Language Syntax, Semantics, Runtime Errors

CS 536: Science of Programming, Fall 2020

Due Mon Feb 15, 11:59 pm

Problems [50 points]

Class 5: Language Syntax/Operational Semantics

1. [8 points] Translate the program below into our programming language.

   \[ p = 1; \quad k = x = 0; \quad \textbf{while} (k++ < n) \{ ++x; \quad p *= x; \} \]

[2/11: add z]

2. [12 = 3 * 4 points] Let \( S = \text{if } x > 0 \text{ then } x := x*z \text{ else if } y > 0 \text{ then } y := y*z \text{ fi fi.} \)
   
   a. Evaluate \( \langle S, \{ x = 2, y = 6, z = 4 \} \rangle \) to completion, using step-by-step operational (i.e., \( \rightarrow \)) semantics.
   
   b. Evaluate \( \langle S, \{ x = -2, y = 8, z = 5 \} \rangle \) to completion, using step-by-step operational semantics.
   
   c. Evaluate \( \langle S, \{ x = -1, y = -2, z = 6 \} \rangle \) to completion, using step-by-step operational semantics.

3. [9 points] Let \( W = \text{while } k \neq n \text{ do } S \text{ od where } S = k := k+1; \; x := x+k*k. \) Let \( \sigma_0 = \{ k = 0, x = 1, n = 4 \}. \)
   
   Evaluate \( \langle W, \sigma_0 \rangle \) to completion. Show all configurations of the form \( \langle W, \text{state} \rangle \) and the final \( \langle E, \bot \rangle \). You can use \( \rightarrow^n \) to skip other configurations if you like, or you can show them (your choice).

Class 6: Denotational Semantics, Runtime Errs

4. [9 = 3 * 3 points] Give the denotational semantics \( (M(S, \ldots) = ?) \) of the configurations in Problem 2a – 2c.

5. [4 points] Take the \( W \) from Problem 3. What is the set of \( \sigma \) such that \( \langle W, \sigma \rangle \rightarrow^n \langle E, \bot \rangle \)?

6. [8 points] Let \( S = x := b[m-2]/\sqrt{k} \) and let \( \sigma = \{ m = \alpha, k = y, b = \beta \}. \) Let \( \delta \) be the length of \( b \), so \( \beta(0), \ldots, \beta(\delta-1) \) are the values of \( b[0], b[1], \ldots \). Describe the set of all \( \sigma \) that cause \( M(S, \sigma) = \{ \bot_e \}. \)
   
   (As in class, divide by zero and square root of a negative number cause errors.)