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CD LAB 8 : RD Parser for Array Declarations and Expression Statements
&
CD LAB 9 : RD Parser for Decision Making and Looping Statements

LAB 8 :

P1) Design the recursive descent parser to parse array declarations and expression statements with error reporting. Subset of grammar 7.1 is as follows:

Program → main () { declarations statement-list }
identifier-list → id | id, identifier-list | id[number] , identifier-list | id[number]
statement_list → statement statement_list | ∈
statement → assign-stat;
assign_stat → id = expn
expn→ simple-expn eprime
eprime→relop simple-expn|∈
simple-exp→ term seprime
seprime→addop term seprime |∈
term → factor tprime
tprime → mulop factor tprime |∈
factor → id | num
relop → = = | != | <= | >= | > | <
addop → + | -
mulop → * | / | %

lex.c :

```
#include <stdlib.h>
#include <stdio.h>
#include <ctype.h>
#include <string.h>
```

```
static int row=1,col=1;
char buf[2048];
char dbuf[128];
int ind=0;

const char specialsymbols[]={'?',';',':',','};
const char arithmeticsymbols[]={'*'};
const char *keywords[] = {"auto", "double", "int", "struct", "break", "else", "long",
"switch", "case", "enum", "register", "typedef", "char", "extern", "return", "union",
"continue", "for", "signed", "void", "do", "if", "static", "while", "default", "goto",
"sizeof", "volatile", "const", "short", "unsigned", "printf", "scanf", "true", "false",
"bool"};
const char *datypes[] = {"int","char","void","float","bool","double"};

struct token
{
	char lexeme[128];
	unsigned int row,col;
	char type[64];
};

struct sttable
{
	int sno;
	char lexeme[128];
	char dtype[64];
	char type[64];
	int size;
};

int isKeyword(char *w)
{

   for(int i=0;i<sizeof(keywords)/sizeof(char*);i++)
	if(strcmp(w,keywords[i])==0)
		return 1;
   return 0;
}

int isdtype(char *w)
{
	for(int i=0;i<sizeof(datypes)/sizeof(char*);i++)
		if(strcmp(w,datypes[i])==0)
			return 1;
	return 0;
```

```
}

void newLine()
{
	++row; col=1;
}

void printTable(struct sttable *tab,int n)
{
	for(int i=0;i<n;i++)
		printf("%d %s %s %s %d\
n",tab[i].sno,tab[i].lexeme,tab[i].dtype,tab[i].type,tab[i].size);
}

int findTable(struct sttable *tab,char *nam,int n)
{
	for(int i=0;i<n;i++)
		if(strcmp(tab[i].lexeme,nam)==0)
			return 1;
	return 0;
}

struct sttable fillTable(int sno,char *lexn,char *dt,char *t,int s)
{
	struct sttable tab;
	tab.sno=sno;
	strcpy(tab.lexeme,lexn);
	strcpy(tab.dtype,dt);
	strcpy(tab.type,t);
	tab.size=s;
	return tab;
}

void fillToken(struct token *tkn,char c,int row,int col, char *type)
{
	tkn->row=row;
	tkn->col=col;
	strcpy(tkn->type,type);
	tkn->lexeme[0]=c;
	tkn->lexeme[1]='\0';
}

int charIs(int c,const char *arr)
{
	int len;
```

```
	if(arr==specialsymbols)
		len=sizeof(specialsymbols)/sizeof(char);

	else if(arr==arithmeticsymbols)
		len=sizeof(arithmeticsymbols)/sizeof(char);

	for(int i=0;i<len;i++)
		if(c==arr[i])
			return 1;
	return 0;
}

int sz(char *w)
{
	if(strcmp(w,"int")==0)
		return sizeof(int);
	if(strcmp(w,"char")==0)
		return sizeof(char);
	if(strcmp(w,"void")==0)
		return 0;
	if(strcmp(w,"float")==0)
		return sizeof(float);
		if(strcmp(w,"bool")==0)
		return 1;
}

struct token getNextToken(FILE *fa)
{
	int c;
	struct token tkn=
	{
		.row=-1
	};
	int gotToken=0;

	while(!gotToken && (c=fgetc(fa))!=EOF)
	{
		if(charIs(c,specialsymbols))
		{
			fillToken(&tkn,c,row,col,"SS");
			gotToken=1;
			++col;
		}
		else if(charIs(c,arithmeticsymbols))
		{
```

```
        fseek(fa,-1,SEEK_CUR);
        c=getc(fa);
        if(isalnum(c)){
        fillToken(&tkn,c,row,col,"ARITHMETICOPERATOR");
        gotToken=1;
        ++col;
        }
        fseek(fa,1,SEEK_CUR);
}
else if(c=='(')
{
        fillToken(&tkn,c,row,col,"LB");
        gotToken=1;
        col++;
}
else if(c==')')
{
        fillToken(&tkn,c,row,col,"RB");
        gotToken=1;
        col++;
}
else if(c=='{')
{
        fillToken(&tkn,c,row,col,"LC");
        gotToken=1;
        col++;
}
else if(c=='}')
{
        fillToken(&tkn,c,row,col,"RC");
        gotToken=1;
        col++;
}
else if(c=='[')
{
        fillToken(&tkn,c,row,col,"LS");
        gotToken=1;
        col++;
}
else if(c==']')
{
        fillToken(&tkn,c,row,col,"RS");
