Project #1. Scanner
2017

Scanner

- **Implementation of C-scanner (both 2 methods)**
  - **Implementation of C-Scanner using C-code (modify Tiny compiler code)**
    - **globals.h main.c util.h util.c scan.h scan.c**
  - Implementation of C-Scanner using lex(flex) by Tiny.l modification

Lexical Convention of C-Minus

여기 있는거만 구현하면 된다

- **Keyword** 6개

  else if int return void while (lower case)

- **Symbol**

  `+ - * / < <= > >= == != = ; ,`
  `( ) [ ] { } /* */`

- **Token**

  $ID = letter\ letter*$

  $NUM = digit\ digit\ *$

  $letter = \mathrm{a} \mid \ldots \mid \mathrm{z} \mid \mathrm{A} \mid \ldots \mid \mathrm{Z}$

  $digit = 0 \mid 1 \mid \ldots \mid 9$

Lexical Convention of C-Minus

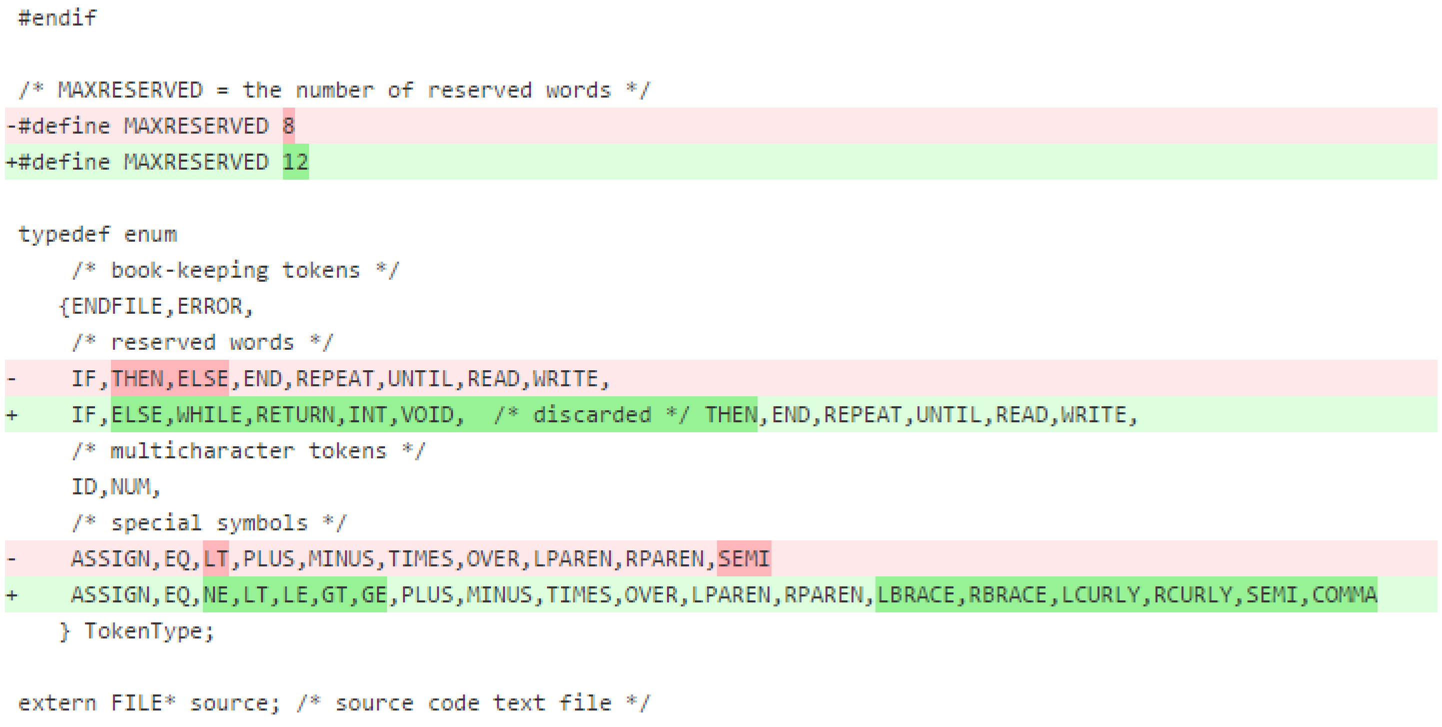
- **White space:** Space Bar, Enter, ↹
  - Ignore other cases except WS between ID, NUM, and keywords (ex: beginning and end of line)

- **Comments (/ * … * /) follow normal C notation.**
  - Cannot be nested.

