

# Final Report

CSE-0302 Summer - 2021

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**Abstract**—Main theme of your assignment or academic projects.

n

**Index Terms**—The word mostly used in your report.

## I. INTRODUCTION

Assignment 4 : Detecting Simple Syntax Errors

Syntax errors are very common in source program. The main purpose of this session is to write programs to detect and report simple syntax errors.

Assignment 5 : Use of CFGs for Parsing

We can think of using CFGs to parse various language constructs in the token streams freed from simple syntactic and semantic errors, as it is easier to describe the constructs with CFGs. But CFGs are hard to apply practically. In this session, we implement a simple recursive descent parser to parse a number of types of statements after exercising with simpler CFGs. We note that a recursive decent parser can be constructed from a CFGs with reduced left recursion and ambiguity.

Assignment 6 : Predictive Parsing

Manual implementation of LL(1) and LR(1) parsing algorithms .

## II. LITERATURE REVIEW

Assignment 4 : Detecting Simple Syntax Errors

A frustrating aspect of software development is that compiler error messages often fail to locate the actual cause of a syntax error. Syntax Errors Just Aren't Natural. Joshua Charles ( Department of Computing Science ), Abram Hindle ( department of Computing Science ), Jose Nelson Amaral ( Department of Computing Science ) Improving Error Reporting with Language Models.

Assignment 5 : Use of CFGs for Parsing

Context Free Grammars (CFG) can be classified on the basis of following two properties: 1) Based on number of strings it generates. During Compilation, the parser uses the grammar of the language to make a parse tree (or derivation tree) out of the source code. Vilhjálmur orsteinsson, Hulda Óladóttir, Hrafn Loftsson (Department of Computer Science) . Both present open-source, wide-coverage context-free grammar (CFG) for Icelandic and an accompanying parsing system.

Assignment 6 : Predictive Parsing

A predictive parser is a recursive descent parser with no backtracking or backup. It is a top-down parser that does not require backtracking. At each step, the choice of the rule to be expanded is made upon the next terminal symbol.

## III. PROPOSED METHODOLOGY

## IV. CONCLUSION AND FUTURE WORK

Every Computer Engineer should learn compiler design so that an interpreted scripting language and interpreter. I think that what is useful is how to : Parse an expression tree, Robust error handling, General-purpose text processing technique, Sanitize input, Schedule tasks in the future with cross-platform timers, Creation of virtual machines.

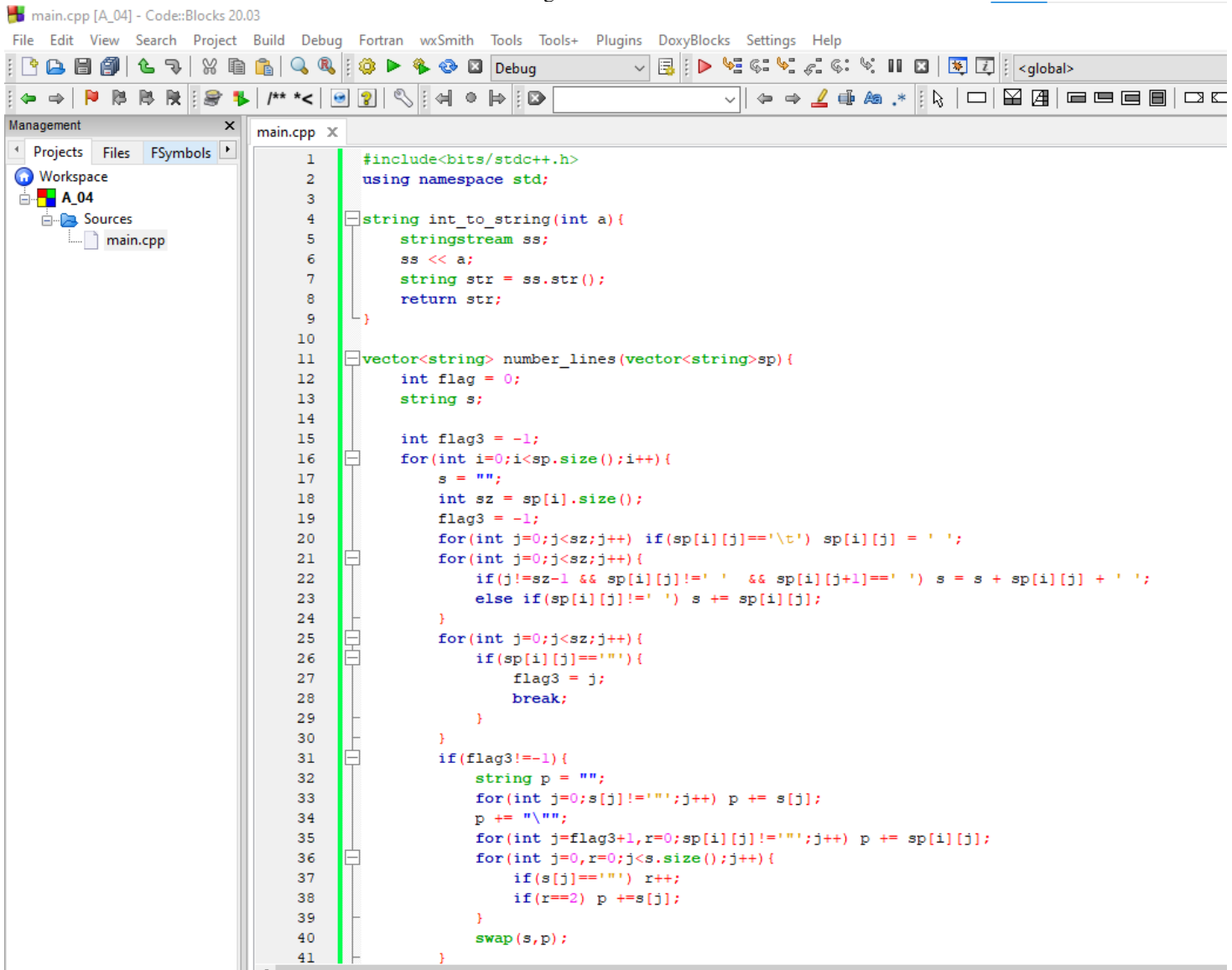
## ACKNOWLEDGMENT

I would like to thank my honourable **Khan Md. Hasib Sir** for his time, generosity and critical insights into this project.

## REFERENCES

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- [7] M. Young, The Technical Writer's Handbook. Mill Valley, CA: University Science, 1989.

