HASKELL

By Marco and Jan

QUOTE: “…”

A Haskell developer after his script did not compile for the 42th time!

Contents

- Functional Programming: Principles
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- Where are my loops?
- Pure Functions
- We maybe have side-effects…
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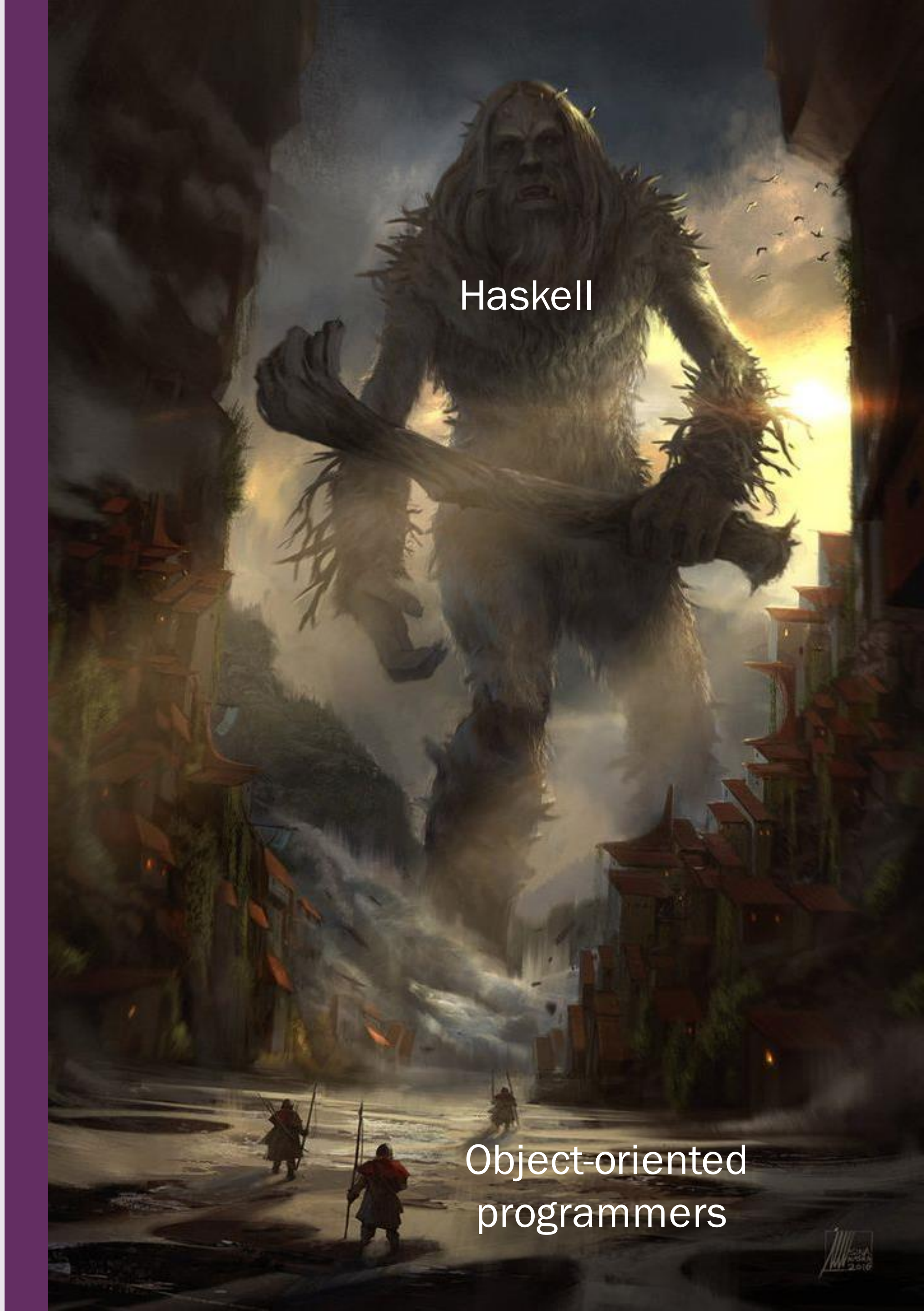
Principles of Functional Programming

- Immutability
  - *Variables cannot be changed*
- No side-effects
- Pure Functions



So what is Haskell?