        gotToken=1;
        col++;
}
```

```
else if(c=='+')
{
	int x=fgetc(fa);
	if(x!='+')
	{
		fillToken(&tkn,c,row,col,"ARITHMETICOPERATOR");
		gotToken=1;
		col++;
		fseek(fa,-1,SEEK_CUR);
	}
	else
	{
		fillToken(&tkn,c,row,col,"UNARYOPERATOR");
		strcpy(tkn.lexeme,"++");
		gotToken=1;
		col+=2;
	}
}
else if(c=='-')
{
	int x=fgetc(fa);
	if(x!='-')
	{
		fillToken(&tkn,c,row,col,"ARITHMETICOPERATOR");
		gotToken=1;
		col++;
		fseek(fa,-1,SEEK_CUR);
	}
	else
	{
		fillToken(&tkn,c,row,col,"UNARYOPERATOR");
		strcpy(tkn.lexeme,"++");
		gotToken=1;
		col+=2;
	}
}
else if(c=='=')
{
	int x=fgetc(fa);
	if(x!='=')
	{
		fillToken(&tkn,c,row,col,"ASSIGNMENTOPERATOR");
		gotToken=1;
		col++;
		fseek(fa,-1,SEEK_CUR);
```

```
            }
            else
            {
                fillToken(&tkn,c,row,col,"RELATIONALOPERATOR");
                strcpy(tkn.lexeme,"++");
                gotToken=1;
                col+=2;
            }
        }
        else if(isdigit(c))
        {
            fillToken(&tkn,c,row,col++,"NUMBER");
            int j=1;
            while((c=fgetc(fa))!=EOF && isdigit(c))
            {
                tkn.lexeme[j++]=c;
                col++;
            }
            tkn.lexeme[j]='\0';
            gotToken=1;
            fseek(fa,-1,SEEK_CUR);
        }
        else if(c == '#')
        {
            while((c = fgetc(fa))!= EOF && c != '\n');
            newLine();
    }
    else if(c=='\n')
        {
            newLine();
            c = fgetc(fa);
            if(c == '#')
            {
                while((c = fgetc(fa)) != EOF && c != '\n');
                newLine();
            }
            else if(c != EOF)
            {
                fseek(fa, -1, SEEK_CUR);
            }
        }
        else if(isspace(c))
            ++col;
        else if(isalpha(c) || c=='_')
        {
```

```
		tkn.row=row;
		tkn.col=col++;
		tkn.lexeme[0]=c;
		int j=1;
		while((c=fgetc(fa))!=EOF && isalnum(c))
		{
			tkn.lexeme[j++]=c;
			col++;
		}
		tkn.lexeme[j]='\0';
		if(isKeyword(tkn.lexeme))
			strcpy(tkn.type,"KEYWORD");
		else
			strcpy(tkn.type,"IDENTIFIER");
		gotToken=1;
		fseek(fa,-1,SEEK_CUR);
	}
	else if(c=='/')
	{
		int d=fgetc(fa);
		++col;
		if(d=='/')
		{
			while((c=fgetc(fa))!= EOF && c!='\n')
				++col;
			if(c=='\n')
				newLine();
		}
		else if(d=='*')
		{
			do
			{
				if(d=='\n')
					newLine();
				while((c==fgetc(fa))!= EOF && c!='*')
				{
					++col;
					if(c=='\n')
					{
						newLine();
					}
				}
				++col;
			}while((d==fgetc(fa))!= EOF && d!='/' && (++col));
			++col;
```

```
        }
        else
        {
                fillToken(&tkn,c,row,--col,"ARITHMETIC OPERATOR");
                gotToken=1;
                fseek(fa,-1,SEEK_CUR);
        }
}
else if(c==''')
{
        tkn.row=row;
        tkn.col=col;
        strcpy(tkn.type, "STRING LITERAL");
        int k = 1;
        tkn.lexeme[0] = ''';
        while((c = fgetc(fa)) != EOF && c != ''')
        {
                tkn.lexeme[k++] = c;
                ++col;
        }
        tkn.lexeme[k] = ''';
        gotToken = 1;
}
else if(c == '<' || c == '>' || c == '!')
{
        fillToken(&tkn, c, row, col, "RELATIONALOPERATOR");
        ++col;
        int d = fgetc(fa);
        if(d == '=')
        {
                ++col;
                strcat(tkn.lexeme, "=");
        }
        else
        {
                if(c == '!')
                {
                        strcpy(tkn.type, "LOGICALOPERATOR");
                }
                fseek(fa, -1, SEEK_CUR);
        }
        gotToken = 1;
}
else if(c == '&' || c == '|')
{
```

```
                int d = fgetc(fa);
                if(c == d)
                {
                        tkn.lexeme[0] = tkn.lexeme[1] = c;
                        tkn.lexeme[2] = '\0';
                        tkn.row = row;
                        tkn.col = col;
                        ++col;
                        gotToken = 1;
                        strcpy(tkn.type, "LOGICALOPERATOR");
                }
                else
                        {
                        fseek(fa, -1, SEEK_CUR);
                }
                ++col;
        }
        else
                ++col;
    }
    return tkn;
}
```

