CPSC 323 Compilers and Languages
LEX & YACC

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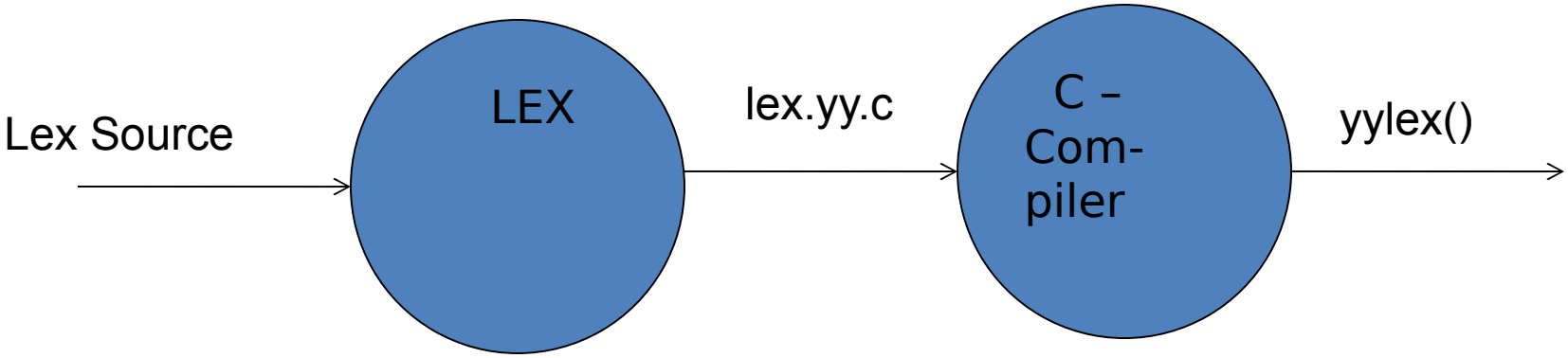
Inputs from Prof Doina Bein & Prof James Choi

1. LEX

- **Lex is a program (generator) that generates lexical analyzers, (widely used on Unix).**
- **Window version is called Flex**
- **It reads the input stream (specifying the lexical analyzer) and outputs source code implementing the lexical analyzer in the C programming language.**


Lex Source
LEX
lex.yy.c
C –
Com-
piler
yylex()

The Lex source (3 sections)

%%

Token Definitions section

%%

Tokens & action section

%%

User Defined section (subroutines)

1.1 Token Definition section

Elementary Expressions

- Use of REs

- Σ = {all alphabets, digits, special chars, etc}

Excepts some special chars such as,

$, ^, [,] - ? Etc -> in that case use “ “ sign.

- concatenation
- union a| b| c| … | z or [a..z], [a-d0-9]
- Kleene Closure [a-z]*
- + [a-z0-9]+

- **Pattern Matching examples.**

Expression	Matches
`abc`	`abc`
`abc*`	`ab abc abcc abccc ...`
`abc+`	`abc abcc abccc ...`
`a(bc)+`	`abc abcbc abcbcbc ...`
`a(bc)?`	`a abc`
`[abc]`	one of: `a`, `b`, `c`
`[a-z]`	any letter, a-z
`[a\-z]`	one of: `a`, `-`, `z`
`[-az]`	one of: `-`, `a`, `z`
`[A-Za-z0-9]+`	one or more alphanumeric characters
`[ \t\n]+`	whitespace
`[^ab]`	anything except: `a`, `b`
`[a^b]`	one of: `a`, `^`, `b`
`[a|b]`	one of: `a`, `|`, `b`
`a|b`	one of: `a`, `b`

Example of Token Definition

```
%%
letter      [a-zA-Z]
digit       [0-9]
ident       {letter}({letter} | {digit}) *
Real        {digit}+”.”{digit}+
op          “+” | “-” |  “*” | “/”
ws          [   \n \t]+
```

1.2 Tokens and action section

This section describes, what to do with it once a token is recognized (actions).

e.g.,

```
{newline}        linecount++
{integer}        { printf (“ found integer”);
                  return INTEGER
                 }
```

1.3 user defined section

section where a user can define own functions that can be used I previous sections.

