CS/CoE 1622 Introduction to Compiler Construction
Fall 2018

Part II: Syntax Analysis

1. Objective

In this phase of the project, you are required to write a parser using YACC for the CS/CoE 1622 programming language, MINI-JAVA. The parser communicates with the *lexer* you built in Part I and output the parse tree of the input MINI-JAVA program.

2. Due Date

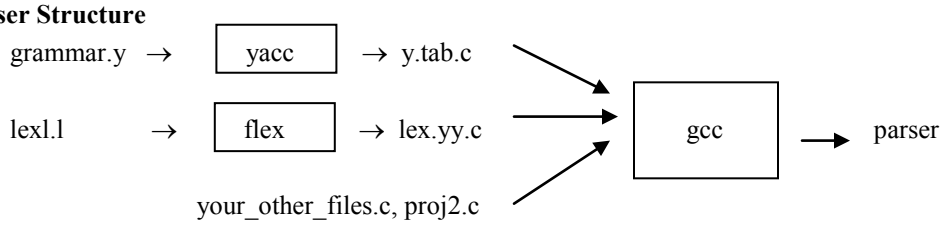
The assignment is due November 10th 11:59pm midnight.

3. Grammar Specification

The grammar is specified by syntax diagrams (Appendix B).

4. Implementation

4.1 Parser Structure



terminal# **parser < test1.java**

Grammar.y has similar file structure as that of "lex.l".

```
%{ /* definition */
#include  "proj2.h"
#include  <stdio.h>
%}
%token <intg>  PROGRAMnum IDnum ....  SCONSTnum
%type  <tptr>  Program ClassDecl   .....  Variable
%%  /* yacc specification */
Program  :  PROGRAMnum IDnum SEMInum ClassDecl
          {  $$ = MakeTree(ProgramOp, $4, MakeLeaf(IDNode, $2)); printtree($$, 0);  }
          ;
/* other rules */
Expression  :   SimpleExpression   {$$ = $1;}
              |   SimpleExpression Comp_op SimpleExpression
                   {  MkLeftC($1, $2);   $$ = MkRightC($3, $2);   }
%%
int yycolumn, yyline;
FILE *treelst;
main()   {   treelst = stdout;   yyparse(); }
yyerror(char *str)  {   printf("yyerror: %s at line %d\n", str, yyline); }
#include "lex.yy.c"
```

Modification has to be made in your lex.l. When assigning yylval, you need to

```
{int}        { yycolumn += yyleng; yylval.intg = atoi(yytext); return(ICONSTnum);}
{variable}   { .... yylval.intg = index; ... }
```

4.2 Data Strutures

Appendix A lists functions that are provided for your convenience to implement and debug your code. The C source code "proj2.c" and header file "proj2.h" could be found from class webpage.
The parse tree is defined as follows.

```
/* syntax tree node struct */
typedef struct treenode
    {   int NodeKind, NodeOpType, IntVal;
        struct treenode *LeftC, *RightC;
    } ILTree, *tree;
```

You need to distinguish the following kinds of nodes (defined in proj2.h): IDNode, NUM Node, STRINGNode, DUM MYNode, INTEGERTNode or EXPRNode. The first 4 kinds correspond to an identifier, an integer constant, a string constant and a null node. A leaf node of INTEGERTNode kind is created for "int" type declaration, i.e. create the node for every INTnum token. All interior nodes are of EXPRNode kind.

Each Leaf node contains an IntVal field. For an ID or string constant node, IntVal is the value to find its lexeme (a pointer to symbol table). For a NUMNode, it is the value. For a DUMMYNode, it is always 0.

Each interior node is associated with an operator type. Defined in proj2.h, we have the following types.

