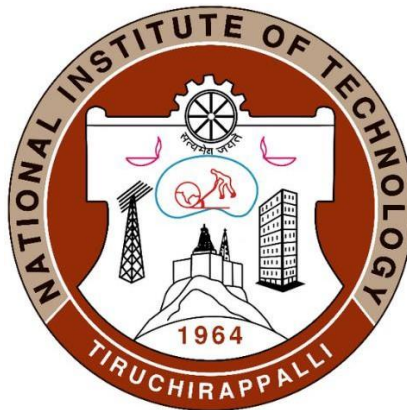


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CSPC62 COMPILER DESIGN TOPIC: C++ Compiler LAB REPORT-2 Sub Topic : Syntax Analyzer

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SYNTAX ANALYZER

Introduction

What is a Syntax Analyzer?

A syntax analyzer, also known as a parser, is a program that checks the grammatical structure of an input program written in a specific programming language. It verifies if the code follows the language's rules and constructs.

Role in Compilers:

Syntax analysis is a crucial stage in the compilation process, typically the second phase after lexical analysis.

1. **Lexical Analysis:** Breaks down the source code into smaller meaningful units called tokens (keywords, identifiers, operators, literals).
2. **Syntax Analysis:** Checks if the sequence of tokens adheres to the grammar rules of the programming language.

How it Works:

- The syntax analyzer uses a set of predefined rules, that define valid program structures.
- It reads the token stream generated by the lexical analyzer one token at a time.
- It applies the grammar rules to determine if the sequence of tokens forms a valid construct in the language.
- If a violation is found, it reports a syntax error with details like the line number and potential error message.

Benefits:

- **Early Error Detection:** Syntax analysis helps identify errors early in the development process, saving time and effort compared to debugging runtime errors.
- **Improved Code Quality:** By enforcing language rules, syntax analysis promotes well-structured and maintainable code.
- **Enables Further Compilation Stages:** A successfully parsed program can proceed to semantic analysis (checking types) and code generation (creating machine code).

Limitations:

- **Focuses on Structure:** Syntax analyzers only verify the code's structure, not its logical correctness or efficiency.
- **Language Specific:** Each language has its own grammar rules, so a syntax analyzer is designed for a particular programming language.

Applications:

Syntax analyzers are used in various contexts:

- **Compilers and Interpreters:** As a core component for translating code into machine code or executing it directly.
- **Text Editors and IDEs:** To provide real-time syntax highlighting and error checking as developers write code.
- **Data Validation:** To ensure data entered in a specific format adheres to defined rules.

Key Functionalities:

- **Lexical Analysis:** The code likely uses the `yyin` stream and `yytext` variable to handle the input source code. Functions like `yyerror` might be used for error reporting during the lexical analysis phase (not shown in the provided code).
- **Grammar Parsing:** The code utilizes the `yylex` function to retrieve tokens from the input. The `%token` section defines the recognized tokens, including keywords, operators, identifiers, and literals.
- **Abstract Syntax Tree (AST) Construction:** The parser uses a recursive descent approach to build an AST representing the program structure. The `create_Node` function creates AST nodes with labels, values, and references to child nodes.
- **Error Handling:** The `yyerror` function reports syntax errors encountered during parsing, potentially including line numbers and error messages.

Parsing Rules:

The grammar rules are defined using BNF (Backus-Naur Form) notation within the `%%` section. These rules specify how different tokens can be combined to form valid program constructs. Here are some key observations:

- The program can start with a sequence of headers, followed by a function declaration and more program statements, or just statements alone.
- Function declarations include return type, identifier, parameter list, and a compound statement containing local declarations and statements.
- Statements can be variable declarations, assignments, control flow statements (if, else, while, for), input/output statements (cout, cin), return statements, or error handling.
- Expressions are built using arithmetic operators (+, -, *, /), comparison operators (<=, >=, ==, !=, <, >), and unary operators.

Explanation of grammar rules:

`program: headers function_declaration program`

`| statement_list program`

`| EOL program`

`| EOL ;`

Explanation:

- This rule defines the structure of the entire program. It allows for headers followed by function declarations and other program elements, or just a list of statements, or end-of-line. It recurses to accommodate multiple instances of program elements.

`headers: header`

`| headers EOL headers`

`| EOL headers`

`| EOL;`

Explanation:

- This rule defines the structure of headers in the program. It allows for one or more headers, each followed by an end-of-line token.

