

<:Grammar:>

1. <finalProgram> → <program> EOF
2. <program> → <moduleDeclarations> <otherModules><driverModule><otherModules>
3. <moduleDeclarations> → <moduleDeclaration><moduleDeclarations>
4. <moduleDeclarations> → ϵ
5. <moduleDeclaration> → DECLARE MODULE ID SEMICOL
6. <otherModules> → <module><otherModules>
7. <otherModules> → ϵ
8. <driverModule> → DRIVERDEF DRIVER PROGRAM DRIVERENDDEF <moduleDef>
9. <module> → DEF MODULE ID ENDDF TAKES INPUT SQBO <input_plist> SQBC
SEMICOL <ret><moduleDef>
10. <ret> → RETURNS SQBO <output_plist> SQBC SEMICOL
11. <ret> → ϵ
12. <input_plist> → ID COLON <dataType> <leftFactored_input_plist>
13. <leftFactored_input_plist> → COMMA ID COLON
<dataType><leftFactored_input_plist>
14. <leftFactored_input_plist> → ϵ
15. <output_plist> → ID COLON <type><leftFactored_output_plist>
16. <leftFactored_output_plist> → COMMA ID COLON <type><leftFactored_output_plist>
17. <leftFactored_output_plist> → ϵ
18. <dataType> → INTEGER
19. <dataType> → REAL
20. <dataType> → BOOLEAN
21. <dataType> → ARRAY SQBO <arrRange> SQBC OF <type>
22. <arrRange> → <sign> <leftFactored_arrRange>

- 23. <leftFactored_arrRange> → ID RANGEOP <sign> ID
- 24. <leftFactored_arrRange> → NUM RANGEOP <sign> NUM
- 25. <sign> → <pm>
- 26. <sign> → ϵ
- 27. <type> → INTEGER
- 28. <type> → REAL
- 29. <type> → BOOLEAN
- 30. <moduleDef> → START <statements> END
- 31. <statements> → <statement> <statements> | ϵ
- 32. <statement> → <ioStmt>
- 33. <statement> → <simpleStmt>
- 34. <statement> → <declareStmt>
- 35. <statement> → <conditionalStmt>
- 36. <statement> → <iterativeStmt>
- 37. <ioStmt> → GET_VALUE BO ID BC SEMICOL
- 38. <ioStmt> → PRINT BO <leftFactored_ioStmt>
- 39. <leftFactored_ioStmt> → <var> BC SEMICOL
- 40. <leftFactored_ioStmt> → <boolValues> BC SEMICOL
- 41. <boolValues> → true
- 42. <boolValues> → false
- 43. <var> → ID <whichId>
- 44. <var> → NUM
- 45. <var> → RNUM
- 46. <whichId> → SQBO <sign> <leftFactored_whichId>
- 47. <whichId> → ϵ
- 48. <leftFactored_whichId> → ID SQBC

- 49. <leftFactored_whichId> → NUM SQBC
- 50. <simpleStmt> → <assignmentStmt>
- 51. <simpleStmt> → <moduleReuseStmt>
- 52. <assignmentStmt> → ID <whichStmt>
- 53. <whichStmt> → <lvalueIDStmt>
- 54. <whichStmt> → <lvalueARRStmt>
- 55. <lvalueIDStmt> → ASSIGNOP <expression> SEMICOL
- 56. <lvalueARRStmt> → SQBO <arithmeticExprWArr> SQBC ASSIGNOP <expression>
SEMICOL
- 57. <moduleReuseStmt> → <optional> USE MODULE ID WITH PARAMETERS
<idList>SEMICOL
- 58. <optional> → SQBO <idList> SQBC ASSIGNOP
- 59. <optional> → ϵ
- 60. <idList> → ID<leftFactored_idList>
- 61. <leftFactored_idList> → COMMA ID<leftFactored_idList>
- 62. <leftFactored_idList> → ϵ
- 63. <expression> → <arithmeticBooleanExpr><logicalTerm>
- 64. <expression> → <unaryTerm>
- 65. <unaryTerm> → <pm> <arithmeticFactor>
- 66. <arithmeticFactor> → BO <arithmeticExpr> BC
- 67. <arithmeticFactor> → <var>
- 68. <arithmeticBooleanExpr> → <arithmeticExpr> <relationalTerm>
- 69. <arithmeticBooleanExpr> → <boolValues>
- 70. <logicalTerm> → <logicalOp> <arithmeticBooleanExpr>
- 71. <logicalTerm> → ϵ
- 72. <relationalTerm> → <relationalOp> <arithmeticExpr>

