MiniJoy

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$$
\begin{array}{rcl}
e & := & \vec{t} \\
t & := & n \;|\; + \\
 & | & \text{lt} \;|\; \text{eq} \;|\; \text{if } e\ e \\
 & | & x \;|\; \lambda x^?.e \;|\; \text{call}
\end{array}
$$

Figure 1: MiniJoy Syntax

$$
\begin{array}{rcl}
R & := & m \to m \\
m & := & <e,\ s> \\
s & := & \vec{v} \\
v & := & n \;|\; \text{true} \;|\; \text{false} \;|\; (\lambda x^?.e)
\end{array}
$$

$$
\begin{array}{rcl}
<n : e,\ s> & \to & <e,\ n : s> \\
<+ : e,\ n_1 : n_2 : s> & \to & <e,\ (n_1 + n_2) : s> \\
<lt : e,\ n_1 : n_2 : s> & \to & <e,\ (n_1 < n_2) : s> \\
<eq : e,\ n_1 : n_2 : s> & \to & <e,\ (n_1 = n_2) : s> \\
<\text{if } e_1\ e_2 : e_3,\ \text{true} : s> & \to & <e_1 \cdot e_3,\ s> \\
<\text{if } e_1\ e_2 : e_3,\ \text{false} : s> & \to & <e_2 \cdot e_3,\ s> \\
<(\lambda x^?.e_1) : e_2,\ s> & \to & <e_2,\ (\lambda x^?.e_1) : s> \\
<\text{call} : e_1, (\lambda\ .e_2) : s> & \to & <e_2 \cdot e_1,\ s> \\
<\text{call} : e_1, (\lambda x.e_2) : v : s> & \to & <e_2[x/v] \cdot e_1,\ s>
\end{array}
$$

Figure 2: MiniJoy Semantics

$$
\begin{array}{rcl}
b & := & \text{int} \;|\; \text{bool} \;|\; \alpha \;|\; f \\
f & := & \alpha ...\ \vec{b} \to \alpha ...\ \vec{b} \\
i..., o... & := & \alpha ...\ \vec{b}
\end{array}
$$

Figure 3: MiniJoy Types

$$\textsc{Empty}\ \frac{\alpha... = \text{fresh}}{\Gamma \vdash \epsilon : \alpha... \to \alpha...}$$

$$\textsc{Num}\ \frac{\alpha... = \text{fresh}}{\Gamma \vdash n : \alpha... \to \alpha...\ \text{int}}$$

$$\textsc{Add}\ \frac{\alpha... = \text{fresh}}{\Gamma \vdash + : \alpha...\ \text{int int} \to \alpha...\ \text{int}}$$

$$\textsc{Lt}\ \frac{\alpha... = \text{fresh}}{\Gamma \vdash \text{lt} : \alpha...\ \text{int int} \to \alpha...\ \text{bool}}$$

$$\textsc{Eq}\ \frac{\alpha... = \text{fresh}}{\Gamma \vdash \text{eq} : \alpha...\ \text{int int} \to \alpha...\ \text{bool}}$$

$$\textsc{If}\ \frac{\Gamma \vdash e_1 : i... \to o... \qquad \Gamma \vdash e_2 : i... \to o...}{\Gamma \vdash \text{if}\ e_1\ e_2 : i...\ \text{bool} \to o...}$$

$$\textsc{Var}\ \frac{x : b \in \Gamma \qquad \alpha... = \text{fresh}}{\Gamma \vdash x : \alpha... \to \alpha...\ b}$$

$$\textsc{LamNoArg}\ \frac{\Gamma \vdash e : i... \to o... \qquad \alpha... = \text{fresh}}{\Gamma \vdash \lambda\ .e : \alpha... \to \alpha...\ (i... \to o...)}$$

$$\textsc{LamArg}\ \frac{\Gamma, x : b \vdash e : i... \to o... \qquad \alpha... = \text{fresh}}{\Gamma \vdash \lambda x.e : \alpha... \to \alpha...\ (i...\ b \to o...)}$$

$$\textsc{Call}\ \frac{\alpha..., \beta... = \text{fresh}}{\Gamma \vdash \text{call} : \alpha...\ (\alpha... \to \beta...) \to \beta...}$$

$$\textsc{Expr}\ \frac{\begin{array}{c}\Gamma \vdash e_1 : i_1... \to o_1... \qquad \Gamma \vdash e_2 : i_2... \to o_2... \\ o_1... \sim i_2... = \Phi\end{array}}{\Gamma \vdash e_1\ e_2 : \Phi(i_1... \to o_2...)}$$

Figure 4: MiniJoy Inference