## Assignment : 04



```

1  #include<bits/stdc++.h>
2  using namespace std;
3
4  string int_to_string(int a){
5      stringstream ss;
6      ss << a;
7      string str = ss.str();
8      return str;
9  }
10
11 vector<string> number_lines(vector<string>sp){
12     int flag = 0;
13     string s;
14
15     int flag3 = -1;
16     for(int i=0;i<sp.size();i++){
17         s = "";
18         int sz = sp[i].size();
19         flag3 = -1;
20         for(int j=0;j<sz;j++) if(sp[i][j]!='\t') sp[i][j] = ' ';
21         for(int j=0;j<sz;j++){
22             if(j!=sz-1 && sp[i][j]!=' ' && sp[i][j+1]==' ') s = s + sp[i][j] + ' ';
23             else if(sp[i][j]!=' ') s += sp[i][j];
24         }
25         for(int j=0;j<sz;j++){
26             if(sp[i][j]==' '){
27                 flag3 = j;
28                 break;
29             }
30         }
31         if(flag3!=-1){
32             string p = "";
33             for(int j=0;s[j]!='';j++) p += s[j];
34             p += "\n";
35             for(int j=flag3+1,r=0;sp[i][j]!='';j++) p += sp[i][j];
36             for(int j=0,r=0;j<s.size();j++){
37                 if(s[j]=='') r++;
38                 if(r==2) p +=s[j];
39             }
40             swap(s,p);
41         }