- **Please see "Kenneth C. Louden book p. 491-492"**

Hint: where to see?

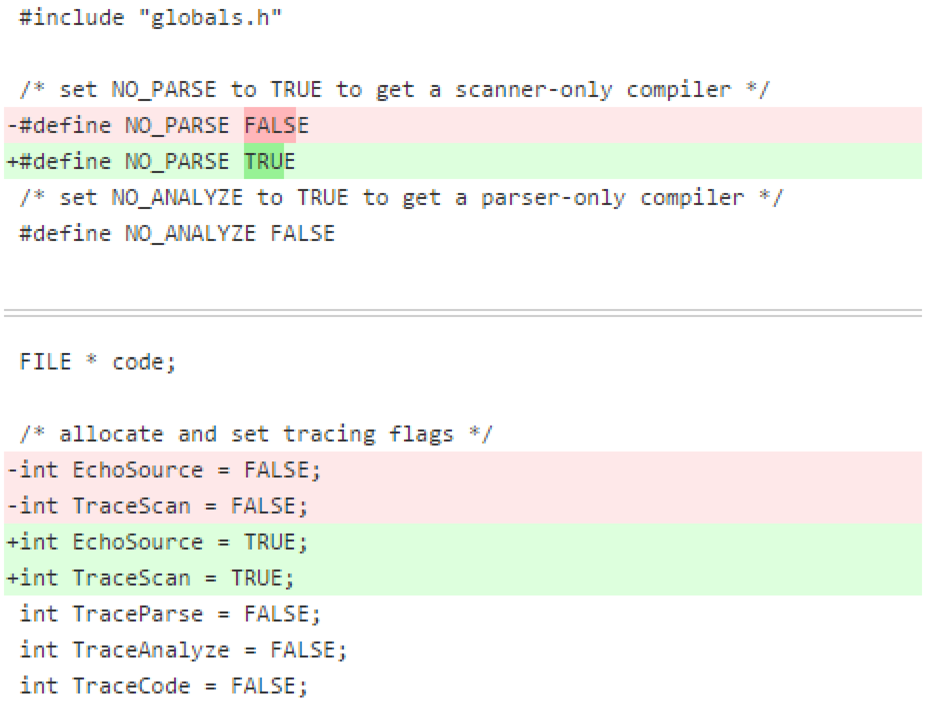
- **globals.h**
  - TokenType should be modified for C-Minus



```
 #endif

 /* MAXRESERVED = the number of reserved words */
-#define MAXRESERVED 8
+#define MAXRESERVED 12

 typedef enum
     /* book-keeping tokens */
    {ENDFILE,ERROR,
     /* reserved words */
-    IF,THEN,ELSE,END,REPEAT,UNTIL,READ,WRITE,
+    IF,ELSE,WHILE,RETURN,INT,VOID,  /* discarded */ THEN,END,REPEAT,UNTIL,READ,WRITE,
     /* multicharacter tokens */
     ID,NUM,
     /* special symbols */
-    ASSIGN,EQ,LT,PLUS,MINUS,TIMES,OVER,LPAREN,RPAREN,SEMI
+    ASSIGN,EQ,NE,LT,LE,GT,GE,PLUS,MINUS,TIMES,OVER,LPAREN,RPAREN,LBRACE,RBRACE,LCURLY,RCURLY,SEMI,COMMA
    } TokenType;

 extern FILE* source; /* source code text file */
```

Hint: where to see?