l8.c:

```
#include "lex.c"

void program();
void declarations();
void datatype();
void idlist();
void idlistprime();
void assignstat();
void statementlist();
void statement();
void expn();
void eprime();
void simpleexp();
void seprime();
void term();
void tprime();
void factor();
void relop();
void addop();
void mulop();
```

```
struct token tkn;
FILE *f1;
char *rel[] = {"==", "!=", "<=", ">=", ">", "<"};
char *add[] = {"+", "-"};
char *mul[] = {"*", "/", "%"};

int isrel(char *w)
{
    int i;
    for (i = 0; i < sizeof(rel) / sizeof(char *); i++)
        if (strcmp(w, rel[i]) == 0)
            return 1;
    return 0;
}

int isadd(char *w)
{
    int i;
    for (i = 0; i < sizeof(add) / sizeof(char *); i++)
        if (strcmp(w, add[i]) == 0)
            return 1;
    return 0;
}

int ismul(char *w)
{
    int i;
    for (i = 0; i < sizeof(mul) / sizeof(char *); i++)
        if (strcmp(w, mul[i]) == 0)
            return 1;
    return 0;
}

int main()
{
    FILE *fa, *fb;
    int ca, cb;
    fa = fopen("l8input.c", "r");
    if (fa == NULL)
    {
        printf("Cannot open file \n");
        exit(0);
    }
```

```
fb = fopen("l8output.c", "w+");
ca = getc(fa);
while (ca != EOF)
{
    if (ca == ' ')
    {
        putc(ca, fb);
        while (ca == ' ')
            ca = getc(fa);
    }
    if (ca == '/')
    {
        cb = getc(fa);
        if (cb == '/')
        {
            while (ca != '\n')
                ca = getc(fa);
        }
        else if (cb == '*')
        {
            do
            {
                while (ca != '*')
                    ca = getc(fa);
                ca = getc(fa);
                } while (ca != '/');
        }
        else
        {
            putc(ca, fb);
            putc(cb, fb);
        }
    }
    else
        putc(ca, fb);
    ca = getc(fa);
}
fclose(fa);
fclose(fb);

fa = fopen("l8input.c", "r");
if (fa == NULL)
{
    printf("Cannot open file");
    return 0;
```

```
}
fb = fopen("temp.c", "w+");
ca = getc(fa);
while (ca != EOF)
{
    if (ca == "")
    {
        putc(ca, fb);
        ca = getc(fa);
        while (ca != "")
        {
            putc(ca, fb);
            ca = getc(fa);
        }
    }
    else if (ca == '#')
    {

        while (ca != '\n')
        {

            ca = getc(fa);
        }
        ca = getc(fa);
    }
    putc(ca, fb);
    ca = getc(fa);
}
fclose(fa);
fclose(fb);

fa = fopen("temp.c", "r");
 fb = fopen("l8output.c", "w");
ca = getc(fa);
while (ca != EOF)
{
    putc(ca, fb);
    ca = getc(fa);
}
fclose(fa);
fclose(fb);
remove("temp.c");

f1 = fopen("l8output.c", "r");
if (f1 == NULL)
```

```
    {
        printf("Error! File cannot be opened!\n");
        return 0;
    }
    while ((tkn = getNextToken(f1)).row != -1)
    {
        if (strcmp(tkn.lexeme, "main") == 0)
        {
            program();
            break;
        }
    }
    fclose(f1);
}

void program()
{

    if (strcmp(tkn.lexeme, "main") == 0)
    {
        tkn = getNextToken(f1);
        if (strcmp(tkn.lexeme, "(") == 0)
        {
            tkn = getNextToken(f1);
            if (strcmp(tkn.lexeme, ")") == 0)
            {
                tkn = getNextToken(f1);
                if (strcmp(tkn.lexeme, "{") == 0)
                {
                    tkn = getNextToken(f1);
                    declarations();
                    statementlist();
                    if (strcmp(tkn.lexeme, "}") == 0)
                    {
                        printf("Compilation successful\n");
                        return;
                    }
                    else
                    {
                        printf("} missing at row=%d col=%d", tkn.row, tkn.col);
                        exit(1);
                    }
                }
                else
                {
```

```
                printf("{ missing at row=%d col=%d", tkn.row, tkn.col);
                exit(1);
            }
        }
        else
        {
            printf(") missing at row=%d col=%d", tkn.row, tkn.col);
            exit(1);
        }
    }
    else
    {
        printf("( missing at row=%d col=%d", tkn.row, tkn.col);
        exit(1);
    }
  }
}
void declarations()
{
  if (isdtype(tkn.lexeme) == 0)
  {
    return;
  }
  datatype();
  idlist();
  if (strcmp(tkn.lexeme, ";") == 0)
  {
    tkn = getNextToken(f1);
    declarations();
  }
  else
  {
    printf("; missing at row=%d col=%d", tkn.row, tkn.col);
    exit(1);
  }
}
void datatype()
{
  if (strcmp(tkn.lexeme, "int") == 0)
  {
    tkn = getNextToken(f1);
    return;
  }
  else if (strcmp(tkn.lexeme, "char") == 0)
  {
```

```
        tkn = getNextToken(f1);
            return;
    }
    else
    {
        printf("%s Missing datatype at row=%d col=%d", tkn.lexeme, tkn.row, tkn.col);
        exit(1);
    }
}
void idlist()
{
    if (strcmp(tkn.type, "IDENTIFIER") == 0)
    {
        tkn = getNextToken(f1);
        idlistprime();
    }
    else
    {
        printf("Missing IDENTIFIER at row=%d col=%d", tkn.row, tkn.col);
    }
}
void idlistprime()
{
    if (strcmp(tkn.lexeme, ",") == 0)
    {
        tkn = getNextToken(f1);
        idlist();
    }
    if (strcmp(tkn.lexeme, "[") == 0)
    {
        tkn = getNextToken(f1);
        if (strcmp(tkn.type, "NUMBER") == 0)
        {
            tkn = getNextToken(f1);
            if (strcmp(tkn.lexeme, "]") == 0)
            {
                tkn = getNextToken(f1);
                if (strcmp(tkn.lexeme, ",") == 0)
                {
                    tkn = getNextToken(f1);
                    idlist();
                }
                else
                {
                    return;
```

```
            }
        }
    }
}
else
{
    return;
}
}
void statementlist()
{
    if (strcmp(tkn.type, "IDENTIFIER") != 0)
    {
        return;
    }
    statement();
    statementlist();
}
void statement()
{
    assignstat();
    if (strcmp(tkn.lexeme, ";") == 0)
    {
        tkn = getNextToken(f1);
        return;
    }
}
void assignstat()
{
    if (strcmp(tkn.type, "IDENTIFIER") == 0)
    {
        tkn = getNextToken(f1);
        if (strcmp(tkn.lexeme, "=") == 0)
        {
            tkn = getNextToken(f1);
            expn();
        }
        else
        {
            printf("= missing at row=%d col=%d", tkn.row, tkn.col);
            exit(1);
        }
    }
    else
    {
```

```
        printf("Missing IDENTIFIER at row=%d col=%d", tkn.row, tkn.col);
        exit(1);
    }
}
void expn()
{
    simpleexp();
    eprime();
}
void eprime()
{
    if (isrel(tkn.lexeme) == 0)
    {
        return;
    }
    relop();
    simpleexp();
}
void simpleexp()
{
    term();
    seprime();
}
void seprime()
{
    if (isadd(tkn.lexeme) == 0)
    {
        return;
    }
    addop();
    term();
    seprime();
}
void term()
{
    factor();
    tprime();
}
void tprime()
{
    if (ismul(tkn.lexeme) == 0)
    {
        return;
    }
    mulop();
```

```
    factor();
    tprime();
}
void factor()
{
    if (strcmp(tkn.type, "IDENTIFIER") == 0)
    {
        tkn = getNextToken(f1);
        return;
    }
    else if (strcmp(tkn.type, "NUMBER") == 0)
    {
        tkn = getNextToken(f1);
        return;
    }
}
void relop()
{
    if (strcmp(tkn.lexeme, "==") == 0)
    {
        tkn = getNextToken(f1);
        return;
    }
    if (strcmp(tkn.lexeme, "!=") == 0)
    {
        tkn = getNextToken(f1);
        return;
    }
    if (strcmp(tkn.lexeme, "<=") == 0)
    {
        tkn = getNextToken(f1);
        return;
    }
    if (strcmp(tkn.lexeme, ">=") == 0)
    {
        tkn = getNextToken(f1);
        return;
    }
    if (strcmp(tkn.lexeme, "<") == 0)
    {
        tkn = getNextToken(f1);
        return;
    }
    if (strcmp(tkn.lexeme, ">") == 0)
    {
```

```
        tkn = getNextToken(f1);
        return;
    }
}
void addop()
{
    if (strcmp(tkn.lexeme, "+") == 0)
    {
        tkn = getNextToken(f1);
        return;
    }

    if (strcmp(tkn.lexeme, "-") == 0)
    {
        tkn = getNextToken(f1);
        return;
    }
}

void mulop()
{

    if (strcmp(tkn.lexeme, "*") == 0)
    {
        tkn = getNextToken(f1);
        return;
    }

    if (strcmp(tkn.lexeme, "/") == 0)
    {
        tkn = getNextToken(f1);
        return;
    }

    if (strcmp(tkn.lexeme, "*") == 0)
    {
        tkn = getNextToken(f1);
        return;
    }

}
```