`function_declaration: datatype identifier LPAREN parameter_list
RPAREN LBRACE statement_list RBRACE statement_list`

Explanation:

- This rule represents the declaration of a function in the program. It includes the function's return type, name, parameters, and the statements within the function's body.

```
parameter_list: datatype identifier COMMA parameter_list
| datatype identifier
| EOL
;
```

Explanation:

- This rule defines the parameters of a function. It allows for multiple parameters separated by commas or an end-of-line token.

```
statement_list:
    statement statement_list
| EOL statement_list
| EOL
|
;
```

Explanation:

- This rule represents a list of statements in the program. It includes declarations, assignments, loops, etc.
- It allows for multiple statements separated by end-of-line tokens.

```
statement: declaration_statement
```

```
| assignment_statement SEMICOLON
| for_statement
| if_statement
| if_else_statement
| while_statement
| cout_statement
| cin_statement
| return_statement
| error SEMICOLON
| EOL
;
```

Explanation:

- This rule represents various types of statements that can occur in the program. It covers declarations, assignments, loops, conditional statements, I/O operations, and error handling.

```
if_statement: if_x LPAREN E RPAREN LBRACE statement_list RBRACE
| if_statement EOL
```

Explanation:

- This rule handles if statements, including nested if statements. It allows for a single if statement or multiple if statements separated by end-of-line tokens.

```
else_statement: else_x LBRACE statement_list RBRACE  
| else_x statement  
| else_statement EOL  
;
```

Explanation:

- This rule handles else statements, including nested else statements. It allows for a single else statement or multiple else statements separated by end-of-line tokens.

```
if_else_statement: if_statement else_statement
```

Explanation:

- This rule handles if-else constructs. It allows for if statements followed by corresponding else statements.

```
while_statement: while_x LPAREN E RPAREN LBRACE statement_list  
RBRACE
```

Explanation:

- This rule handles while loops. It allows for while loops with conditions and statements within their bodies.

```
for_statement: for_x LPAREN declaration_statement E SEMICOLON E  
RPAREN LBRACE statement_list RBRACE
```

Explanation:

- This rule handles for loops. It allows for the declaration of loop control variables, loop conditions, and statements within the loop body.

return_statement: return_x E SEMICOLON

| return_x SEMICOLON

Explanation:

- This rule handles return statements, which can either return a value or be used to exit a function without returning a value.

cout_statement: cout insert_statement SEMICOLON

Explanation:

- This rule handles cout statements, which are used for outputting data to the console. It allows for multiple insert operations to display data.

insert_statement: insert E insert_statement

| insert string insert_statement

| insert E

| insert string

Explanation:

- This rule handles insert statements within cout, allowing for inserting expressions or strings into the output stream.

cin_statement: cin extract_statement SEMICOLON

Explanation:

- This rule handles cin statements, which are used for inputting data from the console. It allows for extracting data into variables.

```
extract_statement: extract identifier extract_statement  
| extract identifier  
;
```

Explanation:

- This rule handles extract statements within cin, allowing for extracting data into variables.

```
declaration_statement: datatype id_list SEMICOLON
```

Explanation:

- This rule represents a declaration statement, defining variables with specific data types.

```
id_list: identifier COMMA id_list  
| assignment_statement COMMA id_list  
| assignment_statement  
| identifier
```

Explanation:

- This rule defines a list of identifiers in a declaration or assignment statement, allowing for multiple variables to be declared or assigned.

assignment_statement:

```

    F assignmentop E
;

```

Explanation:

- This rule represents an assignment statement, assigning the result of an expression to a variable.

E: F assignmentop E

```

|   E comparisionop T {
        // Comparison operations
    }
|   E PLUS T
|   E MINUS T
|   T
;

```

Explanation:

- This rule defines expressions, including arithmetic operations and comparisons. It handles expressions involving addition, subtraction, multiplication, division, and comparison operations.

T:

```
    T MUL F
|    T DIV F
|    F
;
```

Explanation:

- This rule defines terms in expressions, including multiplication and division operations.

F:

```
    number
| character
|    LPAREN E RPAREN
|    identifier
| unary identifier
| identifier unary
;
```

Explanation:

- This rule defines factors in expressions, including numbers, characters, identifiers, and unary operations.
- It handles parentheses, allowing for the grouping of expressions.

1. Create a parser for your programming language:

Code Snippets:

Lexer.l:

```
%option yylineno
```

```
%{
```

```
    #include "temp2.tab.h"
```

```
    #include<stdio.h>
```

```
    #include<stdlib.h>
```

```
    #include <string.h>
```

```
    #include <stdarg.h>
```

```
    #include "TreeNode.h"
```

```
    int st[100];
```

```
    int top,count,currscope,up,declared = 0;
```

```
    char decl[20];
```

```
    int flag = 0;
```

```
    void installID(char *text,int nm,int scp);
```

```
    void display();
```

```
    struct entry
```

```
    {
```

```
        char arr[20];
```

```
        int scope;
```

```
        char dtype[10];
```

```
        int value;
```

```
    };
```

```
    struct entry symbolTable[100];
```

```
    TreeNode *createNode(char *label, int value, char *value_str, int num_children,  
    ...){
```

```

        TreeNode *newNode = (TreeNode *)malloc(sizeof(TreeNode));

        newNode->label = label;

        newNode->value = value;

        newNode->value_str = (char*)malloc(sizeof(char) * strlen(value_str) + 1);
        strcpy(newNode->value_str,value_str);

        newNode->num_children = num_children;

        newNode->children = malloc(sizeof(TreeNode*) * num_children);

        va_list args;

        va_start(args, num_children);

        for (int i = 0; i < num_children; i++) {

            newNode->children[i] = va_arg(args, TreeNode*);

        }

        va_end(args);

        return newNode;

    }

}%

/* regular definitions */

delim [ \t]

ws {delim}+

letter [a-zA-Z]

digit [0-9]

id {letter}{{letter}}{digit}*

relop (<|=|>|=|!=|<|>)

logicalop (&&|[]|[])

leftshift (<<)

rightshi (>>)

plus [+]

minus [-]

