

# **Introduction to Yacc**

# Review of Parser

- Parser invokes scanner for tokens.
- Parser analyze the syntactic structure according to grammars.
- Finally, parser executes the semantic routines.
- YACC generates the definition for `yyparse()` in **y.tab.c** and LEX generates the definition for `yylex()` in **lex.yy.c**.

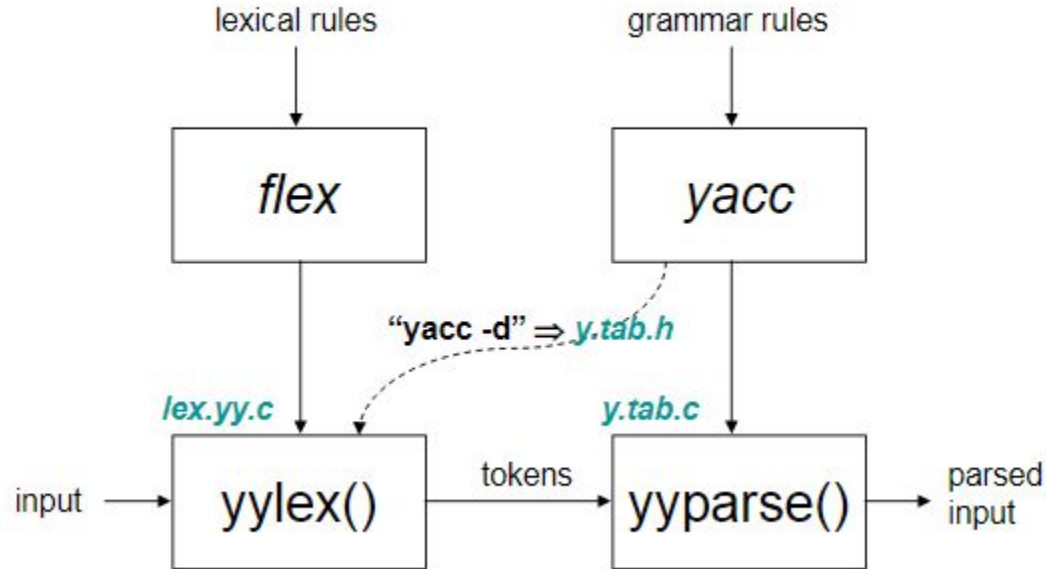
# Introduction to yacc

- Yacc – yet another compiler compiler
- An LALR(1) parser generator.
- Yacc generates
  - Tables – according to the grammar rules.
  - Driver routines – in C programming language.
  - y.output – a report file.

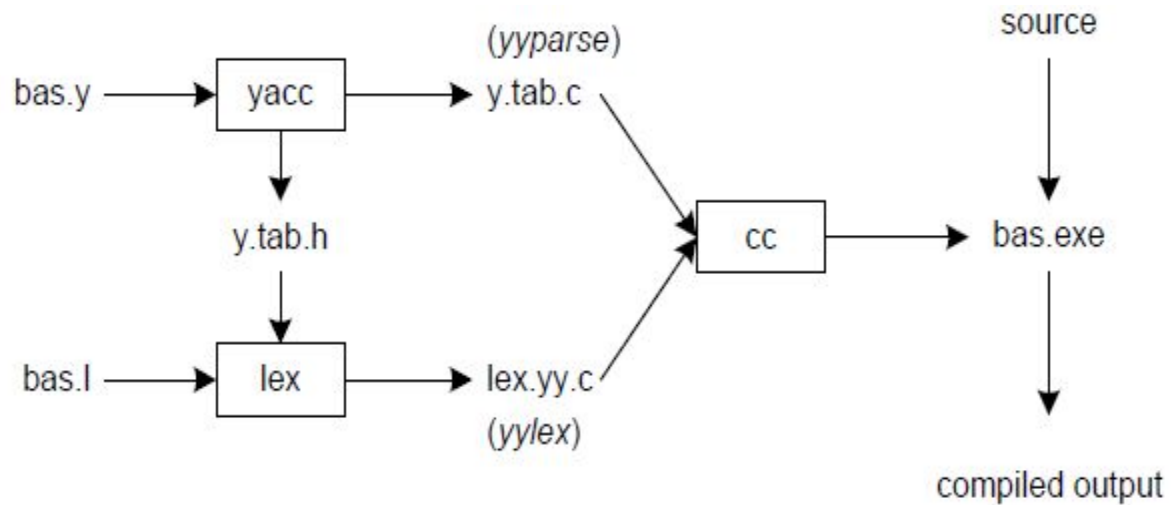
# Cooperate with lex

- Invokes `yylex()` automatically.
- Generate *y.tab.h* file
- The lex input file must contains `y.tab.h`
- For each token that lex recognized, a number is returned (from *yylex()* function)

# Using Yacc together with Lex



# Linking lex&yacc



- Yacc environment

- Yacc processes a yacc specification file and produces a y.tab.c file.
- An integer function yyparse() is produced by Yacc.
  - Calls yylex() to get tokens.
  - Return non-zero when an error is found.
  - Return 0 if the program is accepted.
- Need main() and yyerror() functions.
- Example:

```
yyerror(const char *str)
{ printf("yyerror: %s at line %d\n", str, yyline);
}
main()
{
    if (!yyparse()) {printf("accept\n");}
    else printf("reject\n");
}
```