```

Fig. 1. Proposed Methodology

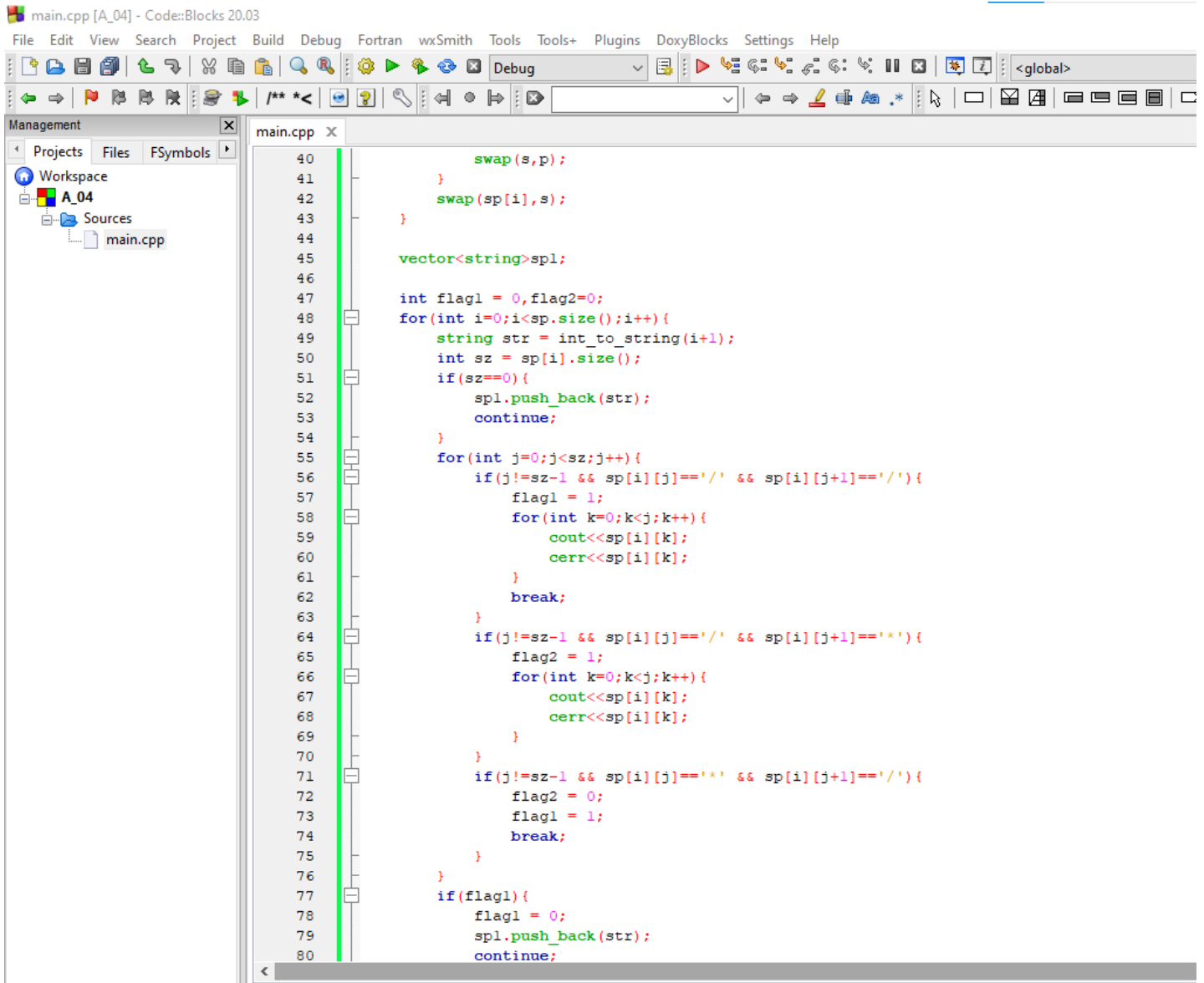


Fig. 2. Proposed Methodology

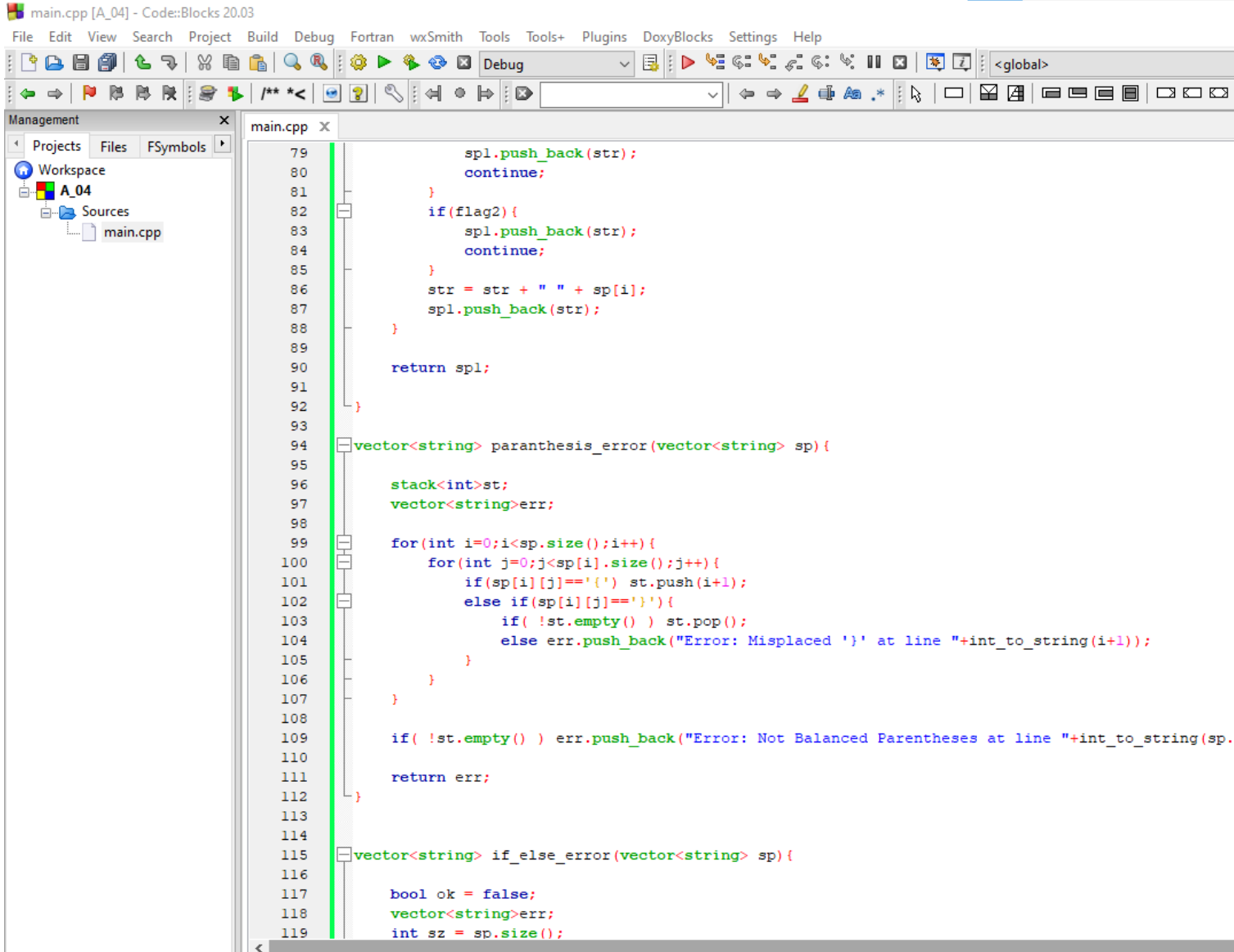
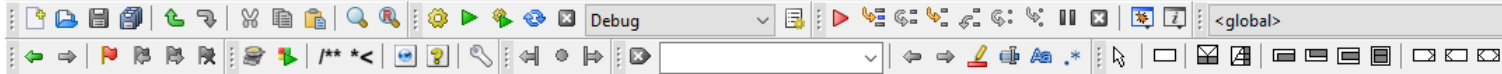


Fig. 3. Proposed Methodology

main.cpp [A\_04] - Code::Blocks 20.03

File Edit View Search Project Build Debug Fortran wxSmith Tools Tools+ Plugins DoxyBlocks Settings Help



Management

Projects Files FSymbols

Workspace

A\_04

Sources

main.cpp

main.cpp x

```
118     vector<string>err;
119     int sz = sp.size();
120     for(int i=0;i<sz;i++){
121         if(sz<4) continue;
122         int x = sp[i].size();
123         for(int j=0;j<x;j++){
124             if(j+1<x && sp[i][j]=='i' && sp[i][j+1]=='f') ok = true;
125             if(j+3<x && sp[i][j]=='e' && sp[i][j+1]=='l' && sp[i][j+2]=='s' && sp[i][j+3]=='e'){
126                 if( ok ){
127                     ok = false;
128                     continue;
129                 }
130                 else err.push_back("Error: Not Matched else at line "+int_to_string(i+1));
131             }
132         }
133     }
134
135     return err;
136 }
137
138 bool comp(char a){
139     if(a=='=' || a=='>' || a=='<' ) return false;
140
141     return true;
142 }
143
144 bool col(char a){
145
146     if(a==',' || a==';' || a=='+' || a=='-' || a=='*' || a=='/' || a=='(' || a==')' || a=='\'' || a=='\"')
147         return false;
148
149 }
150
151 vector<string> dup_token_error(vector<string> sp){
152
153     vector<string>err;
154     int sz = sp.size();
155
156     for(int j=0;j<sz;j++){
157
158         string p = "",s=sp[j];
```

