Dichiarazioni

Semantica statica

Assioma: **dichiarazione vuota**	$\mathcal{DS}_1 : \ \vdash \text{nil} : \emptyset$
Assioma: **ambiente statico**	$\mathcal{DS}_2 : \ \vdash \rho : \Delta \quad \text{se: } \rho \vdash_\Delta$
Base: **dichiarazione costante**	$\mathcal{DS}_3 : \ \dfrac{\Delta \vdash_V \ e : \tau}{\Delta \vdash_V \ \text{const } x : \tau = e : [x \leftarrow \tau]}$
Induttivo: **composizione privata**	$\mathcal{DS}_4 : \ \dfrac{\Delta \vdash_V \ d_1 : \Delta_1 \quad \Delta[\Delta_1] \vdash_{V \cup V'} d_2 : \Delta_2}{\Delta \vdash_V d_1 \text{ in } d_2 : \Delta_2}$
Induttivo: **composizione sequenziale**	$\mathcal{DS}_5 : \ \dfrac{\Delta \vdash_V \ d_1 : \Delta_1 \quad \Delta[\Delta_1] \vdash_{V \cup V'} d_2 : \Delta_2}{\Delta \vdash_V d_1 \ ; \ d_2 : \Delta_1[\Delta_2]}$
Base: **dichiarazione variabile**	$\mathcal{DS}_6 : \ \dfrac{\Delta \vdash e : \tau}{\Delta \vdash \text{var } x : \tau = e : [x \leftarrow \tau loc]}$
Base: **dichiarazione procedura**	$\mathcal{DS}_7 : \ \dfrac{\text{form} : \Delta_0 \quad \Delta[\Delta_0] \vdash_{V \cup V'} C}{\Delta \vdash_V \text{proc } P(\text{form})C : [P = \mathcal{T}(\text{form})\text{proc}]}$
Base: **associazione parametri formali e attuali**	$\mathcal{DS}_8 : \ \dfrac{\text{form} : \Delta_0 \quad \Delta \vdash_V ae : \mathcal{T}(\text{form})}{\Delta \vdash_V \text{form} = ae : \Delta_0}$

Semantica dinamica

Assioma: **dichiarazione vuota**	$\mathcal{D}_1 : \ \vdash \langle \text{nil}, \sigma \rangle \rightarrow_d \langle \emptyset, \sigma \rangle$	
Assioma: **dichiarazione costante con costante**	$\mathcal{D}_2 : \ \rho \vdash_\Delta \langle \text{const } x : \tau = k, \sigma \rangle \rightarrow_d \langle [x \leftarrow k], \sigma \rangle$	$\mathcal{D}_{3-2} : \ \dfrac{\rho \vdash_\Delta \langle e, \sigma \rangle \rightarrow_e^* \langle k, \sigma \rangle}{\rho \vdash_\Delta \langle \text{const } x : \tau = e, \sigma \rangle \rightarrow_d \langle [x \leftarrow k], \sigma \rangle}$
Base: **dichiarazione costante con espressione**	$\mathcal{D}_3 : \ \dfrac{\rho \vdash_\Delta \langle e, \sigma \rangle \rightarrow_e \langle e', \sigma \rangle}{\rho \vdash_\Delta \langle \text{const } x : \tau = e, \sigma \rangle \rightarrow_d \langle \text{const } x : \tau = e', \sigma \rangle}$	