INPUT :

~/Desktop/5th_sem_LABS/CD_LAB/lab 8/l8input.c - Sublime Text

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l8input.c

```
int main)
{
    int s[20];
    int x,y,z;
    x=y+z;
    z=x+y;
}
```

Output :

```
rajvardhan@rajvardhan-HP-Pavilion-Laptop-15-cc1xx:~/Desktop/5th_sem_LABS/CD_LAB/
lab 8$ gcc l8.c -o lab8_p1
rajvardhan@rajvardhan-HP-Pavilion-Laptop-15-cc1xx:~/Desktop/5th_sem_LABS/CD_LAB/
lab 8$ ./lab8_p1
( missing at row=1 col=9rajvardhan@rajvardhan-HP-Pavilion-Laptop-15-cc1xx:~/Desk
top/5th_sem_LABS/CD_LAB/lab 8$
```

INPUT:

~/Desktop/5th_sem_LABS/CD_LAB/lab 8/l8input.c - Sublime Text

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l8input.c

```
int main()
{
    int s[20];
    int x,y,z;
    x=y+z;
    z=x+y;
}
```

Output :

```
rajvardhan@rajvardhan-HP-Pavilion-Laptop-15-cc1xx:~/Desktop/5th_sem_LABS/CD_LAB/
lab 8$ gcc l8.c -o lab8_p1
rajvardhan@rajvardhan-HP-Pavilion-Laptop-15-cc1xx:~/Desktop/5th_sem_LABS/CD_LAB/
lab 8$ ./lab8_p1
Compilation successful
rajvardhan@rajvardhan-HP-Pavilion-Laptop-15-cc1xx:~/Desktop/5th_sem_LABS/CD_LAB/
lab 8$
```

LAB 9 :

