

Homework 2: Operational Semantics for WHILE

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Assignment: HW2

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1 Operational Semantics of WHILE using evaluation order rules

The language specification for WHILE language and Small Step operational semantics for the language are described below.

1.1 WHILE language specification

$e ::=$	x	<i>Expressions</i> variables/addresses
	v	values
	$x := e$	assignment
	$e; e$	sequential expressions
	$e \text{ op } e$	binary operations
	if e then e else e	conditional expressions
	while (e) e	while expressions
	not e	negation/not unary operation
	e and e	and operation
	e or e	or operation
$v ::=$	i	<i>Values</i> integer values
	b	boolean values
$op ::=$	$+ \mid - \mid * \mid / \mid > \mid >= \mid < \mid <=$	<i>Binary operators</i>

1.2 Small Step operational semantics for WHILE language

Let ' σ ' refer to the **Store** which holds the state of the different variables used in the expressions.

[SS-VALUE]	$\frac{}{v, \sigma \rightarrow v, \sigma}$
[SS-VARIABLE-ACCESS-REDUCTION]	$\frac{x \in \text{domain}(\sigma) \quad \sigma(x) = v}{x, \sigma \rightarrow v, \sigma}$
[SS-ASSIGNMENT-REDUCTION]	$\frac{}{x := v, \sigma \rightarrow v, \sigma[x := v]}$
[SS-ASSIGNMENT-CONTEXT]	$\frac{e, \sigma \rightarrow e', \sigma'}{x := e, \sigma \rightarrow x := e', \sigma'}$
[SS-SEQUENCE-REDUCTION]	$\frac{}{v; e, \sigma \rightarrow e, \sigma}$
[SS-SEQUENCE-CONTEXT]	$\frac{e_1, \sigma \rightarrow e'_1, \sigma'}{e_1; e_2, \sigma \rightarrow e'_1; e_2, \sigma'}$
[SS-OPERATION-REDUCTION]	$\frac{v = \mathbf{apply\ op} \ v_1 \ v_2}{v_1 \ \mathbf{op} \ v_2, \sigma \rightarrow v, \sigma}$
[SS-OPERATION-CONTEXT #2]	$\frac{e, \sigma \rightarrow e', \sigma'}{v \ \mathbf{op} \ e, \sigma \rightarrow v \ \mathbf{op} \ e', \sigma'}$
[SS-OPERATION-CONTEXT #1]	$\frac{e_1, \sigma \rightarrow e'_1, \sigma'}{e_1 \ \mathbf{op} \ e_2, \sigma \rightarrow e'_1 \ \mathbf{op} \ e_2, \sigma'}$
[SS-IF-TRUE-REDUCTION]	$\frac{}{\mathbf{if\ true\ then} \ e_1 \ \mathbf{else} \ e_2, \sigma \rightarrow e_1, \sigma}$
[SS-IF-FALSE-REDUCTION]	$\frac{}{\mathbf{if\ false\ then} \ e_1 \ \mathbf{else} \ e_2, \sigma \rightarrow e_2, \sigma}$
[SS-IF-CONTEXT]	$\frac{e_1, \sigma \rightarrow e'_1, \sigma'}{\mathbf{if} \ e_1 \ \mathbf{then} \ e_2 \ \mathbf{else} \ e_3, \sigma \rightarrow \mathbf{if} \ e'_1 \ \mathbf{then} \ e_2 \ \mathbf{else} \ e_3, \sigma'}$
[SS-WHILE-CONTEXT]	$\frac{}{\mathbf{while} \ (e_1) \ e_2, \sigma \rightarrow \mathbf{if} \ e_1 \ \mathbf{then} \ e_2; \mathbf{while} \ (e_1) \ e_2 \ \mathbf{else} \ \mathbf{false}, \sigma}$

[SS-NOT-CONTEXT]

$\text{not } e, \sigma \rightarrow \text{if } e \text{ then false else true, } \sigma$

[SS-AND-CONTEXT]

$e1 \text{ and } e2, \sigma \rightarrow \text{if } e1 \text{ then if } e2 \text{ then true else false else false, } \sigma$

[SS-OR-CONTEXT]

$e1 \text{ or } e2, \sigma \rightarrow \text{if } e1 \text{ then true else if } e2 \text{ then true else false, } \sigma$