Fig. 4. Proposed Methodology

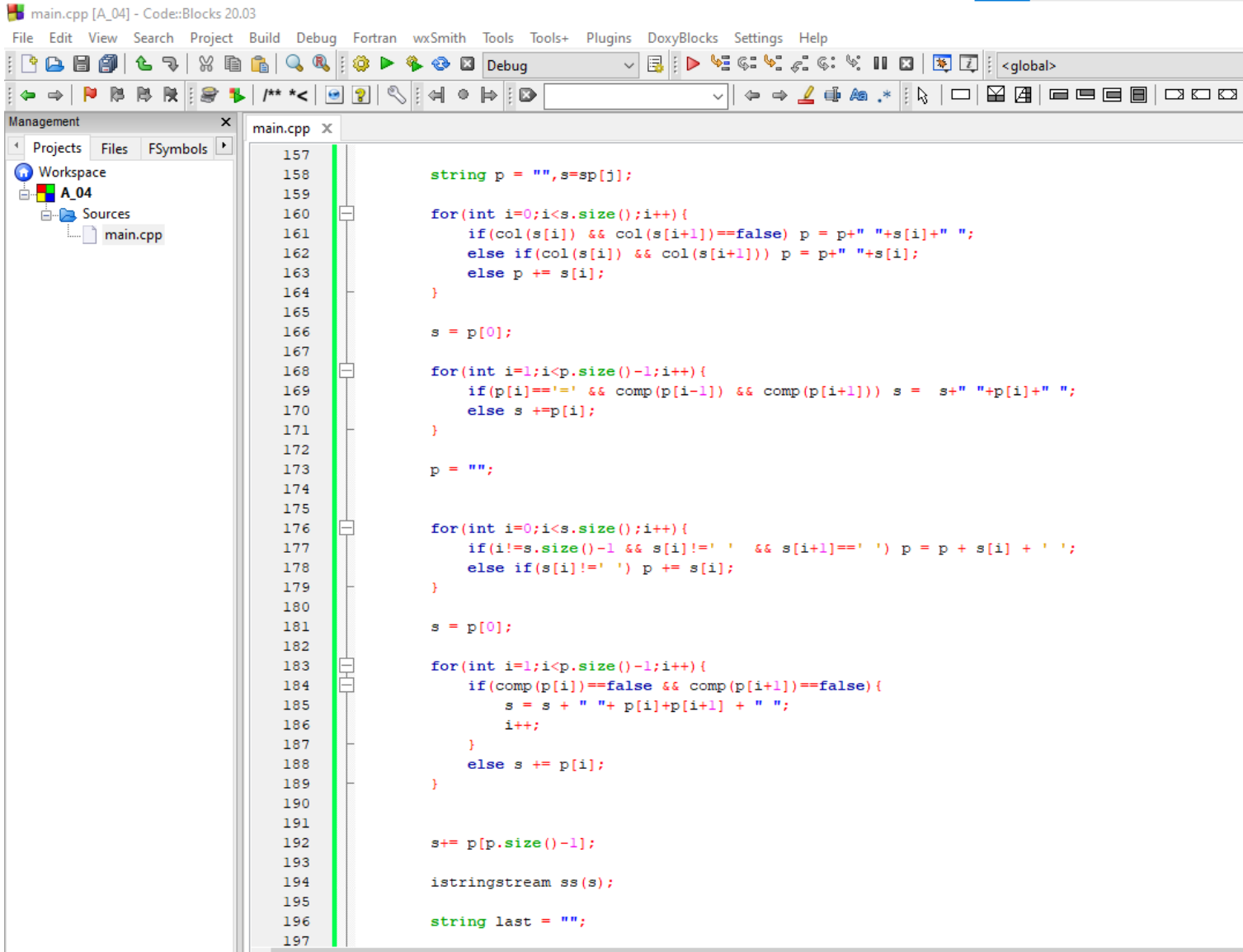


Fig. 5. Proposed Methodology

The screenshot shows the Code::Blocks IDE interface. The title bar reads "main.cpp [A\_04] - Code::Blocks 20.03". The menu bar includes File, Edit, View, Search, Project, Build, Debug, Fortran, wxSmith, Tools, Tools+, Plugins, DoxyBlocks, Settings, and Help. The toolbar contains various icons for file operations, editing, and debugging. The left sidebar shows the "Management" pane with tabs for Projects, Files, and FSymbols. Under the "Files" tab, a workspace named "A\_04" is shown, containing a "Sources" folder with the file "main.cpp". The main editor window displays the code for "main.cpp" with line numbers 196 to 236. The code is as follows:

```
196     string last = "";
197
198     while(ss>>s){
199         if(s==last) err.push_back("Error: Duplicate token at line "+int_to_string(j+1));
200         last = s;
201     }
202
203 }
204
205 return err;
206 }
207
208
209
210 int main(){
211
212     freopen("input.txt","r",stdin);
213     freopen("out.txt","w",stdout);
214
215     string s;
216
217     vector<string>sp, paran_error, if_else_err, dup_token_err, error;
218
219     cerr<<"input\n";
220
221     while(getline(cin,s)){
222         sp.push_back(s);
223         cerr<<s<<"\n";
224     }
225
226     cerr<<"\n";
227
228     sp = number_lines(sp);
229
230     cerr<<"\noutput:\n";
231
232     cerr<<"Recognized tokens in the lines of code:\n";
233
234     for(int i=0;i<sp.size();i++){
235         cout<<sp[i]<<"\n";
236         cerr<<sp[i]<<"\n";
```

Fig. 6. Proposed Methodology

```
main.cpp [A_04] - Code::Blocks 20.03
File Edit View Search Project Build Debug Fortran wxSmith Tools Tools+ Plugins DoxyBlocks Settings Help
Debug
<global>
Management
Projects Files FSymbols
Workspace
A_04
Sources
main.cpp
233
234 for(int i=0;i<sp.size();i++){
235     cout<<sp[i]<<"\n";
236     cerr<<sp[i]<<"\n";
237 }
238
239 paran_error = paranthesis_error(sp);
240
241 if_else_err = if_else_error(sp);
242
243 dup_token_err = dup_token_error(sp);
244
245 paran_error.erase( unique( paran_error.begin(), paran_error.end() ), paran_error.end() );
246
247 if_else_err.erase( unique( if_else_err.begin(), if_else_err.end() ), if_else_err.end() );
248
249 dup_token_err.erase( unique( dup_token_err.begin(), dup_token_err.end() ), dup_token_err.end() );
250
251
252 cout<<"\n\nERROR: \n";
253 cerr<<"\n\nERROR: \n";
254
255 for(int i=0;i<paran_error.size();i++){
256     cout<<paran_error[i]<<"\n";
257     cerr<<paran_error[i]<<"\n";
258 }
259
260 for(int i=0;i<if_else_err.size();i++){
261     cout<<if_else_err[i]<<"\n";
262     cerr<<if_else_err[i]<<"\n";
263 }
264
265 for(int i=0;i<dup_token_err.size();i++){
266     cout<<dup_token_err[i]<<"\n";
267     cerr<<dup_token_err[i]<<"\n";
268 }
269
270 return 0;
271
272 }
```

Fig. 7. Proposed Methodology



## Assignment : 05

The screenshot shows the Code::Blocks IDE interface. The title bar reads "main.cpp - Code::Blocks 20.03". The menu bar includes File, Edit, View, Search, Project, Build, Debug, Fortran, wxSmith, Tools, Tools+, Plugins, DoxyBlocks, Settings, and Help. The toolbar contains various icons for file operations, editing, and execution. The left sidebar shows the "Management" pane with tabs for Projects, Files, and FSymbols, and a "Workspace" icon. The main editor window displays the following C++ code:

```
1 #include<stdio.h>
2 #include<string.h>
```

Below the editor, a console window titled "C:\Users\User\Desktop\amina\Final\_Assignment-05\main.exe" shows the program's output:

```
THE GRAMMAR IS AS FOLLOWS

ENTER ANY STRING ( 0 for EXIT ) : hello

THE STRING can NOT be PARSED !!!

ENTER ANY STRING ( 0 for EXIT ) :
```