Lex example:

```
letter    [a-zA-Z]
digit     [0-9]
ident     {letter}({letter} | {digit}) *
op        "+" | "-" | "*" | "/" | "(" | ")" | ";"
ws        [   n t]+
%%
{ws}                ;
{ident}    { yylval = install (yytext);
             return ID;}
{op}       return yytext[0];
%%
main()
   { ..... }

Int install (char *ident) {
/* install the identifier into the symbol
      table */
```

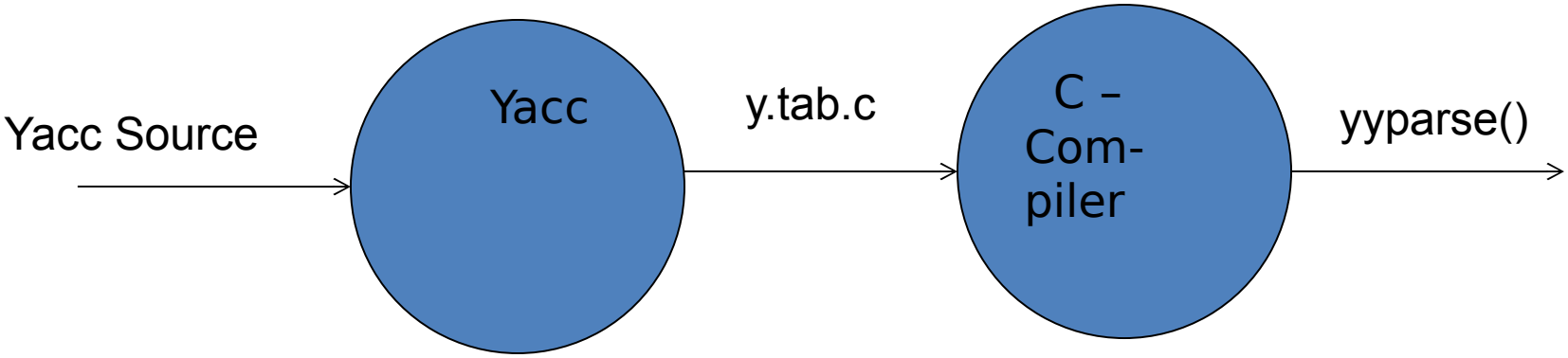
Lex predefined variables. – stats with yy….

Name	Function
`int yylex(void)`	call to invoke lexer, returns token
`char *yytext`	pointer to matched string
`yyleng`	length of matched string
`yylval`	value associated with token
`int yywrap(void)`	wrapup, return 1 if done, 0 if not done
`FILE *yyout`	output file
`FILE *yyin`	input file
`INITIAL`	initial start condition
`BEGIN`	condition switch start condition
`ECHO`	write matched string

2. Yacc

- **Yacc reads the grammar and generate C code for a parser.**
- **Grammars written in Backus Naur Form (BNF) .**
- **BNF grammar used to express *context-free languages* .**
- **This known as *bottom-up or shift-reduce parsing* .**

(LALR parser)


Yacc Source
Yacc
y.tab.c
C –
Com-
piler
yyparse()

Yacc source

(consists of 3 sections)

Definition & Declaration section

%%

Syntax rules & Action section

%%

User defined section

2.1 definition & declaration section

Define or declare variables, tokens etc

e.g.,

```
%token    ID
%token    INTEGER
%left     '+' '-'  /* operator associativity */
%start    expr    /* the starting symbol */
```

