

Applications of Finite Automata in Lexical Analysis and as a Ticket Vending Machine – A Review

Ezhilarasu P

Associate Professor

Department of Computer Science and Engineering
Hindusthan College of Engineering and Technology Coimbatore, India
prof.p.ezhilarasu@gmail.com

Krishnaraj N

Head of the Department

Department of Information Technology
Sree Sastha Institute of Engineering and Technology, Chennai, India
drnkrishnaraj@gmail.com

Abstract: In this paper, we explain the two applications of finite automata. First is about the first phase of a compiler design called as lexical analysis. The lexical analysis used to identify the token with its type. Second is about the designing of vending machine to issue the tickets for the simple applications.

Keywords: Finite Automata, Lexical Analysis, Vending Machine.

I. INTRODUCTION

Automata theory defined as the study of abstract machines and automata, as well as the computational problems that can be solved using them [1]. The important abstract machines are 1. Finite Automata 2. Pushdown Automata 3. Turing Machine. In this, finite automata are the simpler machine, which initially proposed to model brain function of the human. The simplest example for finite automata is the switch with two states "on" and "off" [1].

The Finite Automata is the combination of five tuples focusing on states and transition through input symbols. In figure 1, the starting state is OFF, ending state is ON and collection is ON and OFF. It is having only one input PUSH for making the transition from the state ON to OFF, then OFF to ON. The switch is one of the simplest practical applications of finite automata.

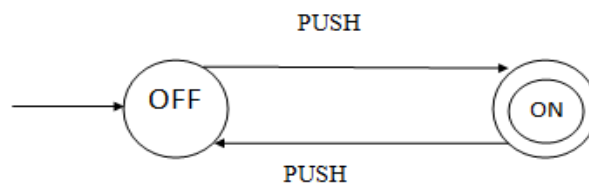


Fig. 1. A Finite Automaton for the switch with on/off states.

The finite automata concepts also used in various fields. In the design of a compiler, it used in the lexical analysis to produce tokens in the form of identifiers, keywords and constants from the input program. In pattern recognition, it used to search keywords by using string-matching algorithms, Ex. UNIX tools like awk, Procmail, and egrep. In network, finite automata concepts used in the communication protocol.

II. RELATED WORK

Zvi Kohavi and Niraj K. Jha [2009] described the advanced topics in finite-state machine design and testing. They also gave the behavior, limitations and structure of logic devices, [2]. Hopcroft, Motwani and Ullman [2001] listed the applications of finite automata. Finite automata are the useful model for many software and hardware. They used in software for digital circuits, finding text pattern in web pages and verifying systems (Example Communication protocol). In compiler design, the initial phase is lexical analysis for generating tokens. Finite automata also used in the lexical analysis, [3]. Ezhilarasu et al. [2014] classified finite automata based on single

loop, double loop and more than double loop into many categories. Many applications may use this classification as a base, [4], [5], [6].

III. FINITE AUTOMATA APPLICATIONS

Finite Automata concepts used in many applications. In this paper, we discuss the two namely

1. Lexical Analysis

2. Ticket Vending Machine

A. LEXICAL ANALYSIS

In the compiler, the source code converted into target code in six phases. The first phase is lexical analysis. In this phase, source code converted into tokens. Example, for tokens are keywords, identifiers and constants as they have the meaning as a unit. The white spaces and comments not considered during conversion. They cannot form any category of tokens. The lexical analyzer gets the input character by character. Then by using pattern-matching technique, it identifies the symbol. Symbol table manager and error handler also associated with the six phases of a compiler. The methods used to implement lexical analyzers can also be applied to other areas such as query languages and information retrieval systems [7]

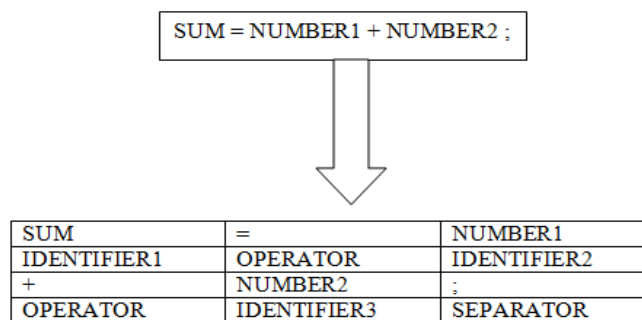


Fig. 2. Lexical Analysis for the input SUM=NUMBER1+NUMBER2;.

LEXEME	Token category
SUM	"Identifier"
=	"Assignment operator."
NUMBER1	"Identifier"
+	"Addition operator."
NUMBER2	"Identifier"
;	"End of statement."

Table . 1. Lexeme with token type for the figure 1.

A lexeme is the unit derived from the source program with each group is related to anyone symbolic category. The given source code "SUM=NUMBER1+NUMBER2;" is having six lexeme, as given in the table 1.

The lexical analyzer read the input character by character until finding the lexeme. First character 'S' is obtained. Then character 'U' followed by 'M' and '='. The last character '=' omitted. The first three characters combined to form the lexeme "SUM". Then the character '=' and 'N' scanned by the lexical analyzer. The last character 'N' omitted to form the lexeme "=". Then the remaining lexemes "NUMBER1", "+", "NUMBER2", ";" identified by the lexical analyzer. The pattern matching technique is used to match the lexeme with the token type.

