K- Language v0.2

1 Semantics

$$
\begin{array}{rcl}
n & \in & \mathbb{Z} \\
b & \in & \mathbb{B} = \{T, F\} \\
v & \in & Val = \mathbb{Z} + \mathbb{B} + \{\cdot\} \\
\sigma & \in & Env = Id \to Addr \\
M & \in & Mem = Addr \to Val
\end{array}
$$

$$\frac{}{\sigma, M \vdash \texttt{NUM}\ (n) \Downarrow n, M}$$

$$\frac{}{\sigma, M \vdash \texttt{TRUE} \Downarrow T, M} \qquad \frac{}{\sigma, M \vdash \texttt{FALSE} \Downarrow F, M}$$

$$\frac{}{\sigma, M \vdash \texttt{UNIT} \Downarrow \cdot, M}$$

$$\frac{}{\sigma, M \vdash \texttt{VAR}\ x \Downarrow v, M} M(\sigma(x)) = v$$

$$\frac{\sigma, M \vdash E_1 \Downarrow n_1, M_1 \qquad \sigma, M_1 \vdash E_2 \Downarrow n_2, M_2}{\sigma, M \vdash \texttt{ADD}\ (E_1,\ E_2) \Downarrow n, M_2} n = n_1 + n_2$$

$$\frac{\sigma, M \vdash E_1 \Downarrow n_1, M_1 \qquad \sigma, M_1 \vdash E_2 \Downarrow n_2, M_2}{\sigma, M \vdash \texttt{SUB}\ (E_1,\ E_2) \Downarrow n, M_2} n = n_1 - n_2$$

$$\frac{\sigma, M \vdash E_1 \Downarrow n_1, M_1 \qquad \sigma, M_1 \vdash E_2 \Downarrow n_2, M_2}{\sigma, M \vdash \texttt{MUL}\ (E_1,\ E_2) \Downarrow n, M_2} n = n_1 \times n_2$$

$$\frac{\sigma, M \vdash E_1 \Downarrow n_1, M_1 \qquad \sigma, M_1 \vdash E_2 \Downarrow n_2, M_2}{\sigma, M \vdash \texttt{DIV}\ (E_1,\ E_2) \Downarrow n, M_2} n = n_1 \div n_2$$

$$\frac{\sigma, M \vdash E_1 \Downarrow n_1, M_1 \qquad \sigma, M_1 \vdash E_2 \Downarrow n_2, M_2}{\sigma, M \vdash \texttt{EQUAL}\ (E_1,\ E_2) \Downarrow T, M_2} n_1 = n_2$$

$$\frac{\sigma, M \vdash E_1 \Downarrow n_1, M_1 \qquad \sigma, M_1 \vdash E_2 \Downarrow n_2, M_2}{\sigma, M \vdash \texttt{EQUAL}\ (E_1,\ E_2) \Downarrow F, M_2} n_1 \neq n_2$$

$$\frac{\sigma, M \vdash E_1 \Downarrow b_1, M_1 \qquad \sigma, M_1 \vdash E_2 \Downarrow b_2, M_2}{\sigma, M \vdash \texttt{EQUAL}\ (E_1,\ E_2) \Downarrow T, M_2} b_1 = b_2$$

$$\frac{\sigma, M \vdash E_1 \Downarrow b_1, M_1 \qquad \sigma, M_1 \vdash E_2 \Downarrow b_2, M_2}{\sigma, M \vdash \texttt{EQUAL}\ (E_1,\ E_2) \Downarrow F, M_2} b_1 \neq b_2$$

$$\frac{\sigma, M \vdash E_1 \Downarrow \cdot, M_1 \qquad \sigma, M_1 \vdash E_2 \Downarrow \cdot, M_2}{\sigma, M \vdash \texttt{EQUAL}\ (E_1,\ E_2) \Downarrow T, M_2}$$

$$\frac{\sigma, M \vdash E_1 \Downarrow n_1, M_1 \qquad \sigma, M_1 \vdash E_2 \Downarrow n_2, M_2}{\sigma, M \vdash \texttt{LESS}\ (E_1,\ E_2) \Downarrow T, M_2} n_1 < n_2$$

$$\frac{\sigma, M \vdash E_1 \Downarrow n_1, M_1 \qquad \sigma, M_1 \vdash E_2 \Downarrow n_2, M_2}{\sigma, M \vdash \texttt{LESS}\ (E_1,\ E_2) \Downarrow F, M_2} n_1 \geq n_2$$

$$\frac{\sigma, M \vdash E_1 \Downarrow T, M_1 \qquad \sigma, M_1 \vdash E_2 \Downarrow T, M_2}{\sigma, M \vdash \texttt{LESS}\ (E_1,\ E_2) \Downarrow F, M_2}$$

$$\frac{\sigma, M \vdash E_1 \Downarrow T, M_1 \qquad \sigma, M_1 \vdash E_2 \Downarrow F, M_2}{\sigma, M \vdash \texttt{LESS}\ (E_1,\ E_2) \Downarrow F, M_2}$$

$$\frac{\sigma, M \vdash E_1 \Downarrow F, M_1 \qquad \sigma, M_1 \vdash E_2 \Downarrow T, M_2}{\sigma, M \vdash \texttt{LESS}\ (E_1,\ E_2) \Downarrow T, M_2}$$

