

$$\langle \text{program} \rangle \rightarrow \langle \text{roots} \rangle$$

$$\begin{aligned} \langle \text{roots} \rangle &\rightarrow \varepsilon \\ &| \quad \langle \text{root} \rangle \langle \text{roots} \rangle \end{aligned}$$

$$\begin{aligned} \langle \text{root} \rangle &\rightarrow \langle \text{dcl} \rangle; \\ &| \quad \langle \text{function} \rangle \\ &| \quad \langle \text{comment} \rangle \end{aligned}$$

$$\langle \text{dcl} \rangle \rightarrow \langle \text{type} \rangle \langle \text{id} \rangle \langle \text{dclend} \rangle$$

$$\langle \text{type} \rangle \rightarrow \langle \text{primitivetype} \rangle \langle \text{arraytype} \rangle$$

$$\begin{aligned} \langle \text{primitivetype} \rangle &\rightarrow \text{bool} \\ &| \quad \text{double} \\ &| \quad \text{int} \\ &| \quad \text{char} \\ &| \quad \text{container} \\ &| \quad \text{string} \end{aligned}$$

$$\begin{aligned} \langle \text{arraytype} \rangle &\rightarrow \langle \text{type} \rangle [ ] \\ &| \quad \varepsilon \end{aligned}$$

$$\langle \text{id} \rangle \rightarrow \langle \text{letter} \rangle \langle \text{idend} \rangle$$

$$\langle \text{letter} \rangle \rightarrow [\text{a} - \text{zA} - \text{Z}]$$

$$\begin{aligned} \langle \text{idend} \rangle &\rightarrow \langle \text{letter} \rangle \langle \text{idend} \rangle \\ &| \quad \langle \text{digit} \rangle \langle \text{idend} \rangle \\ &| \quad \varepsilon \end{aligned}$$

$$\begin{aligned} \langle \text{dclend} \rangle &\rightarrow \varepsilon \\ &| \quad \langle \text{assign} \rangle \end{aligned}$$

$$\langle \text{assign} \rangle \rightarrow <-- \langle \text{expr} \rangle$$

$$\langle \text{expr} \rangle \rightarrow \langle \text{term} \rangle \langle \text{exprend} \rangle$$

$$\langle \text{term} \rangle \rightarrow \langle \text{comp} \rangle \langle \text{termend} \rangle$$

$$\langle \text{comp} \rangle \rightarrow \langle \text{factor} \rangle \langle \text{compend} \rangle$$

$$\begin{aligned} \langle \text{factor} \rangle &\rightarrow ( \langle \text{expr} \rangle ) \\ &| \quad !(\langle \text{expr} \rangle) \\ &| \quad \langle \text{callid} \rangle \\ &| \quad \langle \text{numeric} \rangle \\ &| \quad \langle \text{string} \rangle \\ &| \quad \langle \text{functioncall} \rangle \\ &| \quad \langle \text{cast} \rangle \\ &| \quad \text{LOW} \\ &| \quad \text{HIGH} \\ &| \quad \text{true} \\ &| \quad \text{false} \end{aligned}$$

$$\langle callid \rangle \rightarrow \langle id \rangle \langle arraycall \rangle$$

$$\langle arraycall \rangle \rightarrow [\langle notnulldigits \rangle]$$

$$| \quad \varepsilon$$

$$\langle notnulldigits \rangle \rightarrow [1 - 9] \langle digits \rangle$$

$$\langle digits \rangle \rightarrow \varepsilon$$

$$| \quad \langle digit \rangle \langle digits \rangle$$

$$\langle digit \rangle \rightarrow [0 - 9]$$

$$\langle numeric \rangle \rightarrow \langle plusminus \rangle \langle digitsnotempty \rangle \langle numericend \rangle$$

$$\langle plusminus \rangle \rightarrow \varepsilon$$

$$| \quad -$$

$$\langle digitsnotempty \rangle \rightarrow \langle digit \rangle \langle digits \rangle$$

$$\langle numericend \rangle \rightarrow \varepsilon$$

$$| \quad . \langle digitsnotempty \rangle$$

$$\langle string \rangle \rightarrow " \langle stringmidt \rangle "$$

$$\langle stringmidt \rangle \rightarrow \langle letter \rangle \langle stringmidt \rangle$$

$$| \quad \langle symbol \rangle \langle stringmidt \rangle$$

$$| \quad \langle digit \rangle \langle stringmidt \rangle$$

$$| \quad \varepsilon$$

$$\langle symbol \rangle \rightarrow !$$

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$$\langle \text{functioncall} \rangle \rightarrow \text{call } \langle \text{id} \rangle (\langle \text{callexpr} \rangle)$$

$$\begin{aligned} \langle \text{callexpr} \rangle &\rightarrow \langle \text{subcallexpr} \rangle \\ &| \quad \varepsilon \end{aligned}$$

