TFL with Exceptions
CPSC 509: Programming Language Principles

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Syntax

$x \in \text{VAR}, \quad n \in \mathbb{Z}, \quad t \in \text{TERM}, \quad v \in \text{VALUE},$
$E \in \text{ECTXT}, \quad H \in \text{HLCTXT} \quad r \in \text{REDEX}$
$f \in \text{FAULTY} \subseteq \text{REDEX}, \quad err \in \text{ERROR}, \quad c \in \text{CONFIG}$
$p \in \text{PGM} = \{\, t \in \text{TERM} \mid FV(t) = \emptyset \,\}, \quad \text{OBS} = \{\, \text{procedure}, \infty \,\} \cup \mathbb{Z} \cup \text{ERROR}$

$$
\begin{aligned}
t \quad &::= \quad x \mid t\,t \mid \lambda x.t \mid \text{let } x = t \text{ in } t \mid n \mid t + t \\
&\quad\;\mid \quad \text{raise } (t) \mid \text{try } t \text{ handle } x.t \\
v \quad &::= \quad n \mid \lambda x.t \\
E \quad &::= \quad \Box \mid E[\Box\, t] \mid E[v\, \Box] \mid E[\text{let } x = \Box \text{ in } t] \mid E[\Box + t] \mid E[v + \Box] \mid E[\text{raise } (\Box)] \mid E[\text{try } \Box \text{ handle } x.t] \\
H \quad &::= \quad \Box \mid H[\Box\, t] \mid H[v\, \Box] \mid H[\text{let } x = \Box \text{ in } t] \mid H[\Box + t] \mid H[v + \Box] \mid H[\text{raise } (\Box)] \\
r \quad &::= \quad v\, v \mid \text{let } x = v \text{ in } t \mid v + v \mid \text{try } H[\text{raise } (v)] \text{ handle } x.t \mid \text{try } v \text{ handle } x.t \\
f \quad &::= \quad v_1\, v_2 \qquad\quad v_1 \notin \{\, \lambda x.t \textbf{ for } (x,t) \in \text{VAR} \times \text{TERM} \,\} \\
&\quad\;\mid \quad v_1 + v_2 \qquad \{\, v_1, v_2 \,\} \nsubseteq \mathbb{Z} \\
err \quad &::= \quad \text{mismatch} \mid \text{unhandled} \\
c \quad &::= \quad p \mid err
\end{aligned}
$$

$$\boxed{(\bullet \rightsquigarrow \bullet) \subseteq \text{REDEX} \times \text{TERM}}$$

$$(\lambda x.t)\, v \rightsquigarrow [v/x]t$$

$$\text{let } x = v \text{ in } t \rightsquigarrow [v/x]t$$

$$n_1 + n_2 \rightsquigarrow n_3 \quad n_3 = n_1 + n_2$$

$$\text{try } H[\text{raise } (v)] \text{ handle } x.t \rightsquigarrow [v/x]t$$

$$\text{try } v \text{ handle } x.t \rightsquigarrow v$$

$$\boxed{(\bullet \longrightarrow \bullet) \subseteq \text{PGM} \times \text{CONFIG}} \quad \textbf{Single-step Reduction}$$

$$\frac{r \rightsquigarrow p}{E[r] \longrightarrow E[p]} \qquad \frac{}{E[f] \longrightarrow \text{mismatch}} \qquad \frac{}{H[\text{raise } (v)] \longrightarrow \text{unhandled}}$$

$$\boxed{(\bullet \xrightarrow{\infty}) \subseteq \text{PGM}} \quad \textbf{Divergence}$$

$$\frac{p_1 \longrightarrow p_2 \quad p_2 \xrightarrow{\infty}}{p_1 \xrightarrow{\infty}}$$

$$eval : \text{PGM} \overset{\text{dens}}{\to} \text{OBS}$$

$$eval(t) = n \qquad\qquad\qquad \text{if } t \longrightarrow^* n$$

$$eval(t) = \textcolor{blue}{\mathsf{procedure}} \quad \text{if } t \longrightarrow^* \lambda x.t_0$$

$$eval(p) = err \qquad\qquad\quad \text{if } p \longrightarrow^* err$$

$$eval(p) = \infty \qquad\qquad\qquad \text{if } p \overset{\infty}{\longrightarrow}$$