4. Type Rules for for-loop

for (int i=e0; e1; s1) s2

5) $$\frac{\Gamma \mid\!-_{e}\, s1 : \tau}{\Gamma \mid\!-_{s}\, s1;}$$ **(stmt-expr)**

6) $$\frac{\Gamma \mid\!-_{e}\, s2 : \tau}{\Gamma \mid\!-_{s}\, s2;}$$ **(stmt-expr)**

3) $$\frac{}{\Gamma \mid\!-_{e}\, true : bool}$$ **(True)**

4) $$\frac{}{\Gamma \mid\!-_{e} false : bool}$$ **(False)**

2) $$\frac{\Gamma,(l,i{:}\tau) \mid\!-_{sl}\, i{=}e0 \quad \forall_{\tau`}{:}(l,i{:}\tau`) \notin \Gamma}{\Gamma \mid\!-_{sl}\, \tau\ i;\ i{=}e0}$$ **(var-decl)**

1) $$\frac{\Gamma,(l,i{:}int),(-,e0{:}int) \mid\!-_{sl}\, \tau\ i;\ i{=}e0 \quad \tau_{i} < \tau_{e0} \quad \Gamma,(l,i{:}int) \mid\!-_{e}\, e1{:}bool \quad \tau_{e1} < bool \quad \Gamma,(l,i{:}int) \mid\!-_{s}\, s1 \quad \Gamma,(l,i{:}int) \mid\!-_{s}\, s2}{\Gamma \mid\!-_{s} for\ (int\ i{=}e0;\ e1;\ s1)\ s2}$$ **(for)**

5. derivation

(return : int[]) |- sl int[] y; y = new int[2]; y[1] = 1; return y;

9) $$\frac{\Gamma=(return\ :int[]),(l,y:int[])\ \vdash_e y:int[] \qquad int[]<int[] \qquad (return\ :int[])\in\Gamma}{\Gamma=(return\ :int[]),(l,y:int[])\ \vdash_s return\ y;}$$ **(return)**

8) $$\frac{\Gamma=(return\ :int[]),(l,y:int[])\ \vdash_e y\ :int[] \qquad \Gamma=(return\ :int[]),(l,y:int[])\ \vdash_e 1:int}{\Gamma=(return\ :int[]),(l,y:int[])\ \vdash_e y[1]:int}$$ **(array-lookup)**

6) $$\frac{\Gamma=(return\ :int[]),(l,y:int[])\ \vdash_e y[1]\ :int[] \qquad \Gamma=(return\ :int[]),(l,y:int[])\ \vdash_e 1:int \qquad int[]<int}{\Gamma=(return\ :int[]),(l,y:int[])\ \vdash_e y[1]=1;}$$ **(assign)**

5) $$\frac{}{\Gamma=(return\ :int[]),(l,y:int[])\ \vdash_e y:int[]}$$ **(int-literal)**

7) $$\frac{\Gamma=(return\ :int[]),(l,y:int[])\ \vdash_e 2:int}{\Gamma=(return\ :int[]),(l,y:int[])\ \vdash_e new\ int[2]\ :int[]}$$ **(new-array)**

4) $$\frac{\Gamma=(return\ :int[]),(l,y:int[])\ \vdash_e y:int[] \qquad \Gamma=(return\ :int[]),(l,y:int[])\ \vdash_e new\ int[2]\ :int[] \qquad int[]<int[]}{\Gamma=(return\ :int[]),(l,y:int[])\ \vdash_e y=new\ int[2];}$$

(assign)

3) $$\frac{\Gamma=(\mathit{return}\ :\mathit{int}[]),(l,y:\mathit{int}[])\ |\!-_{sl}\ y=\mathit{new}\ \mathit{int}[2];\quad \forall_{\tau`}:(l,y:\tau`)\notin\Gamma}{\Gamma=(\mathit{return}\ :\mathit{int}[])\ |\!-_{sl}\ \mathit{int}[]\ y;\ y=\mathit{new}\ \mathit{int}[2];}$$ **(var-decl)**

2) $$\frac{\Gamma=(\mathit{return}\ :\mathit{int}[])\ |\!-_{sl}\ \mathit{int}[]\ y;\ \Gamma=(\mathit{return}\ :\mathit{int}[])\ |\!-_{sl}\ y=\mathit{new}\ \mathit{int}[2];\ \ \Gamma=(\mathit{return}\ :\mathit{int}[])\ |\!-_{sl}\ y[1]=1;\ \ \Gamma=(\mathit{return}\ :\mathit{int}[])\ |\!-_{sl}\ \mathit{return}\ y}{\Gamma=(\mathit{return}\ :\mathit{int}[])\ |\!-_{sl}\ \mathit{int}[]\ y;\ y=\mathit{new}\ \mathit{int}[2];\ y[1]=1;\ \mathit{return}\ y;}$$

(seq)

1) $$\frac{}{\Gamma=(\mathit{return}\ :\mathit{int}[])\ |\!-_{sl}\ \mathit{int}[]\ y;\ y=\mathit{new}\ \mathit{int}[2];\ y[1]=1;\ \mathit{return}\ y;}$$