PROJECT REPORT

ON

COMPILER DESIGN

COURSE NAME: COMPILER DESIGN LABORATORY

COURSE NO: CSE 3212

DATE OF SUBMISSION: 15.06.2021

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FLEX

FLEX (Fast Lexical analyzer generator) is a tool for generating scanners. Scanners perform lexical analysis by dividing the input into meaningful units. For a C program the units are *variables*, *constants, keywords, operators, punctuation* etc. These units also called as tokens.

Structure of a Flex program

Definition Section

%%

Rules Section

%%

User Code

Definition Section

The definitions section contains declarations of simple name definitions to simplify the scanner specification, and declarations of start conditions.

Rules Section

This section contains the pattern and corresponding action. The pattern part contains a regular expression of the lexical analyzer and the action part is a C code, which will be executed when a pattern matches with the input.

User Defined Section (Auxiliary Section)

Actions are C source fragments. If it is compound, or takes more than one line, enclose with braces (‘{‘ ‘}’).

BISON

Bison is a general-purpose parser generator that converts a grammar description for an LALR(1) context-free grammar into a C program to parse that grammar. Parsing involves finding the relationship between input tokens. Bison is upward compatible with Yacc: all properly-written Yacc grammars ought to work with Bison with no change. Interfaces with scanner generated by Flex. Scanner called as a subroutine when parser needs the next token.

Structure of a Bison program

```
%{
C Declarations
%}
```

Bison Declarations
%%
Grammar Rules
%%
Additional C Code

C Declarations

This section contains macro definitions and declarations of functions and variables that are used in the actions in the grammar rules.

Bison Declarations

Terminal and nonterminal symbols, attributes and their associations with terminal and nonterminal symbols are defined here. Precedence as well as associativity are specified here.

Grammar Rules

A Bison grammar rule has the following general form:

result: components.....;

Result is the nonterminal symbol that this rule describes and *Components* are various terminal and nonterminal symbols that are put together by this rule.

Additional C Code

Any C code the programmer wants to provide goes here.

Compiler with Flex and Bison

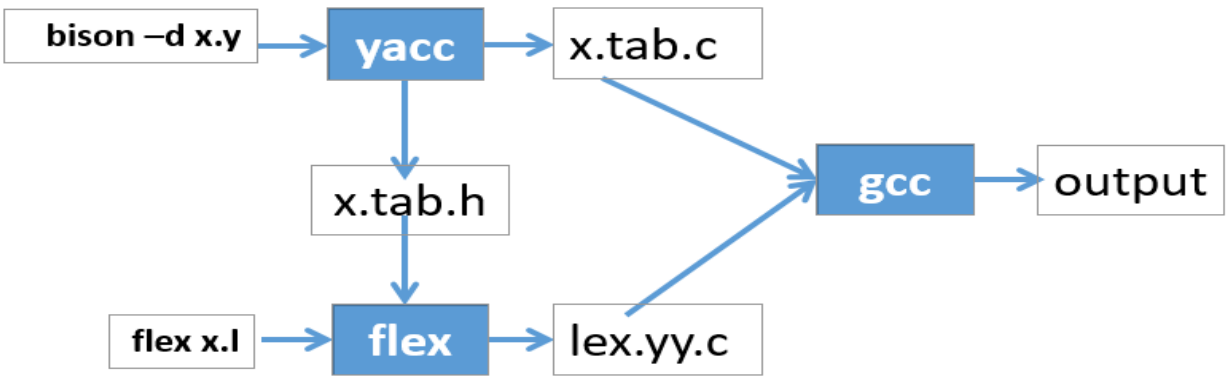

Fig: A diagram of how a compiler build with flex and bison works

Project Description:

DATA TYPES:

1. **Integer:**
   Range: -2,147,483,648 to 2,147,483,647.
   Tokens:
   - INT: Returned if regular expression for detecting integers match an expression
   - INTT: Returned if "int" found for declaring an integer

