LTROLL

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1 Sintaxe Abstrata

e $\in Terms$

code := declaration "linebreak" e

declaration := {vazio} | $l\ T$ *declaration*

e := !l $|if\ e_1\ then\ e_2\ else\ e_3|e_1\ op\ e_2|for\ e_1\ until\ e_2\ do\ e_3|e_1; e_2|e_1{:}\ e_2|notnot\ e_1|\ fn\ x : T \Rightarrow e_1\ in\ e_2$

v $\in Values$

v := n | b | l | $fn\ x : T \Rightarrow e_1$ | *skip*

t $\in Types$

t:= int | *bool* | $T_1 \rightarrow T_2$ | $ref\ T_1$ | *unit*

onde:
n $\in nat$
$b \in bool$
$l \in conjunto\ de\ enderecos$
$op \in \{+, -, <, >, \leq, \geq, =, \neq, or, and\}$

2 Semântica Small Step

$$\frac{e_1, \sigma \rightarrow e_1, \sigma'}{e_1\ op\ e_2, \sigma \rightarrow e_1'\ op\ e_2, \sigma'}[e - op1] \qquad \frac{e_1, \sigma \rightarrow e_1', \sigma'}{v\ op\ e_1, \sigma \rightarrow v\ op\ e_1', \sigma'}[e - op2]$$

$$\frac{[[v_1]] = [[v_2]] - [[v_3]]}{v_2 + v_3, \sigma \to v_1, \sigma}[e - plus3] \qquad \frac{[[v_1]] < [[v_2]]}{v_1 < v_2, \sigma \to false, \sigma}[e - less4]$$

$$\frac{[[v_1]] = [[v_2]] + [[v_3]]}{v_2 - v_3, \sigma \to v_1, \sigma}[e - minus3] \qquad \frac{[[v_1]] \geq [[v_2]]}{v_1 \leq v_2, \sigma \to true, \sigma}[e - lessequal3]$$

$$\frac{[[v_1]] \neq [[v_2]]}{v_1 = v_2, \sigma \to true, \sigma}[e - equal3] \qquad \frac{[[v_1]] \leq [[v_2]]}{v_1 \leq v_2, \sigma \to false, \sigma}[e - lessequal4]$$

$$\frac{[[v_1]] = [[v_2]]}{v_1 = v_2, \sigma \to false, \sigma}[e - equal4] \qquad \frac{[[v_1]] \leq [[v_2]]}{v_1 \geq v_2, \sigma \to true, \sigma}[e - greatequal3]$$

$$\frac{[[v_1]] = [[v_2]]}{v_1 \neq v_2, \sigma \to true, \sigma}[e - nequal3] \qquad \frac{[[v_1]] \geq [[v_2]]}{v_1 \geq v_2, \sigma \to false, \sigma}[e - greatequal4]$$

$$\frac{[[v_1]] \neq [[v_2]]}{v_1 \neq v_2, \sigma \to false, \sigma}[e - nequal4] \qquad \frac{[[v_1]] \ or \ [[v_2]] = [[v_3]]}{v_1 \ and \ v_2, \sigma \to v_3, \sigma}[e - and3]$$

$$\frac{[[v_1]] > [[v_2]]}{v_1 < v_2, \sigma \to true, \sigma}[e - less3] \qquad \frac{[[v_1]] \ and \ [[v_2]] = [[v_3]]}{v_1 \ or \ v_2, \sigma \to v_3, \sigma}[e - or3]$$

$$\frac{e_1, \sigma \to e_1', \sigma'}{if \ e_1 \ then \ e_2 \ else \ e_3, \sigma \to if \ e_1' \ then \ e_2 \ else \ e_3, \sigma'}[e - if1]$$

$$\frac{}{if \ true \ then \ e_2 \ else \ e_3, \sigma \to e_3, \sigma}[e - if2]$$

$$\frac{}{if \ false \ then \ e_2 \ else \ e_2, \sigma \to e_3, \sigma}[e - if3]$$

$$\frac{e_1, \sigma \to e_1', \sigma'}{for \ e_1 \ until \ e_2 \ do \ e_3, \sigma \to for \ e_1' \ until \ e_2 \ do \ e_3, \sigma'}[e - for1]$$

$$\frac{e_2, \sigma \to e_2', \sigma'}{for \ v \ until \ e_2 \ do \ e_3, \sigma \to for \ v \ until \ e_2' \ do \ e_3, \sigma'}[e - for2]$$

$$\frac{[[v_1]] \neq [[v_2]]}{for \ v_1 \ until \ v_2 \ do \ e_3, \sigma \to e_3 : for \ v_1 \ until \ v_2 + 1 \ do \ e_3, \sigma}[e - for3]$$

$$\frac{[[v_1]] = [[v_2]]}{for \ v_1 \ until \ v_2 \ do \ e_3, \sigma \to e_3, \sigma}[e - for4]$$

$$\frac{e_1, \sigma \to e_1', \sigma'}{e_1 \ in \ e_2, \sigma \to e_1' \ in \ e_2, \sigma'}[e - in1]$$

$$\frac{e_2, \sigma \to e_2', \sigma'}{e_1 \ in \ e_2, \sigma \to e_1' \ in \ e_2', \sigma'}[e - in2]$$

$$\frac{}{fn \ x : T \Rightarrow e_1 \ in \ v, \sigma \to e_1\{v/x\}, \sigma}[e - in3]$$

$$\frac{not[[v1]] = [[v2]]}{notnot\ v_1, \sigma \to v_2, \sigma}[e - notnot2]$$

$$\frac{e_1, \sigma \to e_1', \sigma'}{e_1 : e_2, \sigma \to e_1' : e_2, \sigma'}[e - doispontos1]$$