The bottom of the image shows a portion of the C++ code from lines 33 to 41:

```
33         break;
34     }
35     break;
36 }
37 }
38 if(temp[i]>=65 && temp[i]<=90)
39     findter();
40 }
41
```

Fig. 8. Proposed Methodology

main.cpp - Code::Blocks 20.03

File Edit View Search Project Build Debug Fortran wxSmith Tools Tools+ Plugins DoxyBlocks Settings Help

Management x Start here x main.cpp x

Projects Files FSymbols

Workspace

```
40 }
41
42 int main()
43 {
44     FILE *f;
45     // glxscc();
46
47     for(i=0;i<10;i++)
48         pro[i].n=0;
49
50     f=fopen("in.txt","r");
51     while(!feof(f))
52     {
53         fscanf(f,"%s",pro[n].lhs);
54         if(n>0)
55         {
56             if( strcmp(pro[n].lhs,pro[n-1].lhs) == 0 )
57             {
58                 pro[n].lhs[0]='\0';
59                 fscanf(f,"%s",pro[n-1].rhs[pro[n-1].n]);
60                 pro[n-1].n++;
61                 continue;
62             }
63         }
64         fscanf(f,"%s",pro[n].rhs[pro[n].n]);
65         pro[n].n++;
66         n++;
67     }
68     n--;
69
70     printf("\n\nTHE GRAMMAR IS AS FOLLOWS\n\n");
71     for(i=0;i<n;i++)
72         for(j=0;j<pro[i].n;j++)
73             printf("%s -> %s\n",pro[i].lhs,pro[i].rhs[j]);
74
75     while(1)
76     {
77         for(l=0;l<10;l++)
78             str[l]=NULL;
79
80         printf("\n\nENTER ANY STRING ( 0 for EXIT ) : ");
```

Fig. 9. Proposed Methodology

main.cpp - Code::Blocks 20.03

File Edit View Search Project Build Debug Fortran wxSmith Tools Tools+ Plugins DoxyBlocks Settings Help

Management x Start here x main.cpp x

Projects Files FSymbols Workspace

```
80     printf("\n\nENTER ANY STRING ( 0 for EXIT ) : ");
81     scanf("%s",str);
82     if(str[0]=='0')
83         break;
84
85     for(j=0;j<pro[0].n;j++)
86     {
87         for(l=0;l<20;l++)
88             temp[l]=NULL;
89         strcpy(temp,pro[0].rhs[j]);
90
91         m=0;
92         for(i=0;i<strlen(str);i++)
93         {
94             if(str[i]==temp[i])
95                 m++;
96             else if(str[i]!=temp[i] && temp[i]>=65 && temp[i]<=90)
97             {
98                 findter();
99                 if(str[i]==temp[i])
100                     m++;
101             }
102             else if( str[i]!=temp[i] && (temp[i]<65 || temp[i]>90) )
103                 break;
104         }
105
106         if(m==strlen(str) && strlen(str)==strlen(temp))
107         {
108             printf("\n\nTHE STRING can be PARSED !!!");
109             break;
110         }
111     }
112
113     if(j==pro[0].n)
114         printf("\n\nTHE STRING can NOT be PARSED !!!");
115 }
116
117 // cin.ignore(numeric_limits<streamsize>::max(), '\n');
118 }
119
```

Fig. 10. Proposed Methodology

# Assignment : 06

Given Grammer

$$S \rightarrow aXd$$

$$X \rightarrow YZ$$

$$Y \rightarrow b \mid \varepsilon$$

$$Z \rightarrow cX \mid \varepsilon$$

(1)

First of the given grammer

	<i>First</i>	<i>Follow</i>
<i>S</i>	<i>a</i>	<i>S</i>
<i>X</i>	<i>b, c, ε</i>	<i>d</i>
<i>Y</i>	<i>b, ε</i>	<i>c, d</i>
<i>Z</i>	<i>c, ε</i>	<i>d</i>

(2)

Parsing table LL(1)

	a	b	c	d	\$
S	$S \rightarrow aXd$				
X		$X \rightarrow YZ$	$X \rightarrow YZ$		
Y		$Y \rightarrow b$	$Y \rightarrow \varepsilon$	$Y \rightarrow \varepsilon$	
Z			$Z \rightarrow cX$	$Z \rightarrow \varepsilon$	

Fig. 11. Proposed Methodology

input **abcd**

$S \rightarrow aXd$

$S \rightarrow aYZd$       using  $X \rightarrow YZ$

$S \rightarrow abZd$       using  $Y \rightarrow b$

$S \rightarrow abcXd$       using  $Z \rightarrow cX$

$S \rightarrow abc\epsilon d$       using  $Z \rightarrow \epsilon$

$S \rightarrow abcd$       using  $Z \rightarrow \epsilon$

**abcd is accepted by the given grammar.**

Fig. 12. Proposed Methodology

(4)