P1) Modify the Recursive Descent parser implemented in the previous lab to parse decision making and looping statements with error reporting. Subset of grammar 7.1 is as follows:

statement → assign-stat; | decision_stat | looping-stat

decision-stat → if (expn) {statement_list} dprime

<u>l9.c:</u>

```
#include "lex.c"

void program();
void declarations();
void datatype();
void idList();
void idListprime();
void idListprimePrime();
void stmtList();
void stmt();
void assignStat();
void expn();
void eprime();
void simpleExpn();
void seprime();
void term();
void tprime();
void factor();
void relop();
void addop();
void mulop();
void decStat();
void dPrime();
void loopStat();

struct token tkn;
```

```
FILE *f1;

int main()
{
        FILE *fa, *fb;
    int ca, cb;
    fa = fopen("l9input.c", "r");
    if (fa == NULL){
        printf("Cannot open file \n");
        exit(0);
    }

    fb = fopen("l9output.c", "w+");
    ca = getc(fa);
        while (ca != EOF){
                if(ca==' ')
                {
                        putc(ca,fb);
                        while(ca==' ')
                                ca = getc(fa);
                }
                if (ca=='/')
                {
                        cb = getc(fa);
                        if (cb == '/')
                        {
                                while(ca != '\n')
                                        ca = getc(fa);
                        }
                        else if (cb == '*')
                        {
                                do
                                {
                                        while(ca != '*')
                                                ca = getc(fa);
                                        ca = getc(fa);
                                } while (ca != '/');
                        }
                        else{
                                putc(ca,fb);
                                putc(cb,fb);
                        }
                }
                else putc(ca,fb);
                ca = getc(fa);
```

```
        }
        fclose(fa);
        fclose(fb);
        fa = fopen("l9output.c", "r");
        if(fa == NULL){
                printf("Cannot open file");
                return 0;
        }
        fb = fopen("temp.c", "w+");
        ca = getc(fa);
        while (ca != EOF)
{
    if(ca==[illegible])
    {
        putc(ca,fb);
        ca=getc(fa);
        while(ca!=[illegible])
        {
            putc(ca,fb);
            ca=getc(fa);
        }
    }
    else if(ca=='#')
    {
        while(ca!='\n')
        {
            ca=getc(fa);
        }
    }
putc(ca,fb);
ca = getc(fa);
}
        fclose(fa);
        fclose(fb);

        fa = fopen("temp.c", "r");
        fb = fopen("l9output.c", "w");
        ca = getc(fa);
        while(ca != EOF){
                putc(ca, fb);
                ca = getc(fa);
        }
        fclose(fa);
        fclose(fb);
        remove("temp.c");
```

```
        f1=fopen("l9output.c","r");
        if(f1==NULL)
        {
                printf("Error! File cannot be opened!\n");
                return 0;
        }

        while((tkn=getNextToken(f1)).row!=-1)
        {
                if(strcmp(tkn.lexeme, "main") == 0)
                {
                        program();
                        break;
                }
        }
    fclose(f1);
}

void program()
{
        if(strcmp(tkn.lexeme, "main") == 0)
        {
                tkn = getNextToken(f1);
                if(strcmp(tkn.lexeme, "(") == 0)
                {
                        tkn = getNextToken(f1);
                        if(strcmp(tkn.lexeme, ")") == 0)
                        {
                                tkn = getNextToken(f1);
                                if(strcmp(tkn.lexeme, "{") == 0)
                                {
                                        tkn = getNextToken(f1);
                                        declarations();
                                        stmtList();
                                        if(strcmp(tkn.lexeme, "}") == 0)
                                        {
                                                printf("Compilation successful\n");
                                                return;
                                        }
                                        else
                                        {
                                                printf("ERROR: missing \"}\" at row=%d col=
%d\n",tkn.row,tkn.col);
                                                exit(1);
                                        }
```

```
                        }
                        else
                        {
                                printf("ERROR: missing \"{\" at row=%d col=%d\
n",tkn.row,tkn.col);
                                exit(1);
                        }
                }
                else
                {
                        printf("ERROR: missing \")\" at row=%d col=%d\
n",tkn.row,tkn.col);
                        exit(1);
                }
        }
        else
        {
                printf("ERROR: missing \"(\" at row=%d col=%d\
n",tkn.row,tkn.col);
                exit(1);
        }
    }
    else
    {
        printf("ERROR: missing \"main\" at row=%d col=%d\
n",tkn.row,tkn.col);
        exit(1);
    }
}

void declarations()
{
    if(isdtype(tkn.lexeme)==0)
        return;
    datatype();
    idList();
    if(strcmp(tkn.lexeme, ";") == 0)
    {
        tkn = getNextToken(f1);
        declarations();
    }
    else
    {
        printf("ERROR: missing \";\" at row=%d col=%d\n",tkn.row,tkn.col);
        exit(1);
```

```
	}
}

void datatype()
{
	if(strcmp(tkn.lexeme, "int") == 0)
	{
		tkn = getNextToken(f1);
		return;
	}
	else if(strcmp(tkn.lexeme, "char") == 0)
	{
		tkn = getNextToken(f1);
		return;
	}
	else
	{
		printf("ERROR: missing datatype(int or char) at row=%d col=%d\
n",tkn.row,tkn.col);
		exit(1);
	}
}

void idList()
{
	if(strcmp(tkn.type,"IDENTIFIER")==0)
	{
		tkn = getNextToken(f1);
		idListprime();
	}
	else
	{
		printf("ERROR: missing IDENTIFIER at row=%d col=%d\
n",tkn.row,tkn.col);
		exit(1);
	}
}

void idListprime()
{
	if(strcmp(tkn.lexeme, ",") == 0)
	{
		tkn = getNextToken(f1);
		idList();
	}
```

```
	else if(strcmp(tkn.lexeme, "[") == 0)
	{
		tkn = getNextToken(f1);
		if(strcmp(tkn.type,"NUMBER")==0)
		{
			tkn = getNextToken(f1);
			if(strcmp(tkn.lexeme, "]") == 0)
			{
				tkn = getNextToken(f1);
				idListprimePrime();
			}
			else
			{
				printf("ERROR: missing \"]\" at row=%d col=%d\
n",tkn.row,tkn.col);
				exit(1);
			}
		}
		else
		{
			printf("ERROR: missing NUMBER at row=%d col=%d\
n",tkn.row,tkn.col);
			exit(1);
		}
	}
}

void idListprimePrime()
{
	if(strcmp(tkn.lexeme, ",") == 0)
	{
		tkn = getNextToken(f1);
		idList();
	}
	else
		return;
}

void stmtList()
{
	if(strcmp(tkn.type,"IDENTIFIER")==0 || strcmp(tkn.lexeme,"if") == 0 ||
strcmp(tkn.lexeme,"for") == 0 || strcmp(tkn.lexeme,"while") == 0)
	{
		stmt();
		stmtList();
```

```
	}
