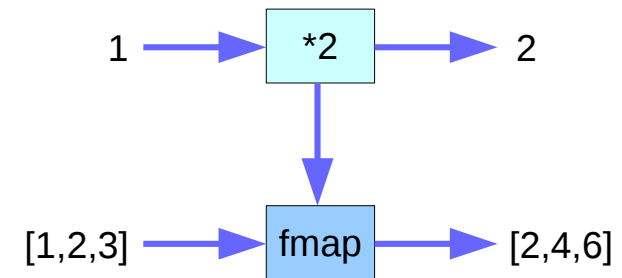
```
map :: (a -> b) -> [a] -> [b]
```

```
ghci> fmap (*2) [1..3]
```

```
[2,4,6]
```

```
ghci> map (*2) [1..3]
```

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[2,4,6]
```

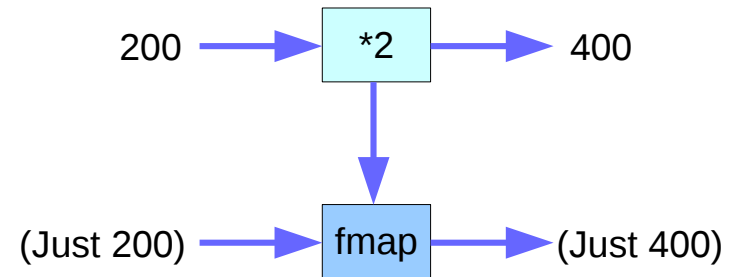


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Functor typeclass

```
ghci> fmap (*2) (Just 200)
Just 400
ghci> fmap (*2) Nothing
Nothing
```

```
ghci> fmap (++ " HEY GUYS IM INSIDE THE JUST") (Just "Something serious.")
Just "Something serious. HEY GUYS IM INSIDE THE JUST"
ghci> fmap (++ " HEY GUYS IM INSIDE THE JUST") Nothing
Nothing
```



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Functor typeclass

class **Functor** **f** where

fmap :: (a -> b) -> **f** a -> **f** b

instance **Functor** **Maybe** where

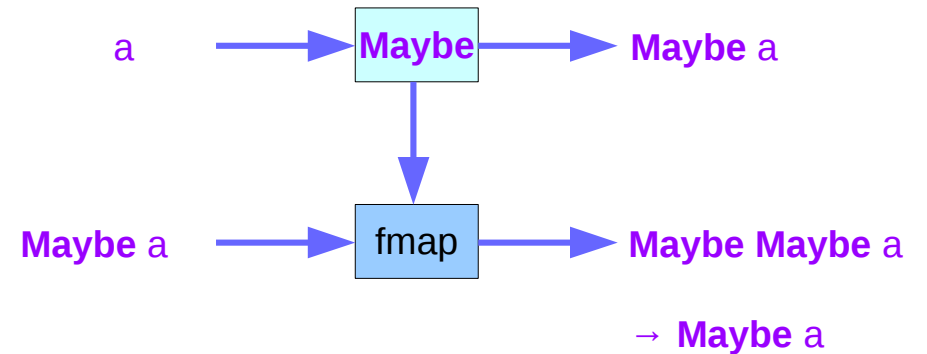
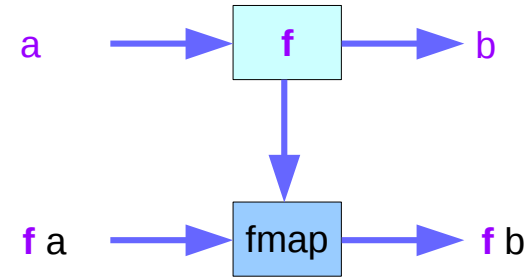
fmap **f** (**Just** x) = **Just** (**f** x)

fmap **f** **Nothing** = **Nothing**

If an empty value of **Nothing**, then just return a **Nothing**.

If a single value packed up in a **Just**,

then we apply the function on the contents of the **Just**.



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Maybe as a functor

Functor typeclass:

- transforming one type to another
- transforming operations of one type to those of another

Maybe a is an instance of a **functor** type class

Functor provides **fmap** method

maps functions of the *base type* (such as *Integer*)
to *functions* of the *lifted type* (such as *Maybe Integer*).

<https://stackoverflow.com/questions/18808258/what-does-the-just-syntax-mean-in-haskell>

Maybe as a functor

A *function* `f` transformed with `fmap`
can work on a `Maybe` value

case maybeVal of

```
Nothing -> Nothing    -- there is nothing, so just return Nothing  
Just val -> Just (f val) -- there is a value, so apply the function to it
```

```
father :: Person -> Maybe Person  
mother :: Person -> Maybe Person
```

```
    f :: Int          -> Int  
fmap f :: Maybe Integer -> Maybe Integer
```

a `Maybe Integer` value: `m_x`

```
fmap f m_x
```

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Maybe as a functor

In fact, you could apply a whole chain of **lifted Integer -> Integer** functions to **Maybe Integer** values and only have to worry about explicitly checking for **Nothing** once when you're finished.

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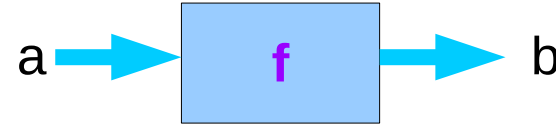
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References

- [1] <ftp://ftp.geoinfo.tuwien.ac.at/navratil/HaskellTutorial.pdf>
- [2] <https://www.umiacs.umd.edu/~hal/docs/daume02yaht.pdf>