LR(0) grammar

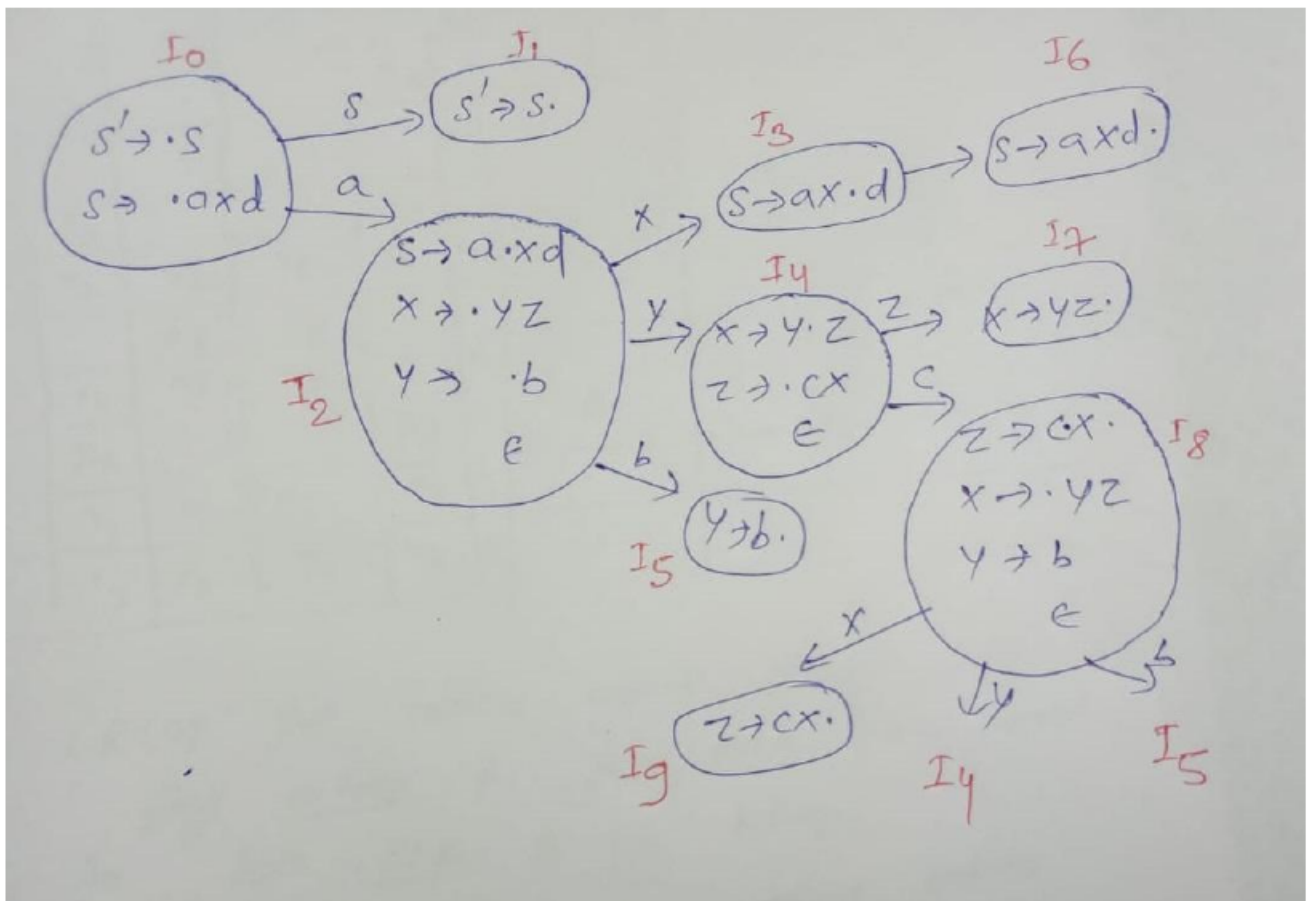


Fig. 13. Proposed Methodology

LR(O) Parsing Tabel

	Action	Action	Action	Action	Action	GOTO	GOTO	GOTO	GOTO
	a	b	c	d	S	S	X	Y	Z
0	$S_2$					1			
1					accept				
2	$r_4$	$S_5 / r_4$	$r_4$	$r_4$	$r_4$				
3				$S_6$					
4	$r_6$	$r_6$	$S_8 / r_6$	$r_6$	$r_6$				
5	$r_3$	$r_3$	$r_3$	$r_3$	$r_3$				
6	$r_1$	$r_1$	$r_1$	$r_1$	$r_1$				
7	$r_2$	$r_2$	$r_2$	$r_2$	$r_2$				
8		$S_5$					9	4	
9	$r_5$	$r_5$	$r_5$	$r_5$	$r_5$				

in the LR(0) parsing table Shift-reduce conflict occurs which can be seen in table.

Fig. 14. Proposed Methodology

(5)

