$$
\begin{array}{rcl}
Num \ni n & ::= & \mathbf{0} \mid \mathbf{1} \mid ... \\
Var \ni x & ::= & x_1 \mid x_2 \mid ... \\
Lab \ni l & ::= & l_1 \mid l_2 \mid ... \\
Expr \ni e & ::= & n \mid x \mid e_1 + e_2 \mid e \texttt{ mod2} \mid e \texttt{ div2} \\
Dec \ni d & ::= & \texttt{var } x = 0 \mid d_1; d_2 \mid \texttt{proc } x_1(x_2)\{I\} \\
Instr \ni I & ::= & x := e \mid I_1; I_2 \mid \texttt{skip} \mid l : \texttt{call } x(e) \mid \\
 & & \texttt{begin } d \texttt{ in } I \texttt{ end} \mid \texttt{if } (e <> 0) \texttt{ then } \{I_1\} \texttt{ else } \{I_2\} \mid \\
 & & \texttt{while } (e <> 0) \texttt{ do } I \texttt{ done} \mid \texttt{return to } l
\end{array}
$$

Definicje relacji semantycznych:

$$
\begin{array}{rcl}
Proc & = & Var \times Instr \times Env \\
\rho \in Env & = & Var \to Loc \\
s \in Store & = & Loc \to (\mathbf{Z} \cup Proc) \\
\mathbf{l} \in Loc & & \\
r_i \in T_I & &
\end{array}
$$

$$
\begin{array}{rcl}
Conf_E & = & (Env \times Store \times Expr) \cup \mathbf{Z} \\
T_E & = & \mathbf{Z} \\
Conf_D & = & (Env \times Store \times Dec) \cup (Env \times Store) \\
T_D & = & Env \times Store \\
Conf_I & = & (Env \times Store \times Instr) \cup Store \cup (Store \times Lab) \\
T_I & = & Store \cup (Store \times Lab)
\end{array}
$$

Założenia:

1. Semantyka wyrażeń jest dana z góry.
2. Istnieje funkcja $newloc : Store \to Loc$ zwracająca nieużywaną lokację w danym składzie.
3. n występujące w regułach semantyki będzie, w zależności od kontekstu, ze zbioru $\mathbf{Z}$ bądź Num.

Semantyka definicji:

$$\frac{}{(\rho,\ s,\ \texttt{var}\ x = 0)\ \longrightarrow\ (\rho[x \to \mathbf{l}],\ s[\mathbf{l} \to 0])} \text{ dla } \mathbf{l} = newloc(s)$$

$$\frac{(\rho,\ s,\ d_1)\ \longrightarrow\ (\rho',\ s') \quad (\rho',\ s',\ d_2)\ \longrightarrow\ (\rho'',\ s'')}{(\rho,\ s,\ d_1; d_2)\ \longrightarrow\ (\rho'',\ s'')}$$

$$\frac{}{(\rho,\ s,\ \texttt{proc}\ x_1(x_2)\{I\})\ \longrightarrow\ (\rho[x_1 \to \mathbf{l}],\ s[\mathbf{l} \to (x_2,\ I,\ \rho)])} \text{ dla } \mathbf{l} = newloc(s)$$

Semantyka instrukcji:

$$\frac{(\rho,\ s,\ e)\ \longrightarrow\ n}{(\rho,\ s,\ x := e)\ \longrightarrow\ s[\rho(x) \to n]} \text{ o ile } x \in Dom(\rho)$$

$$\frac{(\rho,\ s,\ i_1)\ \longrightarrow\ s' \quad (\rho,\ s',\ i_2)\ \longrightarrow\ r_i}{(\rho,\ s,\ i_1; i_2)\ \longrightarrow\ r_i}$$

$$\frac{(\rho,\ s,\ i_1)\ \longrightarrow\ (s',\ l)}{(\rho,\ s,\ i_1; i_2)\ \longrightarrow\ (s',\ l)}$$