Induttiva: **composizione sequenziale**	$\mathcal{D}_4 : \dfrac{\rho \vdash_\Delta \langle d, \sigma \rangle \rightarrow_d \langle d', \sigma' \rangle}{\rho \vdash_\Delta \langle d \,;\, d_1, \sigma \rangle \rightarrow_d \langle d' \,;\, d_1, \sigma' \rangle}$ $\mathcal{D}_5 : \dfrac{\rho[\rho_0] \vdash_{\Delta[\Delta_0]} \langle d_1, \sigma \rangle \rightarrow_d \langle d_1', \sigma' \rangle}{\rho \vdash_\Delta \langle \rho_0 \,;\, d_1, \sigma \rangle \rightarrow_d \langle \rho_0 \,;\, d_1', \sigma' \rangle}$ $\mathcal{D}_6 : \rho \vdash_\Delta \langle \rho_0 \,;\, \rho_1, \sigma \rangle \rightarrow_d \langle \rho_0\, [\rho_1], \sigma \rangle$	$\mathcal{D}_{4-5} : \dfrac{\rho \vdash_\Delta \langle d, \sigma \rangle \rightarrow_d^* \langle \rho_0, \sigma' \rangle}{\rho \vdash_\Delta \langle d \,;\, d_1, \sigma \rangle \rightarrow_d \langle \rho_0 \,;\, d_1, \sigma' \rangle}$ $\mathcal{D}_{5-6} : \dfrac{\rho[\rho_0] \vdash_{\Delta[\Delta_0]} \langle d_1, \sigma \rangle \rightarrow_d^* \langle \rho_1, \sigma' \rangle}{\rho \vdash_\Delta \langle \rho_0 \,;\, d_1, \sigma \rangle \rightarrow_d \langle \rho_0[\rho_1], \sigma' \rangle}$
Induttiva: **composizione privata**	$\mathcal{D}_7 : \dfrac{\rho \vdash_\Delta \langle d, \sigma \rangle \rightarrow_d \langle d', \sigma' \rangle}{\rho \vdash_\Delta \langle d \text{ in } d_1, \sigma \rangle \rightarrow_d \langle d' \text{ in } d_1, \sigma' \rangle}$ $\mathcal{D}_8 : \dfrac{\rho[\rho_0] \vdash_{\Delta[\Delta_0]} \langle d_1, \sigma \rangle \rightarrow_d \langle d_1', \sigma' \rangle}{\rho \vdash_\Delta \langle \rho_0 \text{ in } d_1, \sigma \rangle \rightarrow_d \langle \rho_0 \text{ in } d_1', \sigma' \rangle}$ $\mathcal{D}_9 : \rho \vdash_\Delta \langle \rho_0 \text{ in } \rho_1, \sigma \rangle \rightarrow_d \langle \rho_1, \sigma \rangle$	$\mathcal{D}_{7-8} : \dfrac{\rho \vdash_\Delta \langle d, \sigma \rangle \rightarrow_d^* \langle \rho_0, \sigma' \rangle}{\rho \vdash_\Delta \langle d \text{ in } d_1, \sigma \rangle \rightarrow_d \langle \rho_0 \text{ in } d_1, \sigma' \rangle}$ $\mathcal{D}_{8-9} : \dfrac{\rho[\rho_0] \vdash_{\Delta[\Delta_0]} \langle d_1, \sigma \rangle \rightarrow_d \langle \rho_1, \sigma' \rangle}{\rho \vdash_\Delta \langle \rho_0 \text{ in } d_1, \sigma \rangle \rightarrow_d \langle \rho_1, \sigma' \rangle}$
Assioma: **dichiarazione variabile su costante**	$\mathcal{D}_{10} : \rho \vdash_\Delta \langle \text{var } x : \tau = k, \sigma \rangle \rightarrow_d \langle [x \leftarrow l], \sigma[l \leftarrow k] \rangle$ $l \in Loc_\tau$ nuova locazione	
Base: **dichiarazione variabile su espressione**	$\mathcal{D}_{11} : \dfrac{\rho \vdash_\Delta \langle e, \sigma \rangle \rightarrow_e \langle e', \sigma \rangle}{\rho \vdash_\Delta \langle \text{var } x : \tau = e, \sigma \rangle \rightarrow_d \langle \text{var } x : \tau = e', \sigma \rangle}$	$\mathcal{D}_{11} : \dfrac{\rho \vdash_\Delta \langle e, \sigma \rangle \rightarrow_e^* \langle k, \sigma \rangle}{\rho \vdash_\Delta \langle \text{var } x : \tau = e, \sigma \rangle \rightarrow_d \langle [x \leftarrow l], \sigma[l \leftarrow k] \rangle}$
Assioma: **dichiarazione procedura**	$\mathcal{D}_{12} : \rho \vdash_\Delta \langle \text{proc } P()C, \sigma \rangle \rightarrow_d \langle [P \leftarrow \lambda \epsilon.\, C'], \sigma \rangle$	
Assioma: **dichiarazione procedura**	$\mathcal{D}_{13} : \rho \vdash_\Delta \langle \text{proc } P(\text{form})C, \sigma \rangle \rightarrow_d \langle [P \leftarrow \lambda\, \text{form}.\, C'], \sigma \rangle$	
Associazione formali e attuali	$\mathcal{D}_{14} : \dfrac{\rho \vdash_\Delta \langle e, \sigma \rangle \rightarrow_e \langle e', \sigma \rangle}{\rho \vdash_\Delta \langle (e', ae), \sigma \rangle}$ $\mathcal{D}_{15} : \dfrac{\rho \vdash_\Delta \langle ae, \sigma \rangle \rightarrow_{ae} \langle ae', \sigma \rangle}{\rho \vdash_\Delta \langle (k, ae), \sigma \rangle \rightarrow_{ae} \langle (k, ae'), \sigma \rangle}$ $\mathcal{D}_{16} : \dfrac{\rho \vdash_\Delta \langle ae, \sigma \rangle \rightarrow_{ae} \langle ae', \sigma \rangle}{\rho \vdash_\Delta \langle form = ae, \sigma \rangle \rightarrow_d \langle form = ae', \sigma \rangle}$	