ProgramOp:	program, root node operator
BodyOp:	class body, method body, decl body, statmentlist body.
DeclOp:	each declaration has this operator
CommaOp:	connected by ","
ArrayTypeOp:	array type
TypeIdOp:	type id operator
BoundOp:	bound for array variable declaration
HeadOp:	head of method,
RArgTypeOp:	arguments
VargTypeOp:	arguments specified by "VAL" .e.g. abc(VAL int x)
StmtOp:	statement
IfElseOp:	if-then-else
LoopOp:	while statement
SpecOp:	specification of parameters
RoutineCallOp:	routine call
AssignOp:	assign operator
ReturnOp:	return statement

AddOp, SubOp, MultOp, DivOp, LTOp, GTOp, EQOp, NEOp, LEOp, GEOp, AndOp, OrOp, UnaryNegOp, NotOp: ALU operations

VarOp:	variables
SelectOp:	to access a field/index variable
IndexOp:	follow "[]" to access a variable
FieldOp:	follow "." to access a variable
ClassOp:	for each class
MethodOp:	for each method
ClassDefOp:	for each class defintion

Functions *makeleaf*, *maketree* are used to create leaf nodes and intermediate nodes respectively. *Printtree(tree nd, int depth)* is used to output a tree structure. You need to provide the implementation of following two functions in order to have variable name and string const correctly printed. That is, replace the following code in "proj2.c" with your version.

```
extern char  strg_tbl[];

char* getname(int i) /* i is the index of the  table, passed through yylval*/
        { return( strg_tbl+i );/*return string table indexed at i*/ }

char* getstring(int i)
        { return( strg_tbl+i );/*return string table indexed at i*/}
```

To grade your project, you are also required to print out the parse tree at top level after you have successfully built it. Syntax errors should be reported in your *yyerror* function. You need to give the line number where the error occurs.

The sample output for the example is:

```
  +-[IDNode,0,"xyz"]
R-[ProgramOp]
  |   +-[IDNode,4,"test"]
  | +-[ClassDefOp]
  | | |           +-[DUMMYnode]
  | | |         +-[CommaOp]
  | | |         | +-[STRINGNode,29,"Hello World !!!"]
  | | |       +-[RoutineCallOp]
  | | |       | |   +-[DUMMYnode]
  | | |       | | +-[SelectOp]
  | | |       | | | | +-[DUMMYnode]
  | | |       | | | +-[FieldOp]
  | | |       | | |   +-[IDNode,21,"println"]
  | | |       | +-[VarOp]
  | | |       |   +-[IDNode,14,"system"]
  | | |     +-[StmtOp]
  | | |     | +-[DUMMYnode]
  | | |   +-[BodyOp]
  | | |   | +-[DUMMYnode]
  | | | +-[MethodOp]
  | | | | |   +-[DUMMYnode]
  | | | | | +-[SpecOp]
  | | | | | | +-[DUMMYnode]
  | | | | +-[HeadOp]
  | | | |   +-[IDNode,9,"main"]
  | | +-[BodyOp]
  | |   +-[DUMMYnode]
  | +-[ClassOp]
  |   +-[DUMMYnode]
```

5. Assignment Submission

The submission link will be created soon on courseweb.

Appendix A: Provided functions

function NullExp(); return *ILTree

Returns a null node with kind=DummyNode and semantic value=0.

function MakeLeaf(Kind: NodeKindType; N: integer); return *ILTree

Returns a leaf node of specified Kind with integer semantic value N.

function MakeTree(Op: NodeOpType; Left,Right: *ILTree); return *ILTree

Returns an internal node, T, such that NodeOp(T)=Op; LeftChild(T)=Left; RightChild(T)=Right and NodeKind(T)=InteriorNode.

function NodeOp(T: *ILTree); return NodeOpType

See MakeTree. Returns the integer constant representing NodeOpType of T if T is an interior node, else returns UndefOp. Uses NodeKind(T) to distinguish leaf from interior.

function NodeKind(T: *ILTree); return NodeKindType

Returns the kind of node T.

function LeftChild(T: *ILTree); return *ILTree

Returns pointer to left child of T. Returns pointer to null node if NodeKind(T) <> InteriorNode.

function RightChild(T: *ILTree); return *ILTree

Returns pointer to right child of T. Returns pointer to null node if NodeKind(T)!= InteriorNode.

function IntVal(T: *ILTree); return integer

See MakeLeaf. Returns integer semantic value of node T if NodeKind(T) = IDNode, STRGNode, NUMNode, or BOOLNode. Otherwise returns Undefined.

