COMANDI

SINTASSI

$\mathcal{C}^V$: <Com> C → **skip | I := e | C ; C |**

if b then C else C |

while b do C

Comando Condizionale (IF)

✳ Semantica statica

$$\mathcal{C}s_2: \quad \frac{\Delta \vdash_V e : \text{bool} \quad \Delta \vdash_V c_0 \quad \Delta \vdash_V c_1}{\Delta \vdash_V \textbf{if } e \textbf{ then } c_0 \textbf{ else } c_1}$$

✳ Semantica dinamica

$$\mathcal{C}_3: \quad \frac{\rho \vdash_\Delta \langle e, \sigma\rangle \to_e \langle e', \sigma\rangle}{\rho \vdash_\Delta \langle \textbf{if } e \textbf{ then } c_0 \textbf{ else } c_1, \sigma\rangle \to_c \langle \textbf{if } e' \textbf{ then } c_0 \textbf{ else } c_1, \sigma\rangle}$$

$\mathcal{C}_4$: $\rho \vdash_\Delta \langle \textbf{if true then } c_0 \textbf{ else } c_1, \sigma\rangle \to_c \langle c_0, \sigma\rangle$

$\mathcal{C}_5$: $\rho \vdash_\Delta \langle \textbf{if false then } c_0 \textbf{ else } c_1, \sigma\rangle \to_c \langle c_1, \sigma\rangle$

COMANDO SEQUENZIALE
(o comando di composizione)

- Semantica statica

$$\mathcal{C}s_4: \frac{\Delta \vdash_V c_0,\ \Delta \vdash_V c_1}{\Delta \vdash_V c_0;c_1} \qquad \mathcal{C}s_5: \ \Delta \vdash_V \mathbf{skip}$$

- Semantica dinamica

$$\mathcal{C}_8: \ \rho \vdash_\Delta \langle \mathbf{skip}, \sigma \rangle \to_c \sigma$$

$$\mathcal{C}_9: \frac{\rho \vdash_\Delta \langle c, \sigma \rangle \to_c \langle c', \sigma' \rangle}{\rho \vdash_\Delta \langle c;c_0, \sigma \rangle \to_c \langle c';c_0, \sigma' \rangle}$$

$$\mathcal{C}_{10}: \frac{\rho \vdash_\Delta \langle c, \sigma \rangle \to_c \sigma'}{\rho \vdash_\Delta \langle c;c_0, \sigma \rangle \to_c \langle c_0, \sigma' \rangle}$$

ASSEGNAMENTO

- Semantica statica

$$\mathcal{C}s_1: \frac{\Delta \vdash_V e:\tau}{\Delta \vdash_V x:=e\ ,\ \Delta(x) = \tau\mathrm{loc}}$$

- Semantica dinamica

$$\mathcal{C}_1: \frac{\rho \vdash_\Delta \langle e, \sigma \rangle \to_e \langle e', \sigma \rangle}{\rho \vdash_\Delta \langle x:=e, \sigma \rangle \to_c \langle x:=e', \sigma \rangle}$$

$$\mathcal{C}_2: \ \rho \vdash_\Delta \langle x:=k, \sigma \rangle \to_c \sigma[l \leftarrow k],\ \rho(x)=l$$

ITERAZIONE: WHILE

- Semantica statica

$$\mathcal{CS}_3: \quad \frac{\Delta \vdash_V \texttt{e:bool},\ \Delta \vdash_V \texttt{c}}{\Delta \vdash_V \textbf{while}\ \texttt{e}\ \textbf{do}\ \texttt{c}}$$

- Semantica dinamica

$$\mathcal{C}_6: \quad \frac{\rho \vdash_\Delta \langle \texttt{e},\sigma\rangle \rightarrow^*_e \langle \texttt{true},\sigma\rangle}{\rho \vdash_\Delta \langle \textbf{while}\ \texttt{e}\ \textbf{do}\ \texttt{c},\sigma\rangle \rightarrow_c \langle \texttt{c};\textbf{while}\ \texttt{e}\ \textbf{do}\ \texttt{c},\sigma\rangle}$$

$$\mathcal{C}_7: \quad \frac{\rho \vdash_\Delta \langle \texttt{e},\sigma\rangle \rightarrow^*_e \langle \texttt{false},\sigma\rangle}{\rho \vdash_\Delta \langle \textbf{while}\ \texttt{e}\ \textbf{do}\ \texttt{c},\sigma\rangle \rightarrow_c \sigma}$$

DICHIARAZIONI

SINTASSI

$\mathcal{D}^V$: <Dec> D → **nil** | **const** I:τ = e | **var** I:τ = e
D **in** D | D ; D | ρ

Costante

- Semantica statica

$$\mathcal{D}s_3: \frac{\Delta \vdash_V e:\tau}{\Delta \vdash_V \textbf{const}\ x:\tau=e:[x\leftarrow\tau]}$$

- Semantica dinamica

$$\mathcal{D}_2: \rho \vdash_\Delta \textbf{const}\ x:\tau=k \rightarrow_d [x=k]$$

$$\mathcal{D}_3: \frac{\rho \vdash_\Delta e \rightarrow_e e'}{\rho \vdash_\Delta \textbf{const}\ x:\tau=e \rightarrow_d \textbf{const}\ x:\tau=e'}$$

Dichiarazione privata (D in D)

- Semantica statica

$$\mathcal{D}s_4: \frac{\Delta \vdash_V d_1:\Delta_1 \quad \Delta[\Delta_1] \vdash_{V \cup V'} d_2:\Delta_2}{\Delta \vdash_V d_1\ \textbf{in}\ d_2:\Delta_2}\ \Delta_1:V'$$