- Purely functional programming language
- You tell the computer what stuff is, rather than what to do (declarative style)
- Features:
  - *Type inference*
  - *Statically typed*
  - *Lazyness*
  - *Many, many more…*

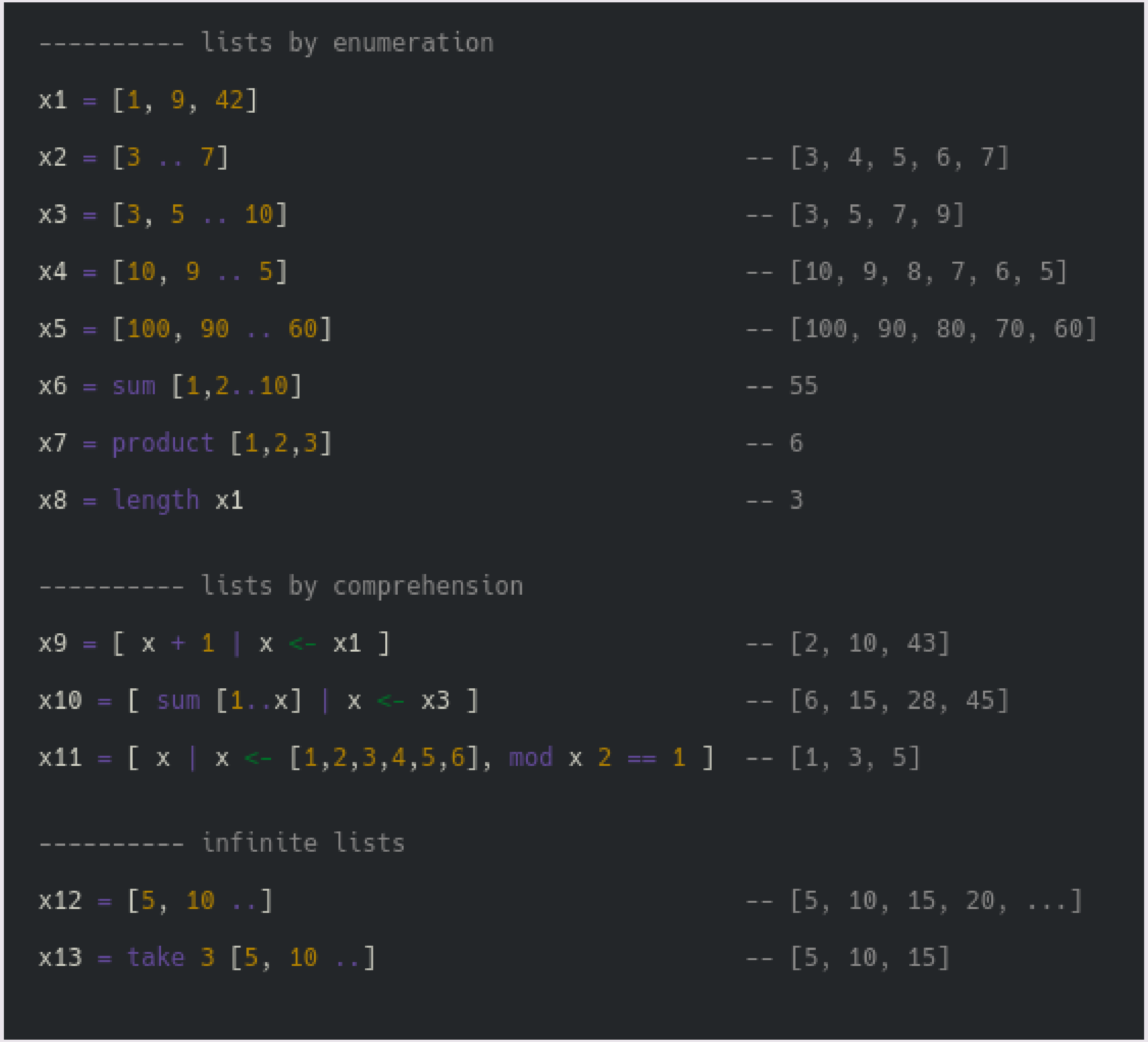
„You can be lazy, if you are smart!“

To Infinity and Beyond!

