CS3300:Compiler Design	Odd Sem 2020
Assignment #2	
Abstract Syntax Tree	Deadline : 27/09/2020, 11:55PM

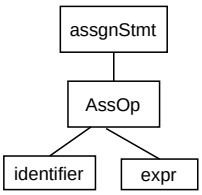
1 Task

The aim of the assignment is to create an Abstract Syntax Tree for the language used in Assignment#1 and perform queries on them.

The Abstract Syntax Tree for various C constructs are as follows: (Note: expr$< i >$ are instances of 'expr' numbered just for clarity.)

- **Assignment Statement**

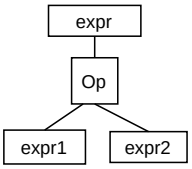
assgnStmt → var AssOp expr
AssOp → { = }



- **Expressions**

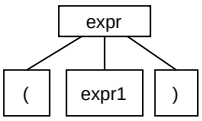
- Binary Operators

expr → expr1 Op expr2
Op → { Relational operators, Binary Opera- tors, Logical Operators }



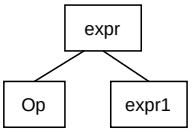
- Parentheses expression

expr → (expr1)



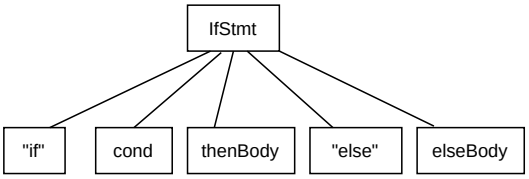
- Unary Operators

expr → Op expr1
Op → { Unary Operators }



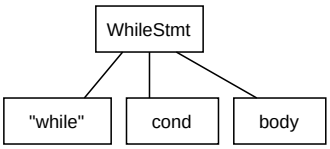
- **If Statement**

If → if (cond) {
thenBody
} else {
elseBody
}



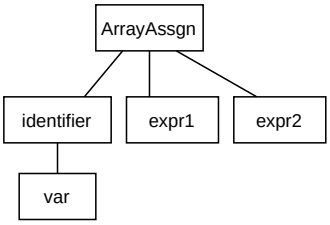
- **While Statement**

WhileStmt → while (cond) {
body
}



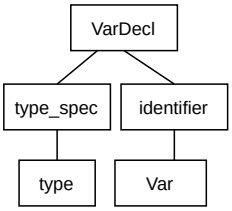
- **Array Assignment Statement**

ArrayAssgn → var [expr1] = expr2 ;



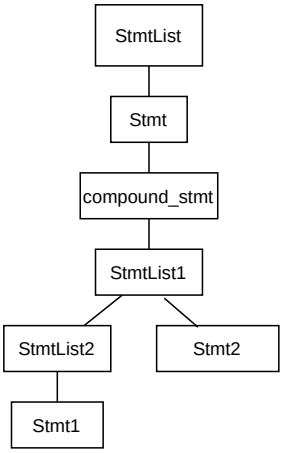
- **Variable Declaration**

VarDecl → type var ;



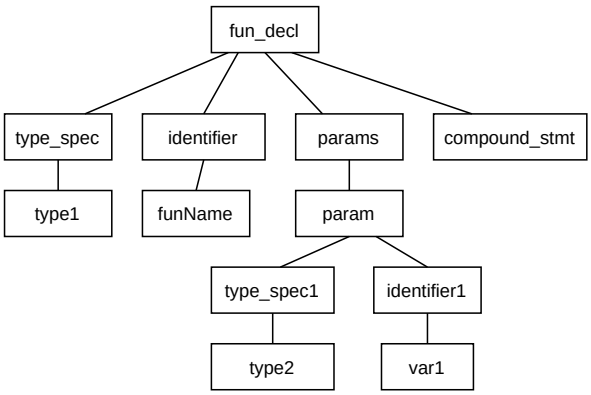
- **Block (Compound) Statement List**

{
Stmt1;
Stmt2;
}



- **Function Definition**

```
type1 funName ( type2 var1 )
{
    stmt ;
}
```



2 Input

The input to the assignment is a subset of C programs restricted to the grammar mentioned in Section 4.

3 Output

Print the following in the same order:

- Longest Path of the Abstract Syntax Tree.
- Longest Path across all the subtrees of 'if' statement. If there are no if statements, Print '0'.
- Longest Path across all the subtrees of 'while' statement. If there are no while statements, Print '0'.
- Longest Path across all the subtrees of 'switch' statement. If there are no switch statements, Print '0'.
- Longest Path of the 'main' function subtree.

