HW3 – Proof Trees and Operational Semantics

CS 476, Fall 2018 Due Sep. 28

1 Instructions

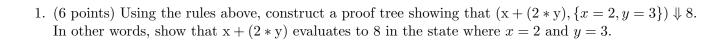
This assignment is to be completed by hand (or in LaTeX if you know how to use it). Submit your answers as a PDF file via Gradescope. If you don't have easy access to a scanner, you can use the one in SEO 1120, the main CS office – the staff will be happy to help you. As always, please don't hesitate to ask for help on Piazza (https://piazza.com/class/jkh8q52qrh06v).

2 Operational Semantics of IMP

Here are the operational semantics rules for a simple imperative programming language, using the "hybrid style" of big steps for expressions and small steps for commands.

3 Problems

There are four problems in all. Each problem is on a separate page. Use as much space as you need for each problem. You can add extra pages if you need to.



2. (3 points) Construct a proof tree showing that

$$(z := x + (2*y); x := \text{if } z = 7 \text{ then } 3 \text{ else } 4, \{x = 2, y = 3\}) \rightarrow (\text{skip}; x := \text{if } z = 7 \text{ then } 3 \text{ else } 4, \{x = 2, y = 3, z = 8\})$$

You can write "P1" to stand for the proof tree from the previous problem.

3. (7 points) Construct a proof tree for the next step that

$$(x := \text{if } z = 7 \text{ then } 3 \text{ else } 4, \{x = 2, y = 3, z = 8\})$$

takes.

- 4. (9 points) Suppose we extended the language with a command " c_1 and then c_2 if e" that behaves as follows:
 - First, it executes c_1 normally.
 - If e is true in the resulting environment, it then executes c_2 .
 - Otherwise, it ignores c_2 and is finished executing.

In other words, to execute c_1 and then c_2 if e, first execute c_1 normally, and then execute c_2 only if e is true.

Give small-step semantic rules for c_1 and then c_2 if e. Remember that a command becomes "skip" when it is finished executing. As a test case, if you've written your rules correctly, x := 3 and then y := 4 if x = 3 should step to (skip, $\{x = 3, y = 4\}$) in three small steps.

Hint: it is probably easiest to define the command using three separate rules.