```

```

mult [*]
div [/]
num ({digit}+)
float ({num}\.{num})
arithmicop ({plus}{minus}{mult}{div})
increment {plus}{plus}
decrement {minus}{minus}
assignop =
string (\\"(\\".|\[^\"])*\\")
character (\'(\\".|\[^\"])*\\')
keyword (if|else|const|while|for|int|float|return|void|main|char|"long
long"|double|short|long|unsigned|signed|define|struct|enum|typedef|sizeof|sta
c|register|auto|break|case|con
nue|default|do|goto|switch|cout|cin|endl|bool|using|namespace|std|include|iostream|
vector|map|set|queue|stack|push_back|pop_back|pop|push|top|front|priority_queue)
inval (((digit}{+}{id}))
comment (\\/\\.*|\\/\\*([^\"]|(\\"+\"/))*\\*+\\/\\n\\*)

%%

\\n {printf("newline\\n");return EOL;}

#include<[^>]+> {printf( "header:%s\\n",yytext); yylval.node = createNode("header",-
1,yytext,0); return header;};

#include\\"([^\"]+)" {printf( "header:%s\\n",yytext); yylval.node = createNode("header",-
1,yytext,0); return header;};

if { printf("if\\n"); yylval.node = createNode("if",-1,yytext,0); return if_x; }
else { printf("else\\n"); yylval.node = createNode("else",-1,yytext,0); return else_x; }
while { printf("while\\n"); yylval.node = createNode("while",-1,yytext,0); return while_x; }
for {printf("for\\n"); yylval.node = createNode("for",-1,yytext,0); return for_x; }
return { printf("return \\n"); yylval.node = createNode("return",-1,yytext,0); return
return_x; }

printf { printf("printf\\n"); yylval.node = createNode("printf",-1,yytext,0); return printf_x; }
cout { printf("cout\\n"); yylval.node = createNode("cout",-1,yytext,0); return cout; }

```

```

cin { printf("cin\n"); yylval.node = createNode("cin",-1,yyltext,0); return cin; }

"<<" { printf("insert\n"); yylval.node = createNode("<<",-1,yyltext,0); return insert; }

">>" { printf("extract\n"); yylval.node = createNode(">>",-1,yyltext,0); return extract; }

{assignop} { printf("assignop:%s\n", yytext); yylval.node = createNode("assignop",-1,yyltext,0); return assignmentop; }

{relop} { ; printf("compop:%s\n", yytext); strcpy(yylval.str,yytext); yylval.node = createNode("comparisionop",-1,yyltext,0); return comparisionop; }

{logicalop} { printf("logicalop:%s\n", yytext); return logicalop; }

int|float|double|char|string|"long long"|short|long { printf("datatype:%s\n", yytext); declared = 1; strcpy(decl, yytext); yylval.node = createNode("datatype",-1,yyltext,0); return datatype; }

{num} { printf("num:%s\n", yytext); yylval.node = createNode("number",atoi(yytext),"NULL",0); return number; }

{increment} { ; printf("unary:%s\n", yytext); yylval.node = createNode("unary",-1,yyltext,0); return unary; }

{decrement} { ; printf("unary:%s\n", yytext); yylval.node = createNode("unary",-1,yyltext,0); return unary; }

{id} { if(declared == 1) {installID(yytext, yylineno, st[top]);} printf("id:%s\n", yytext); yylval.node = createNode("id",-1,yyltext,0); return identifier; }

{character} { printf("character:%s\n", yytext); yylval.node = createNode("character",-1,yyltext,0); return character; }

{string} { printf("string:%s\n", yytext); yylval.node = createNode("string",-1,yyltext,0); return string; }

\n* ;

{ws} ;

{plus} { yylval.node = createNode("plus",-1,yyltext,0); return PLUS;}

{minus} { yylval.node = createNode("minus",-1,yyltext,0); return MINUS;}

{mult} { yylval.node = createNode("mult",-1,yyltext,0); return MUL;}

{div} { yylval.node = createNode("div",-1,yyltext,0); return DIV;}

"{" { printf("Lbrace:%s\n",yytext); currscope++; yylval.node = createNode("{",-1,yyltext,0); return LBRACE; }

"}" { currscope--;printf("Rbrace:%s\n",yytext); yylval.node = createNode("}",-1,yyltext,0); return RBRACE; }

```

```

"(" {printf ("LPAREN: %s, line: %d\n", yytext, yylineno); yylval.node =
createNode("LPAREN",-1,yytext,0); return LPAREN;}

")" {printf ("RPAREN: %s, line: %d\n", yytext, yylineno); yylval.node =
createNode("RPAREN",-1,yytext,0); return RPAREN;}

"[" {printf ("LBRACKET: %s, line: %d\n", yytext, yylineno); yylval.node = createNode("[",-
1,yytext,0); return yytext[0];}

"]" {printf ("RBRACKET: %s, line: %d\n", yytext, yylineno); yylval.node = createNode("]",-
1,yytext,0); return yytext[0];}

";" { declared = 0; printf("semicolon :%s,line:%d\n",yytext,yylineno); yylval.node =
createNode(";",-1,yytext,0); return SEMICOLON; }

"," { printf("comma :%s,line:%d\n",yytext,yylineno); yylval.node = createNode("",-
1,yytext,0); return COMMA; }

{comment} { };

. { return yytext[0]; }

%%