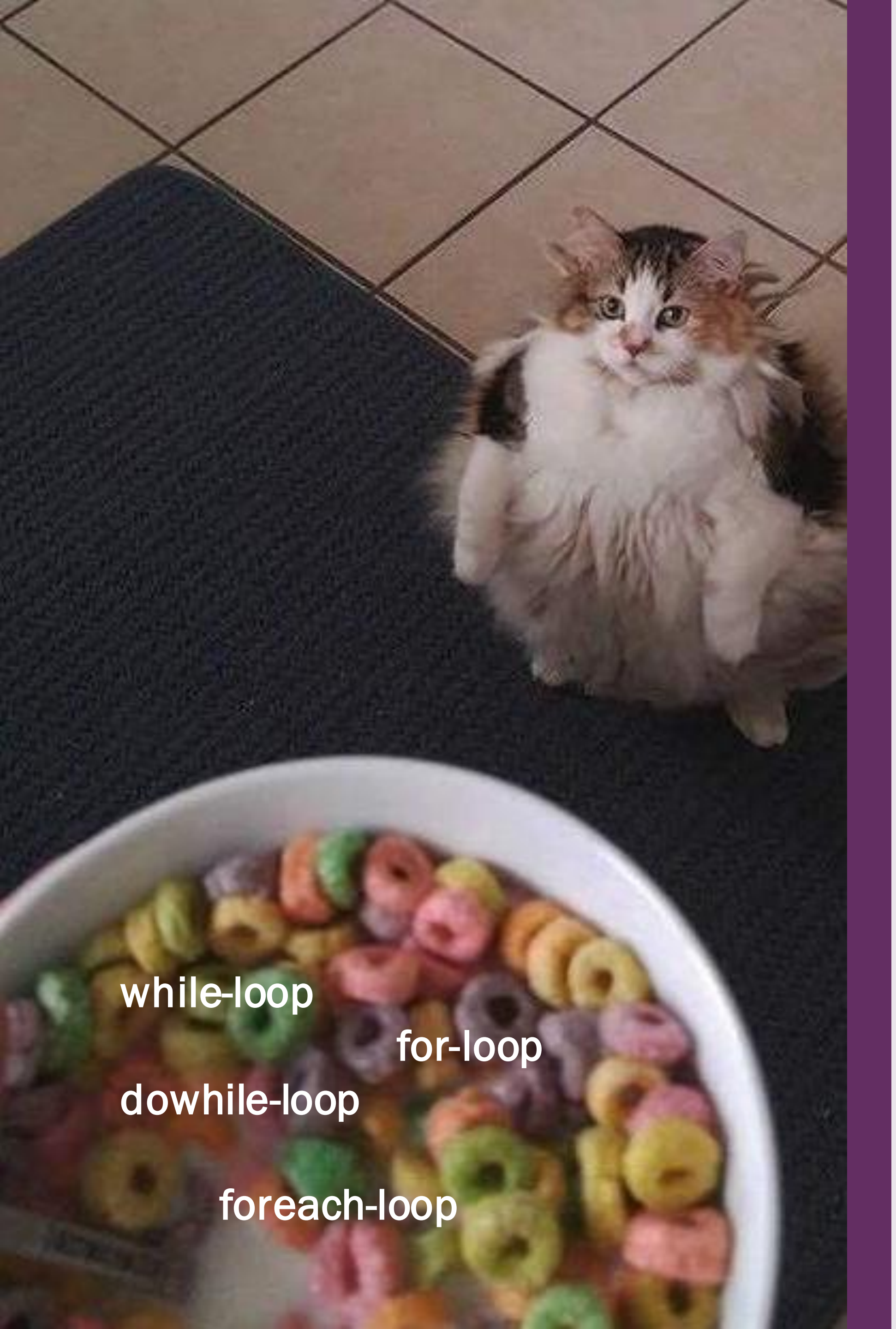
- Haskell
  - *evaluates lazy*
  - *supports infinite lists*

Attention: Infinite Lists might crash your IDE, if your not lazy enough!!!