augumented grammar for LR(1) Parsing table

Fig. 15. Proposed Methodology

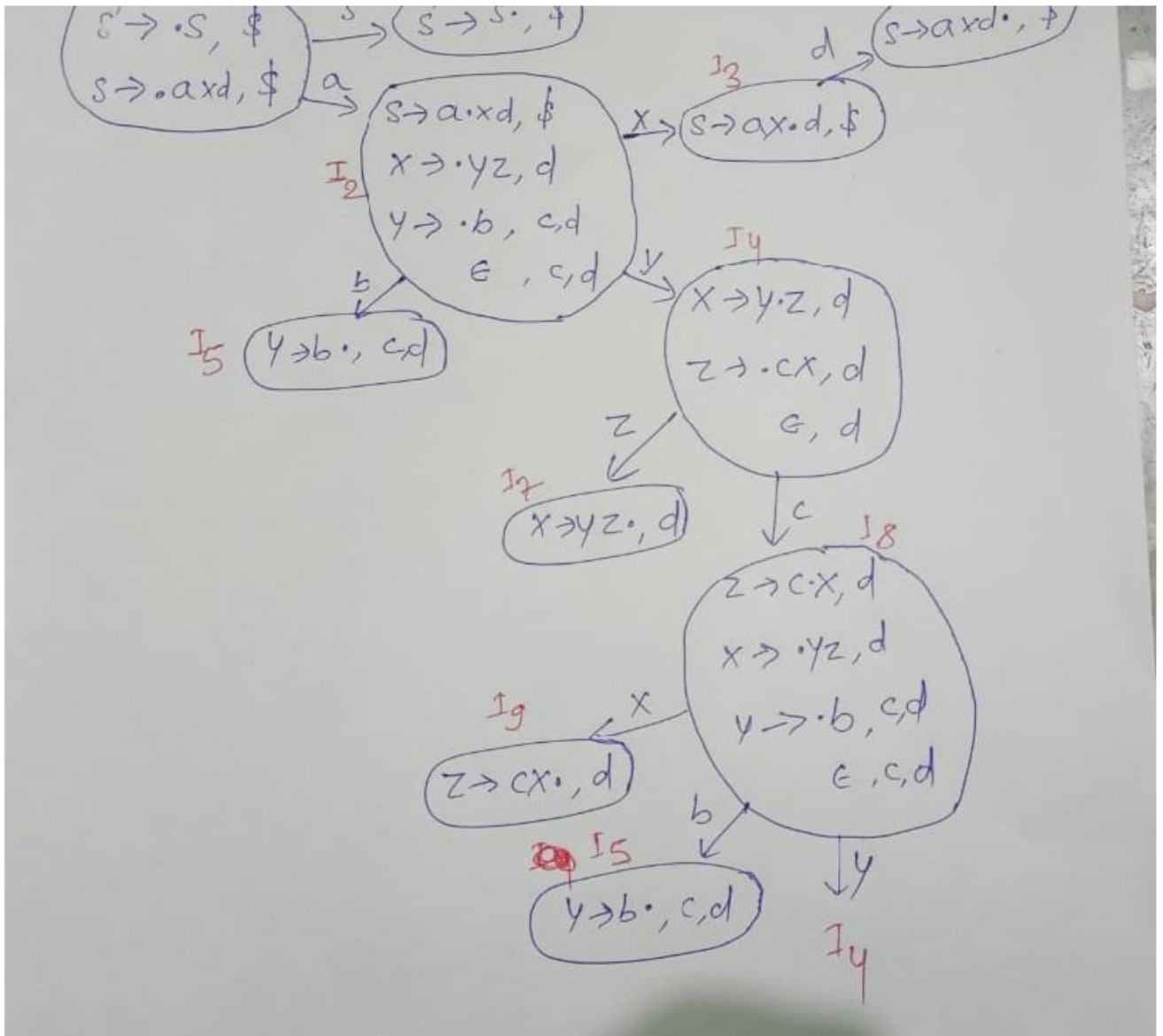


Fig. 16. Proposed Methodology

	Action	Action	Action	Action	Action	GOTO	GOTO	GOTO	GOTO
	a	b	c	d	\$	S	X	Y	Z
0	$S_2$					1			
1					accept				
2		$S_5$	$r_4$	$r_4$			3	4	
3				$S_6$					
4			$S_8$	$r_6$					
5			$r_3$	$r_3$					
6					$r_1$				
7				$r_2$					
8		$S_5$	$r_4$	$r_4$			9	4	
9				$r_5$					

Fig. 17. Proposed Methodology



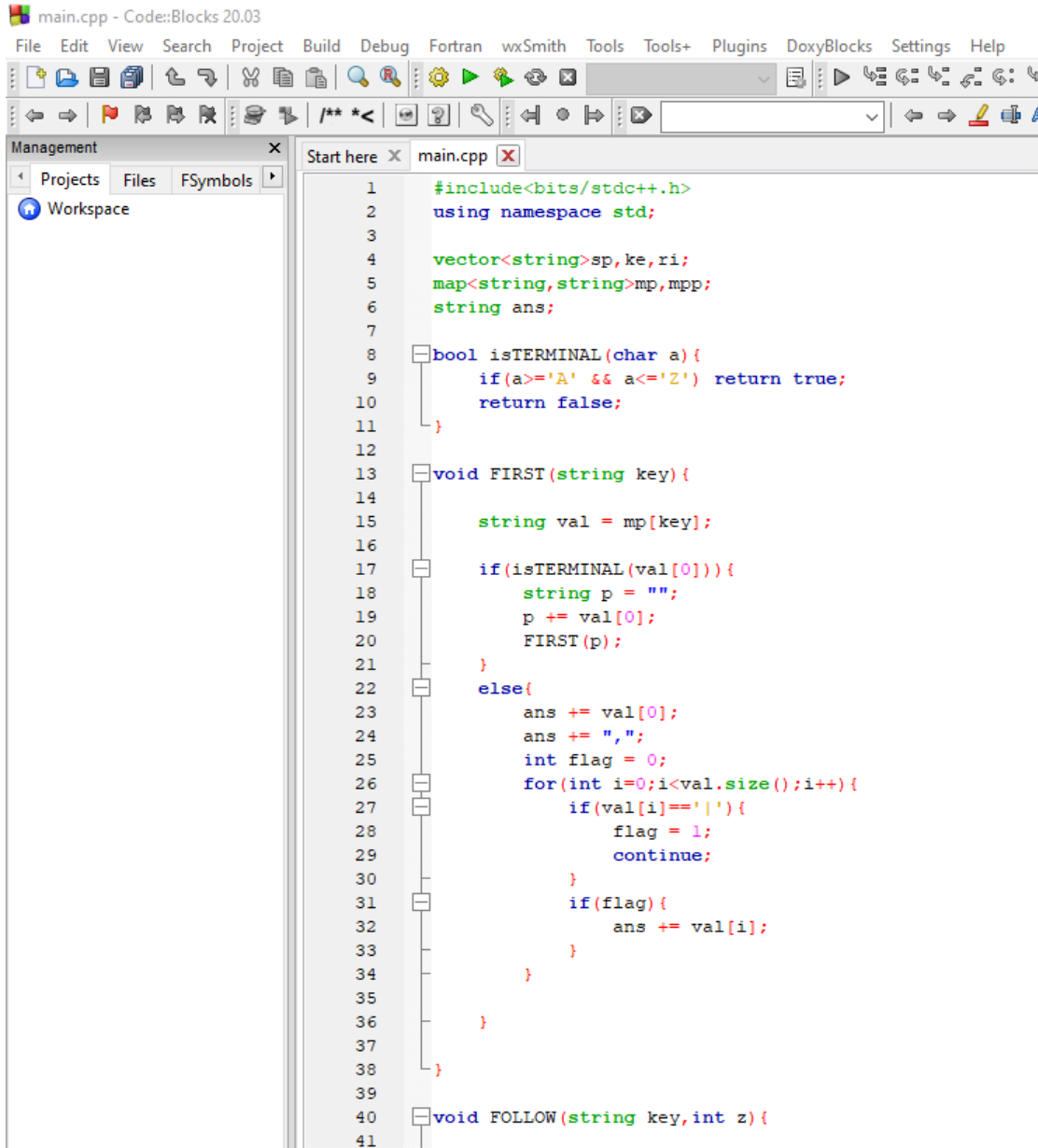
(6) moves of the parser for given input **abcd**

input	current input	stack	production	action		Remarks
abcd\$	a	0	[0,a]	$S_2$		
bcd\$	b	0a2				
bcd\$	b	0a2	[2,b]	$S_5$		
bcd\$	b	0a2b5				
cd\$	c	0a2b5	[5,c]	$r_3$	$Y \rightarrow b$	two time pop from stack
cd\$	c	0a2Y	[2,Y]	4		
cd\$	c	0a2Y4	[4,c]	$S_8$		
d\$	d	0a2Y4c8	[8,d]	$r_4$	$Y \rightarrow \varepsilon$	no time pop from stack
d\$	d	0a2Y4c8Y	[8,Y]	4		
d\$	d	0a2Y4c8Y4	[4,d]	$r_6$	$Z \rightarrow \varepsilon$	no time pop from stack
d\$	d	0a2Y4c8Y4Z	[4,Z]	7		
d\$	d	0a2Y4c8Y4Z7	[7,d]	$r_2$	$X \rightarrow YZ$	four time pop from stack
d\$	d	0a2Y4c8X	[8,X]	9		
d\$	d	0a2Y4c8X9	[9,d]	$r_5$	$Z \rightarrow cX$	four time pop from stack
d\$	d	0a2Y4Z	[4,Z]	7		
d\$	d	0a2Y4Z7	[7,d]	$r_2$	$X \rightarrow YZ$	four time pop from stack