Espressioni

Semantica statica

Assioma: **espressione vuota**	$\mathcal{E}S_1 : \ \vdash n : \text{int}$
Assioma: **int**	$\mathcal{E}S_1 : \ \vdash n : \text{int}$
Assioma: **bool**	$\mathcal{E}S_2 : \ \vdash t : \text{bool}$
Assioma: **identificatori**	$\mathcal{E}S_3 : \Delta \vdash_V \ I : \tau \quad \text{se: } \Delta(I) \in \{\tau, \tau loc\},\ I \in V$
Induttivo: **bop**	$\mathcal{E}S_4 : \dfrac{\Delta \vdash_V e_1 : \tau_1 \qquad \Delta \vdash_V e_2 : \tau_2}{\Delta \vdash_V e_1 \text{ bop } e_2 : \tau_{\text{bop}}(\tau_1, \tau_2)}$
Induttivo: **op**	$\mathcal{E}S_5 : \dfrac{\Delta \vdash_V e_1 : \tau_1 \qquad \Delta \vdash_V e_2 : \tau_2}{\Delta \vdash_V e_1 \text{ op } e_2 : \tau_{\text{op}}(\tau_1, \tau_2)}$
Induttivo: **not**	$\mathcal{E}S_6 : \dfrac{\Delta \vdash_V e_0 : \text{bool}}{\Delta \vdash_V \text{not } e_0 : \text{bool}}$