	return;
}

void stmt()
{
	if(strcmp(tkn.type, "IDENTIFIER")==0)
	{
		assignStat();
		if(strcmp(tkn.lexeme, ";") == 0)
		{
			tkn = getNextToken(f1);
			return;
		}
		else
		{
			printf("ERROR: missing \";\" at row=%d col=%d\
n",tkn.row,tkn.col);
			exit(1);
		}
	}
	else if(strcmp(tkn.lexeme, "if")==0)
		decStat();
	else if((strcmp(tkn.lexeme, "while")==0) || (strcmp(tkn.lexeme, "for")==0))
		loopStat();
	else
	{
		printf("%d.%d : Expected \" statement \"\n",tkn.row,tkn.col);
		exit(0);
	}
}

void assignStat()
{
	if(strcmp(tkn.type,"IDENTIFIER")==0)
	{
		tkn = getNextToken(f1);
		if(strcmp(tkn.lexeme, "=") == 0)
		{
			tkn = getNextToken(f1);
			expn();
		}
		else
		{
```

```
                        printf("ERROR: missing \"=\" at row=%d col=%d\
n",tkn.row,tkn.col);
                        exit(1);
                }
        }
        else
        {
                printf("ERROR: missing IDENTIFIER at row=%d col=%d\
n",tkn.row,tkn.col);
                exit(1);
        }
}

void expn()
{
        simpleExpn();
        eprime();
}

void eprime()
{
        if(strcmp(tkn.type,"RELATIONALOPERATOR")!=0)
                return;
        relop();
        simpleExpn();
}

void simpleExpn()
{
        term();
        seprime();
}

void seprime()
{
        if((strcmp(tkn.lexeme, "+") != 0) && (strcmp(tkn.lexeme, "-") != 0))
                return;
        addop();
        term();
        seprime();
}

void term()
{
        factor();
```

```
	tprime();
}

void tprime()
{
	if((strcmp(tkn.lexeme, "*") != 0) && (strcmp(tkn.lexeme, "/") != 0)&&
(strcmp(tkn.lexeme, "%") != 0))
		return;
	mulop();
	factor();
	tprime();
}

void factor()
{
	if(strcmp(tkn.type,"IDENTIFIER")==0)
	{
		tkn=getNextToken(f1);
		return;
	}
	else if(strcmp(tkn.type,"NUMBER")==0)
	{
		tkn=getNextToken(f1);
		return;
	}
	else
	{
		printf("ERROR: Expected IDENTIFIER or NUMBER at row=%d col=
%d\n",tkn.row,tkn.col);
		exit(1);
	}
}

void relop()
{
	if(strcmp(tkn.lexeme,"==")==0)
	{
		tkn=getNextToken(f1);
		return;
	}
	else if(strcmp(tkn.lexeme,"!=")==0)
	{
		tkn=getNextToken(f1);
		return;
	}
```

```
	else if(strcmp(tkn.lexeme,"<=")==0)
	{
		tkn=getNextToken(f1);
		return;
	}
	else if(strcmp(tkn.lexeme,">=")==0)
	{
		tkn=getNextToken(f1);
		return;
	}
	else if(strcmp(tkn.lexeme,"<")==0)
	{
		tkn=getNextToken(f1);
		return;
	}
	else if(strcmp(tkn.lexeme,">")==0)
	{
		tkn=getNextToken(f1);
		return;
	}
	else
	{
		printf("ERROR: Expected RELATIONAL OPERATOR or NUMBER at
row=%d col=%d\n",tkn.row,tkn.col);
		exit(1);
	}
}
void addop()
{
	if(strcmp(tkn.lexeme,"+")==0)
	{
		tkn=getNextToken(f1);
		return;
	}
	else if(strcmp(tkn.lexeme,"-")==0)
	{
		tkn=getNextToken(f1);
		return;
	}
	else
	{
		printf("ERROR: Expected \"+\" or \"-\" at row=%d col=%d\
n",tkn.row,tkn.col);
		exit(1);
	}
```

```
}
void mulop()
{
	if(strcmp(tkn.lexeme,"*")==0)
	{
		tkn=getNextToken(f1);
		return;
	}
	else if(strcmp(tkn.lexeme,"/")==0)
	{
		tkn=getNextToken(f1);
		return;
	}
	else if(strcmp(tkn.lexeme,"*")==0)
	{
		tkn=getNextToken(f1);
		return;
	}
	else
	{
		printf("ERROR: Expected \"*\" or \"/\" or \"%%\" at row=%d col=%d\
n",tkn.row,tkn.col);
		exit(1);
	}
}

void decStat()
{
	if(strcmp(tkn.lexeme, "if")==0)
	{
		tkn = getNextToken(f1);
		if(strcmp(tkn.lexeme, "(") == 0)
		{
			tkn = getNextToken(f1);
			expn();
			if(strcmp(tkn.lexeme, ")") == 0)
			{
				tkn = getNextToken(f1);
				if(strcmp(tkn.lexeme, "{") == 0)
				{
					tkn = getNextToken(f1);
					stmtList();
					if(strcmp(tkn.lexeme, "}") == 0)
					{
						tkn = getNextToken(f1);
```

```
                                        dPrime();
                                        return;
                                }
                                else
                                {
                                        printf("ERROR: missing \"}\" at row=%d col=
%d\n",tkn.row,tkn.col);
                                        exit(1);
                                }
                        }
                        else
                        {
                                printf("ERROR: missing \"{\" at row=%d col=%d\
n",tkn.row,tkn.col);
                                exit(1);
                        }
                }
                else
                {
                        printf("ERROR: missing \")\" at row=%d col=%d\
n",tkn.row,tkn.col);
                        exit(1);
                }
        }
        else
        {
                printf("ERROR: missing \"(\" at row=%d col=%d\
n",tkn.row,tkn.col);
                exit(1);
        }
    }
    else
    {
        printf("ERROR: missing \"keyword\" at row=%d col=%d\
n",tkn.row,tkn.col);
        exit(1);
    }
}

void dPrime()
{
    if(strcmp(tkn.lexeme, "else")==0)
    {
        tkn = getNextToken(f1);
        if(strcmp(tkn.lexeme, "{") == 0)
```

```
		{
			tkn = getNextToken(f1);
			stmtList();
			if(strcmp(tkn.lexeme, "}") == 0)
			{
				tkn = getNextToken(f1);
				return;
			}
			else
			{
				printf("ERROR: missing \"}\" at row=%d col=%d\
n",tkn.row,tkn.col);
				exit(1);
			}
		}
		else
		{
			printf("ERROR: missing \"{\" at row=%d col=%d\
n",tkn.row,tkn.col);
			exit(1);
		}
	}
	else
		return;
}

void loopStat()
{
	if(strcmp(tkn.lexeme, "while")==0)
	{
		tkn = getNextToken(f1);
		if(strcmp(tkn.lexeme, "(") == 0)
		{
			tkn = getNextToken(f1);
			expn();
			if(strcmp(tkn.lexeme, ")") == 0)
			{
				tkn = getNextToken(f1);
				if(strcmp(tkn.lexeme, "{") == 0)
				{
					tkn = getNextToken(f1);
					stmtList();
					if(strcmp(tkn.lexeme, "}") == 0)
					{
						tkn = getNextToken(f1);
```

```
                                        return;
                                }
                                else
                                {
                                        printf("ERROR: missing \"}\" at row=%d col=
%d\n",tkn.row,tkn.col);
                                        exit(1);
                                }
                        }
                        else
                        {
                                printf("ERROR: missing \"{\" at row=%d col=%d\
n",tkn.row,tkn.col);
                                exit(1);
                        }
                }
                else
                {
                        printf("ERROR: missing \")\" at row=%d col=%d\
n",tkn.row,tkn.col);
                        exit(1);
                }
        }
        else
        {
                printf("ERROR: missing \"(\" at row=%d col=%d\
n",tkn.row,tkn.col);
                exit(1);
        }
}
else if(strcmp(tkn.lexeme, "for")==0)
{
        tkn = getNextToken(f1);
        if(strcmp(tkn.lexeme, "(") == 0)
        {
                tkn = getNextToken(f1);
                assignStat();
                if(strcmp(tkn.lexeme, ";") == 0)
                {
                        tkn = getNextToken(f1);
                        expn();
                        if(strcmp(tkn.lexeme, ";") == 0)
                        {
                                tkn = getNextToken(f1);
                                assignStat();
```

