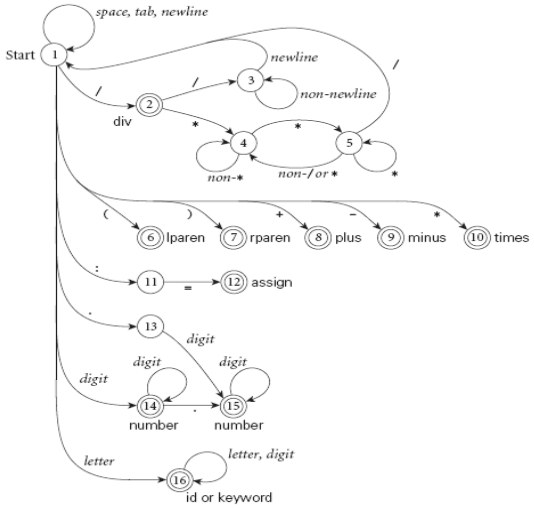
Concepts of Programming Languages, CSCI 305, Fall 2021
Scanning – Ad-hoc and Table Driven, 54-55 & 61-69
Sept. 20

Calculator Language Regular Expressions (page 54)

assign → :=
plus → +
minus → -
times → *
div → /
lparen → (
rparen →)
id → letter (letter | digit)*
except for read and write
number → digit digit* | digit*
(.digit | digit .) digit*
comment → / * (non-* | * non-/)* * /
| // (non-
newline)* newline

Deterministic Automaton for Calculator Language (except whitespace and comment are not handled) (page 57)



```
skip any initial white space (spaces, tabs, and newlines)
if cur_char ∈ {'(', ')', '+', '-', '*'}
    return the corresponding single-character token
if cur_char = ':'
    read the next character
    if it is '=' then return assign else announce an error
if cur_char = '/'
    peek at the next character
    if it is '*' or '/'
        read additional characters until "*/" or newline is seen, respectively
        jump back to top of code
    else return div
if cur_char = .
    read the next character
    if it is a digit
        read any additional digits
        return number
    else announce an error
if cur_char is a digit
    read any additional digits and at most one decimal point
    return number
if cur_char is a letter
    read any additional letters and digits
    check to see whether the resulting string is read or write
    if so then return the corresponding token
    else return id
else announce an error
```

Figure 2.5, page 56, code for ad hoc scanner for the Calculator Language.
Hand execute the ad-hoc scanner code for the Calculator Language on the following code snippet. To parse the code snippet, the parser will repeatedly call the scanner code.

```
/* Simple example */
read noPlayers
read cost        // Cost per player
result:=(noPlayers*cost)-100.00
```

Figure 2.11, page 66, Driver for table-driven scanner

```
state = 0 . . number_of_states
token = 0 . . number_of_tokens
scan_tab : array [char, state] of record
      action : (move, recognize, error)
      new_state : state
token_tab : array [state] of token          -- what to recognize
keyword_tab : set of record
      k_image : string
      k_token : token
-- these three tables are created by a scanner generator tool

tok : token
cur_char : char
remembered_chars : list of char
repeat
      cur_state : state := start_state
      image : string := null
      remembered_state : state := 0       -- none
      loop
            read cur_char
            case scan_tab[cur_char, cur_state].action
                  move:
                        if token_tab[cur_state] ≠ 0
                              -- this could be a final state
                              remembered_state := cur_state
                              remembered_chars := ϵ
                        add cur_char to remembered_chars
                        cur_state := scan_tab[cur_char, cur_state].new_state
                  recognize:
                        tok := token_tab[cur_state]
                        unread cur_char       -- push back into input stream
                        exit inner loop
                  error:
                        if remembered_state ≠ 0
                              tok := token_tab[remembered_state]
                              unread remembered_chars
                              remove remembered_chars from image
                              exit inner loop
                        -- else print error message and recover; probably start over
            append cur_char to image
      -- end inner loop
until tok ∉ {white_space, comment}
look image up in keyword_tab and replace tok with appropriate keyword if found
return ⟨tok, image⟩
```

Table for the calculator program:

State	Current input character														
	space, tab	*newline*	/	*	(	)	+	-	:	=	.	*digit*	*letter*	*other*	
1	17	17	2	10	6	7	8	9	11	–	13	14	16	–	
2	–	–	3	4	–	–	–	–	–	–	–	–	–	–	div
3	3	18	3	3	3	3	3	3	3	3	3	3	3	3	
4	4	4	4	5	4	4	4	4	4	4	4	4	4	4	
5	4	4	18	5	4	4	4	4	4	4	4	4	4	4	
6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	lparen
7	–	–	–	–	–	–	–	–	–	–	–	–	–	–	rparen
8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	plus
9	–	–	–	–	–	–	–	–	–	–	–	–	–	–	minus
10	–	–	–	–	–	–	–	–	–	–	–	–	–	–	times
11	–	–	–	–	–	–	–	–	–	12	–	–	–	–	
12	–	–	–	–	–	–	–	–	–	–	–	–	–	–	assign
13	–	–	–	–	–	–	–	–	–	–	–	15	–	–	
14	–	–	–	–	–	–	–	–	–	–	15	14	–	–	number
15	–	–	–	–	–	–	–	–	–	–	–	15	–	–	number
16	–	–	–	–	–	–	–	–	–	–	–	16	16	–	identifier
17	17	17	–	–	–	–	–	–	–	–	–	–	–	–	white_space
18	–	–	–	–	–	–	–	–	–	–	–	–	–	–	comment

Table of keywords - not shown.

Hand execute the table driven code, using the table for the Calculator Language, on the following code snippet. To parse the code snippet, the parser will repeatedly call the scanner code.

```
/* Simple Program */
read first
read second
third:= fi&st*3.521+second    // error
write third
```