

CSE 130 Midterm Solution, Winter 2019

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Part I. Lambda Calculus [20 pts + 5 extra]

Q1: Reductions [10 pts]

1.1 [5 pts]

$\lambda x y \rightarrow (\lambda z x \rightarrow x z) (x y)$

(A) =b> $\lambda x y \rightarrow y x$ []

(B) =b> $\lambda z x \rightarrow x z$ []

(C) =b> $\lambda x y \rightarrow (\lambda x \rightarrow x (x y))$ []

(D) =a> $\lambda x y \rightarrow (\lambda z a \rightarrow a z) (x y)$ [x]

(E) =a> $\lambda x y \rightarrow (\lambda z y \rightarrow y z) (x y)$ [x]

1.2 [5 pts]

$(\lambda x \rightarrow x) (\lambda y \rightarrow \text{apple } y) (\lambda z \rightarrow z)$

(A) =b> $(\lambda x \rightarrow x) (\text{apple } (\lambda z \rightarrow z))$ []

(B) =b> $(\lambda y \rightarrow \text{apple } y) (\lambda z \rightarrow z)$ [x]

(C) =a> $(\lambda z \rightarrow z) (\lambda y \rightarrow \text{apple } y) (\lambda z \rightarrow z)$ [x]

(D) =a> $(\lambda x \rightarrow x) (\lambda y \rightarrow \text{orange } y) (\lambda z \rightarrow z)$ []

(E) \rightsquigarrow apple ($\backslash z \rightarrow z$)

[x]

Q2: Factorial [10 pts + 5 extra]

```
let STEP = \rec n -> ITE (ISZ n) ONE (MUL n (rec (DEC n)))
```

```
let FACT = FIX STEP
```

Without fixpoint (extra points):

```
let STEP = \p -> PAIR (INC (FST p)) (MUL (FST p) (SND p))
```

```
let FACT = \n -> SND (n STEP (PAIR ONE ONE))
```

Part II. Datatypes and Higher-Order Functions [30 pts]

Q3: Files and Directories [30 pts]

3.1 Size [10 pts]

```
size :: Entry -> Int
size (File _ s) = s
size (Dir _ fs) = foldr (\f acc -> acc + size f) 0 fs
```

Alternatively:

```
size :: Entry -> Int
size (File _ s) = s
size (Dir _ fs) = dirSize fs
  where
    dirSize [] = 0
    dirSize (f:fs) = size f + dirSize fs
```

3.2 Find [20 pts]

```
find :: String -> Entry -> String -> [String]
find path (File name _) f
  | name == f = [path ++ "/" ++ name]
  | otherwise = []
find path (Dir name fs) f
  = let path' = path ++ "/" ++ name
      in foldr (\e xs -> xs ++ find path' e f) [] fs
```