- 73. <relationalTerm> $\rightarrow \epsilon$
- 74. <arithmeticExpr> \rightarrow <term> <leftFactored_arithmeticExpr>
- 75. <leftFactored_arithmeticExpr> \rightarrow <pm> <term> <leftFactored_arithmeticExpr>
- 76. <leftFactored_arithmeticExpr> $\rightarrow \epsilon$
- 77. <pm> \rightarrow PLUS
- 78. <pm> \rightarrow MINUS
- 79. <md> \rightarrow MUL
- 80. <md> \rightarrow DIV
- 81. <term> \rightarrow <factor> <leftFactored_term>
- 82. <leftFactored_term> \rightarrow <md> <factor> <leftFactored_term>
- 83. <leftFactored_term> $\rightarrow \epsilon$
- 84. <factor> \rightarrow BO <expression> BC
- 85. <factor> \rightarrow <var>
- 86. <arithmeticExprWArr> \rightarrow <termWArr> <leftFactored_arithmeticExprWArr>
- 87. <leftFactored_arithmeticExprWArr> \rightarrow <pm> <termWArr>
 <leftFactored_arithmeticExprWArr>
- 88. <leftFactored_arithmeticExprWArr> $\rightarrow \epsilon$
- 89. <termWArr> \rightarrow <signedFactorWArr> <leftFactored_termWArr>
- 90. <leftFactored_termWArr> \rightarrow <md> <signedFactorWArr> <leftFactored_termWArr>
- 91. <leftFactored_termWArr> $\rightarrow \epsilon$
- 92. <signedFactorWArr> \rightarrow <sign> <factorWArr>
- 93. <factorWArr> \rightarrow BO <arithmeticExprWArr> BC
- 94. <factorWArr> \rightarrow ID
- 95. <factorWArr> \rightarrow NUM
- 96. <factorWArr> \rightarrow RNUM
- 97. <logicalOp> \rightarrow AND

98. $\langle \text{logicalOp} \rangle \rightarrow \text{OR}$
99. $\langle \text{relationalOp} \rangle \rightarrow \text{LT}$
100. $\langle \text{relationalOp} \rangle \rightarrow \text{LE}$
101. $\langle \text{relationalOp} \rangle \rightarrow \text{GT}$
102. $\langle \text{relationalOp} \rangle \rightarrow \text{GE}$
103. $\langle \text{relationalOp} \rangle \rightarrow \text{EQ}$
104. $\langle \text{relationalOp} \rangle \rightarrow \text{NE}$
105. $\langle \text{declareStmt} \rangle \rightarrow \text{DECLARE } \langle \text{idList} \rangle \text{ COLON } \langle \text{dataType} \rangle \text{ SEMICOL}$
106. $\langle \text{conditionalStmt} \rangle \rightarrow \text{SWITCH BO ID BC START } \langle \text{caseStmt} \rangle \langle \text{default} \rangle \text{ END}$
107. $\langle \text{caseStmt} \rangle \rightarrow \text{CASE } \langle \text{value} \rangle \text{ COLON } \langle \text{statements} \rangle \text{ BREAK SEMICOL}$
 $\langle \text{leftFactored_caseStmt} \rangle$
108. $\langle \text{leftFactored_caseStmt} \rangle \rightarrow \text{CASE } \langle \text{value} \rangle \text{ COLON } \langle \text{statements} \rangle \text{ BREAK}$
 $\text{SEMICOL } \langle \text{leftFactored_caseStmt} \rangle$
109. $\langle \text{leftFactored_caseStmt} \rangle \rightarrow \epsilon$
110. $\langle \text{value} \rangle \rightarrow \text{NUM}$
111. $\langle \text{value} \rangle \rightarrow \text{true}$
112. $\langle \text{value} \rangle \rightarrow \text{false}$
113. $\langle \text{default} \rangle \rightarrow \text{DEFAULT COLON } \langle \text{statements} \rangle \text{ BREAK SEMICOL}$
114. $\langle \text{default} \rangle \rightarrow \epsilon$
115. $\langle \text{iterativeStmt} \rangle \rightarrow \text{FOR BO ID IN } \langle \text{sign} \rangle \text{ NUM RANGEOP } \langle \text{sign} \rangle \text{ NUM BC START}$
 $\langle \text{statements} \rangle \text{ END}$
116. $\langle \text{iterativeStmt} \rangle \rightarrow \text{WHILE BO } \langle \text{arithmeticBooleanExpr} \rangle \langle \text{logicalTerm} \rangle \text{ BC START}$
 $\langle \text{statements} \rangle \text{ END}$