Semantica dinamica

Assioma: **identificatori**	$\mathcal{E}_2 : \rho \vdash_\Delta \langle I, \sigma \rangle \to_e \langle n, \sigma \rangle \quad \text{se: } \rho(I) = n \text{ o } (\rho(I) = l \text{ e } \sigma(l) = n)$	
Assioma: **op fra due int**	$\mathcal{E}_1 : \rho \vdash_\Delta \langle m \text{ op } n, \sigma \rangle \to_e \langle k, \sigma \rangle \quad \text{se:} \quad m \ \mathbf{op}\ n = k$	$\mathcal{E}_{3-4} : \dfrac{\rho \vdash_\Delta \langle e, \sigma \rangle \to_e^* \langle m, \sigma \rangle}{\rho \vdash_\Delta \langle e \text{ op } e_0, \sigma \rangle \to_e \langle k \text{ op } e_0, \sigma \rangle}$ $\mathcal{E}_{4-1} : \dfrac{\rho \vdash_\Delta \langle e, \sigma \rangle \to_e^* \langle n, \sigma \rangle}{\rho \vdash_\Delta \langle m \text{ op } e, \sigma \rangle \to_e \langle k, \sigma \rangle}$ $\text{se } \mathbf{op}\ n = k \text{ con } m, n, k \in \mathcal{N}$
Induttivo**: op fra due e**	$\mathcal{E}_3 : \dfrac{\rho \vdash_\Delta \langle e, \sigma \rangle \to_e \langle e', \sigma \rangle}{\rho \vdash_\Delta \langle e \text{ op } e_0, \sigma \rangle \to_e \langle e' \text{ op } e_0, \sigma \rangle}$ $\mathcal{E}_4 : \dfrac{\rho \vdash_\Delta \langle e, \sigma \rangle \to_e \langle e', \sigma \rangle}{\rho \vdash_\Delta \langle m \text{ op } e, \sigma \rangle \to_e \langle m \text{ op } e', \sigma \rangle}$	
Assioma: **bop fra due bool**	$\mathcal{E}_5 : \rho \vdash_\Delta \langle t_1 \text{ bop } t_2, \sigma \rangle \to_e \langle t, \sigma \rangle \quad se: \ t_1 \ \mathbf{op}\ t_2 = t,$ $t_1, t_2, t \in \mathcal{B}$	$\mathcal{E}_{3'-6} : \dfrac{\rho \vdash_\Delta \langle e, \sigma \rangle \to_e^* \langle t, \sigma \rangle}{\rho \vdash_\Delta \langle e \text{ bop } e_0, \sigma \rangle \to_e \langle t \text{ bop } e_0, \sigma \rangle}$
Induttivo: **bop fra due e**	$\mathcal{E}_{3'} : \dfrac{\rho \vdash_\Delta \langle e, \sigma \rangle \to_e \langle e', \sigma \rangle}{\rho \vdash_\Delta \langle e \text{ bop } e_0, \sigma \rangle \to_e \langle e' \text{ bop } e_0, \sigma \rangle}$ $\mathcal{E}_6 : \dfrac{\rho \vdash_\Delta \langle e, \sigma \rangle \to_e \langle e', \sigma \rangle}{\rho \vdash_\Delta \langle t \text{ bop } e, \sigma \rangle \to_e \langle t \text{ bop } e', \sigma \rangle}$	$\mathcal{E}_{6-5} : \dfrac{\rho \vdash_\Delta \langle e, \sigma \rangle \to_e^* \langle t_2, \sigma \rangle}{\rho \vdash_\Delta \langle t_1 \text{ bop } e, \sigma \rangle \to_e \langle t, \sigma \rangle}$ $\text{se } t_1 \ \mathbf{op}\ t_2 = t \text{ con } t_1, t_2, t \in \mathcal{B}$

Assioma: **not**	$\mathcal{E}_7 : \rho \vdash_\Delta \langle \text{not } t_1, \sigma \rangle \rightarrow_e \langle t, \sigma \rangle \quad se: \quad \textbf{not } t_1 = t, \; t_1, t \in \mathcal{B}$	$\mathcal{E}_{8-7} : \dfrac{\rho \vdash_\Delta \langle e, \sigma \rangle \rightarrow_e^* \langle t_1, \sigma \rangle}{\rho \vdash_\Delta \langle \text{not } e, \sigma \rangle \rightarrow_e \langle t, \sigma \rangle}$ se $\textbf{not } t_1 = t$ con $t_1, t \in \mathcal{B}$
Induttivo: **not e**	$\mathcal{E}_8 : \dfrac{\rho \vdash_\Delta \langle e, \sigma \rangle \rightarrow_e \langle e', \sigma \rangle}{\rho \vdash_\Delta \langle \text{not } e, \sigma \rangle \rightarrow_e \langle \text{not } e', \sigma \rangle}$	