   Syntax: int a
   int a=10
2. **Float:**
   Range: 1.2E-38 to 3.4E+38
   Tokens:
   - FLOAT: Returned if regular expression for detecting floating point numbers match an expression
   - FL: Returned if "float" found for declaring a floating point number

   Syntax: float b

   float b=5.5
3. **String:**
   Range: a-z (small letters), A-Z (capital letters), 0-9 (digits) and symbols (: _ " ")
   Tokens:
   - STRING: Returned if regular expression for detecting strings match an expression
   - STT: Returned if "string" found for declaring a string

   Syntax: string str

   string st = "CSE"

VARIABLES:

Range: a-z (small letters), A-Z (capital letters), 0-9 (digits). A variable name has to start with a small or a capital letter and can only be 100 characters long.

Type: A variable can contain either an integer value or a floating point number or a string.

Token:

- ID: Returned if regular expression for detecting a variable name matched an expression.

Syntax: int val

float num

string str

OPERATORS:

Token: *yytext is returned for all operators.

Suppose a and b are two integers:

Operators	Data Type	Type	Description	Syntax
+	Integer Float	Arithmetic	Adds two operands.	a+b
-	Integer Float	Arithmetic	Subtracts second operand from the first.	a-b
*	Integer Float	Arithmetic	Multiplies both operands.	a*b
/	Integer Float	Arithmetic	Divides numerator by de-numerator.	a/b
%	Integer	Arithmetic	Modulus Operator and remainder of after an integer division.	a%b
++	Integer	Arithmetic	Increment operator increases the integer value by one.	a++
--	Integer	Arithmetic	Decrement operator decreases the integer value by one.	b--
<=	Integer Float	Relational	True if the value of left operand is greater than or equal to the value of right operand.	(a<=b)
>=	Integer Float	Relational	True if the value of left operand is less than or equal to the value of right operand.	(a>=b)
>	Integer Float	Relational	True if the value of left operand is greater than the value of right operand.	(a>b)
<	Integer Float	Relational	True if the value of left operand is less than the value of right operand.	(a<b)

==	Integer Float	Relational	True if the values of two operands are equal.	(a==b)
!=	Integer Float	Relational	True if the values of two operands are not equal	(a!=b)

CONDITIONAL STATEMENTS;

1. IF-ELIF-ELSE

Tokens:

- IF: Returned when "if" statement is found.
- ELIF: Returned when "elif" statement is found.
- ELSE: Returned when "else" statement is found.

Syntax:

IF

```
if(condition){
 any number of statements
}
```

IF-ELSE

```
if(condition){
any number of statements
}
else{
any number of statements
}
```

IF-ELIF-ELSE

```
if(condition){
any number of statements
}
elif(condition){
any number of statements
}
elif(condition){
any number of statements
}

else{
any number of statements
}
```

NESTED IF-ELIF-ELSE

```
if(condition){
      if(condition){
           any number of statements
      }
      else{
           any number of statements
      }
}
elif(condition){
      if(condition){
           any number of statements
      }
     elif(condition){
           any number of statements
      }
     else{
           any number of statements
      }
 }
else{
       if(condition){
            any number of statements
       }
}
```

2. **SWITCH:**

Tokens:

- SW: Returned when “switch” statement is found.
- CA: Returned when “case” statement is found.
- DF: Returned when “default” statement is found.

Syntax:

switch (expression):

case expression: statement

…….

……..

……..

case expression: statement

default: statement

LOOPS:

1. **FOR LOOP:**

Tokens:

- FOR: Returned when “for” statement is found.

Syntax:

for (expr1, expr2, expr3) {

Any number of statements

}

Suppose i is a loop control variable.

expr1: initial value of loop control variable (i = expr1)

expr2: upper bound of the loop control variable (I < expr2)

expr3: the value by which loop control variables will increment (i = i + expr3)

2. **WHILE LOOP:**

Tokens:

- WHILE: Returned if “while” statement is found.