## – Writing a parser with YACC (Yet Another Compiler Compiler).

- YACC file format:

```
declarations    /* specify tokens, and non-terminals */
%%
translation rules /* specify grammar here */
%%
supporting C-routines
```

- Command “yacc yaccfile” produces y.tab.c, which contains a routine yyparse().
  - yyparse() calls yylex() to get tokens.
  - yyparse() calls a routine called **yylex()** everytime it wants to obtain a token from the input.
  - **yylex()** returns a value indicating the *type* of token that has been obtained. If the token has an actual *value*, this value (or some representation of the value, for example, a pointer to a string containing the value) is returned in an external variable named **yylval**.
- yyparse() returns 0 if the program is grammatically correct, non-zero otherwise



# The structure of YACC programs

DECLARATIONS

%%

RULES

%%

USER SUBROUTINES

# Declarations

The declarations section consists of two parts:

- (i) C declarations and
- (ii) YACC declarations .

The C Declarations are delimited by `%{` and `%}`. This part consists of all the declarations required for the C code written in the *Actions* section and the *Auxiliary functions* section.

YACC copies the contents of this section into the generated `y.tab.c` file without any modification.

`%token` : declares ALL terminals which are not literals.

`%type` : declares return value type for non-terminals.

# Rules

A rule in a YACC program comprises of two parts

- (i) the production part and
- (ii) the action part.

production\_head : production\_body {action in C } ;

# Rules Section

- Each rule contains LHS and RHS, separated by a colon and end by a semicolon.
- White spaces or tabs are allowed.
- Ex:

```
statement: name EUQALSIGN expression  
          | expression ;
```

```
expression: number PLUSSIGN number  
           | number MINUSSIGN number ;
```

# Semantic Routines

- The action in semantic routines are executed for the production rule.
- The action is actually C source code.
- LHS: \$\$      RHS: \$1 \$2 .....
- Default action: { \$\$ = \$1; }
- Action between a rule is allowed. For ex:

```
expression : simple_expression  
| simple_expression {somefunc($1);} relop simple_expression;
```

- Semantic actions
  - Semantic actions associate with productions can be specified.
- \$\$ is the attribute associated with the left handside of the production
- \$\$ represents the result of the non-terminal on the left-hand side of the rule.
- \$1, \$2, \$3, etc., represent the values of the right-hand side components in the production.
- \$1 is the attribute associated with the first symbol in the right handside, \$2 for the second symbol, ...
- An action can be in anywhere in the production, it is also counted as a symbol.

# user subroutines

The user subroutines/auxiliary functions section contains the definitions of two mandatory functions `main()`, `yyerror()`.

# Lex program

## example.l

```
%{  
#include <stdlib.h>  
#include "y.tab.h"  
%}  
%%  
[a-z]* { return VARIABLE; }  
[0-9]+ { yylval = atoi(yytext); return INTEGER; }  
[-+()=/*\n] { return *yytext; }  
[ \t] ;  
%%  
int yywrap(void)  
{ return 1;  
}
```



# Yacc program

## example.y

```
%{
    #include<stdio.h>
    %}

%token INTEGER VARIABLE

%left '+' '-'
%left '*' '/'
%%

program:
    program statement '\n' | ;
statement:  expr          { printf("%d\n", $1); }
           | VARIABLE '=' expr    { $1 = $3; }
           ;
expr:  INTEGER | VARIABLE { $$ = $1; }
      | expr '+' expr    { $$ = $1 + $3; }
      | expr '-' expr    { $$ = $1 - $3; } | expr '*' expr    { $$ = $1 * $3; } | expr '/'
      | expr { $$ = $1 / $3; } | '(' expr ')' { $$ = $2; } ;
%%

void yyerror()
{ printf("\nEntered arithmetic expression is Invalid\n\n");
}
```

- Define the operator precedence and associativity:  
+ and - have the same precedence level and are left-associative.
- \* and / have higher precedence than + and -, and they are also left-associative.
- **The program rule consists of one or more statements, separated by newlines ('\n').**
- The first part handles multiple statements (program statement '\n'), while the second part (;) allows for an empty program (i.e., no statements at all).

- A statement can either be an expression (expr) or an assignment of an expression to a variable. In the first case, the value of the expression (\$1) is printed using `printf("%d\n", $1)`.
- In the second case, a variable (VARIABLE) is assigned the value of an expression (\$3). The variable's value is stored in \$1 (since the variable itself is left-hand side).

- An expr can be: An INTEGER (where \$\$ = \$1 means the value of the expression is the integer itself).
- A VARIABLE (where \$\$ = \$1 means the value of the expression is the value of the variable).
- An expression with binary operators (+, -, \*, /). For example, expr '+' expr means the sum of the first (\$1) and third (\$3) expressions.
- A parenthesized expression ('(' expr)'), where \$\$ = \$2 means the value of the expression is the value of the expression inside the parentheses.

```
(base) psg@psg-OptiPlex-3060:~$ lex example.l  
(base) psg@psg-OptiPlex-3060:~$ yacc example.y  
(base) psg@psg-OptiPlex-3060:~$ gcc lex.yy.c y.tab.c -ll  
(base) psg@psg-OptiPlex-3060:~$ ./a.out
```

a=15

a+30

45

35/5

7

20\*4

80