$$\frac{\sigma, M \vdash E_1 \Downarrow F, M_1 \qquad \sigma, M_1 \vdash E_2 \Downarrow F, M_2}{\sigma, M \vdash \texttt{LESS}\ (E_1,\ E_2) \Downarrow F, M_2}$$

$$\frac{\sigma, M \vdash E_1 \Downarrow \cdot, M_1 \qquad \sigma, M_1 \vdash E_2 \Downarrow \cdot, M_2}{\sigma, M \vdash \texttt{LESS}\ (E_1,\ E_2) \Downarrow F, M_2}$$

$$\frac{\sigma, M \vdash E \Downarrow T, M_1}{\sigma, M \vdash \texttt{NOT}\ E \Downarrow F, M_1} \qquad \frac{\sigma, M \vdash E \Downarrow F, M_1}{\sigma, M \vdash \texttt{NOT}\ E \Downarrow T, M_1}$$

$$\frac{\sigma, M \vdash E \Downarrow v, M_1}{\sigma, M \vdash \texttt{ASSIGN}\ (x,\ E) \Downarrow \cdot, M_1[v/\sigma(x)]}$$

$$\frac{\sigma, M \vdash E_1 \Downarrow v_1, M_1 \qquad \sigma, M_1 \vdash E_2 \Downarrow v_2, M_2}{\sigma, M \vdash \texttt{SEQ}\ (E_1,\ E_2) \Downarrow v_2, M_2}$$

$$\frac{\sigma, M \vdash E_1 \Downarrow T, M_1 \qquad \sigma, M_1 \vdash E_2 \Downarrow v, M_2}{\sigma, M \vdash \texttt{IF2}\ (E_1,\ E_2,\ E_3) \Downarrow \cdot, M_2}$$

$$\frac{\sigma, M \vdash E_1 \Downarrow F, M_1 \qquad \sigma, M_1 \vdash E_3 \Downarrow v, M_2}{\sigma, M \vdash \texttt{IF2}\ (E_1,\ E_2,\ E_3) \Downarrow \cdot, M_2}$$

$$\frac{\sigma, M \vdash E_1 \Downarrow T, M_1 \qquad \sigma, M_1 \vdash E_2 \Downarrow v, M_2}{\sigma, M \vdash \texttt{IF1}\ (E_1,\ E_2) \Downarrow \cdot, M_2} \qquad \frac{\sigma, M \vdash E_1 \Downarrow F, M_1}{\sigma, M \vdash \texttt{IF1}\ (E_1,\ E_2) \Downarrow \cdot, M_1}$$

$$\frac{\begin{array}{c}\sigma, M \vdash E_1 \Downarrow T, M_1 \\ \sigma, M_1 \vdash E_2 \Downarrow v, M_2 \qquad \sigma, M_2 \vdash \texttt{WHILE}\ (E_1,\ E_2) \Downarrow \cdot, M_3\end{array}}{\sigma, M \vdash \texttt{WHILE}\ (E_1,\ E_2) \Downarrow \cdot, M_3}$$

$$\frac{\sigma, M \vdash E_1 \Downarrow F, M_1}{\sigma, M \vdash \texttt{WHILE}\ (E_1,\ E_2) \Downarrow \cdot, M_1}$$

$$\frac{\begin{array}{c}\sigma, M \vdash E_1 \Downarrow n_1, M_1 \qquad \sigma, M_1 \vdash E_2 \Downarrow n_2, M_2 \\ \sigma, M_2[n_1/\sigma(x)] \vdash E_3 \Downarrow v, M_3 \qquad \sigma, M_3 \vdash \texttt{FOR}\ (x,\ n_1 + 1,\ E_2,\ E_3) \Downarrow \cdot, M_4\end{array}}{\sigma, M \vdash \texttt{FOR}\ (x,\ E_1,\ E_2,\ E_3) \Downarrow \cdot, M_4} n_1 \leq n_2$$

$$\frac{\sigma, M \vdash E_1 \Downarrow n_1, M_1 \qquad \sigma, M_1 \vdash E_2 \Downarrow n_2, M_2}{\sigma, M \vdash \texttt{FOR}\ (x,\ E_1,\ E_2,\ E_3) \Downarrow \cdot, M_2} n_1 > n_2$$

$$\frac{\sigma, M \vdash E_1 \Downarrow v_1, M_1 \qquad \sigma[l/x], M_1[v_1/l] \vdash E_2 \Downarrow v_2, M_2}{\sigma, M \vdash \texttt{LET}\ (x,\ E_1,\ E_2) \Downarrow v_2, M_2} l \notin dom(M_1)$$

$$\frac{Read\ n}{\sigma, M \vdash \texttt{READ}\ x \Downarrow \cdot, M[n/\sigma(x)]} \qquad \frac{}{Read\ n}$$

$$\frac{\sigma, M \vdash E \Downarrow n, M_1 \qquad Write\ n}{\sigma, M \vdash \texttt{WRITE}\ E \Downarrow \cdot, M_1} \qquad \frac{}{Write\ n}$$