- **main.c**
  - To meet scanner project goal
  - NO_PARSE, EchoSource, TraceScan

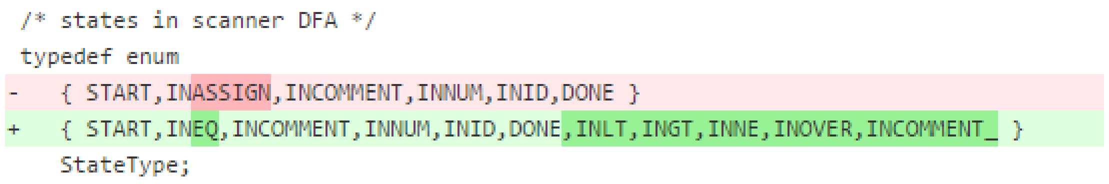


```
 #include "globals.h"

 /* set NO_PARSE to TRUE to get a scanner-only compiler */
-#define NO_PARSE FALSE
+#define NO_PARSE TRUE
 /* set NO_ANALYZE to TRUE to get a parser-only compiler */
 #define NO_ANALYZE FALSE
```

```
 FILE * code;

 /* allocate and set tracing flags */
-int EchoSource = FALSE;
-int TraceScan = FALSE;
+int EchoSource = TRUE;
+int TraceScan = TRUE;
 int TraceParse = FALSE;
 int TraceAnalyze = FALSE;
 int TraceCode = FALSE;
```

Hint: where to see?

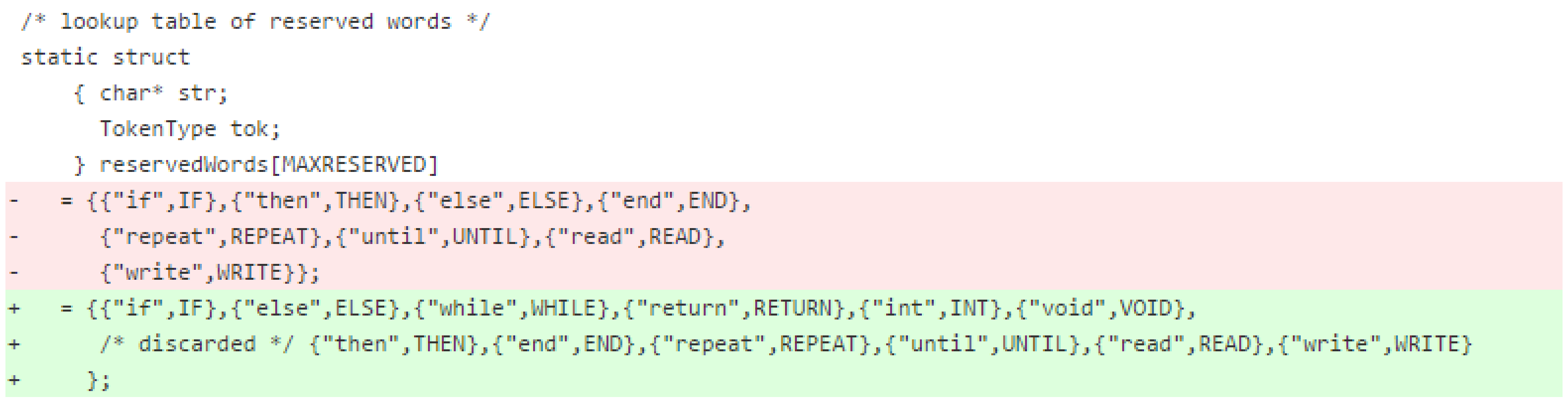
- **scan.c** important file
  code for DFA simulation.
  - Need to add states for C-Minus DFA



```
 /* states in scanner DFA */
 typedef enum
-    { START,INASSIGN,INCOMMENT,INNUM,INID,DONE }
+    { START,INEQ,INCOMMENT,INNUM,INID,DONE,INLT,INGT,INNE,INOVER,INCOMMENT_ }
     StateType;
```

Hint: where to see?