Fig. 18. Proposed Methodology

S	S	0a2X3d6	[6,S]	$r_1$	$S \rightarrow aXd$	six time pop from stack
S	S	0S	[0,S]	1		
S	S	0S1	[1,S]	accept		

Fig. 19. Proposed Methodology



main.cpp - Code::Blocks 20.03

File Edit View Search Project Build Debug Fortran wxSmith Tools Tools+ Plugins DoxyBlocks Settings Help

Management x Start here x main.cpp x

Projects Files FSymbols

Workspace

```
1  #include<bits/stdc++.h>
2  using namespace std;
3
4  vector<string>sp,ke,ri;
5  map<string,string>mp,mpp;
6  string ans;
7
8  bool isTERMINAL(char a){
9      if(a>='A' && a<='Z') return true;
10     return false;
11 }
12
13 void FIRST(string key){
14
15     string val = mp[key];
16
17     if(isTERMINAL(val[0])){
18         string p = "";
19         p += val[0];
20         FIRST(p);
21     }
22     else{
23         ans += val[0];
24         ans += ",";
25         int flag = 0;
26         for(int i=0;i<val.size();i++){
27             if(val[i]=='|'){
28                 flag = 1;
29                 continue;
30             }
31             if(flag){
32                 ans += val[i];
33             }
34         }
35     }
36 }
37
38
39
40 void FOLLOW(string key,int z){
41
```

Fig. 20. Proposed Methodology

```

40 void FOLLOW(string key,int z){
41
42     int flag = 0;
43
44     for(int i=0;i<ri.size();i++){
45         if (ri[i].find(key) != string::npos) {
46             if(key.size()==1){
47                 for(int j=0;j<ri[i].size();j++){
48                     if(ri[i][j]==key[0]){
49                         if(j+1<ri.size() && ri[i][j+1]!='\'){
50                             flag = 1;
51                             if(isTERMINAL(ri[i][j+1])==false){
52                                 if(z==0)ans += "$,";
53                                 ans += ri[i][j+1];
54                             }
55                             else{
56                                 string g = ri[i];
57                                 g.erase(0,1);
58                                 FIRST(g);
59                                 if(z==0)ans += "$,";
60                                 FOLLOW(mpp[ri[i]],1);
61                             }
62                         }
63                     }
64                     break;
65                 }
66             }
67         }
68     }
69     else{
70         flag = 1;
71
72         for(int j=0;j+1<ri[i].size();j++){
73             if(ri[i][j]==key[0] && ri[i][j+1]==key[1]){
74                 if(j+2>=ri[i].size()){
75                     FOLLOW(mpp[ri[i]],1);
76                     if(z==0)ans += ",$";
77                 }
78                 else{
79
80

```

Fig. 21. Proposed Methodology

main.cpp - Code::Blocks 20.03

File Edit View Search Project Build Debug Fortran wxSmith Tools Tools+ Plugins DoxyBlocks Settings Help

Management x Start here x main.cpp x

Projects Files FSymbols

Workspace

```
79
80
81
82
83     break;
84 }
85 }
86 if(flag) break;
87 }
88
89
90 }
91
92
93
94 string remove_space(string s){
95
96     string p="";
97
98     for(int i=0;i<s.size();i++){
99         if(s[i]!=' ') p = p + s[i];
100     }
101
102     return p;
103 }
104
105
106
107
108 int main(){
109
110     freopen("input.txt","r",stdin);
111     freopen("out.txt","w",stdout);
112
113     string s;
114
115     while(getline(cin,s)){
116         sp.push_back(remove_space(s));
117     }
118
119     for(int i=0;i<sp.size();i++){
```

Fig. 22. Proposed Methodology

```
118
119     for(int i=0;i<sp.size();i++){
120         int flag = 0;
121
122         string key="",val="";
123
124         for(int j=0;j<sp[i].size();j++){
125             if(sp[i][j]!=' '){
126                 flag = 1;
127                 continue;
128             }
129
130             if(flag==0) key += sp[i][j];
131             else val += sp[i][j];
132         }
133
134         mp[key] = val;
135         ke.push_back(key);
136     }
137
138     cerr<<"FIRST: \n\n";
139     cout<<"FIRST: \n\n";
140
141     for(int i=0;i<ke.size();i++){
142         ans = "";
143         FIRST(ke[i]);
144         cerr<<"FIRST("<<ke[i]<<")"<<" = {"<<ans<<"}\n";
145         cout<<"FIRST("<<ke[i]<<")"<<" = {"<<ans<<"}\n";
146     }
147
148     for(int i=0;i<ke.size();i++){
149
150         string val = mp[ke[i]];
151         string v = "";
152
153         for(int j=0;j<val.size();j++){
154             if(val[j]=='|') break;
155             v += val[j];
156         }
157
158         mp[ke[i]] = v;
```

Fig. 23. Proposed Methodology

```

138     cerr<<"FIRST: \n\n";
139     cout<<"FIRST: \n\n";
140
141     for(int i=0;i<ke.size();i++){
142         ans = "";
143         FIRST(ke[i]);
144         cerr<<"FIRST("<<ke[i]<<") "<<" = {"<<ans<<"}\n";
145         cout<<"FIRST("<<ke[i]<<") "<<" = {"<<ans<<"}\n";
146     }
147
148     for(int i=0;i<ke.size();i++){
149
150         string val = mp[ke[i]];
151         string v = "";
152
153         for(int j=0;j<val.size();j++){
154             if(val[j]=='|') break;
155             v += val[j];
156         }
157
158         mp[ke[i]] = v;
159         mpp[v] = ke[i];
160         ri.push_back(v);
161     }
162
163     cerr<<"\nFOLLOW: \n\n";
164     cout<<"\nFOLLOW: \n\n";
165
166
167     for(int i=0;i<ke.size();i++){
168         ans = "";
169
170         FOLLOW(ke[i],0);
171         cerr<<"FOLLOW("<<ke[i]<<") "<<" = {"<<ans<<"}\n";
172         cout<<"FOLLOW("<<ke[i]<<") "<<" = {"<<ans<<"}\n";
173     }
174
175
176 }
177

```

Fig. 24. Proposed Methodology