function IsNull(T: *ILTree); return boolean

IsNull(T) iff T is null node.

function SetNodeOp(T: *ILTree; Op: NodeOpType)

NodeKind(T) must be InteriorNode. Makes NodeOp(T) = Op.

function SetNodeKind(T: *ILTree; Kind: NodeKindType)

NodeKind(T) must not be InteriorNode. Makes NodeKind(T) = Kind.

function SetNodeVal(T: *ILTree; Val: integer)

NodeKind(T) must not be InteriorNode. Makes IntVal(T) = Val.

function SetLeftChild(T,NewChild: *ILTree)

NodeKind(T) must be InteriorNode. Makes LeftChild(T) = NewChild.

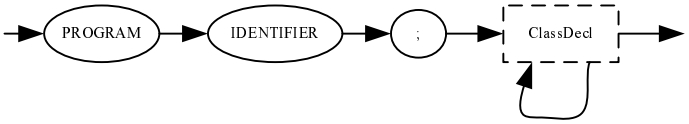
function SetRightChild(T,NewChild: *ILTree)

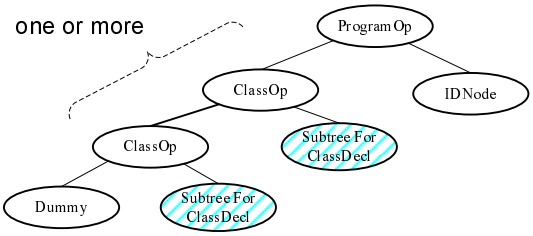
NodeKind(T) must be InteriorNode. Makes RightChild(T) = NewChild.

Appendix B: Syntax diagrams

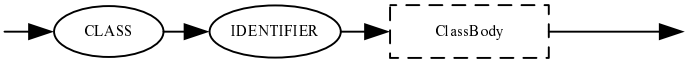
Legend:	dashed boxes → nonterminal symbols solid ellipsis → terminal symbols (tokens)	Legend:	eclipse → normal nodes shaded eclipse → subtree