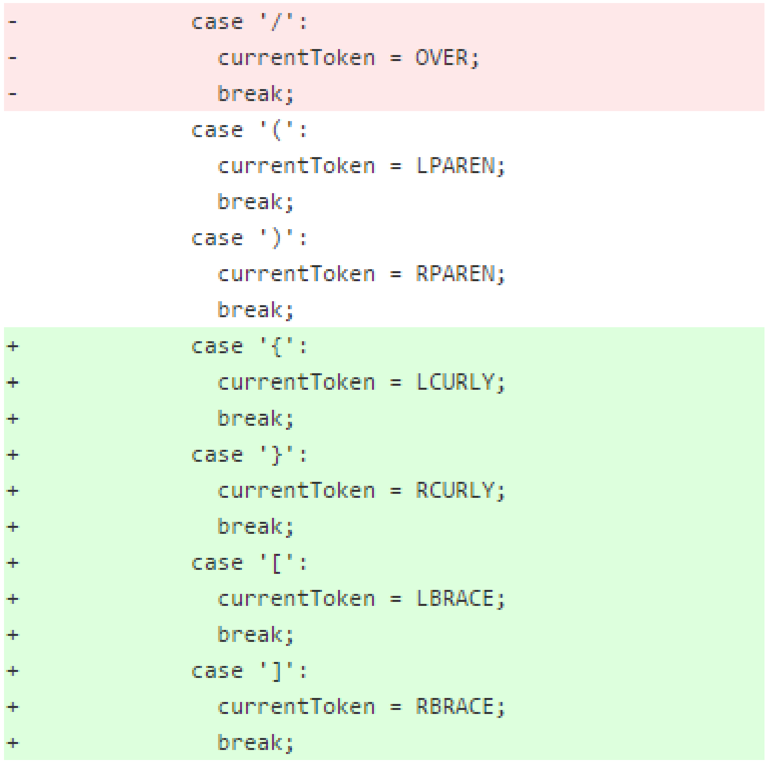
- **scan.c**
  - Reserved word should be added for C-Minus



```
 /* lookup table of reserved words */
 static struct
     { char* str;
       TokenType tok;
     } reservedWords[MAXRESERVED]
-    = {{"if",IF},{"then",THEN},{"else",ELSE},{"end",END},
-       {"repeat",REPEAT},{"until",UNTIL},{"read",READ},
-       {"write",WRITE}};
+    = {{"if",IF},{"else",ELSE},{"while",WHILE},{"return",RETURN},{"int",INT},{"void",VOID},
+       /* discarded */ {"then",THEN},{"end",END},{"repeat",REPEAT},{"until",UNTIL},{"read",READ},{"write",WRITE}
+      };
```

Hint: where to see?