Syntax:

while(condition) {

Any number of statements

}

FUNCTION (MAIN AND USER DEFINED):

Syntax:

return-type function-name (any number of parameters):

any number of statements

return expr

Return-type: Integer, float, string, void. Return if any expression matches tokens consecutively INTT, FL, STT, VOID.

Function-name: Same as variable name. Token is ID which is returned if any expression matches the regular expression to identify a variable name.

Parameters: Syntax is same as variable declaration (int a/float b/string c). A function may not have any parameters.

Return: The value that the function returns.

Syntax:

return a

Token:

- RETURN: Returned if "return" statement is found.

Return variable can be an integer, a floating point number, a string. Void type functions return nothing.

FUNCTION CALL:

Syntax:

function-name (any number of parameters)

Function-name: Same as variable name. Token is ID which is returned if any expression matches the regular expression to identify a variable name.

Parameters: Syntax is same as variable declaration (int a/float b/string c). A function may not have any parameters.

BUILT IN FUNCTIONS:

FUNCTION NAME	SYNTAX	TOKEN	INPUT	OUTPUT
Sine function	sin(expr)	SIN	The floating point value of the angle in degrees.	The sine value of the angle in degrees.
Cosine function	cos(expr)	COS	The floating point value of the angle in degrees.	The cosine value of the angle in degrees.
Tangent function	tan(expr)	TAN	The floating point value of the angle in degrees.	The tangent value of the angle in degrees.
Logarithm	ln(expr)	LN	A floating point value	The e based logarithm value of the input.
Power function	pow(expr1,expr2)	POW	Two floating point values	Returns expr1 raised to the power expr2.
Minimum	min(expr1,expr2)	MIN	Two integers	Returns the minimum value of the two inputs.
Maximum	max(expr1,expr2)	MAX	Two integers	Returns the maximum value of the two inputs.
Absolute Value	abs(expr)	ABS	Two integers	Absolute value of the integer number.
Floor function	floor(expr1)	FLOOR	A floating point value	Returns the floor value of input in integer form
Ceil function	ceil(expr1)	CEIL	A floating point value	Returns the ceil value of input in integer form
Factorial Function	expr!	*yytext is returned for '!'	An integer(less than or equal to 20)	Returns the factorial of input.

GCD Function	gcd(expr1,expr2)	GCD	Two integers	Returns the gcd of the two Inputs.
Prime function	prime(expr)	PRIME	An integer	Checks if input is prime or not. Prints answer.
String Length Function	len(expr)	LEN	A string	Returns the length of the string
String Compare Function	cmp(expr1,expr2)	CMP	Two strings	Prints the result.
String Copy Function	cpy(expr1,expr2)	CPY	Two string variables	Copies second string to the first string variable.
String Concatenation Function	cat(expr1,expr2)	CAT	Two string variables	Combines two strings and stores them in the first string variable.
Print Integer	pfi(expr1)	PFI	An integer	Prints the input.
Print Floating point number	pff(expr1)	PFF	A floating point number	Prints the input.
Print string without newline	pfs(expr1)	PFS	A string(no blank spaces allowed)	Prints the input.
Print String with newline	pfsn(expr1)	PFSN	A string(no blank spaces allowed)	Prints the input.

HEADER:

Any C header file is accepted.

Syntax:

#include<file_name.h>

Token:

HEAD: Returned when a statement matches the regular expression for a header statement.

COMMENT:

Syntax:

//This is a comment

Token:

CMT: Returns when a statement matches the regular expression for a comment.

SYMBOLS:

Symbol	TOKEN
(	*yytext returned
)	*yytext returned
{	*yytext returned
}	*yytext returned
,	*yytext returned
:	COL returned
Blank Space	No action taken
New Line(\n)	No action taken
Tab(\t)	No action taken