2.2 syntax rules & action sections

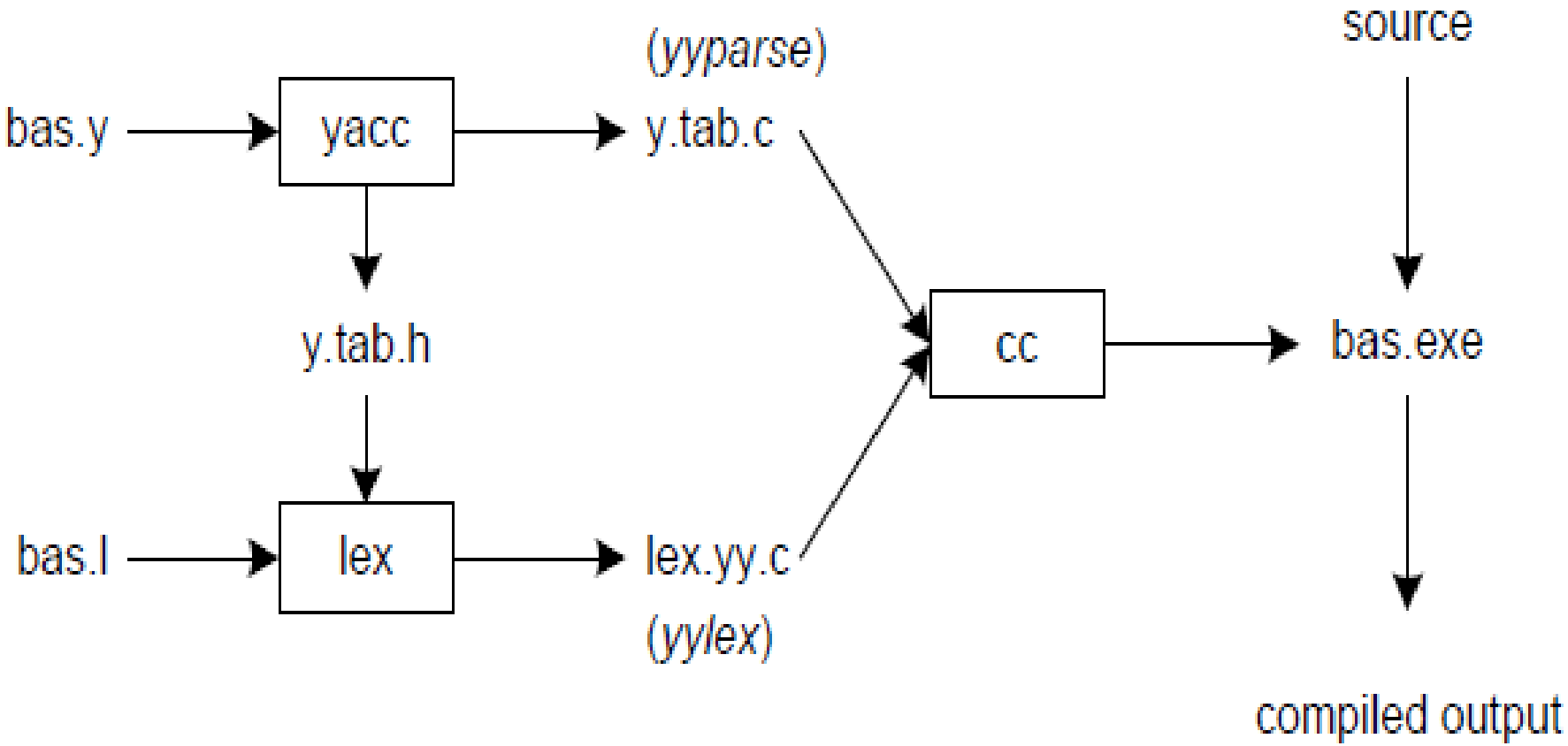
Rules are defined similar to the BNF notation

2.3 user-defined section

Define own functions to be used in the Yacc source

Yacc Example

```
%token   ID
%start   expr
%%
expr :  expr '+'  term     { $$ = $1 + $3}
      | expr '-'  term     { $$ = $1 - $3}
      | term               {$$ = $1}
      ;
term : term '*' factor     {$$ = $1 * $3}
      | term '/' factor    {$$ = $1 / $3}
      | factor;            {$$ = $1}
      ;
Factor : '(' expr ')'      {$$ = $2}
       | ID                {$$ = $1}
       ;
%%
main () {   ..........................  }
```


(yyparse)
source
bas.y
yacc
y.tab.c
y.tab.h
cc
bas.exe
bas.l
lex
lex.yy.c
(yylex)
compiled output