

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

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

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

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

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

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

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

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

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

$$\langle \text{callid} \rangle \rightarrow \langle \text{id} \rangle \langle \text{arraycall} \rangle$$

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

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

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

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

$$\langle \text{digitsnotempty} \rangle \rightarrow \langle \text{digit} \rangle \langle \text{digits} \rangle$$

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

$$\langle \text{digit} \rangle \rightarrow [0 - 9]$$

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

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

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

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

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

$\langle \text{params} \rangle \rightarrow \langle \text{subparams} \rangle$   
 $\quad | \quad \varepsilon$

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

$\langle \text{subparamsend} \rangle \rightarrow , \langle \text{subparams} \rangle$   
 $\quad | \quad \varepsilon$

$\langle \text{stmts} \rangle \rightarrow \varepsilon$   
 $\quad | \quad \langle \text{stmt} \rangle \langle \text{stmts} \rangle$

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

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

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

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

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

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

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

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

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

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

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

$\langle \text{exprend} \rangle \rightarrow + \langle \text{expr} \rangle$   
 $\quad | \quad - \langle \text{expr} \rangle$

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| OR  $\langle expr \rangle$   
 |  $\varepsilon$

$\langle term \rangle \rightarrow \langle comp \rangle \langle termend \rangle$

$\langle termend \rangle \rightarrow * \langle term \rangle$   
 | /  $\langle term \rangle$   
 | AND  $\langle term \rangle$   
 |  $\varepsilon$

$\langle comp \rangle \rightarrow \langle factor \rangle \langle compend \rangle$

$\langle compend \rangle \rightarrow \langle comparisonoperator \rangle \langle comp \rangle$   
 |  $\varepsilon$

$\langle comparisonoperator \rangle \rightarrow >$   
 |  $<$   
 |  $<=$   
 |  $>=$   
 |  $!=$   
 |  $=$

$\langle factor \rangle \rightarrow ( \langle expr \rangle )$   
 |  $!(\langle expr \rangle)$   
 |  $\langle callid \rangle$   
 |  $\langle numeric \rangle$   
 |  $\langle string \rangle$   
 |  $\langle functioncall \rangle$   
 |  $\langle cast \rangle$   
 | LOW  
 | HIGH  
 | true  
 | false

$\langle plusminus \rangle \rightarrow \varepsilon$   
 |  $-$

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

$\langle numericend \rangle \rightarrow \varepsilon$   
 |  $\cdot \langle digitsnotempty \rangle$

$\langle stringmidt \rangle \rightarrow \langle letter \rangle \langle stringmidt \rangle$   
 |  $\langle symbol \rangle \langle stringmidt \rangle$   
 |  $\langle digit \rangle \langle stringmidt \rangle$   
 |  $\varepsilon$

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

$\langle symbol \rangle \rightarrow !$   
 |  $\%$   
 |  $\wedge$   
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$\langle \text{functioncall} \rangle \rightarrow \text{call } \langle \text{id} \rangle (\langle \text{callexpr} \rangle)$

$\langle \text{callexpr} \rangle \rightarrow \langle \text{subcallexpr} \rangle$   
 |  $\varepsilon$

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

$\langle \text{subcallexprend} \rangle \rightarrow , \langle \text{subcallexpr} \rangle$   
 |  $\varepsilon$

$\langle \text{comment} \rangle \rightarrow /* \langle \text{stringmidt} \rangle */$

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