FIRST {

1. 116 $\rightarrow \{\text{WHILE}\}$

2. $115 \rightarrow \{\text{FOR}\}$
3. $114 \rightarrow \varepsilon$
4. $113 \rightarrow \text{DEFAULT}$
5. $112 \rightarrow \text{false}$
6. $111 \rightarrow \text{true}$
7. $110 \rightarrow \text{NUM}$
8. $109 \rightarrow \varepsilon$
9. $107 \rightarrow \text{CASE}$
10. $106 \rightarrow \text{SWITCH}$
11. $105 \rightarrow \text{DECLARE}$
12. $104 \rightarrow \text{NE}$
13. $103 \rightarrow \text{EQ}$
14. $102 \rightarrow \text{GE}$
15. $101 \rightarrow \text{GT}$
16. $100 \rightarrow \text{LE}$
17. $99 \rightarrow \text{LT}$
18. $98 \rightarrow \text{OR}$
19. $97 \rightarrow \text{AND}$
20. $96 \rightarrow \text{RNUM}$
21. $95 \rightarrow \text{NUM}$
22. $94 \rightarrow \text{ID}$
23. $93 \rightarrow \text{BO}$
24. $92 \rightarrow \{\text{PLUS}, \text{MINUS}, \text{BO}, \text{ID}, \text{NUM}, \text{RNUM}\}$
25. $91 \rightarrow \varepsilon$
26. $90 \rightarrow \{\text{MUL}, \text{DIV},\}$
27. $89 \rightarrow \{\text{PLUS}, \text{MINUS}, \text{BO}, \text{ID}, \text{NUM}, \text{RNUM}\}$

- 28. $88 \rightarrow \epsilon$
- 29. $87 \rightarrow \{\text{PLUS}, \text{MINUS}\}$
- 30. $86 \rightarrow \{\text{PLUS}, \text{MINUS}, \text{BO}, \text{ID}, \text{NUM}, \text{RNUM}\}$
- 31. $85 \rightarrow \{\text{ID}, \text{NUM}, \text{RNUM}\}$
- 32. $84 \rightarrow \{\text{BO}\}$
- 33. $83 \rightarrow \epsilon$
- 34. $82 \rightarrow \{\text{MUL}, \text{DIV}\}$
- 35. $81 \rightarrow \{\text{ID}, \text{BO}, \text{NUM}, \text{RNUM}\}$
- 36. $80 \rightarrow \{\text{DIV}\}$
- 37. $79 \rightarrow \text{MUL}$
- 38. $78 \rightarrow \{\text{MINUS}\}$
- 39. $77 \rightarrow \{\text{PLUS}\}$
- 40. $76 \rightarrow \epsilon$
- 41. $75 \rightarrow \{\text{PLUS}, \text{MINUS}\}$
- 42. $74 \rightarrow \{\text{ID}, \text{BO}, \text{NUM}, \text{RNUM}\}$
- 43. $73 \rightarrow \epsilon$
- 44. $72 \rightarrow \{\text{LT}, \text{LE}, \text{GT}, \text{GE}, \text{EQ}, \text{NE}\}$
- 45. $71 \rightarrow \epsilon$
- 46. $70 \rightarrow$
- 47. $\text{FIRST}(\langle \text{default} \rangle) \rightarrow \{\text{DEFAULT}, \epsilon\}$
- 48. $\text{FIRST}(\langle \text{value} \rangle) \rightarrow \{\text{NUM}, \text{true}, \text{false}\}$
- 49. $\text{FIRST}(\langle \text{caseStmt} \rangle) \rightarrow \{\text{CASE}\}$
- 50. $\text{FIRST}(\langle \text{leftFactored_caseStmt} \rangle) \rightarrow \{\text{CASE}, \epsilon\}$
- 51. $\text{FIRST}(\langle \text{conditionalStmt} \rangle) \rightarrow \{\text{SWITCH}\}$
- 52. $\text{FIRST}(\langle \text{declareStmt} \rangle) \rightarrow \{\text{DECLARE}\}$
- 53. $\text{FIRST}(\langle \text{relationalOp} \rangle) \rightarrow \{\text{LT}, \text{LE}, \text{GT}, \text{GE}, \text{EQ}, \text{NE}\}$

