CMPT 383 Comparative Programming Languages

Homework 6

This homework is due by 11:59pm PT on Wednesday Mar 23, 2022. No late submission is accepted. Please save your answers in a single file called `h6_firstname_lastname.pdf` and submit it to Canvas. You may also write on paper and scan it (or take a picture) into a PDF. Please make sure the text is readable.

Requirements:

- Please include an environment in the judgments even if it is not used.

1. (20 points) Consider the FUN language that we learned, provide a big-step operational semantics to expression e_1`<=`e_2. The expression evaluates to `true` if $e_1 \leq e_2$. Otherwise, it evaluates to `false`.

2. (20 points) Consider the FUN language, prove the following expression evaluates to 3 with respect to the big-step operational semantics that can handle recursion.

$$\texttt{let}\ x = 2\ \texttt{in}\ x + 1$$

3. (30 points) Suppose we add a program construct called `testSign` to the FUN language with the following syntax

$$\begin{array}{rcl} e & ::= & \ldots \quad \text{(all existing productions in FUN)} \\ & | & \texttt{'testSign'}\ e\ e\ e\ e \end{array}$$

The evaluation result of `testSign` e_1 e_2 e_3 e_4 is

- the result of e_2, if e_1 evaluates to a negative number
- the result of e_3, if e_1 evaluates to zero
- the result of e_4, if e_1 evaluates to a positive number

Provide a big-step operational semantics for `testSign`.

4. (30 points) Consider the `testSign` in Quesiton 3, provide a small-step operational semantics for `testSign`. Note that for expression `testSign` e_1 e_2 e_3 e_4, the expression e_1 should be evaluated first. You can assume the small-step operational semantics for other FUN constructs already exists. Hint: here is the small-step operational semantics for `if-then-else`.

$$\frac{\langle e_1, E\rangle \rightarrow \langle e_1', E'\rangle}{\langle \texttt{if}\ e_1\ \texttt{then}\ e_2\ \texttt{else}\ e_3, E\rangle \rightarrow \langle \texttt{if}\ e_1'\ \texttt{then}\ e_2\ \texttt{else}\ e_3, E'\rangle}$$

$$\frac{}{\langle \texttt{if true then}\ e_2\ \texttt{else}\ e_3, E\rangle \rightarrow \langle e_2, E\rangle}$$

$$\frac{}{\langle \texttt{if false then}\ e_2\ \texttt{else}\ e_3, E\rangle \rightarrow \langle e_3, E\rangle}$$