$$\langle \text{subcallexpr} \rangle \rightarrow \langle \text{expr} \rangle \langle \text{subcallexprend} \rangle$$

$$\begin{aligned} \langle \text{subcallexprend} \rangle &\rightarrow , \langle \text{subcallexpr} \rangle \\ &| \quad \varepsilon \end{aligned}$$

$$\langle \text{cast} \rangle \rightarrow \langle \text{type} \rangle (\langle \text{expr} \rangle)$$

$$\begin{aligned} \langle \text{compend} \rangle &\rightarrow \langle \text{comparisonoperator} \rangle \langle \text{comp} \rangle \\ &| \quad \varepsilon \end{aligned}$$

$$\begin{aligned} \langle \text{comparisonoperator} \rangle &\rightarrow > \\ &| \quad < \\ &| \quad <= \\ &| \quad >= \\ &| \quad != \\ &| \quad = \end{aligned}$$

$$\begin{aligned} \langle \text{termend} \rangle &\rightarrow * \langle \text{term} \rangle \\ &| \quad / \langle \text{term} \rangle \\ &| \quad \text{AND } \langle \text{term} \rangle \\ &| \quad \varepsilon \end{aligned}$$

$$\begin{aligned} \langle \text{exprrend} \rangle &\rightarrow + \langle \text{expr} \rangle \\ &| \quad - \langle \text{expr} \rangle \\ &| \quad \text{OR } \langle \text{expr} \rangle \\ &| \quad \varepsilon \end{aligned}$$

$$\langle \text{function} \rangle \rightarrow \langle \text{functionstart} \rangle \langle \text{functionmid} \rangle$$

$$\langle \text{functionstart} \rangle \rightarrow \text{function } \langle \text{id} \rangle \text{ return}$$

$$\begin{aligned} \langle \text{functionmid} \rangle &\rightarrow \langle \text{type} \rangle \langle \text{functionend} \rangle \langle \text{expr} \rangle; \text{ end} \\ &| \quad \text{nothing } \langle \text{functionend} \rangle \text{ nothing; end} \end{aligned}$$

$$\langle \text{functionend} \rangle \rightarrow \text{using } (\langle \text{params} \rangle) \text{ begin } \langle \text{stmts} \rangle \text{ return}$$

$$\begin{aligned} \langle \text{params} \rangle &\rightarrow \langle \text{subparams} \rangle \\ &| \quad \varepsilon \end{aligned}$$

$$\langle \text{subparams} \rangle \rightarrow \langle \text{type} \rangle \langle \text{id} \rangle \langle \text{subparamsend} \rangle$$

$$\begin{aligned} \langle \text{subparamsend} \rangle &\rightarrow , \langle \text{subparams} \rangle \\ &| \quad \varepsilon \end{aligned}$$

$$\begin{aligned} \langle \text{stmts} \rangle &\rightarrow \varepsilon \\ &| \quad \langle \text{stmt} \rangle \langle \text{stmts} \rangle \end{aligned}$$

$\langle stmt \rangle \rightarrow \langle callid \rangle \langle assign \rangle;$   
|  $\langle if \rangle$   
|  $\langle while \rangle$   
|  $\langle from \rangle$   
|  $\langle dcl \rangle;$   
|  $\langle functioncall \rangle;$   
|  $\langle switch \rangle$   
|  $\langle comment \rangle$

$\langle if \rangle \rightarrow \text{if}(\langle expr \rangle) \text{ begin } \langle stmts \rangle \text{ end } \langle endif \rangle$

$\langle endif \rangle \rightarrow \text{else } \langle else \rangle$   
|  $\varepsilon$

$\langle else \rangle \rightarrow \langle if \rangle$   
|  $\text{begin } \langle stmts \rangle \text{ end}$

$\langle while \rangle \rightarrow \text{while}(\langle expr \rangle) \text{ begin } \langle stmts \rangle \text{ end}$

$\langle from \rangle \rightarrow \text{from } \langle expr \rangle \text{ to } \langle expr \rangle \text{ step } \langle assign \rangle \text{ begin } \langle stmts \rangle \text{ end}$

$\langle switch \rangle \rightarrow \text{switch } (\langle expr \rangle) \text{ begin } \langle cases \rangle \text{ end}$

$\langle cases \rangle \rightarrow \text{case } \langle expr \rangle: \langle stmts \rangle \langle endcase \rangle$

$\langle endcase \rangle \rightarrow \langle cases \rangle$   
|  $\text{break; } \langle breakend \rangle$   
|  $\text{default: } \langle stmts \rangle \text{ break;}$

$\langle breakend \rangle \rightarrow \langle cases \rangle$   
|  $\text{default: } \langle stmts \rangle \text{ break;}$   
|  $\varepsilon$

$\langle comment \rangle \rightarrow /* \langle stringmid \rangle */$