

Problem Set 3
Comp 301
Fall 2020
Week 5: 02.11.2020 - 07.11.2020

Please use the code boilerplate for LET language, which includes several tests for you to see if your code is correct. Save your code, write your answers for the first two questions on a piece of paper or online environment and include it as a PDF. Zip your code along with the PDF as ID_username.zip with your ID and username (Example: 1234567_galtintas17.zip), and submit this ZIP file. You are expected to submit by the end of PS, however, you have an additional 1 hour to submit after the PS. The solutions will be available on the course BlackBoard after Friday. **Read the questions carefully. Good luck!**

Problem 1: ¹: Write out the derivation of the following program as a derivation tree in the style of the one o EOPL p.5 (See Figure. 1).

Let $\rho = [x = [20], y = [15], z = [10]]$

if zero?(-(x, 12)) then -(z, 3) else -(x, y)

Namely, for the interpreter:

```
(value-of
  << if zero?(-(x, 12)) then -(z, 3) else -(x, y)>>
  ρ)
= (if (expval->bool (value-of <<zero? (-(x, 12))>> ρ))
  (value-of <<-(z, 3)>> ρ)
  (value-of <<-(x, y)>> ρ))
= (if (expval->bool (bool-val #f))
  (value-of <<-(z, 3)>> ρ)
  (value-of <<-(x, y)>> ρ))
= (if #f
  (value-of <<-(z, 3)>> ρ)
  (value-of <<-(x, y)>> ρ))
= (value-of <<-(x, y)>> ρ)
= [5]
```

Code. 1: Interpret value of program

$\frac{\frac{\text{List-of-Int}}{(\text{Int} \ . \ \text{List-of-Int})}}{(\text{Int} \ . \ (\text{Int} \ . \ \text{List-of-Int}))}$ $\frac{(\text{Int} \ . \ (\text{Int} \ . \ (\text{Int} \ . \ \text{List-of-Int})))}{(-7 \ . \ (\text{Int} \ . \ (\text{Int} \ . \ \text{List-of-Int})))}$ $\frac{(-7 \ . \ (3 \ . \ (\text{Int} \ . \ \text{List-of-Int})))}{(-7 \ . \ (3 \ . \ (14 \ . \ \text{List-of-Int})))}$ $\frac{(-7 \ . \ (3 \ . \ (14 \ . \ ())))}{(-7 \ . \ (3 \ . \ (14 \ . \ ())))}$

FIGURE 1. Rules of inference style, as seen on EOPL p.5

¹Similar to EOPL p.70 Exercise 3.4

Problem 2: Now, we want you to fill in the blanks for the output of this interpreter. Similar to first question let $\rho_0 = [x = [20], y = [15], z = [10]]$. Note that below snippet is not complete, although we only want answers to the _____'s, we recommend you to continue the evaluation as a self study exercise.

```

let x = 12 in if zero?(-(x, 12)) then -(-(z, 3), -(y, z)) else -(x, y)
(value-of
  <<let x = 12
    in if zero?(-(x, 12)) then
      -(-(z, 3), -(y, z))
    else -(x, y)>>
   $\rho_0$ )

= (value-of
  <<if zero?(-(x, 12)) then
    -(-(z, 3), -(y, z))
  else -(x, y)>>
  [1]_____)

Let  $\rho_1 = [2]$ _____

= (if (expval->bool (value-of <<zero?(-(x, 12))>>  $\rho_1$ ))
  (value-of <<-(-(z, 3), -(y, z))>>  $\rho_1$ )
  (value-of <<-(x, y)>>  $\rho_1$ ))

= (if [3]_____
  (value-of <<-(-(z, 3), -(y, z))>>  $\rho_1$ )
  (value-of <<-(x, y)>>  $\rho_1$ ))

= (value-of <<[4]_____>>  $\rho_1$ )

= [ (-
  [ (value-of <<[5]_____>>  $\rho_1$ ) ]
  [ (value-of <<[6]_____>>  $\rho_1$ ) ] ) ]

```

Problem 3:² Extend the Let language by adding a new operator minus that takes one argument n and returns -n. For example, the value of minus(-(minus(5), 9)) should be 14, which is equal to -((-5) - 9).

Note[1]: You need to work with Let language codes for this problem.

Note[2]: This problem is a good exercise for Project 2, so we suggest you to spend some time on it. Hint: You need to change lang.rkt and interp.rkt.

After you finish implementing minus operation, run the tests in tests.rkt. At the end of that file we defined extra tests for minus, you can use this as an example to how to write test cases and define your own tests.

²EOPL p.72 Exercise 3.6