- 54. FIRST(<logicalOp>) → {AND,OR}
- 55. FIRST(<factorWArr>) → {BO, ID, NUM, RNUM}
- 56. FIRST(<signedFactorWArr>) → {PLUS, MINUS, BO, ID, NUM, RNUM}
- 57. FIRST(<leftFactored_termWArr>) → {MUL, DIV, ε}
- 58. FIRST(<termWArr>) → {PLUS, MINUS, BO, ID, NUM, RNUM}
- 59. FIRST(<leftFactored_arithmeticExprWArr>) → {PLUS, MINUS, ε}
- 60. FIRST(<arithmeticExprWArr>) → {PLUS, MINUS, BO, ID, NUM, RNUM}
- 61. FIRST(<factor>) → {ID , BO , NUM , RNUM}
- 62. FIRST(<term>) → {ID , BO , NUM , RNUM}
- 63. FIRST(<leftFactored_term>) → {MUL , DIV , ε}
- 64. FIRST(<md>) → {MUL , DIV}
- 65. FIRST(<pm>) → {PLUS , MINUS}
- 66. FIRST(<leftFactored_arithmeticExpr>) → {PLUS , MINUS , ε}
- 67. FIRST(<arithmeticExpr>) → {ID , BO , NUM , RNUM}
- 68. FIRST(<relationalTerm>) → {LT , LE , GT , GE , EQ , NE, ε}
- 69. FIRST(<logicalTerm>) → {AND, OR, ε}
- 70. FIRST(<arithmeticBooleanExpr>) → {ID, BO, NUM, RNUM, true, false}
- 71. FIRST(<arithmeticFactor>) → {BO, ID, NUM, RNUM}
- 72. FIRST(<unaryTerm>) → {PLUS, MINUS}
- 73. FIRST(<expression>) → {PLUS , MINUS , ID, BO, NUM, RNUM, true, false}
- 74. FIRST(<leftFactored_idList>) → {COMMA , ε}
- 75. FIRST(<idList>) → {ID}
- 76. FIRST(<optional>) → {SQBO , ε}
- 77. FIRST(<moduleReuseStmt>) → {SQBO , USE}
- 78. FIRST(<lvalueARRstmt>) → {SQBO}
- 79. FIRST(<lvalueIDstmt>) → {ASSIGNOP}