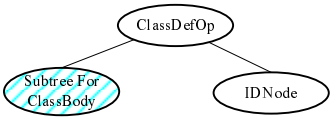
Program



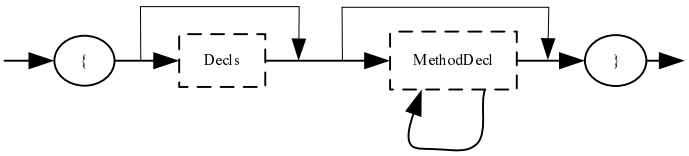


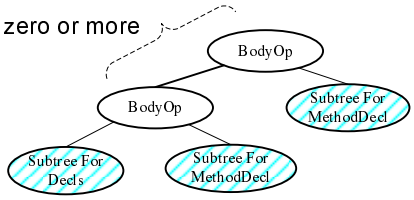
ClassDecl



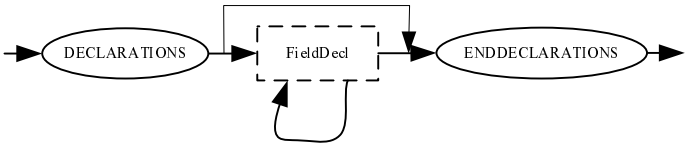


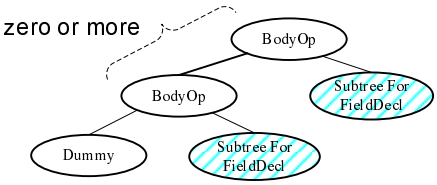
ClassBody



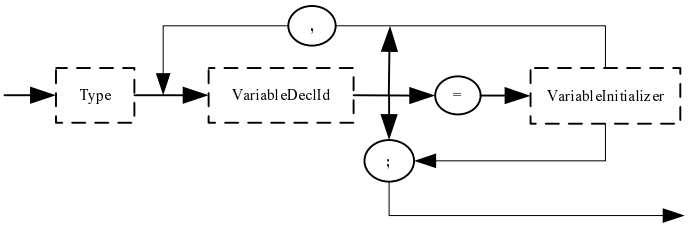


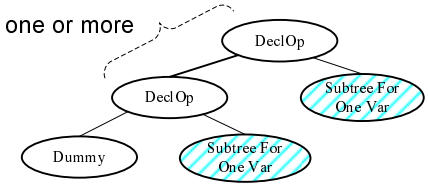
Decls



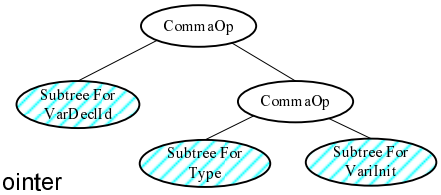


FieldDecl



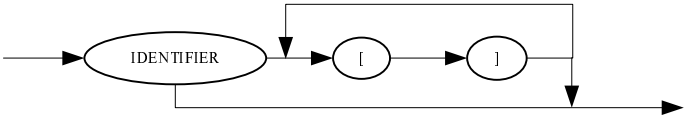


Each Var has the following subtree

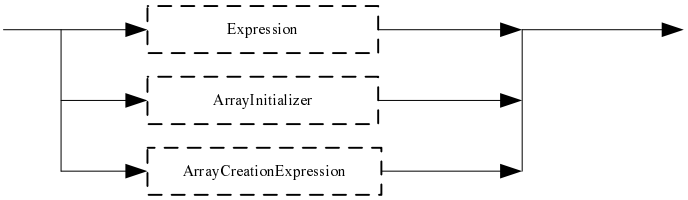


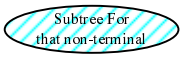
Type should be stored in a separate pointer (global variable) such that it may be used in building the *VariableInitializer* subtree.