B. TICKET VENDING MACHINE

A vending machine defined as a machine that dispenses items. It includes snacks, beverages, alcohol, cigarettes, lottery tickets, cologne, consumer products, and even gold and gems to customers automatically. The customer need to insert inserts currency or credit into the machine [8]. We see many vending machines in real life. The finite automata concepts used to design many vending machines.

1) COIN WEIGHING MACHINE

The simplest example is weighing machine. If weighing machine need a two-rupee coin as an input, then the process involved are

1. The customer stands on the bottom of the weighing machine.
2. Insert the two-rupee coin.

3. The weighing machine checks the coin by using sensors.
4. If the input is valid, reach step 6.
5. Return the coin and the process ends.
6. A blank ticket will reach the printing machine.
7. The noted weight with the randomized sentence like “today you will meet special person” will be printed.
8. The printed ticket disbursed to the customer, and the process ends.

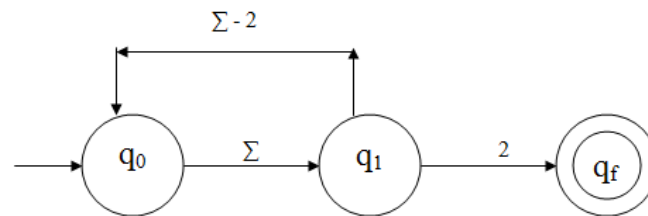


Fig.3.A Mathematical Model of coin weighing machine using finite automata.

The ticket machine represented as a mathematical model as shown in the figure 3. It has q_0 as a starting state, q_f as a final state and q_0, q_1, q_f as a collection of states. The number ‘2’ is used to represent the two-rupee coin as an input character. The transition function implemented between the available states through input characters.

States	Input Character	
	$\Sigma-2$	2
$\rightarrow q_0$	q_1	q_1
q_1	q_0	q_f
$*q_f$	-	-

Table. 2. State Transition Table for the figure 3.

The process involved in the finite automata is given in the table 2. $\Sigma-2$ represents all the coins except the two rupee coin.

2) THEATRE TICKET VENDING MACHINE

The above concept used to design more complex vending machine. Example: vending machine designed to provide cinema theatre ticket. The Cinema Theatre is having two classes namely silver and gold. The rate for the silver class is Rupees 150, and for gold category is Rupees 250.

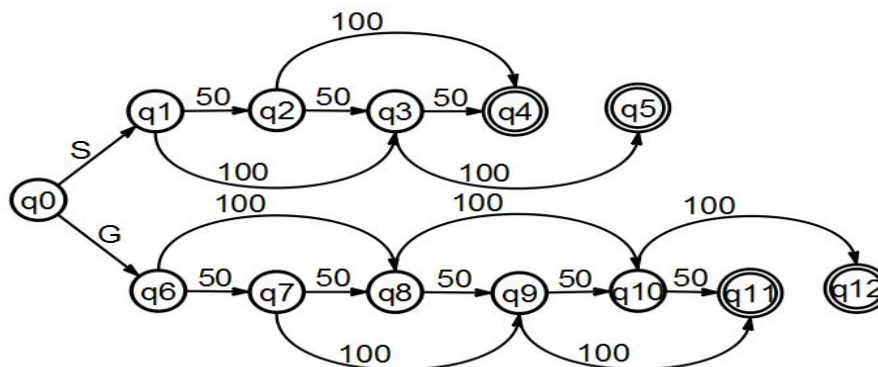


Fig.4.A Mathematical Model of theatre vending machine using finite automata.

The finite automata for the above condition represented by five tuples.

1. Starting state: q_0
2. Final State(s) : q_4, q_5, q_{11}, q_{12}

3.Group of States: q0, q1, q2, q3, q4, q5, q6, q7, q8, q9, q10, q11, q12

4.Transition: As given above in the figure 4

5.Input characters: S,G,50,100

States	Input Character			
	S	G	50	100
→q0	q1	q6	-	-
q1	-	-	q2	q3
q2	-	-	q3	q4
q3	-	-	q4	q5
*q4	-	-	-	-
*q5	-	-	-	-
q6	-	-	q7	q8
q7	-	-	q8	q9
q8	-	-	q9	q10
q9	-	-	q10	q11
q10	-	-	q11	q12
*q11	-	-	-	-
*q12	-	-	-	-

Table.3. State Transition Table for the figure 4.

The vending machine could process only two types of notes 1.50 rupees note 2.100 rupees note. The vending machine has two buttons namely 'S','G'. The S represents the silver class, and G represents the gold category. The customer should choose any one of the given buttons. Here we have four final states namely q4, q5, q11, q12. The states q4, q5, used to print the ticket for the silver class as given in the table 3. If the state is q4, then the ticket card printed for silver class. If the state is q5, then the ticket will be printed for silver class with gift voucher worth rupees 50. If the state is q11, then the ticket card printed for the gold class. If the state is q12, then the ticket will be printed for the golden class with gift voucher worth rupees 50. The gift voucher used to buy snacks in the cinema theatre.

IV. CONCLUSION

This paper is useful for the students, those who are going to study the subject theory of computation. Students will be able to implement the mathematical model for other simple applications. In Computer Science and Engineering there are many subjects, each is having relation with others in some way. The theory of computation is the base for studying the subject principles of compiler design.

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