Linguaggi di programmazione: semantica

Scoping statico e dinamico

1

d_1 var z : int = 2;
d_2 procedure inc(var x : int)
c_1 z:= x + 1;
d_3 var z : int = 3;
c_2 while z=3 do
c_3 inc(z);

1.1 Semantica statica

$$\frac{\emptyset \vdash_\emptyset 2 : int}{\emptyset \vdash_\emptyset d_1 : [z = intloc]}$$

$\Delta_1 = [z = intloc]$
$I_1 = \{z\}$

$$\frac{\text{var x : int} : [x = intloc] \qquad \dfrac{\dfrac{\Delta_1[x = intloc] \vdash_{I_1 \cup \{x\}} x : int \quad \Delta_1[x = intloc] \vdash_{I_1 \cup \{x\}} 1 : int}{\Delta_1[x = intloc] \vdash_{I_1 \cup \{x\}} x + 1 : \tau_+(int, int)}}{\Delta_1[x = intloc] \vdash_{I_1 \cup \{x\}} c_1}}{\Delta_1 \vdash_{I_1} d_2 : [inc = intproc]}$$

$\Delta_2 = \Delta_1[inc = intproc]$
$I_2 = I_1 \cup \{p\}$

$$\frac{\Delta_2 \vdash_{I_2} 3 : int}{\Delta_2 \vdash_{I_2} d_3 : [z = intloc]}$$

$$\frac{\emptyset \vdash_\emptyset d_1; d_2; d_3 : \Delta_2 \qquad \dfrac{\dfrac{\Delta_2 \vdash_{I_2} z : int \quad \Delta_2 \vdash_{I_2} 3 : int}{\Delta_2 \vdash_{I_2} z = 3 : \tau_=(int, int) = bool} \quad \dfrac{\Delta_2 \vdash_{I_2} x : int}{\Delta_2 \vdash_{I_2} c_3} \; \Delta_2(inc) = intproc}{\Delta_2 \vdash_{I_2} c_2}}{\emptyset \vdash_\emptyset d_1; d_2; d_3; c_2}$$

1.2 Semantica dinamica: scoping statico

$$
\begin{array}{ll}
 & < d_1; d_2; d_3; c_2, \emptyset > \\
\xrightarrow{(1)} & < \rho_1 = [z = l_z]; d_2; d_3; c_2, [l_z = 2] > \\
\xrightarrow{(2)} & < \rho_1; \rho_2 = [inc = \lambda \text{var x : int.}[z = l_z]; c_1]; d_3; c_2, [l_z = 2] > \\
\xrightarrow{(3)} & < \rho_1; \rho_2; \rho_3 = [z = l'_z]; c_2, [l_z = 2, l'_z = 3] > \\
\xrightarrow{(4-5)} & < \rho = [inc = \lambda \text{var x : int.}[z = l_z]; c_1, z = l'_z]; c_2, [l_z = 2, l'_z = 3] > \\
\xrightarrow{(6)} & < \rho; c_3; c_2, [l_z = 2, l'_z = 3] > \\
\xrightarrow{(7)} & < \rho; (\text{var x : int} = z; [z = l_z]; c_1); c_2, [l_z = 2, l'_z = 3] > \\
\xrightarrow{(8)} & < \rho; (\text{var x : int} = 3; [z = l_z]; c_1); c_2, [l_z = 2, l'_z = 3] > \\
\xrightarrow{(9)} & < \rho; ([x = l_x]; [z = l_z]; c_1); c_2, [l_z = 2, l'_z = 3, l_x = 3] > \\
\xrightarrow{(10-11)} & < \rho; ([x = l_x, z = l_z]; c_1); c_2, [l_z = 2, l'_z = 3, l_x = 3] > \\
\xrightarrow{(12)} & < \rho; c_2, [l_z = 4, l'_z = 3, l_x = 3] >
\end{array}
$$

... nell'ambiente attuale z fa riferimento ad l'_z che non viene mai modificato da c_2 per via dello scoping statico e quindi il programma non termina.

$\xrightarrow{(1)}$

$$
\frac{\frac{\frac{\emptyset \vdash_{\Delta_2} < d_1, \emptyset > \rightarrow_d < [z = l_z], [l_z = 2] >}{\emptyset \vdash_{\Delta_2} < d_1; d_2, \emptyset > \rightarrow_d < [z = l_z]; d_2, [l_z = 2] >}}{\emptyset \vdash_{\Delta_2} < d_1; d_2; d_3, \emptyset > \rightarrow_d < [z = l_z]; d_2; d_3, [l_z = 2] >}}{\emptyset \vdash_{\Delta_2} < d_1; d_2; d_3; c_2, \emptyset > \rightarrow_c < [z = l_z]; d_2; d_3; c_2, [l_z = 2] >}
$$

$\xrightarrow{(2)}$

$$
\frac{\frac{\frac{\rho_1 \vdash_{\Delta_2} < d_2, [l_z = 2] > \rightarrow_d < [inc = \lambda \text{var x : int.}[z = l_z]; c_1], [l_z = 2] >}{\rho_1 \vdash_{\Delta_2} < d_2; d_3, [l_z = 2] > \rightarrow_d < [inc = \lambda \text{var x : int.}[z = l_z]; c_1]; d_3, [l_z = 2] >}}{\rho_1 \vdash_{\Delta_2} < d_2; d_3; c_2, [l_z = 2] > \rightarrow_c < [inc = \lambda \text{var x : int.}[z = l_z]; c_1]; d_3; c_2, [l_z = 2] >}}{\emptyset \vdash_{\Delta_2} < \rho_1; d_2; d_3; c_2, [l_z = 2] > \rightarrow_c < \rho_1; [inc = \lambda \text{var x : int.}[z = l_z]; c_1]; d_3; c_2, [l_z = 2] >}
$$