Comandi

Semantica statica

Assegnamento	$\mathcal{CS}_1 : \dfrac{\Delta \vdash_V e : \tau}{\Delta \vdash_V x := e} \, , \; \Delta(x) = \tau loc$
If then else	$\mathcal{CS}_2 : \dfrac{\Delta \vdash_V e : \text{bool} \quad \Delta \vdash_V c_0 \quad \Delta \vdash_V c_1}{\Delta \vdash_V \text{if } e \text{ then } c_0 \text{ else } c_1}$
Sequenza	$\mathcal{CS}_3 : \dfrac{\Delta \vdash_V c_0 \quad \Delta \vdash_V c_1}{\Delta \vdash_V c_0 ; c_1}$
Skip	$\mathcal{CS}_4 : \Delta \vdash_V \text{skip}$
While	$\mathcal{CS}_5 : \dfrac{\Delta \vdash_V e : \text{bool} \quad \Delta \vdash_V c}{\Delta \vdash_V \text{while } e \text{ do } C}$
Blocco	$\mathcal{CS}_6 : \dfrac{\Delta \vdash_V d : \Delta' \quad \Delta[\Delta'] \vdash_{V \cup V'} c}{\Delta \vdash_V d; c} \; \Delta' \text{ su } V'$
Chiamata a funzione	$\mathcal{CS}_7 : \dfrac{\Delta \vdash_V ae : aet}{\Delta \vdash_V P(ae)} \quad \Delta(P) = \text{aetproc}$

Semantica dinamica

Assegnamento	$\mathcal{C}_1 : \dfrac{\rho \vdash_\Delta \langle e, \sigma \rangle \rightarrow_e \langle e', \sigma \rangle}{\rho \vdash_\Delta \langle x := e, \sigma \rangle \rightarrow_c \langle x := e', \sigma \rangle}$	$\mathcal{C}_{1-2} : \dfrac{\rho \vdash_\Delta \langle e, \sigma \rangle \rightarrow_e^* \langle k, \sigma \rangle}{\rho \vdash_\Delta \sigma[l \leftarrow k]} \; \rho(x) = l$
Assioma: variabile / costante	$\mathcal{C}_2 : \rho \vdash_\Delta \langle x := k, \sigma \rangle \rightarrow_c \sigma[l \leftarrow k], \rho(x) = l$	

