Type system for Code Geneartion plus Shift0/Reset0

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Assumption: we ignore answer types. (Later we will consider them.)

1 Syntax and Operational Semantics

$$e ::= x \mid \lambda x.e \mid e\ e \mid \underline{\lambda} x.e \mid \underline{\mathbf{reset0}}\ e \mid \underline{\mathbf{shift0}}\ k \to e \mid \underline{\mathbf{throw}}\ k\ e \mid \underline{\mathbf{clet}}\ x = e\ \underline{\mathbf{in}}\ e \mid \cdots$$

2 Type System

$$t ::= \text{BasicType} \mid t \to t \mid \langle t \rangle^{\gamma}$$

Typing rule for code-level lambda:

$$\frac{\Gamma,\ \gamma_1 \geq \gamma,\ x : \langle t_1 \rangle^{\gamma_1} \vdash e\ :\ \langle t_2 \rangle^{\gamma_1}}{\Gamma \vdash \underline{\lambda} x.e\ :\ \langle t_1 \to t_2 \rangle^{\gamma}}\ (\gamma_1 \text{ is eigen var})$$

Typing rule for code-level let (derived rule):

$$\frac{\Gamma \vdash e_1\ :\ \langle t_1 \rangle^{\gamma} \quad \Gamma,\ \gamma_1 \geq \gamma,\ x : \langle t_1 \rangle^{\gamma_1} \vdash e_2\ :\ \langle t_2 \rangle^{\gamma_1}}{\Gamma \vdash \underline{\mathbf{clet}}\ x = e_1\ \underline{\mathbf{in}}\ e_2\ :\ \langle t_2 \rangle^{\gamma}}\ (\gamma_1 \text{ is eigen var})$$

Typing rule for code-level reset0:

$$\frac{\Gamma \vdash e\ :\ \langle t \rangle^{\gamma}}{\Gamma \vdash \underline{\mathbf{reset0}}\ e\ :\ \langle t \rangle^{\gamma}}$$

Typing rule for code-level shift0:

$$\frac{\Gamma,\ k : (\langle t_1 \rangle^{\gamma_1} \Rightarrow \langle t_0 \rangle^{\gamma_0}) \vdash e\ :\ \langle t_0 \rangle^{\gamma_0} \quad \Gamma \models \gamma_1 \geq \gamma_0}{\Gamma \vdash \underline{\mathbf{shift0}}\ k \to e\ :\ \langle t_1 \rangle^{\gamma_1}}$$

Typing rule for code-level throw:

$$\frac{\Gamma,\ \gamma_3 \geq \gamma_1,\ \gamma_3 \geq \gamma_2 \vdash e\ :\ \langle t_1 \rangle^{\gamma_3} \quad \Gamma \models \gamma_2 \geq \gamma_0}{\Gamma,\ k : (\langle t_1 \rangle^{\gamma_1} \Rightarrow \langle t_0 \rangle^{\gamma_0}) \vdash \underline{\mathbf{throw}}\ k\ e\ :\ \langle t_0 \rangle^{\gamma_2}}\ (\gamma_3 \text{ is eigen var})$$

3 Example

$$e_1 = \underline{\mathbf{reset0}}\ \ \underline{\mathbf{clet}}\ x_1 = \%3\ \underline{\mathbf{in}}$$

$$\underline{\mathbf{reset0}}\ \ \underline{\mathbf{clet}}\ x_2 = \%5\ \underline{\mathbf{in}}$$

$$\underline{\mathbf{shift0}}\ k\ \rightarrow\ \underline{\mathbf{clet}}\ y = t\ \underline{\mathbf{in}}$$

$$\underline{\mathbf{throw}}\ k\ (x_1 \mathbin{\underline{+}} x_2 \mathbin{\underline{+}} y)$$

If $t = \%7$ or $t = x_1$, then e_1 is typable.

If $t = x_2$, then e_1 is not typable.

$$e_2 = \underline{\mathbf{reset0}}\ \ \underline{\mathbf{clet}}\ x_1 = \%3\ \underline{\mathbf{in}}$$

$$\underline{\mathbf{reset0}}\ \ \underline{\mathbf{clet}}\ x_2 = \%5\ \underline{\mathbf{in}}$$

$$\underline{\mathbf{shift0}}\ k_2\ \rightarrow\ \underline{\mathbf{shift0}}\ k_1\ \rightarrow\ \underline{\mathbf{clet}}\ y = t\ \underline{\mathbf{in}}$$

$$\underline{\mathbf{throw}}\ k_1\ (\underline{\mathbf{throw}}\ k_2\ (x_1 \mathbin{\underline{+}} x_2 \mathbin{\underline{+}} y))$$

If $t = \%7$, then e_1 is typable.

If $t = x_2$ or $t = x_1$, then e_1 is not typable.