4 Grammar

Below is the grammar to be used for the assignment :

program → decl_list
decl_list → decl_list decl | decl
decl → var_decl | func_decl | struct_decl
struct_decl → "struct" identifier "{" local_decls "}" ";"
var_decl → type_spec identifier ";"
| type_spec identifier "," var_decl
| type_spec identifier "[" integerLit "]" ";"
| type_spec identifier "[" integerLit "]" "," var_decl
type_spec → extern_spec "void" | extern_spec "int" | extern_spec "float"
| extern_spec "void" "*" | extern_spec "int" "*" | extern_spec "float" "*"
| "struct" identifier | "struct" identifier "*"
extern_spec → "extern" |ϵ
fun_decl → type_spec identifier "(" params ")" compound_stmt
params → param_list |ϵ
param_list → param_list "," param | param
param → type_spec identifier | type_spec identifier "[" "]"
stmt_list → stmt_list stmt | stmt
stmt → assign_stmt | compound_stmt | if_stmt | while_stmt | switch_stmt
| return_stmt | break_stmt | continue_stmt | dowhile_stmt| print_stmt
| incr_stmt| decr_stmt
while_stmt → "while" "(" expr ")" stmt
dowhile_stmt → "do" stmt "while" "(" "expr" ")" ";"
print_stmt → "printf" "(" format_specifier "," identifier ")" ";"
format_specifier →""%d""
compound_stmt → "{" local_decls stmt_list "}"
local_decls → local_decls local_decl |ϵ
local_decl → type_spec identifier ";"
| type_spec identifier "[" expr "]" ";"
if_stmt → "if" "(" expr ")" stmt
| "if" "(" expr ")" stmt "else" stmt
return_stmt → "return" ";" | "return" expr ";"
break_stmt → "break" ";"
continue_stmt → "continue" ";"
switch_stmt → "switch" "(" expr ")" "{" compound_case default_case "}"
compund_case → single_case compound_case
| single_case
single_case → "case" integerLit ":" stmt_list
default_case → "default" ":" stmt_list

assign_stmt → identifier ”=” expr ”;”| identifier ”[” expr ”]” ”=” expr ”;”
| identifier ”->” identifier ”=” expr ”;”
| identifier ”.” identifier ”=” expr ”;”

incr_stmt → identifier ”++” ”;”

decr_stmt → identifier ”−−” ”;”

expr → Pexpr ”<” Pexpr | Pexpr ”>” Pexpr
→ Pexpr ”<=” Pexpr | Pexpr ”>=” Pexpr
→ Pexpr ”||” Pexpr | ”sizeof” ”(” Pexpr ”)”
→ Pexpr ”==” Pexpr | Pexpr ”!=” Pexpr| Pexpr ”<=>” Pexpr
→ Pexpr ”&&” Pexpr| Pexpr ”->” Pexpr
→ Pexpr ”+” Pexpr | Pexpr ”-” Pexpr
→ Pexpr ”*” Pexpr | Pexpr ”/” Pexpr | Pexpr ”%” Pexpr
→ ”!” Pexpr | ”-” Pexpr | ”+” Pexpr | ”*” Pexp | ”&” Pexp
→ Pexpr
→ identifier ”(” args ”)”
→ identifier ”[” expr ”]”

Pexpr → integerLit | floatLit | identifier | ”(” expr ”)”