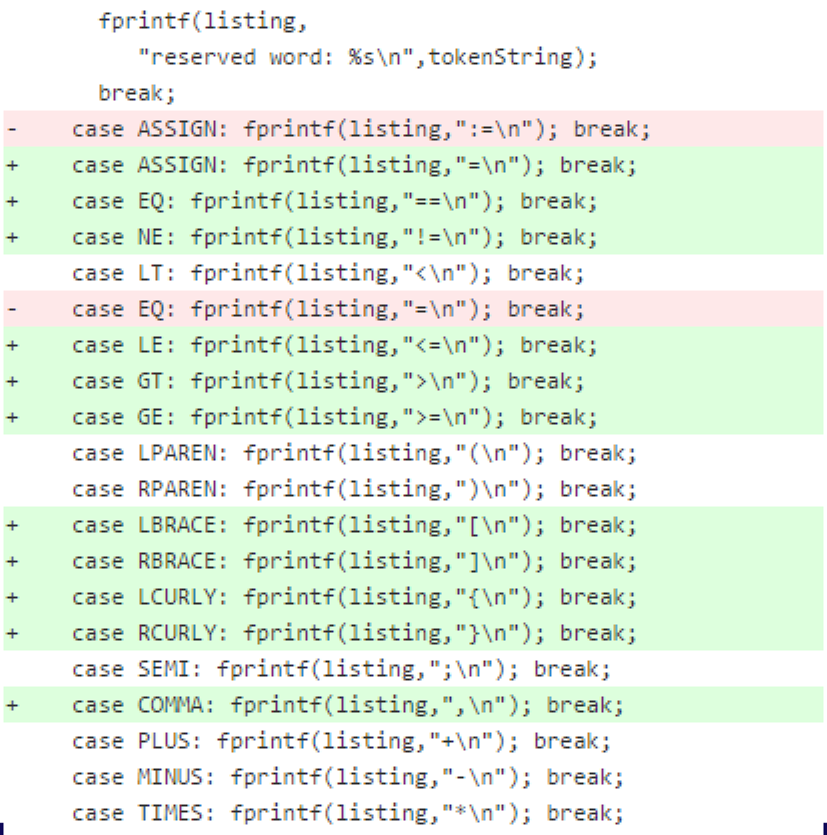
- **scan.c**
  - Need to modify getToken for C-Minus



```diff
-               case '/':
-                 currentToken = OVER;
-                 break;
                case '(':
                  currentToken = LPAREN;
                  break;
                case ')':
                  currentToken = RPAREN;
                  break;
+               case '{':
+                 currentToken = LCURLY;
+                 break;
+               case '}':
+                 currentToken = RCURLY;
+                 break;
+               case '[':
+                 currentToken = LBRACE;
+                 break;
+               case ']':
+                 currentToken = RBRACE;
+                 break;
```

Hint: where to see?

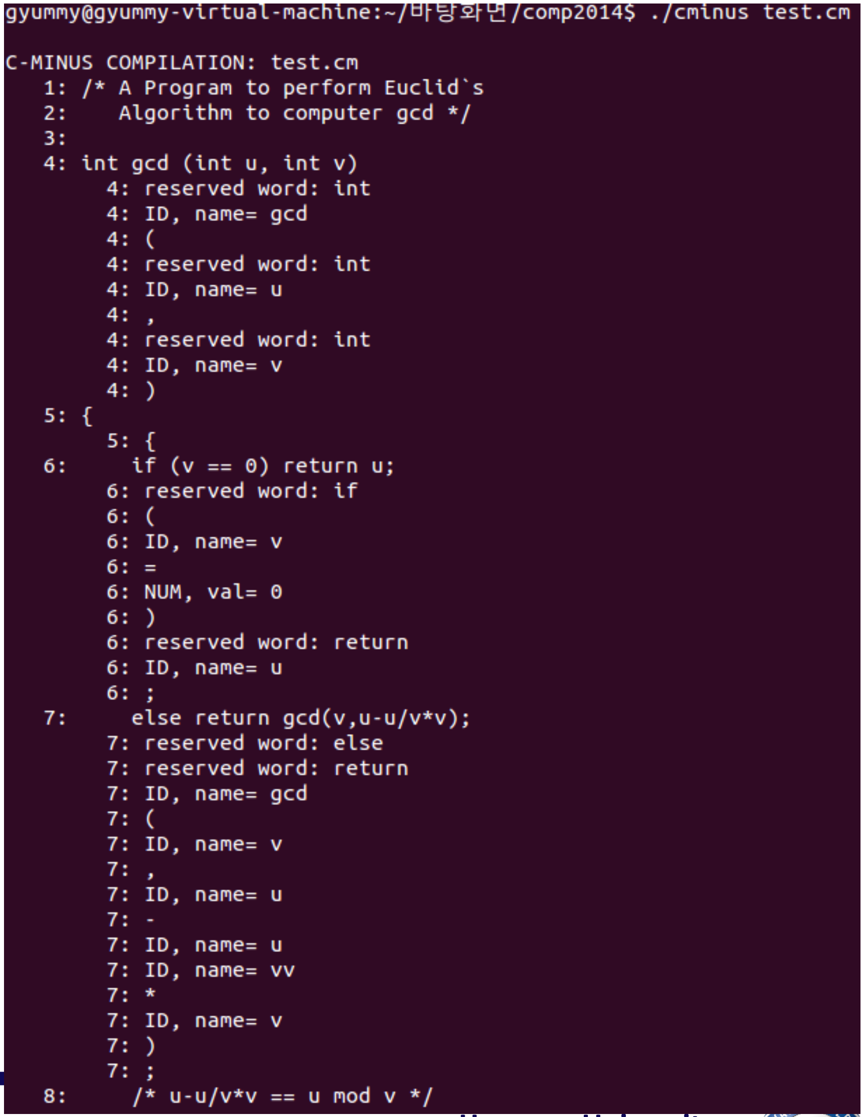
- **util.c**
  - Need to modify printToken() for C-Minus



```
          fprintf(listing,
             "reserved word: %s\n",tokenString);
          break;
-       case ASSIGN: fprintf(listing,":=\n"); break;
+       case ASSIGN: fprintf(listing,"=\n"); break;
+       case EQ: fprintf(listing,"==\n"); break;
+       case NE: fprintf(listing,"!=\n"); break;
        case LT: fprintf(listing,"<\n"); break;
-       case EQ: fprintf(listing,"=\n"); break;
+       case LE: fprintf(listing,"<=\n"); break;
+       case GT: fprintf(listing,">\n"); break;
+       case GE: fprintf(listing,">=\n"); break;
        case LPAREN: fprintf(listing,"(\n"); break;
        case RPAREN: fprintf(listing,")\n"); break;
+       case LBRACE: fprintf(listing,"[\n"); break;
+       case RBRACE: fprintf(listing,"]\n"); break;
+       case LCURLY: fprintf(listing,"{\n"); break;
+       case RCURLY: fprintf(listing,"}\n"); break;
        case SEMI: fprintf(listing,";\n"); break;
+       case COMMA: fprintf(listing,",\n"); break;
        case PLUS: fprintf(listing,"+\n"); break;
        case MINUS: fprintf(listing,"-\n"); break;
        case TIMES: fprintf(listing,"*\n"); break;
```