$$\frac{}{v_1 : e_2, \sigma \to e_2, \sigma}[e - doispontos2]$$

$$\frac{l \in Dom(\sigma)}{v := l, \sigma \to skip, \sigma[l \mapsto v]}[e - assing1]$$

$$\frac{e_2, \sigma \to e_2', \sigma'}{e_1; e_2, \sigma \to e_1; e_2', \sigma'}[e{-}pontoevirgula1]$$

$$\frac{}{e_1; v_1, \sigma \to e_1, \sigma}[e - pontoevirgula2]$$

$$\frac{e_1, \sigma \to e_1', \sigma'}{e_1 := v_1.\sigma \to e_1' := v_1, \sigma'}[e - assing2]$$

$$\frac{l \in Dom(\sigma)\ \sigma(l) = v}{!l, \sigma \to v, \sigma}[e - deref1]$$

$$\frac{e_1, \sigma \to e_1', \sigma'}{notnot\ e_1, \sigma \to notnot\ e_1, \sigma'}[e{-}notnot1] \quad \frac{e_2, \sigma \to e_2', \sigma'}{e_1 := e_2.\sigma \to e_1 := e_2', \sigma'}[e - assing3]$$

3 Sistema de Tipos

$$\frac{}{\Gamma \vdash n : int}[t - int]$$

$$\frac{}{\Gamma \vdash b : bool}[t - bool]$$

$$\frac{}{\Gamma \vdash skip : unit}[t - skip]$$

$$\frac{l\ \in\ \Gamma\ \wedge\ \Gamma\{l\} : refT}{\Gamma \vdash l : refT}[bel]$$

$$\frac{\Gamma \vdash e_1 : T_1 \to T_1' \qquad \Gamma \vdash e_2 : T_1}{\Gamma \vdash e_1\ in\ e_2 : T_1'}[t{-}in]$$

$$\frac{\Gamma \vdash e_1 : T_1}{\Gamma\ fn\ x : T \Rightarrow e_1\ : T \to T_1'}[t - fn]$$

$$\frac{\Gamma \vdash e_1 : refT_1}{\Gamma \vdash !e_1 : T_1}[t - derref]$$

$$\frac{\Gamma \vdash e_1 : T_1 \qquad \Gamma \vdash e_2 : T_1}{\Gamma \vdash e_1 = e_2 : bool}[t - eq]$$

$$\frac{\Gamma \vdash e_1 : T_1 \qquad \Gamma \vdash e_2 : T_1}{\Gamma \vdash e_1 \neq e_2 : bool}[t - neq]$$

$$\frac{\Gamma \vdash e_1 : bool \qquad \Gamma \vdash e_2 : bool}{\Gamma \vdash e_1\ and\ e_2 : bool}[t - \wedge]$$

$$\frac{\Gamma \vdash e_1 : bool \qquad \Gamma \vdash e_2 : bool}{\Gamma \vdash e_1\ or\ e_2 : bool}[t - or]$$

$$\frac{\Gamma \vdash e_1 : bool}{\Gamma \vdash\ notnot\ e_1 : bool}[t - notnot]$$

$$\frac{\Gamma \vdash e_1 : nat \qquad \Gamma \vdash e_2 : nat}{\Gamma \vdash e_1 > e_2 : bool}[t{-}>]$$

$$\frac{\Gamma \vdash e_1 : nat \qquad \Gamma \vdash e_2 : nat}{\Gamma \vdash e_1 < e_2 : bool}[t{-}<]$$

$$\frac{\Gamma \vdash e_1 : nat \qquad \Gamma \vdash e_2 : nat}{\Gamma \vdash e_1 \geq e_2 : bool}[t{-}\geq]$$

$$\frac{\Gamma \vdash e_1 : nat \qquad \Gamma \vdash e_2 : nat}{\Gamma \vdash e_1 \leq e_2 : bool}[t{-}\leq]$$

$$\frac{\Gamma \vdash e_1 : nat \qquad \Gamma \vdash e_2 : nat}{\Gamma \vdash e_1 + e_2 : nat}[t - +]$$

$$\frac{\Gamma \vdash e_1 : nat \qquad \Gamma \vdash e_2 : nat}{\Gamma \vdash e_1 - e_2 : nat}[t{-}minus]$$

$$\frac{\Gamma \vdash e_1 : T_1 \qquad \Gamma \vdash e_2 : T_2}{\Gamma \vdash e_1; e_2 : T_1}[t{-}pontoevirgula]$$

$$\frac{\Gamma \vdash e_1 : T_1 \qquad \Gamma \vdash e_2 : T_2}{\Gamma \vdash e_1 : e_2 : T_2}[t{-}doispontos]$$

$$\frac{\Gamma \vdash e_1 : nat \qquad \Gamma \vdash e_2 : nat \qquad \Gamma \vdash e_3 : T_3}{\Gamma \vdash for\ e_1\ until\ e_2\ do\ e_3 : T_3}[t - for]$$

$$\frac{\Gamma \vdash e_1 : bool \qquad \Gamma \vdash e_2 : T_2 \qquad \Gamma \vdash e_3 : T_2}{\Gamma \vdash if\ e_1\ then\ e_2\ else\ e_3 : T_2}[t - if]$$

$$\frac{\Gamma \vdash e_1 : refT_1 \qquad \Gamma \vdash e_2 : T_1}{\Gamma \vdash\ e_2 := e_1 : unit}[t - assing]$$