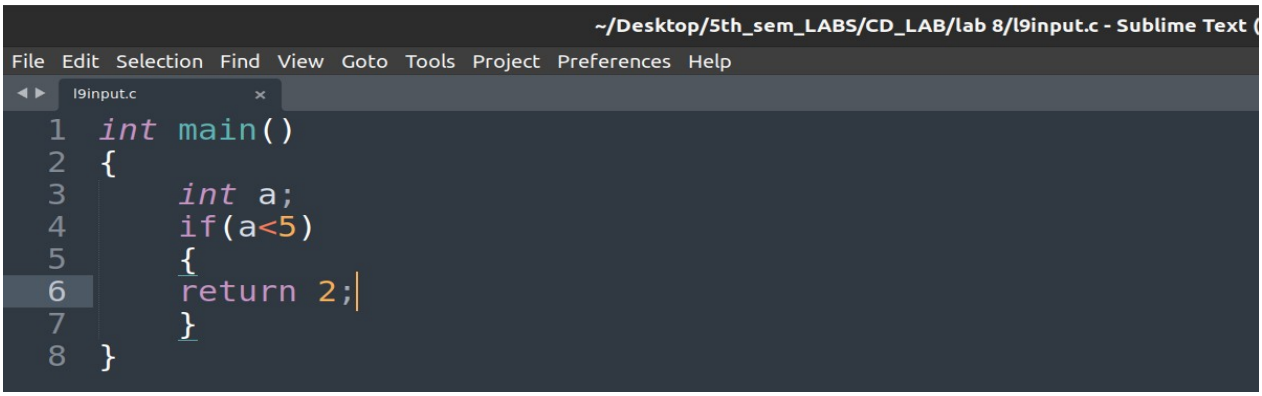
```
                        if(strcmp(tkn.lexeme, ")") == 0)
                        {
                                tkn = getNextToken(f1);

                                if(strcmp(tkn.lexeme, "{") == 0)
                                {
                                        tkn = getNextToken(f1);
                                        stmtList();
                                        if(strcmp(tkn.lexeme, "}") == 0)
                                        {
                                                tkn = getNextToken(f1);
                                                return;
                                        }
                                        else
                                        {
                                                printf("ERROR: missing \"}\" at
row=%d col=%d\n",tkn.row,tkn.col);
                                                exit(1);
                                        }
                                }
                                else
                                {
                                        printf("ERROR: missing \"{\" at row=
%d col=%d\n",tkn.row,tkn.col);
                                        exit(1);
                                }
                        }
                        else
                        {
                                printf("ERROR: missing \")\" at row=%d col=
%d\n",tkn.row,tkn.col);
                                exit(1);
                        }
                }
                else
                {
                        printf("ERROR: missing \";\" at row=%d col=%d\
n",tkn.row,tkn.col);
                        exit(1);
                }
        }
        else
        {
                printf("ERROR: missing \";\" at row=%d col=%d\
n",tkn.row,tkn.col);
```