```

```

void installID(char *text, int nm, int scp)
{
    int present = 0;
    for (int i = 0; i <= up; i++)
    {
        if (strcmp(symbolTable[i].arr, text) == 0 && symbolTable[i].scope ==
currscope)
        {
            present = 1;
            break;
        }
    }
    if (!present)
    {
        strcpy(symbolTable[up].arr, text);
        symbolTable[up].scope = currscope;
    }
}

```



```

        strcpy(symbolTable[up].dtype, decl);
        // symbolTable[up].value = up;
        up++;
    }
}

void display()
{
    printf("\nSymbol Table\n");
    printf("Symbol\t\tscope\t\tdtype\n");
    for (int i = 0; i < up; i++)
    {
        printf("%s\t\t%d\t\t%s\n", symbolTable[i].arr, symbolTable[i].scope,
symbolTable[i].dtype);
    }
}

int yywrap()
{
    return 1;
}

```

Parser.y:

```

%{
    #include "TreeNode.h"
    #include<stdio.h>
    #include<stdlib.h>
    #include<string.h>

    int yylex();
}

```

```

int yyerror(const char *s);

int yyparse();

extern void display();

struct entry{
    char arr[20];
    int scope;
    char dtype[10];
    int value;
};

extern struct entry symbolTable[100];


TreeNode *head = NULL;

struct TreeNode *create_Node(char *label, int value, char *value_str, int
num_children, ...) {
    struct TreeNode *newNode = (struct TreeNode *)malloc(sizeof(struct
TreeNode));
    newNode->label = label;
    newNode->value = value;
    newNode->value_str = (char*)malloc(sizeof(char) * strlen(value_str) + 1);
    strcpy(newNode->value_str,value_str);
    newNode->num_children = num_children;
    newNode->children = NULL;
    if(num_children<1) return newNode;
    newNode->children = malloc(sizeof(TreeNode*) * num_children);

    va_list args;
    va_start(args, num_children);

```

```

        for (int i = 0; i < num_children; i++) {
            newNode->children[i] = va_arg(args, struct TreeNode*);
        }

        va_end(args);

        return newNode;
    }

void printTree(TreeNode *root,int level){
    if(root == NULL){
        return;
    }
    for(int i = 0;i<level;i++){
        printf(" ");
    }

    if(root->value == -1 && strcmp(root->value_str,"NULL") == 0){
        printf("%d.%s\n",level, root->label);
    }else if(root->value == -1){
        printf("%d.%s\n", level,root->value_str);
    }else{
        printf("%d.(%s,%d)\n",level, root->label, root->value);
    }
    // printf("(%s,%d)\n", root->label,root->value);
    for(int i = 0;i<root->num_children;i++){
        printTree(root->children[i],level+1);
    }
}