integerLit → < INTEGER_LITERAL >

floatLit → < FLOAT_LITERAL >

identifier → < IDENTIFIER >

arg_list → arg_list ”,” expr | expr

args → arg_list |ϵ

5 Example

5.1 Input

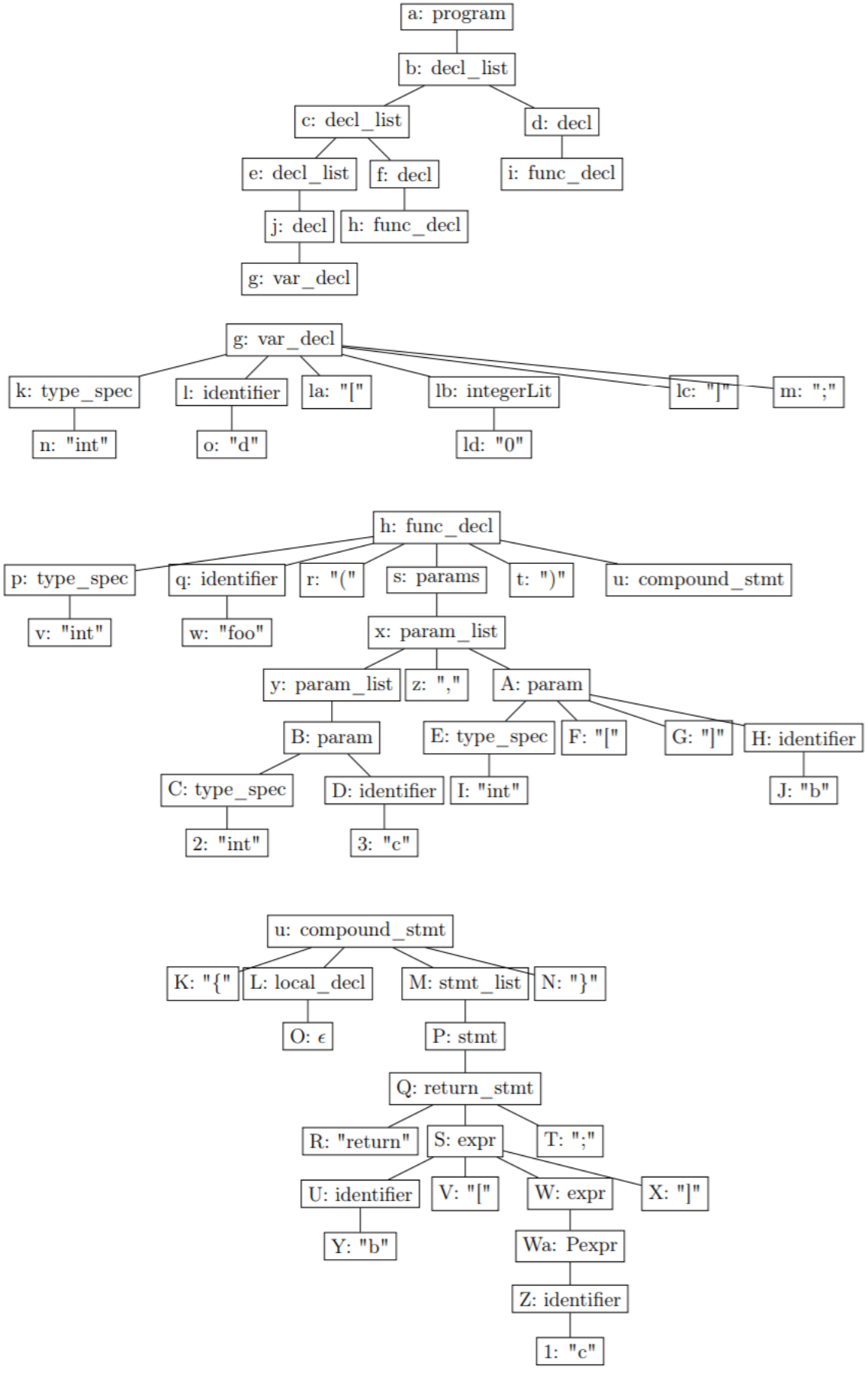
```
int d [ 10 ] ;
int foo ( int c , int [] b)
{
    return b [ c ] ;
}
int main ( )
{
    int i ;
    i = 0;
    if ( i == 0 )
    i = i + 1;
    while ( i < 10)
    {
        i = i + 1;
    }
return foo (4 , d);
}
```

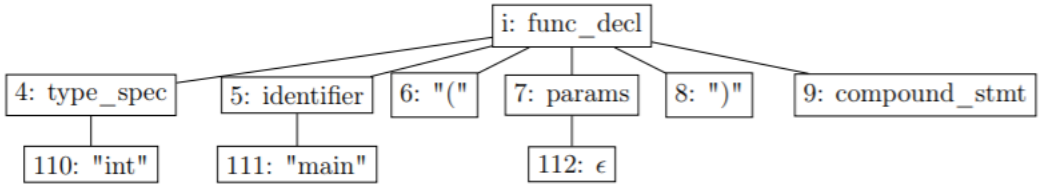
5.2 Output

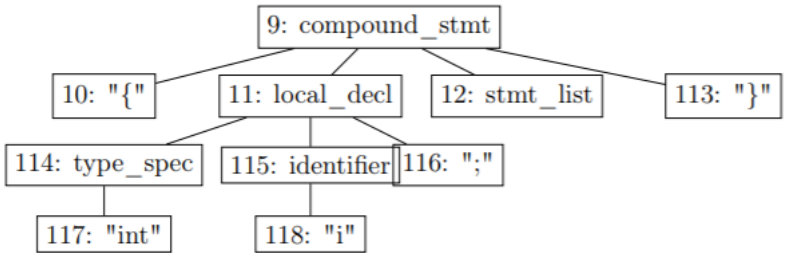
- 32 (Rooted at a)
- 14 (Rooted at 63)
- 17 (Rooted at 35)
- 0
- 25 (Rooted at i)

