

Formal Semantics of Programming Languages

Exercise 2 (May 25)

Wolfgang Schreiner
Wolfgang.Schreiner@risc.uni-linz.ac.at

April 23, 2009

The exercise is to be submitted by the deadline stated above as a report with a decent cover page (title of the course, your name, Matrikelnummer, email address) in one of the following forms:

1. either as a single PDF file uploaded in Moodle (no emails, please), or
2. as a stapled paper report handed out to me (in class or in my mailbox).

1 Expressions with Side effects

Take the following language of commands C , expressions E , numerals N , and identifiers I :

$$\begin{aligned} C &::= I := E \mid C_1; C_2 \mid \mathbf{if} (E_1 = E_2) C \\ E &::= I \mid N \mid E_1 + E_2 \mid \mathbf{exec} C \mathbf{result} E \end{aligned}$$

The **exec** expression executes C and then returns the result of the evaluation of E . Correspondingly, the evaluation of an expression may alter the store.

Define an operational semantics for this language with configurations of the form $\langle C, s \rangle \rightarrow s'$ (command C evaluated in store s yields store s') and $\langle E, s \rangle \rightarrow \langle n, s' \rangle$ (expression E evaluated in store s yields number n and store s').

Correspondingly, define a denotational semantics for this language.

Based on your definitions, formulate a new version of the statement “the operational semantics of E is sound with respect to the denotational semantics” and prove this statement for the case $E = E_1 + E_2$.

2 A New Language Construct

A language designer proposes a new looping construct **entangle** with the following property:

$$\llbracket \mathbf{entangle} (B) C \rrbracket = \llbracket \mathbf{if} B \{C; \mathbf{entangle} (B) C; C\} \rrbracket$$

1. Show the sequence of “unfoldings” of the construct (0–3 unfoldings).
2. Sketch a possible implementation of the construct on a computer.
3. Define a denotational semantics for the construct.
4. Prove that your denotational semantics satisfies above property.