```

```
%}
```

```
%union {
```

```
    int num;
```

```
    char *str;
```

```
        struct TreeNode *node;
```

```
}
```

```
%start program
```

```
%token EOL
```

```
%error-verbose
```

```
%token<node> PLUS MINUS MUL DIV number if_x else_x while_x for_x return_x printf_x  
main_x assignmentop comparisionop logicalop datatype unary identifier string  
character cout cin insert extract header LBRACE RBRACE LPAREN RPAREN  
SEMICOLON COMMA
```

```
%type<node> E T F assignment_statement statement_list function_declaration  
declaration_statement id_list insert_statement extract_statement if_statement  
else_statement if_else_statement while_statement for_statement return_statement  
cout_statement cin_statement statement headers parameter_list program
```

```
/* rules */
```

```
%%
```

```
program: headers function_declaration program { printf("program No: %d\n", $$); $$ =  
create_Node("program", -1, "NULL", 3, $1, $2, $3); head = $$; }
```

```
| statement_list program { $$ = create_Node("program", -1, "NULL", 2, $1, $2); head = $$; }
```

```
| EOL program { $$ = create_Node("program", -1, "NULL", 1, $2); head = $$; }
```

```
| EOL { $$ = NULL; }
```

```
;
```

```
headers: header { printf("headers1\n"); $$ = create_Node("headers", -1, "NULL", 1, $1); }
```

```
| headers EOL headers {printf("headers\n"); $$ = create_Node("headers", -1,"NULL", 2, $1, $3);}
```

```
| EOL headers {printf("headers\n"); $$ = create_Node("headers", -1, "NULL",1, $2);}
```

```
| EOL{ $$ = NULL; };
```

```
function_declaration: datatype identifier LPAREN parameter_list RPAREN LBRACE  
statement_list RBRACE statement_list {printf("Function NO: %d\n",$$); $$ =  
create_Node("function_declaration", -1, "NULL", 9, $1,$2,$3, $4, $5, $6, $7, $8, $9); };
```

```
parameter_list: datatype identifier COMMA parameter_list { $$ =  
create_Node("parameter_list", -1, "NULL",4, $1, $2, $3, $4); }
```

```
| datatype identifier { $$ = create_Node("parameter_list", -1, "NULL",2, $1, $2);}
```

```
| EOL { $$ = NULL;}
```

```
| { $$ = NULL; };
```

```
statement_list:
```

```
statement statement_list {printf("statement_list\n"); $$ =  
create_Node("statement_list", -1, "NULL", 2, $1, $2);}
```

```
| EOL statement_list { $$ = create_Node("statement_list", -1, "NULL", 1, $2);}
```

```
| EOL { $$ = NULL;}
```

```
|
```

```
;
```

```
statement: declaration_statement {printf("declaration_statement\n"); $$ =  
create_Node("declaration_statement", -1, "NULL",0); }
```

```
| assignment_statement SEMICOLON {printf("assignment_statement\n"); $$ =  
create_Node("assignment_statement", -1,"NULL",2, $1, $2);}
```

```
| for_statement {printf("for_statement\n"); $$ = create_Node("for_statement", -1,  
"NULL",1,$1); }
```

```
| if_statement {printf("if_statement\n"); $$ = create_Node("if_statement", -1,  
"NULL",1,$1); }
```

```

| if_else_statement {printf("if_else_statement\n"); $$ =
create_Node("if_else_statement", -1, "NULL", 1, $1); }

| while_statement {printf("while_statement\n"); $$ = create_Node("while_statement", -1,
"NULL", 1, $1); }

| cout_statement {printf("cout_statement\n"); $$ = create_Node("cout_statement", -1,
"NULL", 1, $1); }

| cin_statement {printf("cin_statement\n"); $$ = create_Node("cin_statement", -1,
"NULL", 1, $1); }

| return_statement {printf("return_statement\n"); $$ = create_Node("return_statement",
-1, "NULL", 1, $1); }

| error SEMICOLON { $$ = create_Node("error", -1, "NULL", 0); }

| EOL { $$ = NULL; }

;

```

```

if_statement: if_x LPAREN E RPAREN LBRACE statement_list RBRACE { $$ =
create_Node("if_statement", -1, "NULL", 7, $1, $2, $3, $4, $5, $6, $7); }

| if_x LPAREN E RPAREN statement { $$ = create_Node("if_statement", -1, "NULL",
5, $1, $2, $3, $4, $5); }

| if_statement EOL { $$ = create_Node("if_statement", -1, "NULL", 1, $1); }

```

```

else_statement: else_x LBRACE statement_list RBRACE { $$ =
create_Node("else_statement", -1, "NULL", 3, $1, $2, $3); }

| else_x statement { $$ = create_Node("else_statement", -1, "NULL", 2, $1, $2); }

| else_statement EOL { $$ = create_Node("else_statement", -1, "NULL", 1, $1); }

;

```

```

if_else_statement: if_statement else_statement { $$ =
create_Node("if_else_statement", -1, "NULL", 2, $1, $2); };

```

```

while_statement: while_x LPAREN E RPAREN LBRACE statement_list RBRACE { $$ =
create_Node("while_statement", -1, "NULL", 7, $1, $2, $3, $4, $5, $6, $7); };

```

```
for_statement: for_x LPAREN declaration_statement E SEMICOLON E RPAREN LBRACE
statement_list RBRACE { $$ = create_Node("for_statement", -1, "NULL", 9, $1, $2, $3, $4,
$5, $6, $7, $8, $9); };
```

```
return_statement: return_x E SEMICOLON { $$ = create_Node("return_statement", -
1,"NULL", 2, $1, $2); }
```

```
| return_x SEMICOLON { $$ = create_Node("return_statement", -1, "NULL", 2, $1,$2); };
```

```
cout_statement: cout insert_statement SEMICOLON { $$ =
create_Node("cout_statement", -1,"NULL", 2, $1, $2); };
```

```
insert_statement: insert E insert_statement { $$ = create_Node("insert_statement", -
1,"NULL", 3, $1, $2, $3); }
```

```
| insert string insert_statement { $$ = create_Node("insert_statement", -1, "NULL", 3, $1,
$2, $3); }
```

```
| insert E { $$ = create_Node("insert_statement", -1, "NULL", 2, $1, $2); }
```

```
| insert string { $$ = create_Node("insert_statement", -1, "NULL", 2, $1, $2); }
```

```
cin_statement: cin extract_statement SEMICOLON { $$ = create_Node("cin_statement",
-1, "NULL", 3, $1, $2, $3); };
```

```
extract_statement: extract identifier extract_statement { $$ =
create_Node("extract_statement", -1, "NULL", 3, $1, $2, $3); }
```

```
| extract identifier { $$ = create_Node("extract_statement", -1, "NULL", 2, $1, $2); }
```

```
;
```

```
declaration_statement: datatype id_list SEMICOLON { $$ =
create_Node("declaration_statement", -1, "NULL", 3, $1, $2, $3); };
```

```
id_list: identifier COMMA id_list { $$ = create_Node("id_list", -1, "NULL", 3, $1, $2, $3); }
```

```
| assignment_statement COMMA id_list { $$ = create_Node("id_list", -1, "NULL", 3, $1,
$2, $3); }
```

```
| assignment_statement { $$ = create_Node("id_list", -1, "NULL", 1, $1); }
```

```
| identifier { $$ = create_Node("id_list", -1, "NULL", 1, $1); }
```