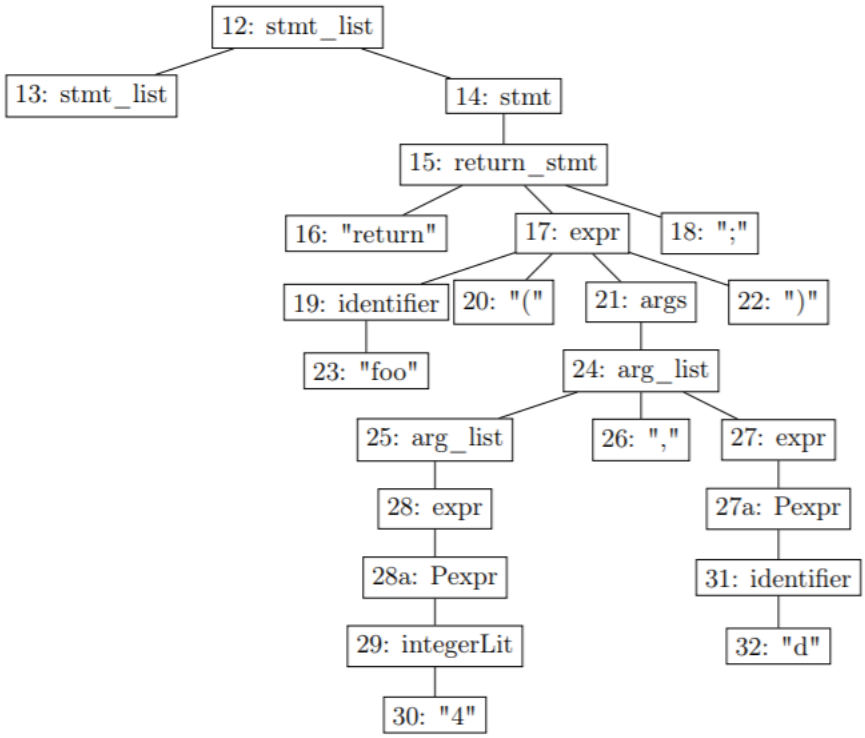
The actual output has to contain only one number on each line.

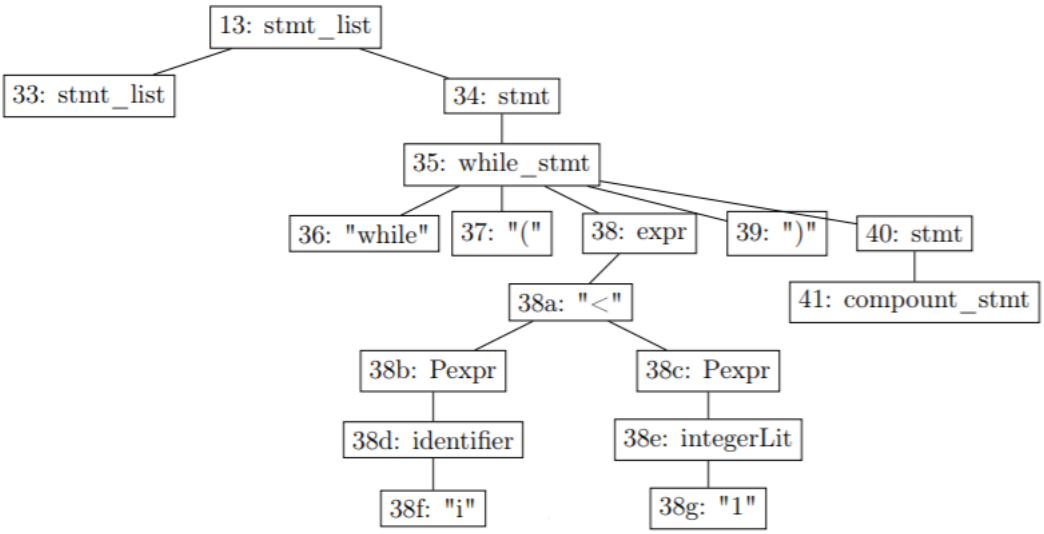
5.3 AST :