INFINITE DATA STRUCTURES CHEATSHEET



```
---------- lists by enumeration

x1 = [1, 9, 42]

x2 = [3 .. 7]                                  -- [3, 4, 5, 6, 7]

x3 = [3, 5 .. 10]                              -- [3, 5, 7, 9]

x4 = [10, 9 .. 5]                              -- [10, 9, 8, 7, 6, 5]

x5 = [100, 90 .. 60]                           -- [100, 90, 80, 70, 60]

x6 = sum [1,2..10]                             -- 55

x7 = product [1,2,3]                           -- 6

x8 = length x1                                 -- 3


---------- lists by comprehension

x9 = [ x + 1 | x <- x1 ]                       -- [2, 10, 43]

x10 = [ sum [1..x] | x <- x3 ]                 -- [6, 15, 28, 45]

x11 = [ x | x <- [1,2,3,4,5,6], mod x 2 == 1 ] -- [1, 3, 5]


---------- infinite lists

x12 = [5, 10 ..]                               -- [5, 10, 15, 20, ...]

x13 = take 3 [5, 10 ..]                        -- [5, 10, 15]
```

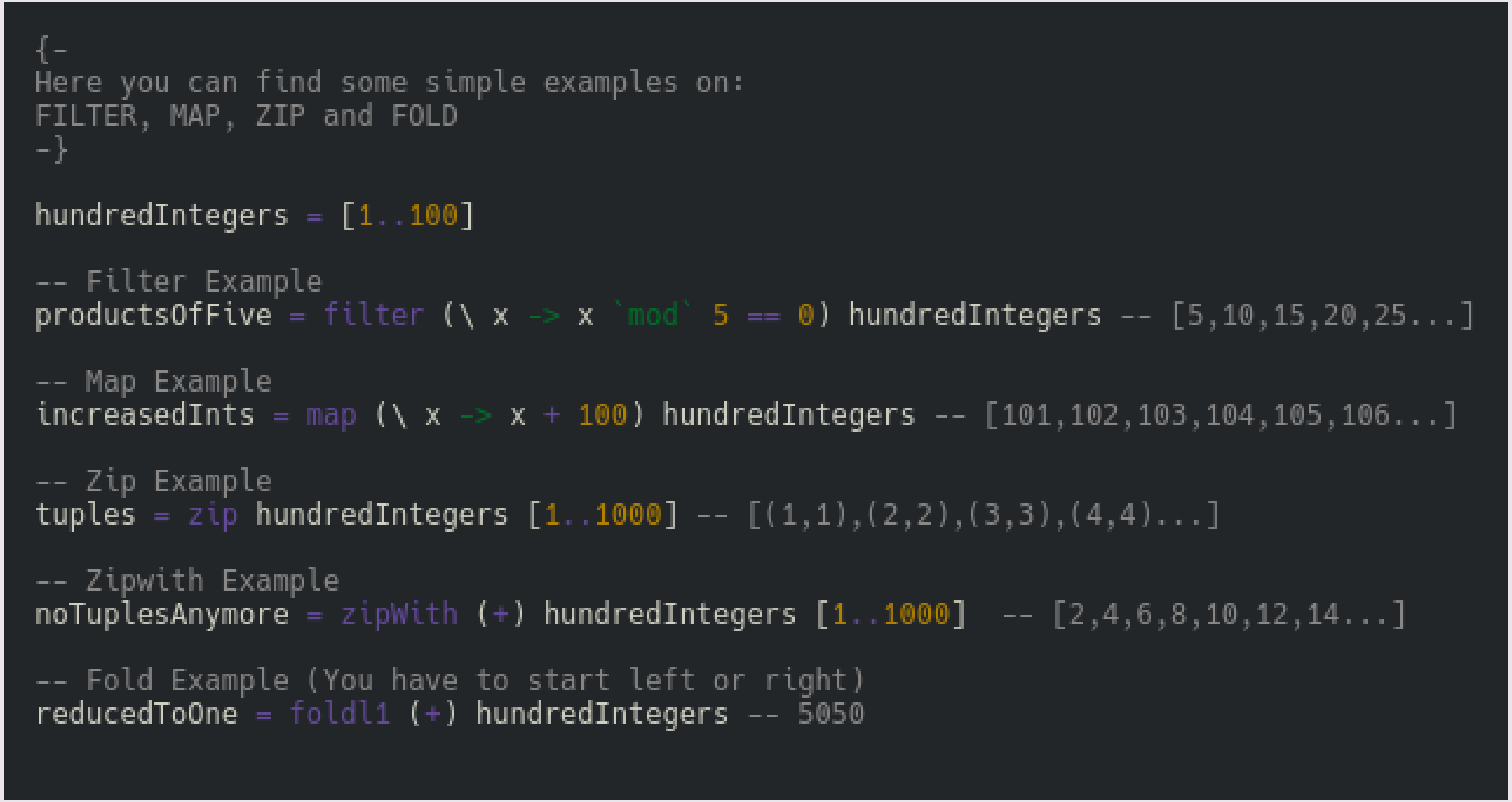


Where are my loops?

Nah, man... Use Higher Order Functions!

- Remember: imperative vs. declarative style
- But how do I work with lists then?
  - *MAP*
    - Transform elements in a list
  - *FOLD (left, right)*
    - Reduce list to one value
  - *ZIP (with)*
    - Combine elements from two lists
  - *FILTER*
    - well... removing some elements
- Do you remember **lambda** calculus?