$\xrightarrow{(3)}$

$$
\frac{\frac{\frac{\rho_1 \rho_2 \vdash_{\Delta_2} < d_3, [l_z = 2] > \rightarrow_d < [z = l'_z], [l_z = 2, l'_z = 3] >}{\rho_1 \rho_2 \vdash_{\Delta_2} < d_3; c_2, [l_z = 2] > \rightarrow_c < [z = l'_z]; c_2, [l_z = 2, l'_z = 3] >}}{\rho_1 \vdash_{\Delta_2} < \rho_2; d_3; c_2, [l_z = 2] > \rightarrow_c < \rho_2; [z = l'_z]; c_2, [l_z = 2, l'_z = 3] >}}{\emptyset \vdash_{\Delta_2} < \rho_1; \rho_2; d_3; c_2, [l_z = 2] > \rightarrow_c < \rho_1; \rho_2; [z = l'_z]; c_2, [l_z = 2, l'_z = 3] >}
$$

$\xrightarrow{(6)}$

$$
\frac{\frac{\frac{\rho \vdash_{\Delta_2} < z = 3, [l_z = 2, l'_z = 3] > \rightarrow_e^* < tt, [l_z = 2, l'_z = 3] >}{\rho \vdash_{\Delta_2} < c_2, [l_z = 2, l'_z = 3] > \rightarrow_c < c_3; c_2, [l_z = 2, l'_z = 3] >}}{\emptyset \vdash_{\Delta_2} < \rho; c_2, [l_z = 2, l'_z = 3] > \rightarrow_c < \rho; c_3; c_2, [l_z = 2, l'_z = 3] >}
$$

$\xrightarrow{(9)}$

$$
\frac{\frac{\frac{\frac{\bullet, \{l_x\} \vdash \bullet : \emptyset, \emptyset}{(3, \bullet), \emptyset \vdash \text{var x : int} = 3, \bullet : [x = l_x], [l_x = 3]}}{\rho \vdash_{\Delta_2} < \text{var x : int} = 3, [l_z = 2, l'_z = 3] > \rightarrow_d < [x = l_x], [l_z = 2, l'_z = 3, l_x = 3] >}}{\emptyset \vdash_{\Delta_2} < \rho; \text{var x : int} = 3, [l_z = 2, l'_z = 3] > \rightarrow_d < \rho; [x = l_x], [l_z = 2, l'_z = 3, l_x = 3] >}}{\emptyset \vdash_{\Delta_2} < \rho; \text{var x : int} = 3; [z = l_z]; c_1; c_2, [l_z = 2, l'_z = 3] > \rightarrow_c < \rho; [x = l_x]; [z = l_z]; c_1; c_2, [l_z = 2, l'_z = 3, l_x = 3] >}
$$

$\xrightarrow{(12)}$

$$\dfrac{\dfrac{\dfrac{\rho[x = l_x, z = l_z] \vdash_{\Delta_2} < x + 1, [l_z = 2, l'_z = 3, l_x = 3] > \rightarrow_e^* < 4, [l_z = 2, l'_z = 3, l_x = 3] >}{\rho[x = l_x, z = l_z] \vdash_{\Delta_2} < z := x + 1, [l_z = 2, l'_z = 3, l_x = 3] > \rightarrow_c [l_z = 4, l'_z = 3, l_x = 3]}}{\rho \vdash_{\Delta_2} < [x = l_x, z = l_z]; z := x + 1, [l_z = 2, l'_z = 3, l_x = 3] > \rightarrow_c [l_z = 4, l'_z = 3, l_x = 3]}}{\rho \vdash_{\Delta_2} < ([x = l_x, z = l_z]; z := x + 1); c_2, [l_z = 2, l'_z = 3, l_x = 3] > \rightarrow_c \vdash_{\Delta_2} < c_2, [l_z = 4, l'_z = 3, l_x = 3] >}$$

1.3 Semantica dinamica: scoping dinamico

$$\begin{aligned}
& < d_1; d_2; d_3; c_2, \emptyset > \\
\xrightarrow{(1)} \quad & < \rho_1 = [z = l_z]; d_2; d_3; c_2, [l_z = 2] > \\
\xrightarrow{(2)} \quad & < \rho_1; \rho_2 = [inc = \lambda \text{var x : int}.c_1]; d_3; c_2, [l_z = 2] > \\
\xrightarrow{(3)} \quad & < \rho_1; \rho_2; \rho_3 = [z = l'_z]; c_2, [l_z = 2, l'_z = 3] > \\
\xrightarrow{(4-5)} \quad & < \rho = [inc = \lambda \text{var x : int}.c_1, z = l'_z]; c_2, [l_z = 2, l'_z = 3] > \\
\xrightarrow{(6)} \quad & < \rho; c_3; c_2, [l_z = 2, l'_z = 3] > \\
\xrightarrow{(7)} \quad & < \rho; (\text{var x : int} = z; c_1); c_2, [l_z = 2, l'_z = 3] > \\
\xrightarrow{(8)} \quad & < \rho; (\text{var x : int} = 3; c_1); c_2, [l_z = 2, l'_z = 3] > \\
\xrightarrow{(9)} \quad & < \rho; ([x = l_x]; c_1); c_2, [l_z = 2, l'_z = 3, l_x = 3] > \\
\xrightarrow{(10-11)} \quad & < \rho; ([x = l_x]; c_1); c_2, [l_z = 2, l'_z = 3, l_x = 3] > \\
\xrightarrow{(12)} \quad & < \rho; c_2, [l_z = 2, l'_z = 4, l_x = 3] > \\
\xrightarrow{(13)} \quad & [l_z = 2, l'_z = 4, l_x = 3]
\end{aligned}$$