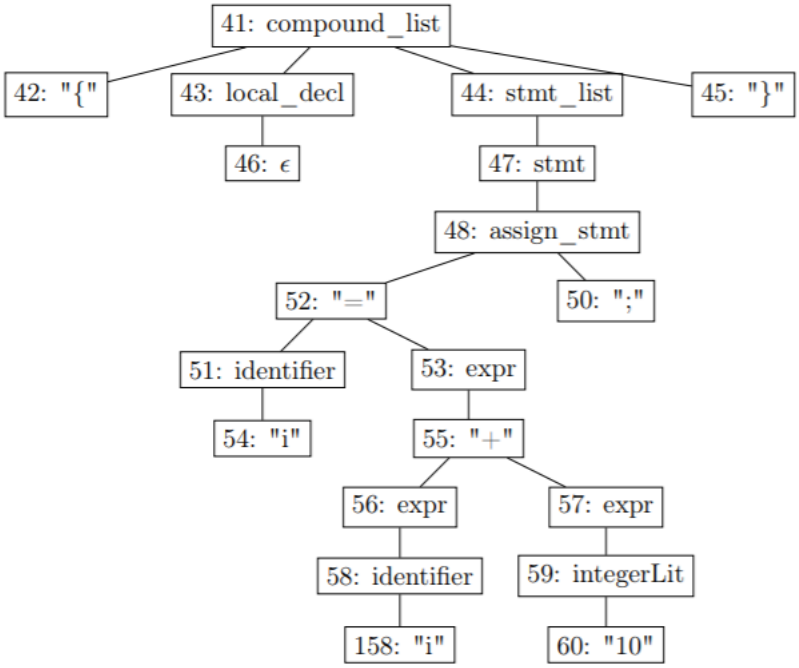

a: program
b: decl_list
c: decl_list
d: decl
e: decl_list
f: decl
i: func_decl
j: decl
h: func_decl
g: var_decl
g: var_decl
k: type_spec
l: identifier
la: "["
lb: integerLit
lc: "]"
m: ";"
n: "int"
o: "d"
ld: "0"
h: func_decl
p: type_spec
q: identifier
r: "("
s: params
t: ")"
u: compound_stmt
v: "int"
w: "foo"
x: param_list
y: param_list
z: ","
A: param
B: param
E: type_spec
F: "["
G: "]"
H: identifier
C: type_spec
D: identifier
I: "int"
J: "b"
2: "int"
3: "c"
u: compound_stmt
K: "{"
L: local_decl
M: stmt_list
N: "}"
O: ϵ
P: stmt
Q: return_stmt
R: "return"
S: expr
T: ";"
U: identifier
V: "["
W: expr
X: "]"
Y: "b"
Wa: Pexpr
Z: identifier
1: "c"