If then else	$\mathcal{C}_3 : \dfrac{\rho \vdash_\Delta \langle e, \sigma\rangle \rightarrow_e \langle e', \sigma\rangle}{\rho \vdash_\Delta \langle \text{if } e \text{ then } c_0 \text{ else } c_1, \sigma\rangle \rightarrow_c \langle \text{if } e' \text{ then } c_0 \text{ else } c_1, \sigma}$ $\mathcal{C}_4 : \rho \vdash_\Delta \langle \text{if true then } c_0 \text{ else } c_1, \sigma\rangle \rightarrow_c \langle c_0, \sigma\rangle$ $\mathcal{C}_5 : \rho \vdash_\Delta \langle \text{if false then } c_0 \text{ else } c_1, \sigma\rangle \rightarrow_c \langle c_1, \sigma\rangle$	$\mathcal{C}_{3-4} : \dfrac{\rho \vdash_\Delta \langle e, \sigma\rangle \rightarrow_e^* \langle true, \sigma\rangle}{\rho \vdash_\Delta \langle \text{if } e \text{ then } c_0 \text{ else } c_1, \sigma\rangle \rightarrow_c \langle c_0, \sigma\rangle}$ $\mathcal{C}_{3-5} : \dfrac{\rho \vdash_\Delta \langle e, \sigma\rangle \rightarrow_e^* \langle false, \sigma\rangle}{\rho \vdash_\Delta \langle \text{if } e \text{ then } c_0 \text{ else } c_1, \sigma\rangle \rightarrow_c \langle c_1, \sigma\rangle}$
Skip	$\mathcal{C}_6 : \rho \vdash_\Delta \langle \text{skip}, \sigma\rangle \rightarrow_e \sigma$	
Sequenza	$\mathcal{C}_7 : \dfrac{\rho \vdash_\Delta \langle c, \sigma\rangle \rightarrow_c \langle c', \sigma'\rangle}{\rho \vdash_\Delta \langle c; c_0, \sigma\rangle \rightarrow_c \langle c'; c_0, \sigma'\rangle}$ $\mathcal{C}_8 : \dfrac{\rho \vdash_\Delta \langle c, \sigma\rangle \rightarrow_c \sigma'}{\rho \vdash_\Delta \langle c; c_0, \sigma\rangle \rightarrow_c \langle c_0, \sigma'\rangle}$	$\mathcal{C}_{7-8} : \dfrac{\rho \vdash_\Delta \langle c, \sigma\rangle \rightarrow_c^* \sigma'}{\rho \vdash_\Delta \langle c; c_0, \sigma\rangle \rightarrow_c \langle c_0, \sigma'\rangle}$
While	$\mathcal{C}_9 : \dfrac{\rho \vdash_\Delta \langle e, \sigma\rangle \rightarrow_e^* \langle \text{true}, \sigma\rangle}{\rho \vdash_\Delta \langle \text{while } e \text{ do } c, \sigma\rangle \rightarrow_c \langle c; \text{while } e \text{ do } c, \sigma\rangle}$ $\mathcal{C}_{10} : \dfrac{\rho \vdash_\Delta \langle e, \sigma\rangle \rightarrow_e^* \langle \text{false}, \sigma\rangle}{\rho \vdash_\Delta \langle \text{while } e \text{ do } c, \sigma\rangle \rightarrow_c \sigma}$	
Blocco / elaborare la dichiarazione	$\mathcal{C}_{11} : \dfrac{\rho \vdash_\Delta \langle d, \sigma\rangle \rightarrow_d \langle d', \sigma'\rangle}{\rho \vdash_\Delta \langle d; c, \sigma\rangle \rightarrow_c \langle d'; c, \sigma'\rangle}$ $\mathcal{C}_{12} : \dfrac{\rho[\rho'] \vdash_{\Delta[\Delta']} \langle c, \sigma\rangle \rightarrow_c \langle c', \sigma'\rangle}{\rho \vdash_\Delta \langle \rho'; c, \sigma\rangle \rightarrow_c \langle \rho'; c', \sigma'\rangle} \quad \rho' \vdash_{\Delta'}$ $\mathcal{C}_{13} : \dfrac{\rho[\rho'] \vdash_{\Delta[\Delta']} \langle c, \sigma\rangle \rightarrow_c \sigma'}{\rho \vdash_\Delta \langle \rho'; c, \sigma\rangle \rightarrow_c \sigma'} \quad \rho' \vdash_{\Delta'}$	$\mathcal{C}_{11-12} : \dfrac{\rho \vdash_\Delta \langle d, \sigma\rangle \rightarrow_d^* \langle \rho', \sigma'\rangle}{\rho \vdash_\Delta \langle d; c, \sigma\rangle \rightarrow_c \langle \rho'; c, \sigma'\rangle}$ $\mathcal{C}_{13-12} : \dfrac{\rho[\rho'] \vdash_{\Delta[\Delta']} \langle c, \sigma\rangle \rightarrow_c^* \sigma'}{\rho \vdash_\Delta \langle \rho'; c, \sigma\rangle \rightarrow_c \sigma'} \quad \rho' \vdash_{\Delta'}$
Chiamata a funzione?	$\mathcal{C}_{14} : \rho \vdash_\Delta \langle P(ae), \sigma\rangle \rightarrow_c \langle \text{form} = ae; C', \sigma\rangle \quad \rho(P) = \lambda\text{form}.\, C'$	