Example– Tiny compiler modification

```
/* A program to perform Euclid's
   Algorithm to computer gcd */

int gcd (int u, int v)
{
    if (v == 0) return u;
    else return gcd(v,u-u/v*v);
    /* u-u/v*v == u mod v */
}

void main(void)
{
    int x; int y;
    x = input(); y = input();
    output(gcd(x,y));
}
```



```
gyummy@gyummy-virtual-machine:~/바탕화면/comp2014$ ./cminus test.cm

C-MINUS COMPILATION: test.cm
   1: /* A Program to perform Euclid`s
   2:    Algorithm to computer gcd */
   3:
   4: int gcd (int u, int v)
        4: reserved word: int
        4: ID, name= gcd
        4: (
        4: reserved word: int
        4: ID, name= u
        4: ,
        4: reserved word: int
        4: ID, name= v
        4: )
   5: {
        5: {
   6:     if (v == 0) return u;
        6: reserved word: if
        6: (
        6: ID, name= v
        6: =
        6: NUM, val= 0
        6: )
        6: reserved word: return
        6: ID, name= u
        6: ;
   7:     else return gcd(v,u-u/v*v);
        7: reserved word: else
        7: reserved word: return
        7: ID, name= gcd
        7: (
        7: ID, name= v
        7: ,
        7: ID, name= u
        7: -
        7: ID, name= u
        7: ID, name= vv
        7: *
        7: ID, name= v
        7: )
        7: ;
   8:     /* u-u/v*v == u mod v */
```

Scanner

- **Implementation of C-scanner (both 2 methods)**
  - Implementation of C-Scanner using C-code (modify Tiny compiler code)
    - globals.h main.c util.h util.c scan.h scan.c
  - Implementation of C-Scanner using lex(flex) by Tiny.l modification

lex / flex

- **Lexeme analysis**
- **Automatically generate a target scanner based on input Res**
- **Work with yacc (bison)**

- 이미 우분투에 flex program이 있다

- **http://flex.sourceforge.net/**
  - Manual: http://flex.sourceforge.net/manual/

lex environment

- **Ubuntu 14.04 기준:**
  - apt-get install flex
- **Usage**
  - tiny.l (in Tiny source) should be modified
  - flex <Lex Filename>
    - ex) flex cminus.l
    - lex.yy.c will be created
- **Output can be different**
  - **It's okay if the output is somewhat different from the previous work.**

Hint: where to see?