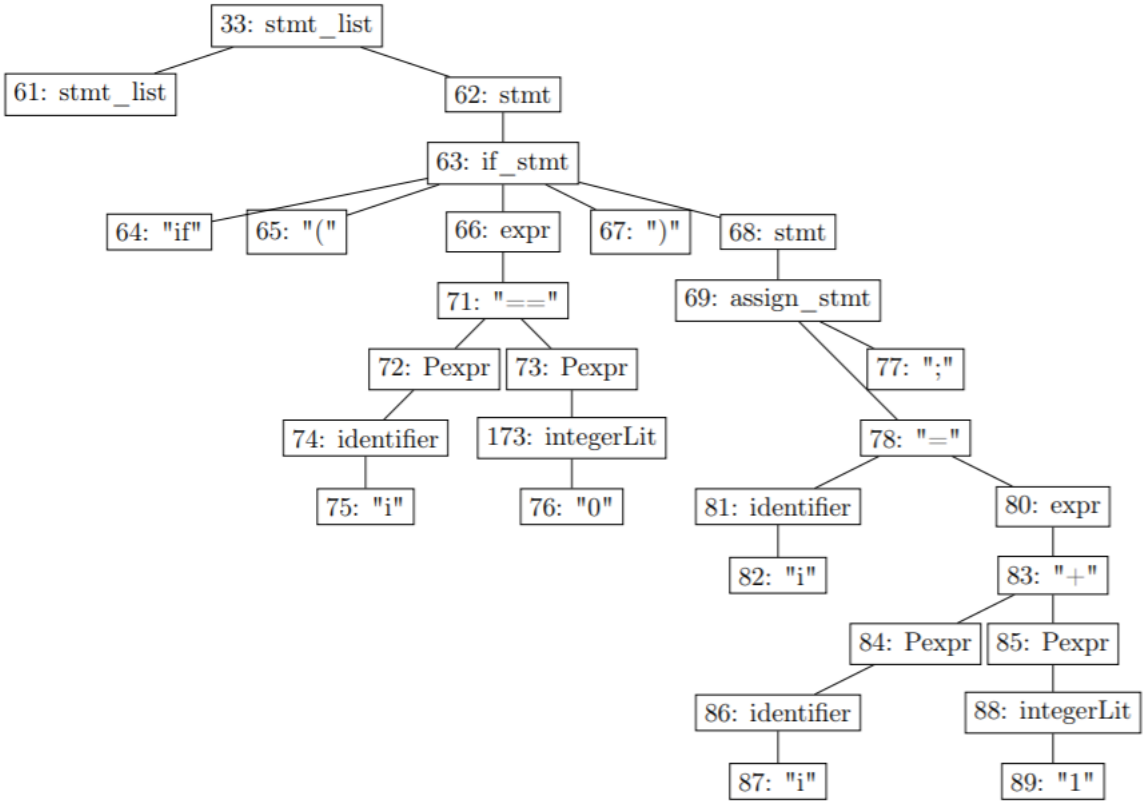

i: func_decl
4: type_spec
5: identifier
6: "("
7: params
8: ")"
9: compound_stmt
110: "int"
111: "main"
112: ϵ

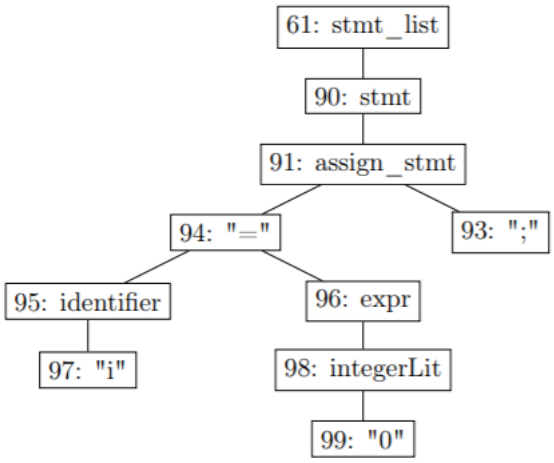

9: compound_stmt
10: "{"
11: local_decl
12: stmt_list
113: "}"
114: type_spec
115: identifier
116: ";"
117: "int"
118: "i"


12: stmt_list
13: stmt_list
14: stmt
15: return_stmt
16: "return"
17: expr
18: ";"
19: identifier
20: "("
21: args
22: ")"
23: "foo"
24: arg_list
25: arg_list
26: ","
27: expr
28: expr
27a: Pexpr
28a: Pexpr
31: identifier
29: integerLit
32: "d"
30: "4"


13: stmt_list
33: stmt_list
34: stmt
35: while_stmt
36: "while"
37: "("
38: expr
39: ")"
40: stmt
38a: "<"
41: compount_stmt
38b: Pexpr
38c: Pexpr
38d: identifier
38e: integerLit
38f: "i"
38g: "1"


41: compound_list
42: "{"
43: local_decl
44: stmt_list
45: "}"
46: ϵ
47: stmt
48: assign_stmt
52: "="
50: ";"
51: identifier
53: expr
54: "i"
55: "+"
56: expr
57: expr
58: identifier
59: integerLit
158: "i"
60: "10"


33: stmt_list
61: stmt_list
62: stmt
63: if_stmt
64: "if"
65: "("
66: expr
67: ")"
68: stmt
71: "=="
69: assign_stmt
72: Pexpr
73: Pexpr
77: ";"
74: identifier
173: integerLit
78: "="
75: "i"
76: "0"
81: identifier
80: expr
82: "i"
83: "+"
84: Pexpr
85: Pexpr
86: identifier
88: integerLit
87: "i"
89: "1"



6 Submission

Submit a tar.gz file with filename as <ROLLNO>_A2.tar.gz (eg. CS15B001_A2.tar.gz) having the following structure:

- CS15B001 <directory>
  - *.l
  - *.y
  - Makefile

Note: The Makefile should run lex, yacc, compile the generated code and generate an executable a.out file.