EvalML4

Syntax:

$$
\begin{aligned}
&i \in \mathbf{int}\\
&b \in \mathbf{bool}\\
&x, y \in \mathbf{Var}\\
&v \in \mathbf{Value} ::= i \mid b \mid (\mathcal{E})\texttt{[fun } x \texttt{ -> } e\texttt{]} \mid (\mathcal{E})\texttt{[rec } x \texttt{ = fun } y \texttt{ -> } e\texttt{]} \mid \texttt{[]} \mid v \texttt{ :: } v\\
&\mathcal{E} \in \mathbf{Env} ::= \bullet \mid \mathcal{E}, x = v\\
&e \in \mathbf{Exp} ::= i \mid b \mid x \mid e \; op \; e \mid \texttt{if } e \texttt{ then } e \texttt{ else } e \mid \texttt{let } x \texttt{ = } e \texttt{ in } e\\
&\qquad\quad \mid \texttt{fun } x \texttt{ -> } e \mid e\ e \mid \texttt{let rec } x \texttt{ = fun } y \texttt{ -> } e \texttt{ in } e\\
&\qquad\quad \mid \texttt{[]} \mid e \texttt{ :: } e \mid \texttt{match } e \texttt{ with [] -> } e \texttt{ | } x \texttt{ :: } y \texttt{ -> } e\\
&op \in \mathbf{Prim} ::= \texttt{+} \mid \texttt{-} \mid \texttt{*} \mid \texttt{<}
\end{aligned}
$$

空の環境 $\bullet$ (とそれに続くコンマ) は入力時には省略する.

Derivation Rules:

$$\frac{}{\mathcal{E} \vdash i \Downarrow i} \quad \text{(E-Int)}$$

$$\frac{}{\mathcal{E} \vdash b \Downarrow b} \quad \text{(E-Bool)}$$

$$\frac{(\mathcal{E}(x) = v)}{\mathcal{E} \vdash x \Downarrow v} \quad \text{(E-Var)}$$

$$\frac{\mathcal{E} \vdash e_1 \Downarrow i_1 \qquad \mathcal{E} \vdash e_2 \Downarrow i_2 \qquad i_1 \texttt{ plus } i_2 \texttt{ is } i_3}{\mathcal{E} \vdash e_1 \texttt{ + } e_2 \Downarrow i_3} \quad \text{(E-Plus)}$$

$$\frac{\mathcal{E} \vdash e_1 \Downarrow i_1 \qquad \mathcal{E} \vdash e_2 \Downarrow i_2 \qquad i_1 \texttt{ minus } i_2 \texttt{ is } i_3}{\mathcal{E} \vdash e_1 \texttt{ - } e_2 \Downarrow i_3} \quad \text{(E-Minus)}$$

$$\frac{\mathcal{E} \vdash e_1 \Downarrow i_1 \qquad \mathcal{E} \vdash e_2 \Downarrow i_2 \qquad i_1 \texttt{ times } i_2 \texttt{ is } i_3}{\mathcal{E} \vdash e_1 \texttt{ * } e_2 \Downarrow i_3} \quad \text{(E-Times)}$$

$$\frac{\mathcal{E} \vdash e_1 \Downarrow i_1 \qquad \mathcal{E} \vdash e_2 \Downarrow i_2 \qquad i_1 \texttt{ less than } i_2 \texttt{ is } b_3}{\mathcal{E} \vdash e_1 \texttt{ < } e_2 \Downarrow b_3} \quad \text{(E-Lt)}$$

$$\frac{\mathcal{E} \vdash e_1 \Downarrow \texttt{true} \qquad \mathcal{E} \vdash e_2 \Downarrow v}{\mathcal{E} \vdash \texttt{if } e_1 \texttt{ then } e_2 \texttt{ else } e_3 \Downarrow v} \quad \text{(E-IfT)}$$

$$\frac{\mathcal{E} \vdash e_1 \Downarrow \texttt{false} \qquad \mathcal{E} \vdash e_3 \Downarrow v}{\mathcal{E} \vdash \texttt{if } e_1 \texttt{ then } e_2 \texttt{ else } e_3 \Downarrow v} \quad \text{(E-IfF)}$$