$$\frac{}{(\rho,\ s,\ \texttt{skip})\ \longrightarrow\ s}$$

$$\frac{(\rho,\ s,\ e)\ \longrightarrow\ n \quad (\rho'[y \to \mathbf{l},\ x \to \rho(x)],\ s[\mathbf{l} \to n],\ I)\ \longrightarrow\ s'}{(\rho,\ s,\ l : \texttt{call}\ x(e))\ \longrightarrow\ s'} \begin{array}{l}\text{o ile } s(\rho(x)) = (y,\ I,\ \rho') \\ \text{dla } \mathbf{l} = newloc(s)\end{array}$$

$$\frac{(\rho,\ s,\ e)\ \longrightarrow\ n \quad (\rho'[y \to \mathbf{l},\ x \to \rho(x)],\ s[\mathbf{l} \to n],\ I)\ \longrightarrow\ (s', l)}{(\rho,\ s,\ l : \texttt{call}\ x(e))\ \longrightarrow\ s'} \begin{array}{l}\text{o ile } s(\rho(x)) = (y,\ I,\ \rho') \\ \text{dla } \mathbf{l} = newloc(s)\end{array}$$

$$\frac{(\rho,\ s,\ e)\ \longrightarrow\ n \quad (\rho'[y \to \mathbf{l},\ x \to \rho(x)],\ s[\mathbf{l} \to n],\ I)\ \longrightarrow\ (s', l')}{(\rho,\ s,\ l : \texttt{call}\ x(e))\ \longrightarrow\ (s',\ l')} \begin{array}{l}\text{o ile } s(\rho(x)) = (y,\ I,\ \rho') \\ \text{oraz } l \neq l' \\ \text{dla } \mathbf{l} = newloc(s)\end{array}$$

$$\frac{(\rho,\ s,\ d) \longrightarrow (\rho', s') \qquad (\rho',\ s',\ I) \longrightarrow r_i}{(\rho,\ s,\ \texttt{begin}\ d\ \texttt{in}\ I\ \texttt{end}) \longrightarrow r_i}$$

$$\frac{(\rho,\ s,\ e) \longrightarrow n \quad (\rho,\ s,\ I_1) \longrightarrow r_i}{(\rho,\ s,\ \texttt{if}\ (e <> 0)\ \texttt{then}\ \{I_1\}\ \texttt{else}\ \{I_2\}) \longrightarrow r_i} \text{ o ile } n \neq 0$$

$$\frac{(\rho,\ s,\ e) \longrightarrow n \quad (\rho,\ s,\ I_2) \longrightarrow r_i}{(\rho,\ s,\ \texttt{if}\ (e <> 0)\ \texttt{then}\ \{I_1\}\ \texttt{else}\ \{I_2\}) \longrightarrow r_i} \text{ o ile } n = 0$$

$$\frac{(\rho,\ s,\ e) \longrightarrow n \quad (\rho,\ s,\ I) \longrightarrow (s',\ l)}{(\rho,\ s,\ \texttt{while}\ (e <> 0)\ \texttt{do}\ I\ \texttt{done}) \longrightarrow (s',\ l)} \text{ o ile } n \neq 0$$

$$\frac{(\rho,\ s,\ e) \longrightarrow n \quad (\rho,\ s,\ I) \longrightarrow s' \quad (\rho,\ s',\ \texttt{while}\ (e <> 0)\ \texttt{do}\ I\ \texttt{done}) \longrightarrow r_i}{(\rho,\ s,\ \texttt{while}\ (e <> 0)\ \texttt{do}\ I\ \texttt{done}) \longrightarrow r_i} \text{ o ile } n \neq 0$$

$$\frac{(\rho,\ s,\ e) \longrightarrow n}{(\rho,\ s,\ \texttt{while}\ (e <> 0)\ \texttt{do}\ I\ \texttt{done}) \longrightarrow s} \text{ o ile } n = 0$$

$$\frac{}{(\rho,\ s,\ \texttt{return to}\ l) \longrightarrow (s,\ l)}$$