$[\text{ass}_{\text{ns}}]$	$\langle x := a,\ s\rangle \rightarrow s[x\mapsto\mathcal{A}[\![a]\!]s]$
$[\text{skip}_{\text{ns}}]$	$\langle \texttt{skip},\ s\rangle \rightarrow s$
$[\text{comp}_{\text{ns}}]$	$\dfrac{\langle S_1,\ s\rangle \rightarrow s',\ \langle S_2,\ s'\rangle \rightarrow s''}{\langle S_1;S_2,\ s\rangle \rightarrow s''}$
$[\text{if}^{\text{tt}}_{\text{ns}}]$	$\dfrac{\langle S_1,\ s\rangle \rightarrow s'}{\langle \texttt{if}\ b\ \texttt{then}\ S_1\ \texttt{else}\ S_2,\ s\rangle \rightarrow s'}$ if $\mathcal{B}[\![b]\!]s = \mathbf{tt}$
$[\text{if}^{\text{ff}}_{\text{ns}}]$	$\dfrac{\langle S_2,\ s\rangle \rightarrow s'}{\langle \texttt{if}\ b\ \texttt{then}\ S_1\ \texttt{else}\ S_2,\ s\rangle \rightarrow s'}$ if $\mathcal{B}[\![b]\!]s = \mathbf{ff}$
$[\text{while}^{\text{tt}}_{\text{ns}}]$	$\dfrac{\langle S,\ s\rangle \rightarrow s',\ \langle \texttt{while}\ b\ \texttt{do}\ S,\ s'\rangle \rightarrow s''}{\langle \texttt{while}\ b\ \texttt{do}\ S,\ s\rangle \rightarrow s''}$ if $\mathcal{B}[\![b]\!]s = \mathbf{tt}$
$[\text{while}^{\text{ff}}_{\text{ns}}]$	$\langle \texttt{while}\ b\ \texttt{do}\ S,\ s\rangle \rightarrow s$ if $\mathcal{B}[\![b]\!]s = \mathbf{ff}$

Table 2.1: Natural semantics for **While**

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

Table 2.2: Structural operational semantics for **While**

$[\text{ass}_{\text{p}}]$	$\{\ P[x\mapsto\mathcal{A}[\![a]\!]]\ \}\ x := a\ \{\ P\ \}$
$[\text{skip}_{\text{p}}]$	$\{\ P\ \}\ \texttt{skip}\ \{\ P\ \}$
$[\text{comp}_{\text{p}}]$	$\dfrac{\{\ P\ \}\ S_1\ \{\ Q\ \},\quad \{\ Q\ \}\ S_2\ \{\ R\ \}}{\{\ P\ \}\ S_1;\ S_2\ \{\ R\ \}}$
$[\text{if}_{\text{p}}]$	$\dfrac{\{\ \mathcal{B}[\![b]\!]\ \wedge\ P\ \}\ S_1\ \{\ Q\ \},\quad \{\ \neg\mathcal{B}[\![b]\!]\ \wedge\ P\ \}\ S_2\ \{\ Q\ \}}{\{\ P\ \}\ \texttt{if}\ b\ \texttt{then}\ S_1\ \texttt{else}\ S_2\ \{\ Q\ \}}$
$[\text{while}_{\text{p}}]$	$\dfrac{\{\ \mathcal{B}[\![b]\!]\ \wedge\ P\ \}\ S\ \{\ P\ \}}{\{\ P\ \}\ \texttt{while}\ b\ \texttt{do}\ S\ \{\ \neg\mathcal{B}[\![b]\!]\ \wedge\ P\ \}}$
$[\text{cons}_{\text{p}}]$	$\dfrac{\{\ P'\ \}\ S\ \{\ Q'\ \}}{\{\ P\ \}\ S\ \{\ Q\ \}}$ if $P \Rightarrow P'$ and $Q' \Rightarrow Q$

Table 9.1: Axiomatic system for partial correctness

$[\text{block}_{\text{ns}}]$	$\dfrac{\langle D_V,\, s\rangle \to_D s',\ \langle S,\, s'\rangle \to s''}{\langle \texttt{begin}\ D_V\ S\ \texttt{end},\, s\rangle \to s''[\text{DV}(D_V) \longmapsto s]}$