$$\frac{\mathcal{E} \vdash e_1 \Downarrow v_1 \qquad \mathcal{E}, x = v_1 \vdash e_2 \Downarrow v}{\mathcal{E} \vdash \texttt{let}\ x\ \texttt{=}\ e_1\ \texttt{in}\ e_2 \Downarrow v} \tag{E-Let}$$

$$\frac{}{\mathcal{E} \vdash \texttt{fun}\ x \to e \Downarrow (\mathcal{E})[\texttt{fun}\ x \to e]} \tag{E-Fun}$$

$$\frac{\mathcal{E} \vdash e_1 \Downarrow (\mathcal{E}_2)[\texttt{fun}\ x \to e_0] \qquad \mathcal{E} \vdash e_2 \Downarrow v_2 \qquad \mathcal{E}_2, x = v_2 \vdash e_0 \Downarrow v}{\mathcal{E} \vdash e_1\ e_2 \Downarrow v} \tag{E-App}$$

$$\frac{\mathcal{E}, x = (\mathcal{E})[\texttt{rec}\ x\ \texttt{=}\ \texttt{fun}\ y \to e_1] \vdash e_2 \Downarrow v}{\mathcal{E} \vdash \texttt{let rec}\ x\ \texttt{=}\ \texttt{fun}\ y \to e_1\ \texttt{in}\ e_2 \Downarrow v} \tag{E-LetRec}$$

$$\frac{\begin{array}{c}\mathcal{E} \vdash e_1 \Downarrow (\mathcal{E}_2)[\texttt{rec}\ x\ \texttt{=}\ \texttt{fun}\ y \to e_0] \qquad \mathcal{E} \vdash e_2 \Downarrow v_2 \\ \mathcal{E}_2, x = (\mathcal{E}_2)[\texttt{rec}\ x\ \texttt{=}\ \texttt{fun}\ y \to e_0], y = v_2 \vdash e_0 \Downarrow v\end{array}}{\mathcal{E} \vdash e_1\ e_2 \Downarrow v} \tag{E-AppRec}$$

$$\frac{}{\mathcal{E} \vdash [] \Downarrow []} \tag{E-Nil}$$

$$\frac{\mathcal{E} \vdash e_1 \Downarrow v_1 \qquad \mathcal{E} \vdash e_2 \Downarrow v_2}{\mathcal{E} \vdash e_1 :: e_2 \Downarrow v_1 :: v_2} \tag{E-Cons}$$

$$\frac{\mathcal{E} \vdash e_1 \Downarrow [] \qquad \mathcal{E} \vdash e_2 \Downarrow v}{\mathcal{E} \vdash \texttt{match}\ e_1\ \texttt{with}\ [] \to e_2\ \texttt{|}\ x :: y \to e_3 \Downarrow v} \tag{E-MatchNil}$$

$$\frac{\mathcal{E} \vdash e_1 \Downarrow v_1 :: v_2 \qquad \mathcal{E}, x = v_1, y = v_2 \vdash e_3 \Downarrow v}{\mathcal{E} \vdash \texttt{match}\ e_1\ \texttt{with}\ [] \to e_2\ \texttt{|}\ x :: y \to e_3 \Downarrow v} \tag{E-MatchCons}$$

$$\frac{(i_3 = i_1 + i_2)}{i_1\ \texttt{plus}\ i_2\ \texttt{is}\ i_3} \tag{B-Plus}$$

$$\frac{(i_3 = i_1 - i_2)}{i_1\ \texttt{minus}\ i_2\ \texttt{is}\ i_3} \tag{B-Minus}$$

$$\frac{(i_3 = i_1 * i_2)}{i_1\ \texttt{times}\ i_2\ \texttt{is}\ i_3} \tag{B-Times}$$

$$\frac{(b_3 = (i_1 < i_2))}{i_1\ \texttt{less than}\ i_2\ \texttt{is}\ b_3} \tag{B-Lt}$$