- Semantica dinamica

$$\mathcal{D}_8: \frac{\rho \vdash_\Delta d \rightarrow_d d'}{\rho \vdash_\Delta d\ \textbf{in}\ d_1 \rightarrow_d d'\ \textbf{in}\ d_1}$$

$$\mathcal{D}_9: \frac{\rho[\rho_0] \vdash_{\Delta[\Delta_0]} d_1 \rightarrow_d d_1'}{\rho \vdash_\Delta \rho_0\ \textbf{in}\ d_1 \rightarrow_d \rho_0\ \textbf{in}\ d_1'} \qquad \mathcal{D}_{10}: \rho \vdash_\Delta \rho_0\ \textbf{in}\ \rho_1 \rightarrow_d \rho_1$$

Variabile modificabile (var I:t = e)

- Semantica statica

$$\mathcal{D}s_6: \frac{\Delta \vdash_V e:\tau}{\Delta \vdash_V \textbf{var}\ x:\tau=e:[x\leftarrow\tau\text{loc}]}$$

- Semantica dinamica

$$\mathcal{D}_{12}: \frac{\rho \vdash_\Delta \langle e,\sigma\rangle \rightarrow_e \langle e',\sigma\rangle}{\rho \vdash_\Delta \langle \textbf{var}\ x:\tau=e,\sigma\rangle \rightarrow_d \langle \textbf{var}\ x:\tau=e',\sigma\rangle}$$

Dichiarazione sequenziale (D ; D)

- Semantica statica $\mathcal{D}s_5: \dfrac{\Delta \vdash_V d_1 : \Delta_1 \quad \Delta[\Delta_1] \vdash_{VUV'} d_2 : \Delta_2}{\Delta \vdash_V d_1 ; d_2 : \Delta_1[\Delta_2]} \; \Delta_1 : V'$

- Semantica dinamica

$$\mathcal{D}_5: \frac{\rho \vdash_\Delta d \rightarrow_d d'}{\rho \vdash_\Delta d ; d_1 \rightarrow_d d' ; d_1} \qquad \mathcal{D}_6: \frac{\rho[\rho_0] \vdash_{\Delta[\Delta_0]} d_1 \rightarrow_d d_1'}{\rho \vdash_\Delta \rho_0 ; d_1 \rightarrow_d \rho_0 ; d_1'}$$

Dichiarazione vuota

- Semantica statica $\mathcal{D}s_1: \vdash \mathbf{nil} : \varnothing$
- Semantica dinamica $\mathcal{D}_1: \vdash \mathbf{nil} \rightarrow_d \varnothing$

Ambiente

- Semantica statica $\mathcal{D}s_2: \vdash \rho : \rho$
- Semantica dinamica $\mathcal{D}_7: \rho \vdash_\Delta \rho_0 ; \rho_1 \rightarrow_d \rho_0[\rho_1]$

ESPRESSIONI

SINTASSI

$\mathcal{E}$: <Exp>

E → A | B

A → ~~I~~ | N | A op A

B → true | false | not B | B bop B

IDENTIFICATORE

✳ Semantica statica $\mathcal{E}s_1: \vdash n:int$ $\mathcal{E}s_2: \vdash t:bool$

✳ Semantica dinamica $\mathcal{E}_2: \rho \vdash_\Delta I \to_e n$ se $\rho(I) = n$

NOT B

✳ Semantica statica

$$\mathcal{E}s_6: \frac{\Delta \vdash_V e_0 : \tau_0}{\Delta \vdash_V \textbf{not}\ e_0 : \tau_{not}(\tau_0)}$$

✳ Semantica dinamica

$$\mathcal{E}_7: \frac{\rho \vdash_\Delta e \to_e e'}{\rho \vdash_\Delta \textbf{not}\ e \to_e \textbf{not}\ e'}$$

$\mathcal{E}_8: \rho \vdash_\Delta \textbf{not}\ t_0 \to_e t$ se not $t_0 = t$

Operatore Binario

✳ Semantica statica $\mathscr{E}_{S_5}: \dfrac{\Delta \vdash_V e_1 : \tau_1 \quad \Delta \vdash_V e_2 : \tau_2}{\Delta \vdash_V e_1 \ \mathbf{op} \ e_2 : \ \tau_{op}(\tau_1, \tau_2)}$

✳ Semantica dinamica $\mathscr{E}_1: \ \rho \vdash_\Delta m \ \mathbf{op} \ n \to_e p \quad$ se $\quad m \ op \ n = p$

$$\mathscr{E}_3: \frac{\rho \vdash_\Delta e \to_e e'}{\rho \vdash_\Delta e \ \mathbf{op} \ e_0 \to_e e' \ \mathbf{op} \ e_0} \qquad \mathscr{E}_4: \frac{\rho \vdash_\Delta e \to_e e'}{\rho \vdash_\Delta m \ \mathbf{op} \ e \to_e m \ \mathbf{op} \ e'}$$

Operatore Booleano Binario

✳ Semantica statica $\mathscr{E}_{S_4}: \dfrac{\Delta \vdash_V e_1 : \tau_1 \quad \Delta \vdash_V e_2 : \tau_2}{\Delta \vdash_V e_1 \ \mathbf{bop} \ e_2 : \ \tau_{bop}(\tau_1, \tau_2)}$

✳ Semantica dinamica

$\mathscr{E}_5: \ \rho \vdash_\Delta t_1 \ \mathbf{bop} \ t_2 \to_e t \quad$ se $\quad t_1 \ bop \ t_2 = t$

$$\mathscr{E}_6: \frac{\rho \vdash_\Delta e \to_e e'}{\rho \vdash_\Delta t \ \mathbf{bop} \ e \to_e t \ \mathbf{bop} \ e'}$$