80. $\text{FIRST}(\langle \text{whichStmt} \rangle) \rightarrow \{\text{SQBO}, \text{ASSIGNOP}\}$
81. $\text{FIRST}(\langle \text{assignmentStmt} \rangle) \rightarrow \{\text{ID}\}$
82. $\text{FIRST}(\langle \text{simpleStmt} \rangle) \rightarrow \{\text{ID}, \text{SQBO}, \text{USE}\}$
83. $\text{FIRST}(\langle \text{whichId} \rangle) \rightarrow \{\text{SQBO}, \epsilon\}$
84. $\text{FIRST}(\langle \text{leftFactored_whichId} \rangle) \rightarrow \{\text{ID}, \text{NUM}\}$
85. $\text{FIRST}(\langle \text{var} \rangle) \rightarrow \{\text{ID}, \text{NUM}, \text{RNUM}\}$
86. $\text{FIRST}(\langle \text{boolValues} \rangle) \rightarrow \{\text{true}, \text{false}\}$
87. $\text{FIRST}(\langle \text{ioStmt} \rangle) \rightarrow \{\text{GET_VALUE}, \text{PRINT}\}$
88. $\text{FIRST}(\langle \text{leftFactored_ioStmt} \rangle) \rightarrow \{\text{ID}, \text{NUM}, \text{RNUM}, \text{true}, \text{false}\}$
89. $\text{FIRST}(\langle \text{statement} \rangle) \rightarrow \{\text{GET_VALUE}, \text{PRINT}, \text{ID}, \text{SQBO}, \text{USE}, \text{DECLARE}, \text{SWITCH}, \text{FOR}, \text{WHILE}\}$
90. $\text{FIRST}(\langle \text{statements} \rangle) \rightarrow \{\text{GET_VALUE}, \text{PRINT}, \text{ID}, \text{SQBO}, \text{USE}, \text{DECLARE}, \text{SWITCH}, \text{FOR}, \text{WHILE}, \epsilon\}$
91. $\text{FIRST}(\langle \text{moduleDef} \rangle) \rightarrow \{\text{START}\}$
92. $\text{FIRST}(\langle \text{type} \rangle) \rightarrow \{\text{INTEGER}, \text{REAL}, \text{BOOLEAN}\}$
93. $\text{FIRST}(\langle \text{sign} \rangle) \rightarrow \{\text{PLUS}, \text{MINUS}, \epsilon\}$
94. $\text{FIRST}(\langle \text{leftFactored_arrRange} \rangle) \rightarrow \{\text{ID}, \text{NUM}\}$
95. $\text{FIRST}(\langle \text{arrRange} \rangle) \rightarrow \{\text{PLUS}, \text{MINUS}, \text{ID}, \text{NUM}\}$
96. $\text{FIRST}(\langle \text{datatype} \rangle) \rightarrow \{\text{INTEGER}, \text{REAL}, \text{BOOLEAN}, \text{ARRAY}\}$
97. $\text{FIRST}(\langle \text{leftFactored_output_plist} \rangle) \rightarrow \{\text{COMMA}, \epsilon\}$
98. $\text{FIRST}(\langle \text{output_plist} \rangle) \rightarrow \{\text{ID}\}$
99. $\text{FIRST}(\langle \text{leftFactored_input_plist} \rangle) \rightarrow \{\text{COMMA}, \epsilon\}$
100. $\text{FIRST}(\langle \text{input_plist} \rangle) \rightarrow \{\text{ID}\}$
101. $\text{FIRST}(\langle \text{ret} \rangle) \rightarrow \{\text{RETURNS}, \epsilon\}$
102. $\text{FIRST}(\langle \text{module} \rangle) \rightarrow \{\text{DEF}\}$
103. $\text{FIRST}(\langle \text{driverModule} \rangle) \rightarrow \{\text{DRIVERDEF}\}$

104. FIRST(<otherModules>) → {DEF , ε}
105. FIRST(<moduleDeclaration>) → {DECLARE}
106. FIRST(<moduleDeclarations>) → {DECLARE , ε}
107. FIRST(<program>) → {DECLARE , DEF, DRIVERDEF}
108. FIRST(<finalProgram>) → {DECLARE, DEF, DRIVERDEF}

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FOLLOW {

1. FOLLOW(<default>) → {END}
2. FOLLOW(<leftFactored_caseStmt>) → {DEFAULT, END}
3. FOLLOW(<leftFactored_termWArr>) → {SQBC, PLUS, MINUS, BC}
4. FOLLOW(<leftFactored_arithmeticExprWArr>) → {SQBC, BC}
5. FOLLOW(<leftFactored_term>) → {PLUS, MINUS, SEMICOL, BC, LT, LE, GT, GE, EQ, NE, AND, OR}
6. FOLLOW(<leftFactored_arithmeticExpr>) → {BC, LT, LE, GT, GE, EQ, NE, AND ,OR, SEMICOL}

7. FOLLOW(<relationalTerm>) → {AND, OR, SEMICOL, BC}
8. FOLLOW(<logicalTerm>) → {SEMICOL, BC}
9. FOLLOW(<leftFactored_idList>) → {SEMICOL, SQBC, COLON}
10. FOLLOW(<optional>) → {USE}
11. FOLLOW(<whichId>) → {BC, SEMICOL, PLUS, MINUS, MUL, DIV, LT, LE, GT, GE, EQ, NE, AND, OR}
12. FOLLOW(<statements>) → {BREAK, END}
13. FOLLOW(<sign>) → {ID, NUM, BO, RNUM}
14. FOLLOW(<leftFactored_output_plist>) → {SQBC}
15. FOLLOW(<leftFactored_input_plist>) → {SQBC}
16. FOLLOW(<ret>) → {START}
17. FOLLOW(<otherModules>) → {DRIVERDEF, EOF}
18. FOLLOW(<moduleDeclarations>) → {DEF, DRIVERDEF}

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