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Homework: VarLang and DefineLang

1. **(10 pt) [Programming, Scoping, Semantics]**

(a) (3 pt) Write a VarLang program that evaluates to 3420. The program must make at least 2 “holes in the scope” using nested let expressions.

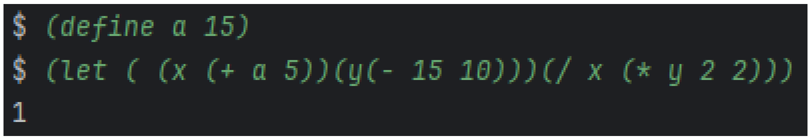
(let ((x 34) (y 20)) (+ (let ((x 100)) (* x 34)) (let ((y 10)) (+ y y))))

(b) (4 pt) Rewrite the above VarLang program into a single DefineLang program using define expressions. Each let expression must have its own define expression and the program should evaluate to 3420. Note that you are allowed to define multiple variables. Make sure you check the grammar and the semantics before writing your program.

(define x 34)
(define y 20)
(define part1 (let ((x 100)) (* x 34)))
(define part2 (let ((y 10)) (+ y y)))
(+ part1 part2)

(c) (3 pt) Complete the following program such that the final program evaluates to `1`.

```
$(define a 15)
$(let ( (x (+ a 5))(y(- 15 10)))
    (/ x (* y 2 2)))
```



```
$ (define a 15)
$ (let ( (x (+ a 5))(y(- 15 10)))(/ x (* y 2 2)))
1
```

2. **(6 pt) [Scope]**

The following VarLang program exhibits a **hole** in the scope of one or more of its variables.

(a) (2 pt) Identify the impacted variables(s)

The impacted variable is y. The variable y is defined on line 2 and then redefined on line 3.

(b) (4 pt) List the line number(s) that constitute the hole in the scope for each impacted variable

The hole in the scope of variable y is from lines 4-5. Variable y is defined on line 2 but then redefined within an inner let on line 3. This makes it so lines 4 and 5 in the second let use the redefinition and are the hole. So when y is used on line 4, its second definition (y=3) is used rather than the original assignment of (y=5)

3. **(12 pt) [Free and Bound Variables]**

The following questions will each present a single VarLang program which references one or more variables. For your answer to each question, please list each variable and indicate whether that variable is **free** or **bound**.

(a) (3 pt)
length$_1$: Bound (* 2 length)
width$_1$: Bound (* 2 width)
peri$_1$: Bound

(b) (4 pt)
radius$_1$: Free (* radius radius)
radius$_2$: Free (* radius radius)
pi$_1$: Free
area$_1$: Bound

(c) (5 pt)
numerator$_1$: Bound (/ numerator denominator)
denominator$_1$: Bound (/ numerator denominator)
ratio$_1$: Bound (* ratio c)
c$_1$: Free (* ratio c)
min$_1$: Bound