Homework 4

February 20, 2020

1 Introduction

For this homework, you will reuse the type-class instances of Vec from the previous homework though Vec is now defined with newtype.

```
newtype Vec a = Vec {runVec :: [a]}
```

1. You should implement the instances of Vec for the following type classes.
   (a) Functor class, where you should implement the fmap function.
   (b) Applicative class, where you should implement the pure and liftA2 functions. (You should import it with import GHC.Base (liftA2).)
   (c) Semigroup class, where you should implement the <> operator.
   (d) Monoid class, where you should implement the mempty function.
2. You should simplify the Vec instances of Num, Fractional, and Floating using fmap, pure, and liftA2 as appropriate.
3. You should simplify the implementation of dft and fft functions to leverge Vec Double and Vec (Complex Double). The final implementation should be closer to the mathematical representation of the algorithms. The functions should be given the following types:

```
range :: Double -> Double -> Double -> [Double]
absolute :: Vec (Complex Double) -> Vec Double
rd :: Int -> Vec Double -> Vec Double
dft :: [Double] -> Vec (Complex Double)
fft :: [Double] -> Vec (Complex Double)
```

2 Testing

You can test the implementation using the following main

```
main = do
         let n = 2^8
         let s1 = map (\x -> sin(20*pi*x) + sin(40*pi*x)/2) $ range 0 1 n

         start <- getCurrentTime
         let dft1 = fmap (/n) $ absolute $ dft s1
         print(rd 2 dft1)
         end <- getCurrentTime
         print (diffUTCTime end start)

         start2 <- getCurrentTime
         let fft1 = fmap (/n) $ absolute $ fft s1
         print(rd 2 fft1)
         end2 <- getCurrentTime
         print (diffUTCTime end2 start2)
```

After running the main, you should expect identical output for dft and fft functions while fft is much faster (though the difference is less than the previous homework).

3 Submission

Please write your solution in a file – `hwk4.hs` and submit it to the dropbox.