CS 421 --- Interpreter Activity 2

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(Hand in one copy per team. Do NOT mangle or staple the corners; it will jam the scanner!)

Here is part of the code for the \texttt{i4.hs} interpreter.

```hs
0 data Val = IntVal Integer
1 deriving (Show, Eq)

2 data Exp = IntExp Integer
3 | IntOpExp String Exp Exp
4 | VarExp String
5 | LetExp String Val Exp
6 deriving (Show, Eq)

7 type Env = [(String, Val)]
8
9 intOps = [("+", (+)),
10     ("-", (-)),
11     ("*", (*)),
12     ("/", div)]

13 liftIntOp f (IntVal i1) (IntVal i2) = IntVal (f i1 i2)
14 liftIntOp f _ _ = IntVal 0

15 eval :: Exp \rightarrow Env \rightarrow Val
16 eval (IntExp i) _ = IntVal i

17 eval (IntOpExp op e1 e2) env =
18     let v1 = eval e1 env
19         v2 = eval e2 env
20         Just f = lookup op intOps
21     in liftIntOp f v1 v2

22 eval (VarExp v) env =
23     case lookup v env of
24         Just vv \rightarrow v
25         Nothing \rightarrow IntVal 0

26 eval (LetExp var e1 e2) env =
27     let v1 = eval e1 env
28     in eval e2 (var, v1) env
```
Problem 1) Code review this. Three lines have errors, and they are different ones than from last time! Find them and correct them.

Problem 2) Consider the following code:

```haskell
Prelude> delta = 1
1 Prelude> inc x = x + delta
2 Prelude> inc 10
11
4 Prelude> messup x = let delta = 2 in delta + inc x
5 Prelude> messup 10
-- What happens?
```

Have each member of the team predict the output of `messup 10`. Come to a consensus about the output and why.

Adding functions to the Interpreter

Consider the following code that would add functions to the language. For the data types we are only showing the added clauses to save space.

```haskell
data Val = FunVal String Exp

data Exp = FunExp String Exp
  | FunApp Exp Exp

eval (FunExp var body) env = FunVal var body
eval (FunApp e1 e2) env =
  let FunVal var body = eval e1 env
    arg = eval e2 env
  in eval body ((var,arg):env)
example = eval (FunExp "x" (IntOpExp "+" (VarExp "x") (VarExp "delta"))) ["delta", IntVal 1]
```

Problem 3) The constructor for `FunVal` takes an `Exp` for the body, not a `Val`. Why do we not evaluate the body of the function when we create the `FunVal`?

Problem 4) What does the syntax `((var, arg):env)` indicate?
**Problem 5)** Here is a reasonably equivalent program to the Haskell one above.

```haskell
Prelude> eval (LetExp "delta" (IntExp 1))
  (LetExp "inc" (FunVal "x" (IntOpExp "+" (VarExp "x") (VarExp "delta"))))
  (LetExp "messup" (FunVal "x" (LetExp "delta" (IntExp 2)
    (IntOpExp "+" (VarExp "delta") (FunApp (VarExp "inc") (VarExp "x"))))))
  (FunApp (VarExp "messup") (IntExp 10))))
```

Does it give the same result as the Haskell program? Hint: the answer is `no.` What goes wrong?

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**Closures**

**Problem 6)** The instructor will talk briefly about *Closures*, which fix this problem. Modify the given code to implement closures.
Interpreter Activity 2--- Reflector's Report

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1. What was a strength of your team's performance for this activity?

2. What could you do next time to increase your team's performance?

3. What insights did you have about the activity or your team's interaction today?

Interpreter Activity 2 --- Team's Assessment (SII)

Manager or Reflector: Consider the objectives of this activity and your team's experience with it, and then answer the following questions after consulting with your team.

1. What was a strength of this activity? List one aspect that helped it achieve its purpose.

2. What is one thing we could do to improve this activity to make it more effective?

3. What insights did you have about the activity, either the content or at the meta level?