- **globals.h, main.c, util.c**
  - Same as manual implementation
- **scan.c**
  - This file is not used because getToken() is automatically generated using flex

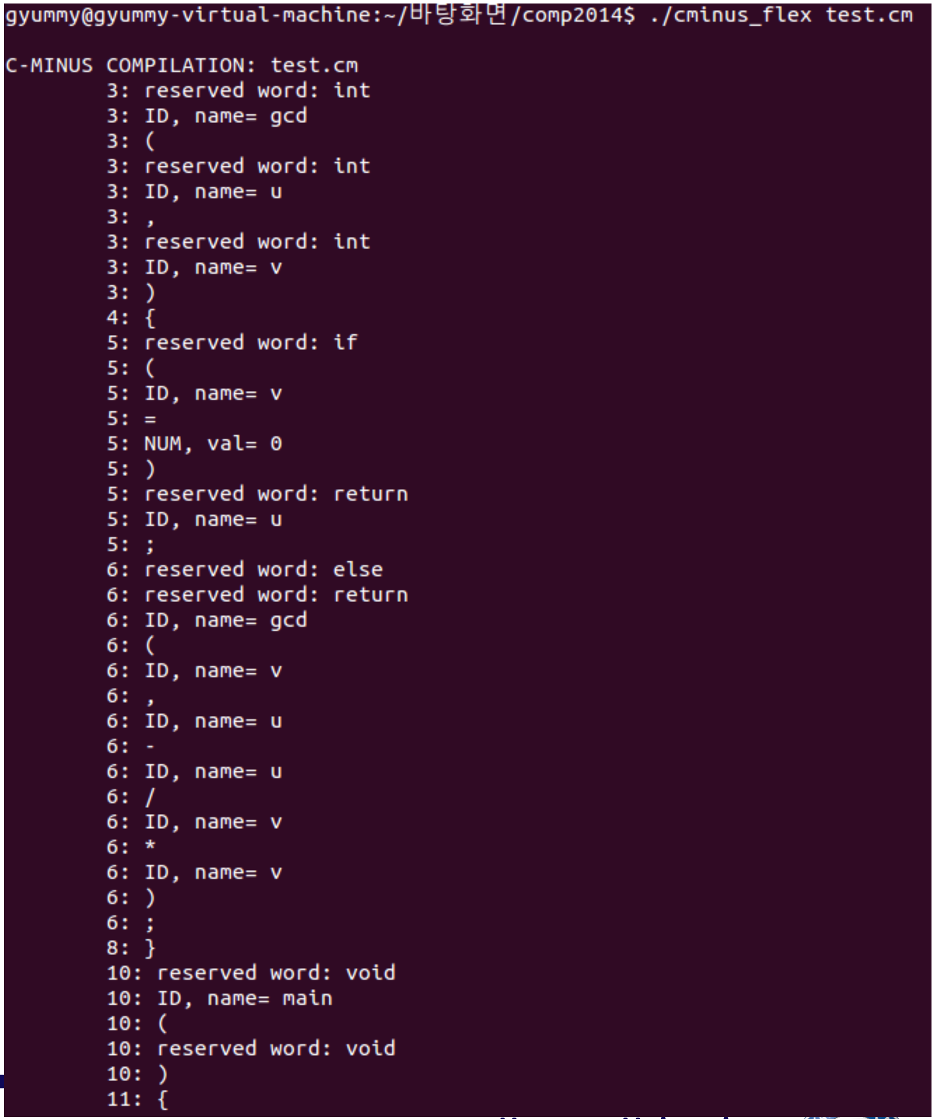
Hint: where to see?

- **cminus.l**
  - Should be created for C-Minus using tiny.l

구조 변경은 필요 없다.