VariableDeclId

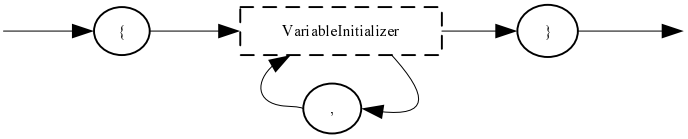


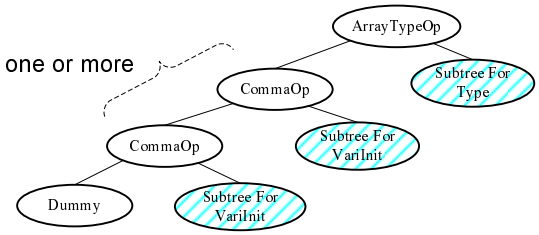
VariableInitializer



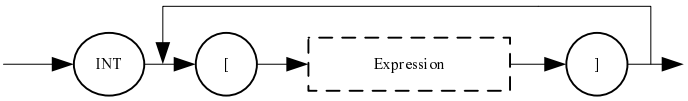


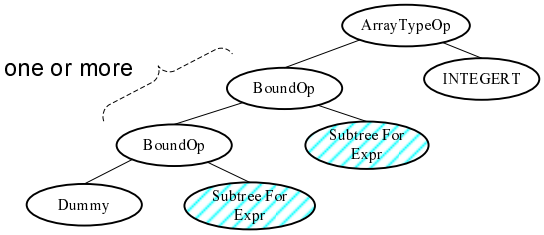
ArrayInitializer



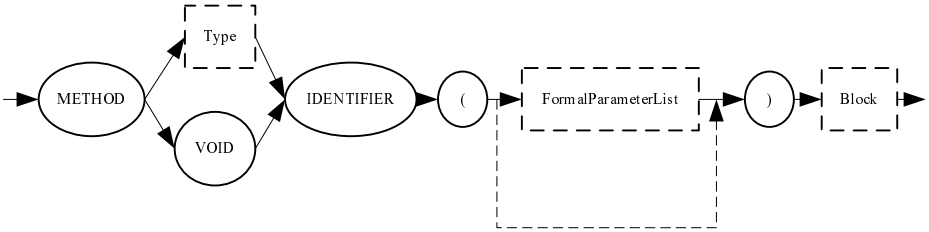


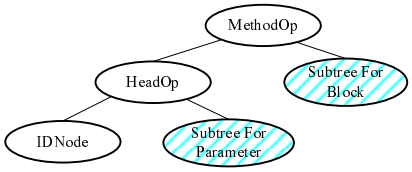
ArrayCreationExpression





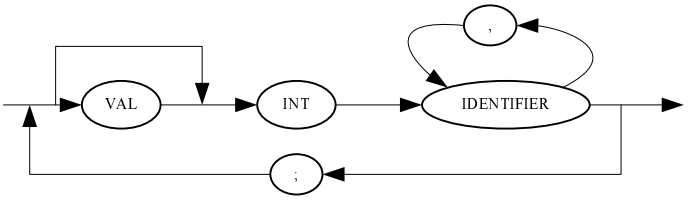
MethodDecl

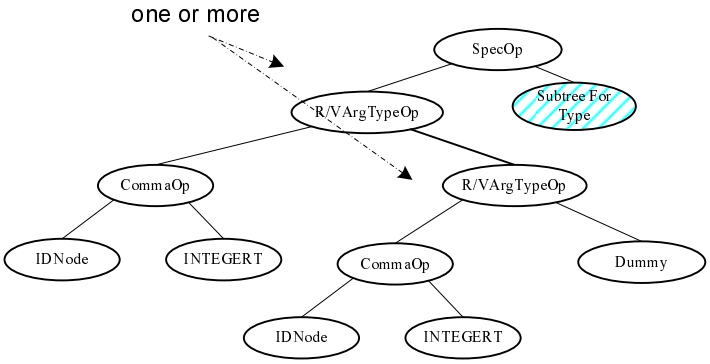




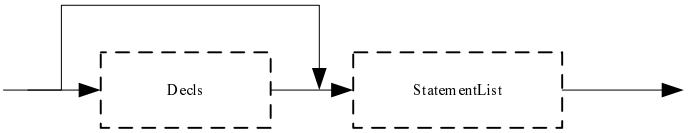
Type should be stored in a separate pointer (global variable) such that it may be used in building the *Parameter* and *Block* subtrees.