Table 3.1: Natural semantics for statements of **Block**

$[\text{var}_{\text{ns}}]$	$\dfrac{\langle D_V,\, s[x \mapsto \mathcal{A}[\![a]\!]s]\rangle \to_D s'}{\langle \texttt{var}\ x := a;\ D_V,\, s\rangle \to_D s'}$
$[\text{none}_{\text{ns}}]$	$\langle \varepsilon,\, s\rangle \to_D s$

Table 3.2: Natural semantics for variable declarations

$[\text{ass}_{\text{ns}}]$	$env_P \vdash \langle x := a,\, s\rangle \to s[x \mapsto \mathcal{A}[\![a]\!]s]$
$[\text{skip}_{\text{ns}}]$	$env_P \vdash \langle \texttt{skip},\, s\rangle \to s$
$[\text{comp}_{\text{ns}}]$	$\dfrac{env_P \vdash \langle S_1,\, s\rangle \to s',\ env_P \vdash \langle S_2,\, s'\rangle \to s''}{env_P \vdash \langle S_1;S_2,\, s\rangle \to s''}$
$[\text{if}^{\text{tt}}_{\text{ns}}]$	$\dfrac{env_P \vdash \langle S_1,\, s\rangle \to s'}{env_P \vdash \langle \texttt{if}\ b\ \texttt{then}\ S_1\ \texttt{else}\ S_2,\, s\rangle \to s'}$ if $\mathcal{B}[\![b]\!]s = \mathbf{tt}$
$[\text{if}^{\text{ff}}_{\text{ns}}]$	$\dfrac{env_P \vdash \langle S_2,\, s\rangle \to s'}{env_P \vdash \langle \texttt{if}\ b\ \texttt{then}\ S_1\ \texttt{else}\ S_2,\, s\rangle \to s'}$ if $\mathcal{B}[\![b]\!]s = \mathbf{ff}$
$[\text{while}^{\text{tt}}_{\text{ns}}]$	$\dfrac{env_P \vdash \langle S,\, s\rangle \to s',\ env_P \vdash \langle \texttt{while}\ b\ \texttt{do}\ S,\, s'\rangle \to s''}{env_P \vdash \langle \texttt{while}\ b\ \texttt{do}\ S,\, s\rangle \to s''}$ if $\mathcal{B}[\![b]\!]s = \mathbf{tt}$
$[\text{while}^{\text{ff}}_{\text{ns}}]$	$env_P \vdash \langle \texttt{while}\ b\ \texttt{do}\ S,\, s\rangle \to s$ if $\mathcal{B}[\![b]\!]s = \mathbf{ff}$
$[\text{block}_{\text{ns}}]$	$\dfrac{\langle D_V,\, s\rangle \to_D s',\ \text{upd}_\text{P}(D_P,\, env_P) \vdash \langle S,\, s'\rangle \to s''}{env_P \vdash \langle \texttt{begin}\ D_V\ D_P\ S\ \texttt{end},\, s\rangle \to s''[\text{DV}(D_V) \longmapsto s]}$
$[\text{call}^{\text{rec}}_{\text{ns}}]$	$\dfrac{env_P \vdash \langle S,\, s\rangle \to s'}{env_P \vdash \langle \texttt{call}\ p,\, s\rangle \to s'}$ where $env_P\ p = S$

Table 3.3: Natural semantics for **Proc** with dynamic scope rules

$[\text{call}_{\text{ns}}]$	$\dfrac{env'_P \vdash \langle S,\, s\rangle \to s'}{env_P \vdash \langle \texttt{call}\ p,\, s\rangle \to s'}$ where $env_P\ p = (S,\, env'_P)$
$[\text{call}^{\text{rec}}_{\text{ns}}]$	$\dfrac{env'_P[p \mapsto (S,\, env'_P)] \vdash \langle S,\, s\rangle \to s'}{env_P \vdash \langle \texttt{call}\ p,\, s\rangle \to s'}$ where $env_P\ p = (S,\, env'_P)$

Table 3.4: Procedure calls in case of mixed scope rules (choose one)