Example – Flex

```
/* A program to perform Euclid's
   Algorithm to computer gcd */

int gcd (int u, int v)
{
    if (v == 0) return u;
    else return gcd(v,u-u/v*v);
    /* u-u/v*v == u mod v */
}

void main(void)
{
    int x; int y;
    x = input(); y = input();
    output(gcd(x,y));
}
```



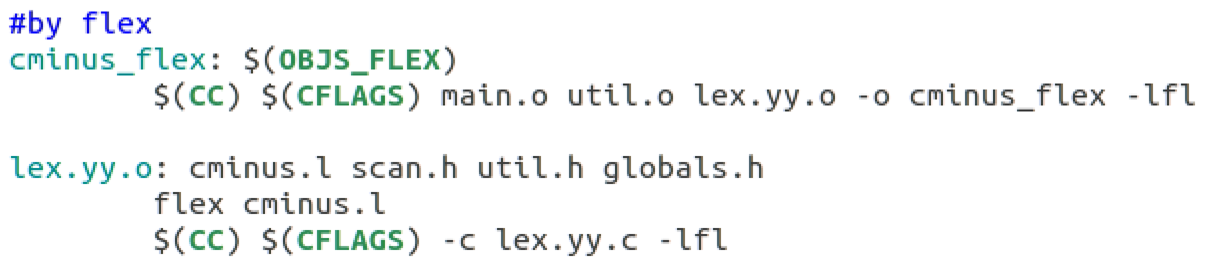
```
gyummy@gyummy-virtual-machine:~/바탕화면/comp2014$ ./cminus_flex test.cm

C-MINUS COMPILATION: test.cm
        3: reserved word: int
        3: ID, name= gcd
        3: (
        3: reserved word: int
        3: ID, name= u
        3: ,
        3: reserved word: int
        3: ID, name= v
        3: )
        4: {
        5: reserved word: if
        5: (
        5: ID, name= v
        5: =
        5: NUM, val= 0
        5: )
        5: reserved word: return
        5: ID, name= u
        5: ;
        6: reserved word: else
        6: reserved word: return
        6: ID, name= gcd
        6: (
        6: ID, name= v
        6: ,
        6: ID, name= u
        6: -
        6: ID, name= u
        6: /
        6: ID, name= v
        6: *
        6: ID, name= v
        6: )
        6: ;
        8: }
        10: reserved word: void
        10: ID, name= main
        10: (
        10: reserved word: void
        10: )
        11: {
```

Compilation

- **Use the Makefile!**
  - Use Tiny compiler Makefile
  - The Makefile should be modificed

Compilation using flex

- **Compilation using flex**
  - Following code should be added to Makefile



```
#by flex
cminus_flex: $(OBJS_FLEX)
	$(CC) $(CFLAGS) main.o util.o lex.yy.o -o cminus_flex -lfl

lex.yy.o: cminus.l scan.h util.h globals.h
	flex cminus.l
	$(CC) $(CFLAGS) -c lex.yy.c -lfl
```

    - *'-lfl': must be added*
    - *'cminus.l' should exist in the same folder with other header files.*
    - OS X: -lf

Report

- **Guideline (~5pages)**
  - Compilation method and environment
  - Explanation about how to implement and how to operate
  - Example and Result Screenshot

- **File format**
  - MS Word, HWP, PDF, …

Submission

- Submission/questions
  yj99.compiler@gmail.com

- Scanner submission deadline
  – 10/13(Fri) 23:59:59

Contact (Prof. Yongjun Park)

- **Yongjun Park**
  - Email : yj99.compiler@gmail.com
  - Please send me an email if you have any question.

- **Submission**
  - Using email
    - Subject: Student#_Name_Project#_ProjectName (학번_이름_프로젝트번호_프로젝트제목)
      - Example: **2017001234_yongjunpark_1_Scanner**
    - File name: Student#_Name_Project#_ProjectName.zip (학번_이름_프로젝트번호_프로젝트.zip)
      - Example: **2017001234_yongjunpark_1_Scanner.zip**

Q&A