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Programming Language and Compiler Design,
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Series 1.bis (more about S.O.S.)

Exercise 1

Let S be the statement 'while **true** do skip;'. Show that its execution loops in every state according to the natural semantics first, and then according to the structural operational semantics. Can you exhibit a statement of **While** such that there exists a state in which it loops in natural semantics and not in structural operational semantics, or vice versa? Why?

Exercise 2

1. Write down the mathematical phrase corresponding to stating that S.O.S is deterministic.
2. Show that it is true.
3. Deduce that there is exactly one derivation sequence starting in configuration $< S, s >$; and then that a statement of While cannot both terminate and loop on a state s.

Exercise 3

(Useful lemma to prove the equivalence of semantics functions of S.O.S. and natural semantics.)

1. Suppose that $< S_1; S_2, s > \Rightarrow^* < S_2, s' >$. Show that it is *not* necessary that $< S_1, s > \Rightarrow^* s'$
2. Prove that if $< S_1, s > \Rightarrow^k s'$ then $< S_1; S_2, s > \Rightarrow^k < S_2, s' >$.

Exercise 4

1. Prove that if $< S_1; S_2, s > \Rightarrow^k s''$, then there exists a state s' and natural numbers m and n such that $k = m + n$, $< S_1, s > \Rightarrow^m s'$ and $< S_2, s' > \Rightarrow s''$.
2. (uses exercise 2)
   Let S_1, S_2, S_3 be statements in **While**.
   Show that $(S_1; S_2); S_3$ and $S_1; (S_2; S_3)$ are semantically equivalent with respect to the S.O.S. semantics. (First, what does it mean to be semantically equivalent?...)