## **CSC 2125**

## **Homework Operational Semantics**

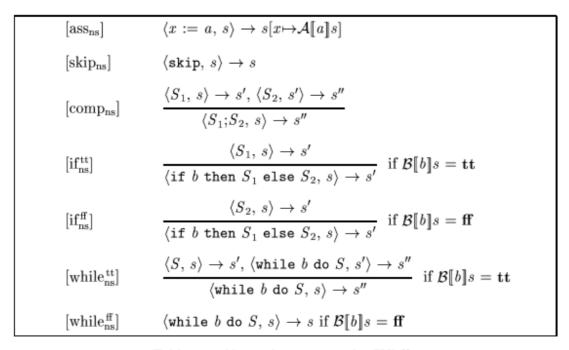


Table 2.1: Natural semantics for While

- 1. Consider following statement repeat S until b
  - a. Extend the natural operational ("big-step") semantics of the WHILE language (Table 2.1 from [1]) by a rule for relation → for the repeat-construct. (The semantics for the repeat-construct should not rely on the existence of a while-construct)
  - b. Two statements in a natural semantic are considered equivalent if for all states s and s':

 $\langle S_1, s \rangle \rightarrow s' \text{ iff } \langle S_2, s \rangle \rightarrow s'$ 

How can you show that the repeat construct is semantically equivalent to **S**; while ¬b do S.

Why does this lead to the conclusion that the extended semantics is deterministic?

$[ass_{sos}]$	$\langle x := a, s \rangle \Rightarrow s[x \mapsto \mathcal{A}[\![a]\!]s]$
$[skip_{sos}]$	$\langle \texttt{skip}, s \rangle \Rightarrow s$
$[\mathrm{comp}_{\mathrm{sos}}^1]$	$\frac{\langle S_1, s \rangle \Rightarrow \langle S'_1, s' \rangle}{\langle S_1; S_2, s \rangle \Rightarrow \langle S'_1; S_2, s' \rangle}$
$[\operatorname{comp}_{\operatorname{sos}}^2]$	$\frac{\langle S_1, s \rangle \Rightarrow s'}{\langle S_1; S_2, s \rangle \Rightarrow \langle S_2, s' \rangle}$
$[\mathrm{if}_{\mathrm{sos}}^{\mathrm{tt}}]$	$\langle \texttt{if } b \texttt{ then } S_1 \texttt{ else } S_2, s \rangle \Rightarrow \langle S_1, s \rangle \texttt{ if } \mathcal{B}[\![b]\!]s = \texttt{tt}$
$[\mathrm{if}^{\mathrm{ff}}_{\mathrm{sos}}]$	$\langle \texttt{if} \ b \ \texttt{then} \ S_1 \ \texttt{else} \ S_2, \ s \rangle \Rightarrow \langle S_2, \ s \rangle \ \texttt{if} \ \mathcal{B}[\![b]\!]s = \texttt{ff}$
$[\text{while}_{\text{sos}}]$	$\langle \texttt{while} \ b \ \texttt{do} \ S, \ s \rangle \Rightarrow$
	$\langle \texttt{if} \ b \ \texttt{then} \ (S; \texttt{while} \ b \ \texttt{do} \ S) \ \texttt{else} \ \texttt{skip}, \ s \rangle$

Table 2.2: Structural operational semantics for While

- 2. Consider following statement **repeat S until b** 
  - a. Define the structural operational ("small-step") semantics as in Table 2.2 from [1] for the repeat-construct. (The semantics for the repeat-construct should not rely on the existence of a while-construct)
  - b. How must the notion of semantic equivalence be defined for structural operational semantics?
- 3. What distinguishes the two notions of semantic equivalence in 1) and 2)?
- [1] Nielson, H., Nielson, F.: "Semantics with Applications: A Formal Introduction", Wiley Professional Computing, 1992.