Grammar

Non-terminals:

$$
\begin{aligned}
\text{Expr} &\rightarrow \text{nr} \mid \text{Expr iop Expr} \mid \text{!var} \mid \text{(E)} \\
\text{Cond} &\rightarrow \text{bl} \mid \text{Expr bop Expr} \\
\text{Stmt} &\rightarrow \text{()} \mid \text{Stmt ; Stmt} \mid \text{var := Expr} \\
&\quad \mid \textit{if}\ \text{Cond}\ \textit{then}\ \text{Body}\ \textit{else}\ \text{Body} \\
&\quad \mid \textit{while}\ \text{Cond}\ \textit{do}\ \text{Body} \\
\text{Body} &\rightarrow \text{Stmt} \\
&\quad \mid \text{\{ Stmt \}}
\end{aligned}
$$

Terminals:

$$
\begin{aligned}
\text{iop} &\rightarrow + \mid - \mid * \mid / \\
\text{bop} &\rightarrow == \mid != \mid < \mid > \mid <= \mid >= \\
\text{var} &\rightarrow \langle \textit{string} \rangle \\
\text{nr} &\rightarrow \langle \textit{int} \rangle \mid \langle \textit{float} \rangle \\
\text{bl} &\rightarrow \textit{true} \mid \textit{false}
\end{aligned}
$$

Rules

Arithmetic expressions (E):

$$\begin{aligned}
\langle n\boldsymbol{c}, \boldsymbol{s}, \boldsymbol{m}\rangle &\to \langle \boldsymbol{c}, n\boldsymbol{s}, \boldsymbol{m}\rangle \\
\langle !v\boldsymbol{c}, \boldsymbol{s}, \boldsymbol{m}\rangle &\to \langle \boldsymbol{c}, m(v), \boldsymbol{s}, \boldsymbol{m}\rangle \\
\langle (E_1\ iop\ E_2)\boldsymbol{c}, \boldsymbol{s}, \boldsymbol{m}\rangle &\to \langle E_1\ E_2\ iop\ \boldsymbol{c}, \boldsymbol{s}, \boldsymbol{m}\rangle \\
\langle iop\ \boldsymbol{c}, n_2 n_1 \boldsymbol{s}, \boldsymbol{m}\rangle &\to \langle \boldsymbol{c}, n\boldsymbol{s}, \boldsymbol{m}\rangle \text{ where } n = n_1\ \underline{iop}\ n_2
\end{aligned}$$

Boolean conditions (C):

$$\begin{aligned}
\langle b\boldsymbol{c}, \boldsymbol{s}, \boldsymbol{m}\rangle &\to \langle b, n\boldsymbol{s}, \boldsymbol{m}\rangle \\
\langle (E_1\ bop\ E_2)\boldsymbol{c}, \boldsymbol{s}, \boldsymbol{m}\rangle &\to \langle E_1\ E_2\ bop\ \boldsymbol{c}, \boldsymbol{s}, \boldsymbol{m}\rangle \\
\langle bop\ \boldsymbol{c}, n_2 n_1 \boldsymbol{s}, \boldsymbol{m}\rangle &\to \langle \boldsymbol{c}, b\boldsymbol{s}, \boldsymbol{m}\rangle \text{ where } b = n_1\ \underline{bop}\ n_2
\end{aligned}$$

Statements (S):

$$\begin{aligned}
\langle ()\boldsymbol{c}, \boldsymbol{s}, \boldsymbol{m}\rangle &\to \langle \boldsymbol{c}, \boldsymbol{s}, \boldsymbol{m}\rangle \\
\langle (S_1; S_2)\boldsymbol{c}, \boldsymbol{s}, \boldsymbol{m}\rangle &\to \langle S_1 S_2 \boldsymbol{c}, \boldsymbol{s}, \boldsymbol{m}\rangle \\
\langle v := E\boldsymbol{c}, \boldsymbol{s}, \boldsymbol{m}\rangle &\to \langle E := \boldsymbol{c}, v\boldsymbol{s}, \boldsymbol{m}\rangle \\
\langle := \boldsymbol{c}, nv\boldsymbol{s}, \boldsymbol{m}\rangle &\to \langle \boldsymbol{c}, \boldsymbol{s}, \boldsymbol{m}[v = n]\rangle
\end{aligned}$$

Branching (if):

$$\begin{aligned}
\langle (if\ C\ then\ S_t\ else\ S_f)\boldsymbol{c}, \boldsymbol{s}, \boldsymbol{m}\rangle &\to \langle C\ branch\ \boldsymbol{c}, S_t S_f \boldsymbol{s}, \boldsymbol{m}\rangle \\
\langle branch\ \boldsymbol{c}, true\ S_t S_f \boldsymbol{s}, \boldsymbol{m}\rangle &\to \langle S_t \boldsymbol{c}, \boldsymbol{s}, \boldsymbol{m}\rangle \\
\langle branch\ \boldsymbol{c}, false\ S_t S_f \boldsymbol{s}, \boldsymbol{m}\rangle &\to \langle S_f \boldsymbol{c}, \boldsymbol{s}, \boldsymbol{m}\rangle
\end{aligned}$$

Looping ($while$):

$$\begin{aligned}
\langle (while\ C\ do\ S)\boldsymbol{c}, \boldsymbol{s}, \boldsymbol{m}\rangle &\to \langle C\ loop\ \boldsymbol{c}, CS\boldsymbol{s}, \boldsymbol{m}\rangle \\
\langle loop\ \boldsymbol{c}, false\ CS\boldsymbol{s}, \boldsymbol{m}\rangle &\to \langle \boldsymbol{c}, \boldsymbol{s}, \boldsymbol{m}\rangle \\
\langle loop\ \boldsymbol{c}, true\ CS\boldsymbol{s}, \boldsymbol{m}\rangle &\to \langle S(while\ C\ do\ S)\boldsymbol{c}, \boldsymbol{s}, \boldsymbol{m}\rangle
\end{aligned}$$