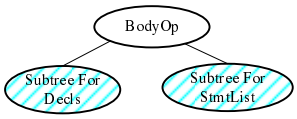
FormalParameterList



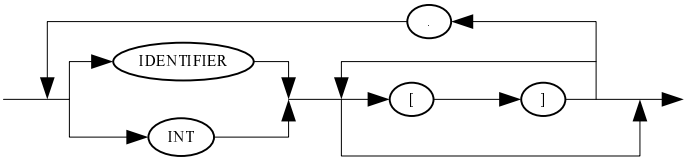


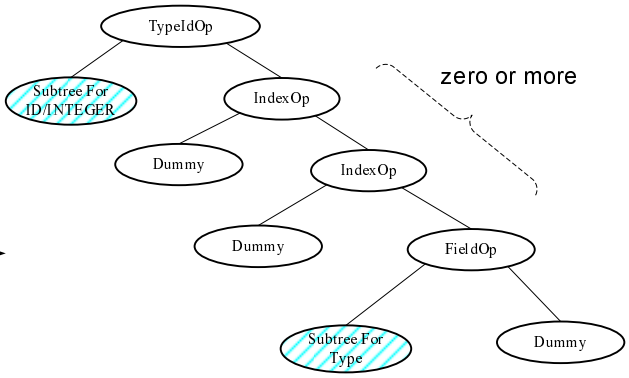
Block



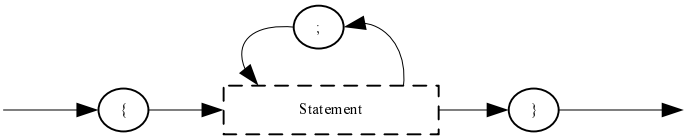


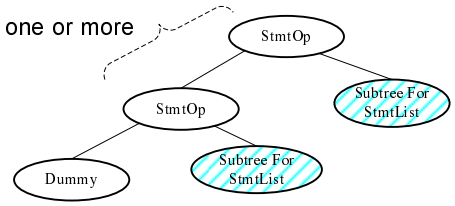
Type



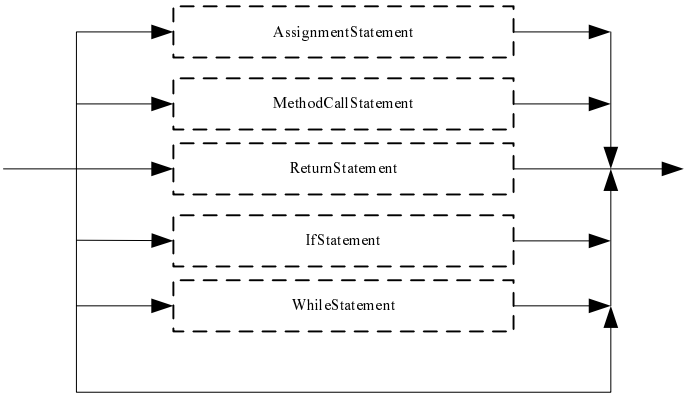


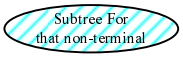
StatementList



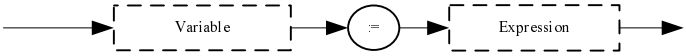


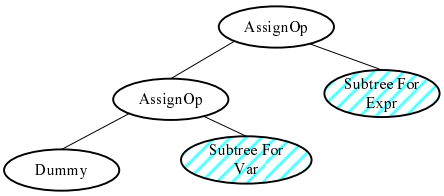
Statement



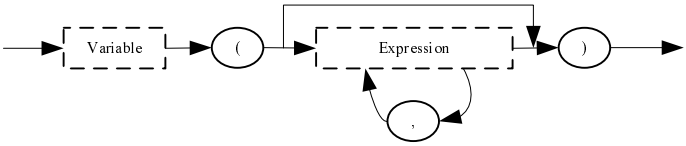


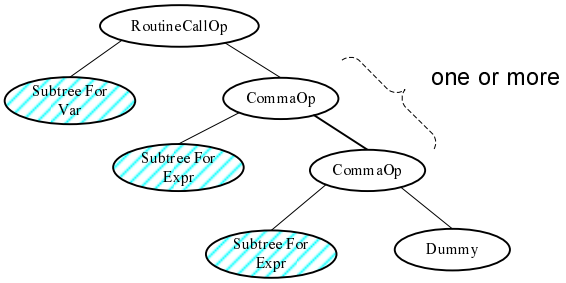
AssignmentStatement



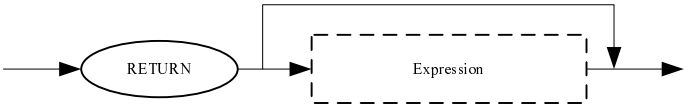


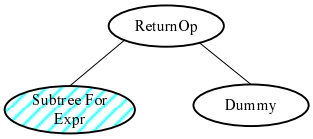
MethodCallStatement



