λ_{ref} Language Definition

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1 Overview

2 Syntax

The syntax of λ_{ref} is given below.

$$
\begin{array}{rcl}
v & ::= & \texttt{()} \\
& | & n \in \mathbb{N} \\
& | & b \in \mathbb{B} \\
& | & x \\
& | & \lambda x.e
\end{array}
\qquad
\begin{array}{rcl}
e & ::= & v \\
& | & e_1\ e_2 \\
& | & \textbf{let}\ x = e_1\ \textbf{in}\ e_2 \\
& | & \textbf{if}\ e_1\ \textbf{then}\ e_2\ \textbf{else}\ e_3 \\
& | & \textit{ref}\ e \\
& | & !e \\
& | & e_1 := e_2
\end{array}
$$

3 Small Step Semantics

$$\frac{}{\texttt{()}\ \texttt{val}}\ (\textbf{unit})$$

$$\frac{}{n\ \texttt{val}}\ (\textbf{int})$$

$$\frac{}{b\ \texttt{val}}\ (\textbf{bool})$$

$$\frac{}{\lambda x.e\ \texttt{val}}\ (\textbf{lam})$$

$$\frac{l \in \textbf{Label}}{l\ \texttt{val}}\ (\textbf{label})$$

values

$$\frac{(e_1, \sigma) \longmapsto (e_1', \sigma')}{(\textbf{if}\ e_1\ \textbf{then}\ e_2\ \textbf{else}\ e_3, \sigma) \longmapsto (\textbf{if}\ e_1'\ \textbf{then}\ e_2\ \textbf{else}\ e_3, \sigma')}\ (\textbf{if})$$

$$\frac{}{(\textbf{if true then}\ e_2\ \textbf{else}\ e_3, \sigma) \longmapsto (e_2, \sigma)}\ (\textbf{if-true})$$

$$\frac{}{(\textbf{if false then}\ e_2\ \textbf{else}\ e_3, \sigma) \longmapsto (e_3, \sigma)}\ (\textbf{if-false})$$

`if`–expression

$$\frac{e_1 \longmapsto e_1'}{\textbf{let}\ x = e_1\ \textbf{in}\ e_2 \longmapsto \textbf{let}\ x = e_1'\ \textbf{in}\ e_2}\ (\textbf{let-e})$$

$$\frac{v\ \texttt{val}}{\textbf{let}\ x = v\ \textbf{in}\ e \longmapsto e[v/x]}\ (\textbf{let})$$

`let`–expression

$$\frac{(e_1, \sigma) \longmapsto (e_1', \sigma')}{(e_1\ e_2, \sigma) \longmapsto (e_1'\ e_2, \sigma')}\ (\textbf{ap-l})$$

$$\frac{v\ \texttt{val} \qquad (e_2, \sigma) \longmapsto (e_2', \sigma')}{(v\ e_2, \sigma) \longmapsto (v\ e_2', \sigma')}\ (\textbf{ap-r})$$

$$\frac{v\ \texttt{val}}{((\lambda x.e)\ v, \sigma) \longmapsto (e[v/x], \sigma)}\ (\textbf{ap})$$

function application

$$\frac{(e, \sigma) \longmapsto (e', \sigma')}{(\mathit{ref}\ e, \sigma) \longmapsto (\mathit{ref}\ e', \sigma')}\ (\textbf{ref-e})$$

$$\frac{v\ \texttt{val} \qquad l \notin \mathrm{dom}(\sigma)}{(\mathit{ref}\ v, \sigma) \longmapsto (l, \sigma[l \mapsto v])}\ (\textbf{ref})$$

$$\frac{(e, \sigma) \longmapsto (e', \sigma')}{(!e, \sigma) \longmapsto (!e', \sigma')}\ (\textbf{deref-e})$$

$$\frac{l\ \texttt{val} \qquad l \in \mathrm{dom}(\sigma)}{(!l, \sigma) \longmapsto (\sigma(l), \sigma)}\ (\textbf{deref})$$

$$\frac{(e_1, \sigma) \longmapsto (e_1', \sigma')}{(e_1 := e_2, \sigma) \longmapsto (e_1' := e_2, \sigma')}\ (\textbf{set-l})$$

$$\frac{l\ \texttt{val} \qquad (e_2, \sigma) \longmapsto (e_2', \sigma')}{(l := e_2, \sigma) \longmapsto (l := e_2', \sigma')}\ (\textbf{set-r})$$

$$\frac{l \in \mathrm{dom}(\sigma) \qquad v\ \texttt{val}}{(l := v, \sigma) \longmapsto (\texttt{()}, \sigma[l \mapsto v]}\ (\textbf{set})$$

references