COMP3141

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CSE, UNSW (and Data6

21 July 2020

Exercise 5

Assignment Project Exam Help

- Parse a serie

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Exercise 5

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- Parse a serie
- Stack push a https://eduassistpro.github.io/

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- Parse a serie
- Stack push a https://eduassistpro.github.io/
- Evaluate a se

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Exercise 5

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- Parse a serie
- Stack push a https://eduassistpro.github.io/
- Evaluate a se
- Calculate a string.

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Recall: GADTs

Generalised Algebraic Datatypes (*GADTs*) is an extension to Haskell that, among other things, allows dat

```
{-# LANGUAGE GA
-- Unary natur
data Nat = Z | S Nat
-- is the same as
data Nat :: * where
  Z :: Nat
  S :: Nat -> Nat
```

The `printf` function

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Consider the well known C function `printf`:

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The `printf` function

Consider the well known C function `printf`:

In C, the type (and number) of parameters passed to this functio
the first parameter (the format string)

The `printf` function

To do a similar thing in Haskell, we would like to use a richer type that allows us to define a function whose subsequent parameter is determined by the first.

The `printf` **function**

To do a similar thing in Haskell, we would like to use a nicer type that allows us to
define a function whose subsequent parameter is determined by the first.

```
data Format :: * -> * w
  End :: Format (
  Str :: Format t
  Dec :: Format t -> Format (Int, t)      -- %d
  L :: String -> Format t -> Format t
  deriving instance Show (Format ts)
  -- just like deriving (Show) for normal data types.
```

Our format strings are indexed by a tuple type containing all of the types of the
%directives used.

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The printf **function**

is written:

```
L "Hello" $ Str $ L " You are "
    $ Dec $ L " years old!" End
```

The `printf` **function**

```
printf :: Format ts -> ts -> IO ()
printf End () =
    pure ()
printf (Str fmt) s =
    do putStr s
printf (Dec fmt) (i,ts) =
    do putStr (show i); printf fmt ts
printf (L s fmt) ts =
    do putStr s; printf fmt ts
```

Vectors

Define a natural number kind to use on the type level:

```haskell
data Nat = Z | S Nat
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data Vec (a :: *) :: Na
  Nil  :: Vec a Z
  Cons :: a -> Vec a n -> Vec a (S n)
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```

The functions hd and tl can be total:

```haskell
hd :: Vec a (S n) -> a
hd (Cons x xs) = x
tl :: Vec a (S n) -> Vec a n
tl (Cons x xs) = xs
```

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Vectors, continued

Our map for vectors is as follows:

```
mapVec :: (a -> b) -> Vec a n -> Vec b n
mapVec f Nil = Nil
mapVec f (Cons x xs) = ...
```

Vectors, continued

Our map for vectors is as follows:

```
mapVec :: (a -> b) -> Vec a n -> Vec b n
mapVec f Nil = Nil
mapVec f (Cons x xs)
```

Properties

Using this type, it's impossible to write a map that changes the length of the vector.

Properties are verified by the compiler!

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Appending Vectors

Example (Problem)

```
appendV :: Vec a m -> Vec a n -> Vec a ???
```

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We want to write   for
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We want to write   for
kind Nat.

We can define a nor

```
plus :: Nat -> Nat -> Nat
plus Z y = y
plus (S x) y = S (plus x y)
```

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Appending Vectors

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plus Z y = y
plus (S x) y = S (plus x y)
```

This function is not applicable to type-level `Nat`s, though.
⇒ we need a type level function.

Type Families

Type level functions, also called *type families*, are defined in Haskell like so:

```
{-# LANGUAGE Ty
type family Plu
  Plus Z     y = y
  Plus (S x) y = S (Plu
```

We can use our type family to define `appendV`:

```
appendV :: Ve  a   n  > V  a m -> V a (Plus m n)
appendV Nil         ys = ys
appendV (Cons x xs) ys = Cons x (appendV xs ys)
```

Concatenating Vectors

Example (Problem)

```
concatV :: Vec (Vec a m) n -> Vec a ...
```

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concatV :: Vec (Vec a m) n -> Vec a ???
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We want to write `m * n` in the `???` above, but we do not have times defined for kind `Nat`.

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```
{-# LANGUAGE TY
type family Times (a :: Nat) (b :: Nat) :: Nat where
  Times Z n = Z
  Times (S m) n = Plus n (Times m n)
```

We can use our type family to define concatV:

```
concatV :: Vec (Vec a m) n -> Vec a (Times n m)
concatV Nil = Nil
concatV (Cons v vs) = v `appendV` concatV vs
```

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Filtering Vectors

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Example (Prob

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```
filterV :: (a -> b
```

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Filtering Vectors

Assignment Project Exam Help

Example (Prob
https://eduassistpro.github.io/

```
filterV :: (a -> bo
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What is the size of the result of filter?

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Filtering Vectors

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We do not know the s

Filtering Vectors

Example (Problem)

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```

We do not know the s

We can use our type f

```
filterV :: (a -> Bool) -> Vec a n -> [a]
filterV p Nil     = []
filterV p (Cons x xs)
                | p x   = x : filterV p xs
                | otherwise = filterV p xs
```

Homework

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1. Assignme   ).

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Homework

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2. Week 7's qu https://eduassistpro.github.io/

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4. This week's quiz is also up, it's due Friday week (in 9 days).

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Consultations

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- Consultations will be made on request. Ask on piazza or email
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- Will be in the Thursday lecture slot, 9am to 11am on Blackb

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- Make sure to join the queue on Hopper. Be ready to share your (`ghci` or `stack repl`) and editor set up.