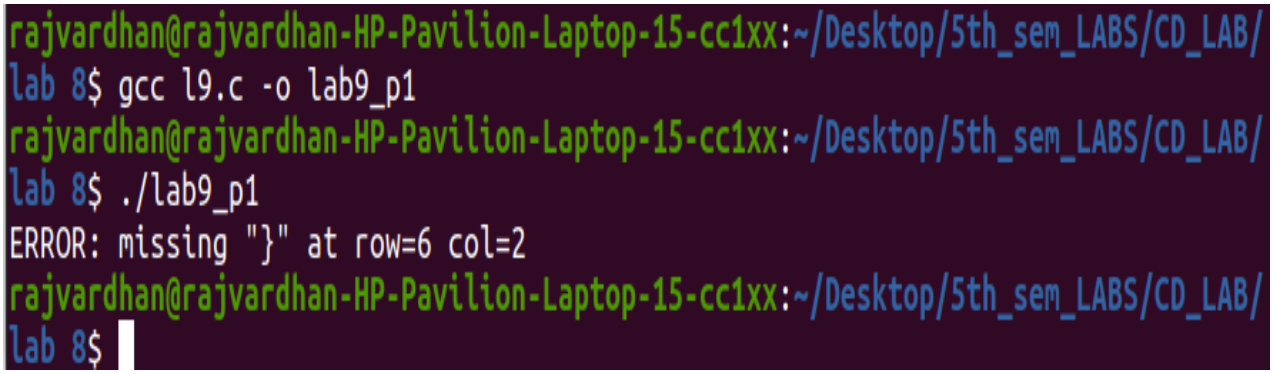
```
                        exit(1);
                }
        }
        else
        {
                printf("ERROR: missing \"(\" at row=%d col=%d\
n",tkn.row,tkn.col);
                exit(1);
        }
    }
    else
    {
        printf("ERROR: missing \"keyword\" at row=%d col=%d\
n",tkn.row,tkn.col);
        exit(1);
        }

}
```

Input:



Output:



Input:

~/Desktop/5th_sem_LABS/CD_LAB/lab 8/l9input.c - Sublime Text

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l9input.c

```c
int main()
{
    int a;
    while(a<5)
    {
        a = a + 5
    }
}
```

Output:

```
rajvardhan@rajvardhan-HP-Pavilion-Laptop-15-cc1xx:~/Desktop/5th_sem_LABS/CD_LAB/
lab 8$ gcc l9.c -o lab9_p1
rajvardhan@rajvardhan-HP-Pavilion-Laptop-15-cc1xx:~/Desktop/5th_sem_LABS/CD_LAB/
lab 8$ ./lab9_p1
ERROR: missing ";" at row=7 col=2
rajvardhan@rajvardhan-HP-Pavilion-Laptop-15-cc1xx:~/Desktop/5th_sem_LABS/CD_LAB/
lab 8$
```

Input:

~/Desktop/5th_sem_LABS/CD_LAB/lab 8/l9input.c - Sublime Text

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l9input.c

```c
#include <stdio.h>
int main()
{
    int a;
    while(a<5)
    {
        a = a + 5;
    }
}
```

Output:

```
rajvardhan@rajvardhan-HP-Pavilion-Laptop-15-cc1xx:~/Desktop/5th_sem_LABS/CD_LAB/
lab 8$ gcc l9.c -o lab9_p1
rajvardhan@rajvardhan-HP-Pavilion-Laptop-15-cc1xx:~/Desktop/5th_sem_LABS/CD_LAB/
lab 8$ ./lab9_p1
Compilation successful
rajvardhan@rajvardhan-HP-Pavilion-Laptop-15-cc1xx:~/Desktop/5th_sem_LABS/CD_LAB/
lab 8$
```