assignment_statement:

```
    F assignmentop E { printf("assignment-statement\n"); $$ =  
create_Node("assignment_statement", -1, "NULL", 3, $1, $2, $3); $1->value = $3->value;  
}  
;
```

```
E: F assignmentop E { $$ = create_Node("E", -1, "NULL", 3, $1, $2, $3); $1->value = $3->  
value; }
```

```
|      E comparisionop T { $$ = create_Node("E", -1, "NULL", 3, $1, $2, $3);
```

```
        if (strcmp($2->value_str, "<=") == 0) {
```

```
            $$->value = $1->value <= $3->value;
```

```
        } else if (strcmp($2->value_str, ">=") == 0) {
```

```
            $$->value = $1->value >= $3->value;
```

```
        } else if (strcmp($2->value_str, "==") == 0) {
```

```
            $$->value = $1->value == $3->value;
```

```
        } else if (strcmp($2->value_str, "!=") == 0) {
```

```
            $$->value = $1->value != $3->value;
```

```
        }
```

```
        else if (strcmp($2->value_str, "<") == 0) {
```

```
            $$->value = $1->value < $3->value;
```

```
        }
```

```
        else if (strcmp($2->value_str, ">") == 0) {
```

```
            $$->value = $1->value > $3->value;
```

```
        }
```

```
    }
```

```
| E PLUS T { $$ = create_Node("E", $1->value+$3->value, "NULL", 3, $1, $2, $3); }
```

```
| E MINUS T { $$ = create_Node("E", $1->value-$3->value, "NULL", 3, $1, $2, $3); }
```

```
| T { $$ = create_Node("E", $1->value, "NULL", 1, $1); }
```


;

T:

```
T MUL F { $$ = create_Node("T", $1->value*$3->value, "NULL", 3, $1, $2, $3);}  
| T DIV F { $$ = create_Node("T", $1->value/$3->value, "NULL", 3, $1, $2, $3);}  
| F { $$ = create_Node("T", $1->value, "NULL", 1, $1); }  
;
```

F:

```
number { $$ = create_Node("F", -1, "NULL", 1, $1); }  
| character { $$ = create_Node("F", -1, "NULL", 1, $1); }  
| LPAREN E RPAREN { $$ = create_Node("F", $2->value, "NULL", 3, $1, $2, $3); }  
| identifier { $$ = create_Node("identifier", -1, "NULL", 1, $1); }  
| unary identifier { $$ = create_Node("F", -1, "NULL", 2, $1, $2); }  
| identifier unary { $$ = create_Node("F", -1, "NULL", 2, $1, $2); }  
;
```

%%

```
#include <ctype.h>
```

```
int yyerror(const char *s)
```

```
{
```

```
    extern int yylineno;
```

```
    // valid = 0;
```

```
    if(yylineno != 27){
```

```
        printf("Line no: %d \n The error is: %s\n",yylineno,s);
```

```
    }
```

```
}
```

```
extern FILE *yyin;
```

```
int main(int argc,char **argv){
```

```
    if(argc<2)
```

```

{
    printf("Usage: %s <filename>\n",argv[0]);
    return 1;
}
FILE *fp = fopen(argv[1], "r");
if(fp==NULL)
{
    printf("Error: File not found\n");
    return 1;
}
extern char *yytext;
yyin=fp;
yyparse();
printf("-----\n");
printTree(head,0);
printf("-----\n");
display();
}

```

2. Show that this parser correctly parses the input token generated by your lexical analyser for any program written in your programming language as well as identifies errors.

Sample Code A:

```
1  #include<bits/stdc++.h>
2  | #include"file.cpp"
3
4  | int main(int a,int b,int c){
5      | int a = 5,d;
6      | cin>>a>>b;
7      | char c = 'c';
8      | for(int i = 0; i < 10;i++){
9          | a = a + 1;
10         | }
11         | if(b == 10) a = 10;
12         | else{
13             | cout<<"2"<<" ";
14         | }
15         | return 0;
16     | }
17
```

You, 48 minutes ago • first com

Output Parse Tree:

