Independently and Identically Distributed

λ_{IIC}

Eric Jackson

Syntax

TODO

Static Semantics

TODO

Dynamic Semantic

Small-Step Semantics

$$\frac{\langle e,\, n,\, m\rangle \to \langle e',\, n',\, m'\rangle}{\langle E(e),\, n,\, m\rangle \to \langle E(e'),\, n',\, m'\rangle}\ \textsc{Context}$$

$$\frac{}{\langle (\lambda x:\tau.\, e)\, e_2,\, n,\, m\rangle \to \langle e\{e_2/x\},\, n,\, m\rangle}\ \beta\textsc{-Reduction}$$

$$\frac{}{\langle \mathbf{let}\ x = e_1\ \mathbf{in}\ e_2,\, n,\, m\rangle \to \langle e_2\{e_1/x\},\, n,\, m\rangle}\ \textsc{Let}$$

$$\frac{r_1 \bar{\oplus} r_2 = r}{\langle r_1 \oplus r_2,\, n,\, m\rangle \to \langle r,\, n,\, m\rangle}\ \textsc{Bop}$$

$$\frac{}{\langle \mathbf{coin},\, n,\, m\rangle \to \langle \mathbf{hd}\ n,\, \mathbf{tl}\ n,\, m\rangle}\ \textsc{Coin}$$

$$\frac{}{\langle \mathbf{rand},\, n,\, m\rangle \to \langle \mathbf{hd}\ m,\, n,\, \mathbf{tl}\ m\rangle}\ \textsc{Rand}$$

$$\frac{}{\langle (\mathbf{case}\ \mathbf{inl}_{\tau_1+\tau_2} e\ \mathbf{of}\ e_2 \mid e_3),\, n,\, m\rangle \to \langle e_2\, e,\, n,\, m\rangle}\ \textsc{Case-Left}$$

$$\frac{}{\langle (\mathbf{case}\ \mathbf{inr}_{\tau_1+\tau_2} e\ \mathbf{of}\ e_2 \mid e_3),\, n,\, m\rangle \to \langle e_3\, e,\, n,\, m\rangle}\ \textsc{Case-Right}$$

$$\frac{}{\langle \mathbf{\#1}\ (e_1, e_2),\, n,\, m\rangle \to \langle e_1,\, n,\, m\rangle}\ \textsc{Proj-1}$$

$$\frac{}{\langle \mathbf{\#2}\ (e_1, e_2),\, n,\, m\rangle \to \langle e_2,\, n,\, m\rangle}\ \textsc{Proj-2}$$

$$\frac{}{\langle v_1\ \mathbf{to}\ x\ \mathbf{in}\ e_2, n, m\rangle \to \langle e_2\{v_1/x\}, n, m\rangle}\ \textsc{To-pc}$$

Big-Step Semantics

$$\frac{\langle e_1, n, m\rangle \Downarrow \langle \lambda x.\, e_1', n', m'\rangle \qquad \langle e_1'\{e_2/x\}, n', m'\rangle \Downarrow \langle v, n'', m''\rangle}{\langle e_1\, e_2,\, n,\, m\rangle \Downarrow \langle v,\, n'',\, m''\rangle}\ \beta\textsc{-Reduction}$$

$$\frac{\langle e_2\{e_1/x\}, n, m\rangle \Downarrow \langle v, n', m'\rangle}{\langle \mathbf{let}\ x = e_1\ \mathbf{in}\ e_2,\, n,\, m\rangle \Downarrow \langle v,\, n',\, m'\rangle}\ \textsc{Let}$$

$$\frac{\langle e_1, n, m\rangle \Downarrow \langle r_1, n', m'\rangle \qquad \langle e_2, n', m'\rangle \Downarrow \langle r_2, n'', m''\rangle \qquad r_1 \bar{\oplus} r_2 = r}{\langle e_1 \oplus e_2,\, n,\, m\rangle \Downarrow \langle r,\, n'',\, m''\rangle}\ \textsc{Bop}$$

$$\frac{}{\langle \mathbf{coin},\, n,\, m\rangle \Downarrow \langle \mathbf{hd}\ n,\, \mathbf{tl}\ n,\, m\rangle}\ \textsc{Coin}$$

$$\frac{}{\langle \mathbf{rand},\, n,\, m\rangle \Downarrow \langle \mathbf{hd}\ m,\, n,\, \mathbf{tl}\ m\rangle}\ \textsc{Rand}$$

$$\frac{\langle e_2\, e_1, n, m\rangle \Downarrow \langle v, n', m'\rangle}{\langle (\mathbf{case}\ \mathbf{inl}_{\tau_1+\tau_2} e_1\ \mathbf{of}\ e_2 \mid e_3),\, n,\, m\rangle \Downarrow \langle v,\, n',\, m'\rangle}\ \textsc{Case-Left}$$

$$\frac{\langle e_3\, e_1, n, m\rangle \Downarrow \langle v, n', m'\rangle}{\langle(\textbf{case inr}_{\tau_1+\tau_2} e_1 \textbf{ of } e_2 \,|\, e_3),\, n,\, m\rangle \Downarrow \langle v,\, n',\, m'\rangle}\ \textsc{Case-Left}$$

$$\frac{\langle e_1, n, m\rangle \Downarrow \langle v, n', m'\rangle}{\langle \textbf{\#1}\ (e_1, e_2),\, n,\, m\rangle \Downarrow \langle v, n', m'\rangle}\ \textsc{Proj-1}$$

$$\frac{\langle e_2, n, m\rangle \Downarrow \langle v, n', m'\rangle}{\langle \textbf{\#2}\ (e_1, e_2),\, n,\, m\rangle \Downarrow \langle v, n', m'\rangle}\ \textsc{Proj-2}$$

$$\frac{\langle e_1, n, m\rangle \Downarrow \langle v, n'm'\rangle \qquad \langle e\{v/x\}, n', m'\rangle \Downarrow \langle v', n'', m''\rangle}{\langle e_1 \textbf{ to } x \textbf{ in } e_2, n, m\rangle \Downarrow \langle v', n'', m''\rangle}\ \textsc{To-pc}$$

Denotational Semantics

$$\begin{aligned}
[\![r]\!] &\triangleq \delta_r \\
[\![\lambda x : \tau.\, e]\!] &\triangleq x \mapsto [\![e]\!] \\
[\![\textbf{let } x = e_1 \textbf{ in } e_2]\!] &\triangleq [\![e_2\{e_1/x\}]\!] \\
[\![e_1\ e_2]\!] &\triangleq [\![e_1]\!] \circ [\![e_2]\!] \\
[\![\textbf{coin}]\!] &\triangleq \frac{1}{2}(\delta_0 + \delta_1) \\
[\![\textbf{rand}]\!] &\triangleq \lambda
\end{aligned}$$