FOLD, MAP, ZIP, FILTER Cheatsheet

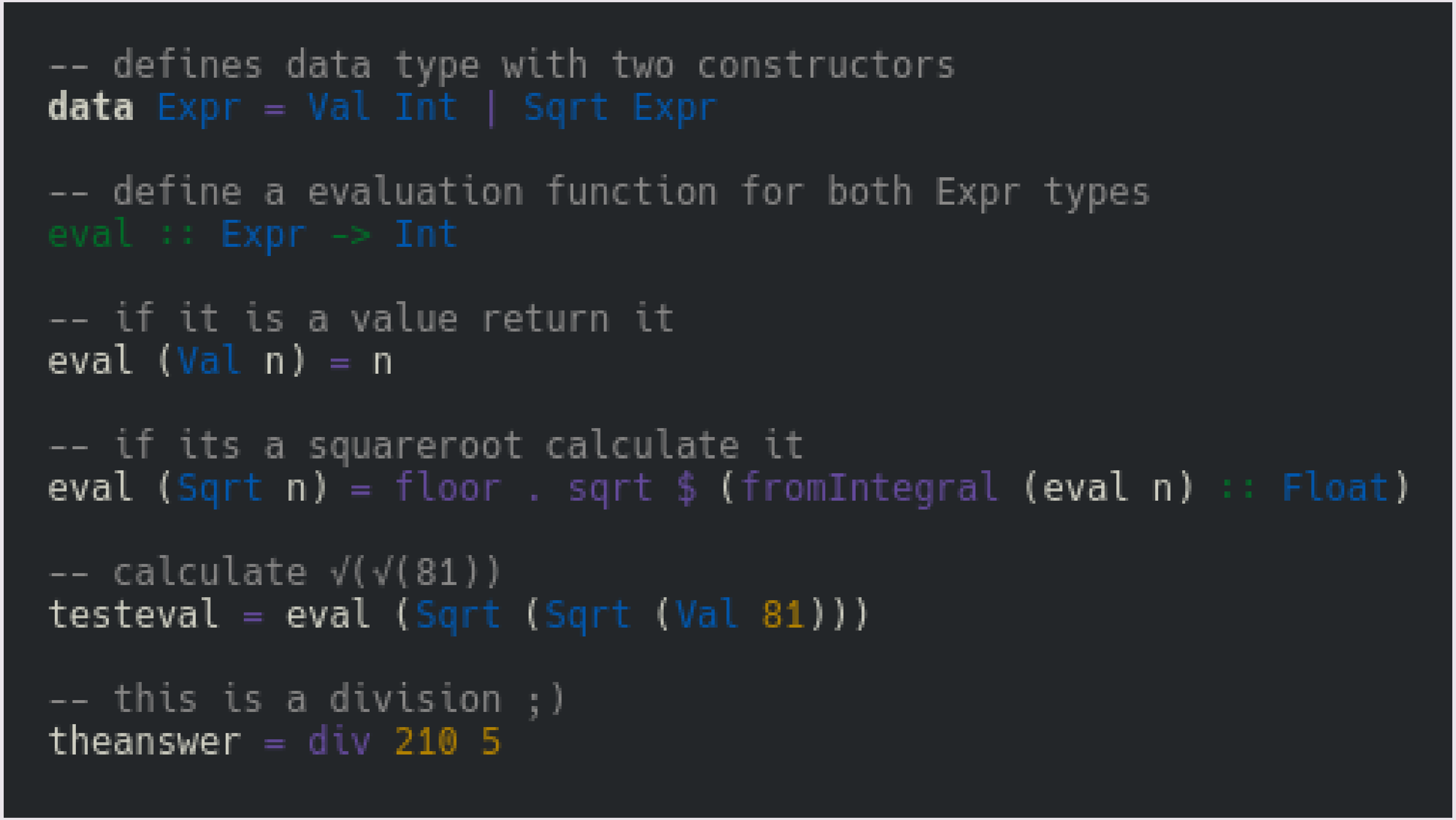


```haskell
{-
Here you can find some simple examples on:
FILTER, MAP, ZIP and FOLD
-}

hundredIntegers = [1..100]

-- Filter Example
productsOfFive = filter (\ x -> x `mod` 5 == 0) hundredIntegers -- [5,10,15,20,25...]

-- Map Example
increasedInts = map (\ x -> x + 100) hundredIntegers -- [101,102,103,104,105,106...]

-- Zip Example
tuples = zip hundredIntegers [1..1000] -- [(1,1),(2,2),(3,3),(4,4)...]

-- Zipwith Example
noTuplesAnymore = zipWith (+) hundredIntegers [1..1000]  -- [2,4,6,8,10,12,14...]

-- Fold Example (You have to start left or right)
reducedToOne = foldl1 (+) hundredIntegers -- 5050
```