- PS C:\Users\khsd1\Documents\Programming\Compiler project\newparsetree> flex temp2.1
- PS C:\Users\khsd1\Documents\Programming\Compiler project\newparsetree> bison -t -d temp2.y
temp2.y:84.2: warning: empty rule for typed nonterminal, and no action
temp2.y:104.2: warning: empty rule for typed nonterminal, and no action
temp2.y: conflicts: 128 shift/reduce, 52 reduce/reduce
- PS C:\Users\khsd1\Documents\Programming\Compiler project\newparsetree> gcc lex.yy.c temp2.tab.c
- PS C:\Users\khsd1\Documents\Programming\Compiler project\newparsetree> ./a.exe file.cpp
header:#include<bits/stdc++.h>
newline
header:#include"file.cpp"
datatype:int
id:main
LPAREN: (, line: 4
datatype:int
id:a
comma :,,line:4
datatype:int
id:b
comma :,,line:4
datatype:int
id:c
RPAREN:), line: 4
Lbrace:{
newline
datatype:int
id:a
assignop:=
num:5
comma :,,line:5
id:d
semicolon ;,,line:5
declaration_statement
newline
cin
extract
id:a
extract
id:b
semicolon ;,,line:6

```

semicolon ;;,line:6
cin_statement
newline
datatype:char
id:c
assignop:=
character:'c'
semicolon ;;,line:7
declaration_statement
newline
for
LPAREN: (, line: 8
datatype:int
id:i
assignop:=
num:0
semicolon ;;,line:8
id:i
compop:<
num:10
semicolon ;;,line:8
id:i
unary:++
RPAREN: ), line: 8
Lbrace:{
newline
id:a
assignop:=
id:a
num:1
semicolon ;;,line:9
assignment_statement
newline
Rbrace:}
for_statement
newline
if
LPAREN: (, line: 11
id:b

if
LPAREN: (, line: 11
id:b
compop==
num:10
RPAREN: ), line: 11
id:a
assignop:=
num:10
semicolon ;;,line:11
assignment_statement
newline
else
Lbrace:{
newline
cout
insert
string:"2"
insert
string:" "
semicolon ;;,line:13
cout_statement
newline
Rbrace:}
newline
return
if_else_statement
num:0
semicolon ;;,line:15
return_statement
newline
Rbrace:}
newline
Function NO: 13112952
program No: 13113016
-----
0.program
    1.headers
    2.headers

```

```

2.headers
  3.#include<bits/stdc++.h>
2.headers
  3.#include"file.cpp"
1.function_declaration
  2.int
  2.main
  2.(
    2.parameter_list
      3.int
      3.a
      3.,
      3.parameter_list
        4.int
        4.b
        4.,
        4.parameter_list
          5.int
          5.c
    2.)
  2.{
    2.statement_list
      3.statement_list
        4.declaration_statement
        4.statement_list
          5.statement_list
            6.cin_statement
              7.cin_statement
                8.cin
                8.extract_statement
                  9.>>
                  9.a
                  9.extract_statement
                    10.>>
                    10.b
              8.;
            6.statement_list
              7.statement_list
                8.declaration statement

```

```

8.declaration_statement
8.statement_list
9.statement_list
10.for_statement
11.for_statement
12.for
12.(
12.declaration_statement
13.int
13.id_list
14.assignment_statement
15.identifier
16.i
15.=
15.E
16.T
17.F
18.(number,0)
13.;
12.(E,0)
13.E
14.T
15.identifier
16.i
13.<
13.T
14.F
15.(number,10)
12.;
12.E
13.T
14.F
15.i
15.++
12.)
12.{
12.statement_list
13.statement_list
14.assignment statement
14.assignment_statement
15.assignment_statement
16.(identifier,-2)
17.a
16.=
16.(E,-2)
17.E
18.T
19.identifier
20.a
17.+
17.T
18.F
19.(number,1)
15.;
10.statement_list
11.statement_list
12.if_else_statement
13.if_else_statement
14.if_statement
15.if_statement
16.if
16.(
16.(E,1)
17.E
18.T
19.identifier
20.b
17.==
17.T
18.F
19.(number,10)
16.)
16.assignment_statement
17.assignment_statement
18.identifier
19.a
18.=
18.E

```

```

18.=
18.E
19.T
20.F
21.(number,10)
17.;
14.else_statement
15.else_statement
16.else
16.{
16.statement_list
17.statement_list
18.cout_statement
19.cout_statement
20.cout
20.insert_statement
21.<<
21."2"
21.insert_statement
22.<<
22." "
12.statement_list
13.return_statement
14.return_statement
15.return
15.E
16.T
17.F
18.(number,0)
2.}

```

Sample Code B: (For Error detection)

```

1  #include<bits/stdc++.h>
2
3  int main(int a){
4      int a = 5,d;
5      cin>>a;;
6      char c == 'c';
7      for(int i=0;i<10;i++){
8          a = a + 1;
9      }
10     /
11     if(b == 10) {
12         a = 10;
13     }
14
15     return 0;
16 }
17

```


Erros Detecting Output:

