

Formal Semantics of Programming Languages

Exercise 2 (December 1)

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The exercise is to be submitted by **December 1** (hard deadline)

1. as a single PDF file sent to me per email, or
2. as a paper report (cover page with full name and Matrikelnummer, pages stapled) handed out to me in class.

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').

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. Define a denotational semantics for the construct.
3. Prove that your semantics satisfies the property stated above.
4. Sketch a possible implementation of the construct on a computer.