Pure Functions and Haskell

- All functions take a parameter
- All functions must return a value
- Anytime a function is called with the same parameter it returns the same value
  - *Output depends ONLY on parameters*

Pure Functions in Practice

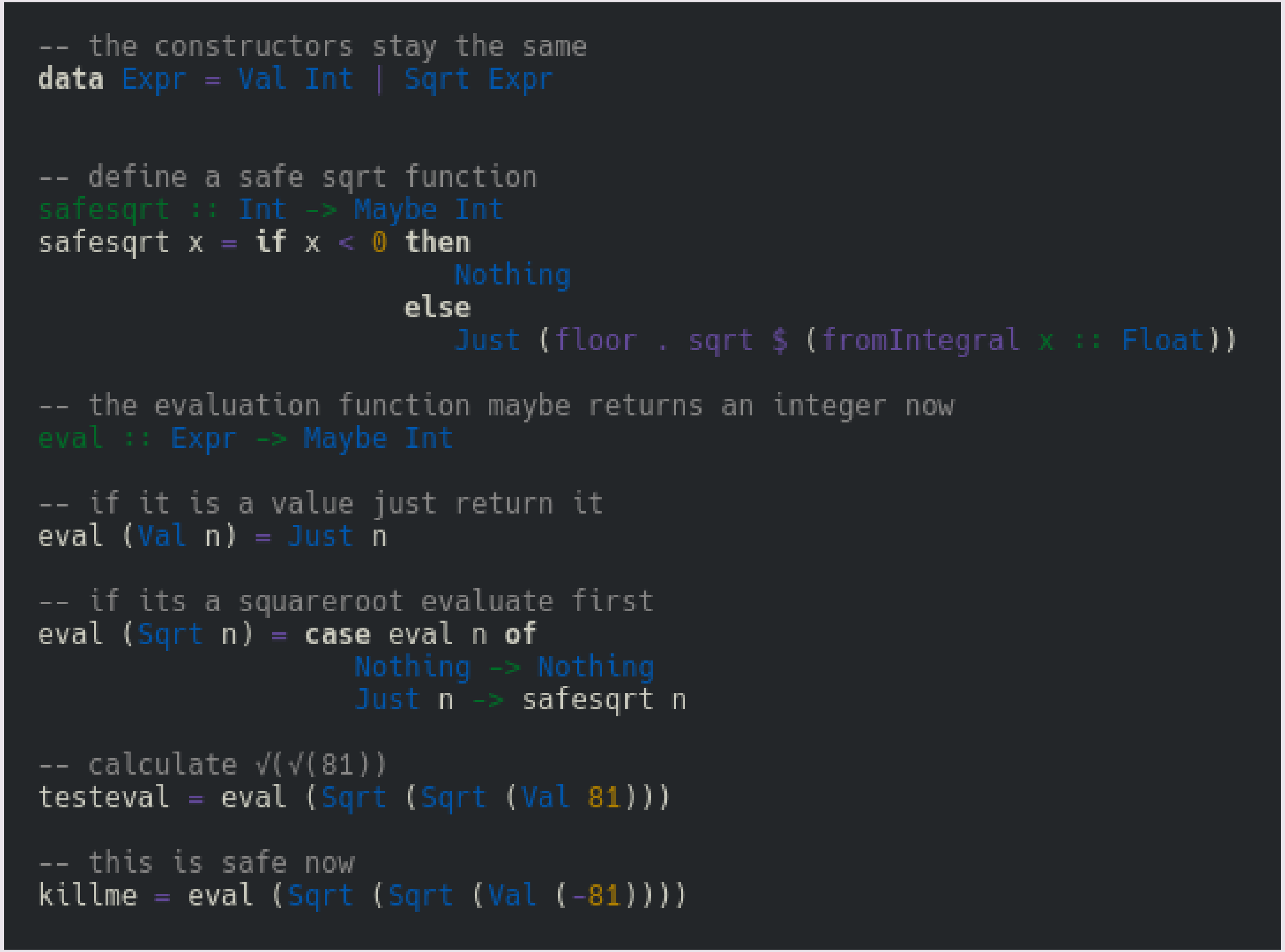


```haskell
-- defines data type with two constructors
data Expr = Val Int | Sqrt Expr

-- define a evaluation function for both Expr types
eval :: Expr -> Int

-- if it is a value return it
eval (Val n) = n

-- if its a squareroot calculate it
eval (Sqrt n) = floor . sqrt $ (fromIntegral (eval n) :: Float)

-- calculate √(√(81))
testeval = eval (Sqrt (Sqrt (Val 81)))

-- this is a division ;)
theanswer = div 210 5
```

„No side-effects? You must be kidding!“

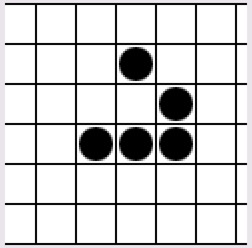
- In the real world things **maybe** go wrong…
- We cannot find a file **maybe**…
- **Maybe** Haskell knows a solution…

Maybe - Assignment



```haskell
-- the constructors stay the same
data Expr = Val Int | Sqrt Expr


-- define a safe sqrt function
safesqrt :: Int -> Maybe Int
safesqrt x = if x < 0 then
                         Nothing
                      else
                         Just (floor . sqrt $ (fromIntegral x :: Float))

-- the evaluation function maybe returns an integer now
eval :: Expr -> Maybe Int

-- if it is a value just return it
eval (Val n) = Just n

-- if its a squareroot evaluate first
eval (Sqrt n) = case eval n of
                   Nothing -> Nothing
                   Just n -> safesqrt n

-- calculate √(√(81))
testeval = eval (Sqrt (Sqrt (Val 81)))

-- this is safe now
killme = eval (Sqrt (Sqrt (Val (-81))))
```

Conway‘s Game of Life



- Let‘s see, what a Haskell application could look like…
- And we come to Sebastian's task!