- PS C:\Users\khsd1\Documents\.Programming\Compiler project\newparsetree> ./a.exe file_error.cpp

header:#include<bits/stdc++.h>

datatype:int

id:main

LPAREN: (, line: 3

datatype:int

id:a

RPAREN:), line: 3

Lbrace:{

newline

datatype:int

id:a

assignop: =

num:5

comma :,,line:4

id:d

semicolon ;,,line:4

declaration_statement

newline

cin

extract

id:a

semicolon ;,,line:5

cin_statement

semicolon ::,line:5

semicolon ;,,line:5

Line no: 5

The error is: syntax error, unexpected SEMICOLON

newline

datatype:char

id:c

compop: ==

Line no: 6

The error is: syntax error, unexpected comparisionop, expecting SEMICOLON
character: 'c'

semicolon ;,,line:6

newline

for

LPAREN: (, line: 7

datatype:int

id:i

assignop: =

num:0

semicolon ;,,line:7

id:i

compop: <

num:10

semicolon ;,,line:7

id:i

unary: ++

RPAREN:), line: 7

```

RPAREN: ), line: 7
Lbrace:{
newline
id:a
assignop:=
id:a
num:1
semicolon ;;,line:8
assignment_statement
newline
Rbrace:}
for_statement
newline
Line no: 10
    The error is: syntax error, unexpected DIV
newline
if
LPAREN: (, line: 11
id:b
compop:==
num:10
RPAREN: ), line: 11
Lbrace:{
newline
id:a
assignop:=

    id:a
    assignop:=
    num:10
    semicolon ;;,line:12
    newline
    Rbrace:}
    return
    num:0
    semicolon ;;,line:15
    return_statement
    newline
    Rbrace:}
Function NO: 14292456
Line no: 16
    The error is: syntax error, unexpected RBRACE
newline

```

3. Write a simple program in your language with all kinds of tokens and keywords and show that your compiler is correctly detecting the tokens and errors. Parse the program using your

parser. Print step by step parsing process and draw the parse tree.

```
1  #include<bits/stdc++.h>
2
3  int main(int a){
4      int a = 5,d;
5      cin>>a;
6      char c = 'c';
7      for(int i=0;i<10;i++){
8          a = a + 1;
9      }
10     if(b==10) {
11         a = 10;
12     }
13     return 0;
14 }
15
```

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Output:

```
PS C:\Users\khsd1\Documents\Programming\Compiler project\newparsetree> ./a.exe file2.cpp
header:#include<bits/stdc++.h>
datatype:int
id:main
LPAREN: (, line: 3
datatype:int
id:a
RPAREN: ), line: 3
Lbrace:{
newline
datatype:int
id:a
assignop:=
num:5
comma :,line:4
id:d
semicolon ;;,line:4
declaration_statement
newline
cin
extract
id:a
semicolon ;;,line:5
cin_statement
newline
datatype:char
id:c
assignop:=
character:'c'
semicolon ;;,line:6

id:d
semicolon ;;,line:4
declaration_statement
newline
cin
extract
id:a
semicolon ;;,line:5
cin_statement
newline
datatype:char
id:c
assignop:=
character:'c'
semicolon ;;,line:6
declaration_statement
newline
for
LPAREN: (, line: 7
datatype:int
id:i
assignop:=
num:0
semicolon ;;,line:7
id:i
compop:<
num:10
semicolon ;;,line:7
id:i
unary:++
RPAREN: ), line: 7
Lbrace:{
```

```
RPAREN: ), line: 7
Lbrace:{
newline
id:a
assignop:=
id:a
num:1
semicolon ;;,line:8
assignment_statement
newline
Rbrace:}
for_statement
newline
if
LPAREN: (, line: 10
id:b
RPAREN: ), line: 10
Lbrace:{
newline
id:a
assignop:=
num:10
semicolon ;;,line:11
assignment_statement
newline
Rbrace:}
newline
return
if_statement
num:0
semicolon ;;,line:13
return_statement
newline
Rbrace:}
newline
Function NO: 13047272
program No: 13047224
```

```

0.program
1.headers
2.#include<bits/stdc++.h>
1.function_declaration
2.int
2.main
2.(
2.parameter_list
3.int
3.a
2.)
2.{
2.statement_list
3.statement_list
4.declaration_statement
4.statement_list
5.statement_list
6.cin_statement
7.cin_statement
8.cin
8.extract_statement
9.>>
9.a
8.;
6.statement_list
7.statement_list
8.declaration_statement
8.statement_list
9.statement_list
10.for_statement
11.for_statement
12.for
12.(
12.for
12.(
12.declaration_statement
13.int
13.id_list
14.assignment_statement
15.identififer
16.i
15.=
15.E
16.T
17.F
18.(number,0)
13.;
12.(E,0)
13.E
14.T
15.identififer
16.i
13.<
13.T
14.F
15.(number,10)
12.;
12.E
13.T
14.F
15.i
15.++
12.)

```

```

12.)
12.{
12.statement_list
13.statement_list
14.assignment_statement
15.assignment_statement
16.(identifier,-2)
17.a
16.=
16.(E,-2)
17.E
18.T
19.identifier
20.a
17.+
17.T
18.F
19.(number,1)
15.;
10.statement_list
11.statement_list
12.if_statement
13.if_statement
14.if_statement
15.if
15.(
15.E
16.T
17.identifier
18.b
15.)
15.{
15.statement_list
16.statement_list
17.assignment_statement
18.assignment_statement
17.assignment_statement
18.assignment_statement
19.identifier
20.a
19.=
19.E
20.T
21.F
22.(number,10)
18.;
15.}
12.statement_list
13.return_statement
14.return_statement
15.return
15.E
16.T
17.F
18.(number,0)
2.}

```