COMP3400
2024
Assignment 2 Written

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In addition to this written work there are *three* coding questions.

Either

The Functor and Applicative for the `Either` data-type is as follows:

```
1  instance Functor (Either a) where
2      fmap f (Right x) = Right (f x)
3      fmap f (Left x)  = Left x
4
5  instance Applicative (Either e) where
6      pure             =  Right
7      Left  e  <*>  _  =  Left e
8      Right f  <*>  r  =  fmap f r
```

When writing your proofs *use the line numbers given above* when justifying your steps.

Question 1. *Easy* [4 MARKS]

Show `Either` satisfies the *second* functor law:

```
9  fmap (g . h) = fmap g . fmap h
```

Question 2. *Medium* [6 MARKS]

Show `Either` satisfies the *third* applicative law:

```
10 x <*> pure y = pure (\g -> g y) <*> x
```

ZipWith

Recall the alternate definition for a list applicative given in Tutorial 9.

```
1  instance Functor [] where
2      fmap _ []     = []
3      fmap g (x:xs) = g x : (fmap g xs)
4
5  instance Applicative [] where
6      pure f = repeat f
7      [] <*> _ = []
8      _ <*> [] = []
9      (f:fs) <*> (x:xs) = (f x) : (fs <*> xs)
```

When writing your proofs *use the line numbers given above* when justifying your steps.

Question 3. *Medium* [10 MARKS]

Use *structural induction* to show this Applicative satisfies the *forth* applicative law:

```
10 x <*> (y <*> z) = (pure (.) <*> x <*> y) <*> z
```

Parsing

Question 4. *Medium* [10 MARKS]

Complete the grammar for polynomials given below.

```
Polynom ::= ? | ? "+" ?

Factors ::= Factor | Factor Factors

Factor ::= "(" ? ")" | ?

Mono ::= ? | ? | ? | ? | Constant

Constant ::= ?
```

Hint: The order of precedence (lowest to highest) for polynomial operations is: Addition, Multiplication, Brackets.