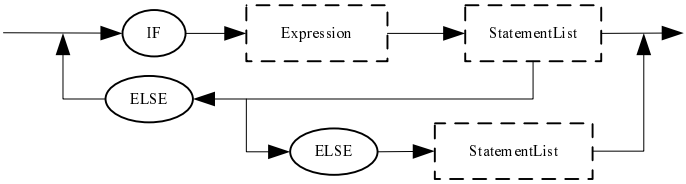


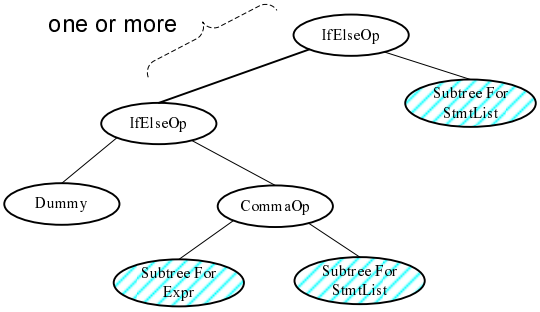
ReturnStatement



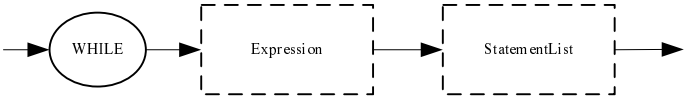


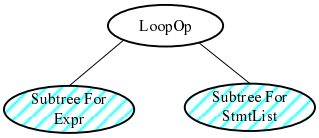
IfStatement



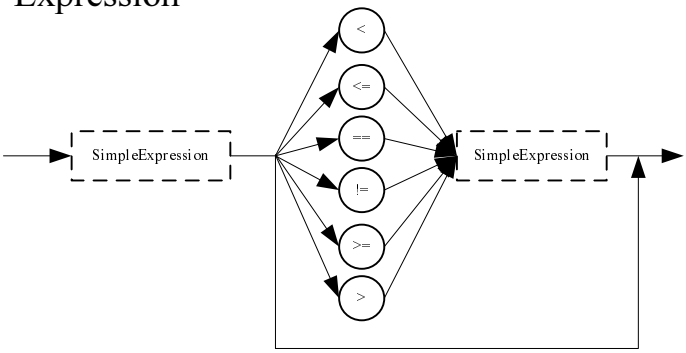


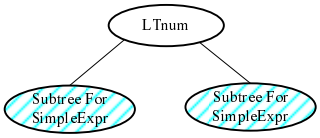
WhileStatement



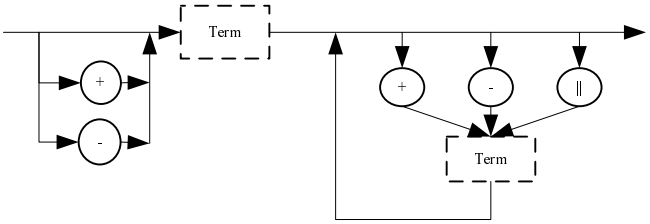


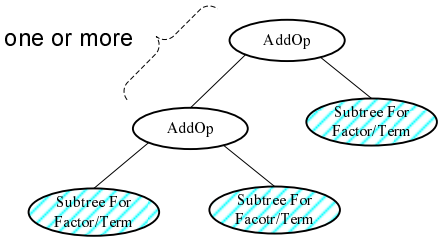
Expression



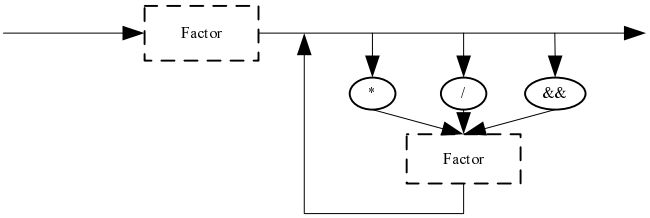


SimpleExpression

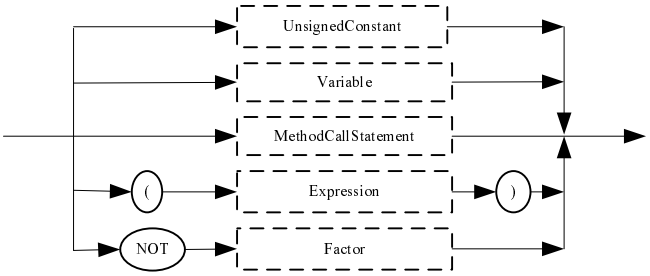


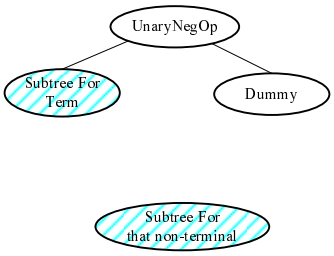


Term

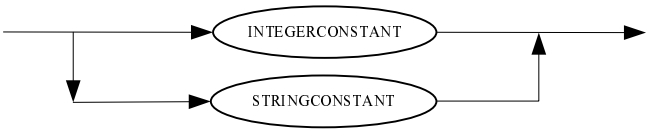


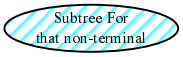
Factor





UnsignedConstant





Variable