# Theory of Computation (CS F351)


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# *Finite Automata*

(Chapter-2)

# Concepts

innovate achieve lead

1. We look at the models of Computations and devices for accepting and generating languages.

2. A restricted model of a computer is – a *Finite Automaton or a Finite state Machine*

3. *The FA shares one common property with a real computer- Both got a CPU of fixed and finite capacity.*

## What a finite automaton does:

- It accepts a string as an input, delivered to it on an input tape.
- It produces no output.
- But it gives an indication of whether the input string is approved or disapproved or accepted or rejected.

We can see it as a language recognition device.

Hence an *Automaton* is a Machine designed to respond to encoded instructions; a robot.

Uses:
Automata are applicable to algorithms and computer programs.

Ex: 1→ The lexical analysis process which identifies program units like operators, identifiers, constants etc., is often based on the simulation of Finite Automaton

Ex : 2→ The problem of finding the occurrences of a string within the other

## Operations of a Finite Automaton

Strings are fed into the device through input tape.

1. The tape is divided into squares where we can write a single symbol.
2. The main part of the machine is called as *finite control*.
3. At any given instance of time the *finite control* can be at one of the specified finite no. states.
4. This finite control can sense the symbols written on the tape, with a movable Read head.

Initially the RH is placed at the leftmost square of the tape.

Then the FC is in initial state.

At regular intervals automaton reads one symbol from the input tape then enters a new state depends only on the current state and the symbol read.

That is why this machine is called by the deterministic finite automaton.

After reading an input symbol, the read head moves one square to the right on the tape so that on the next move it will read the symbol in the next square.

This process is repeated again and again-

- read symbol,

- move the head to the right,

- change the state of the FC

At some point , the reading head reaches the end of the input string.

The automaton then indicates the acceptance or rejection of what it has read, by its state at the end.

If the state at the end is one among the final states then it is accepted.

The language accepted by the machine is set of all strings it accepts.

## Formal definition

A Deterministic Finite Automaton is a quintuple- $( K, \sum , \delta, s, F )$

$K$ is a finite set of states

$\sum$ is an alphabet

$s \in K$ is the start state

$F$ subset of $K$ is the set of final states

$\delta$ *is the transition function from* $K \times \sum \rightarrow K$

## Rules of transition for a automaton *M* :

Rules are encoded into the transition function.

Thus the automaton M in state q *€ K and symbol read from the input tape is*

*a € ∑, the transition function is given as δ(q, a) € K is the uniquely determined state to which the M passes.*

Since the automaton is not allowed move its head backwards, it can not visit the part of the tape which is already read.

Hence the already read part of the string will not influence the future of the machine.

The language accepted by a automaton *M*, *L(M)*, is the set of all strings accepted by *M*

Ex 1: Let M be the deterministic finite automaton ( $K, \sum, \delta, s, F$ )

Where K={q0, q2}
∑= {a, b}
s= {q0}
F= {q0}

And δ is the function tabulated as follows

| State (q) | Next symbol(σ) | $\delta(q, \sigma)$ |
|---|---|---|
| q0 | a | q0 |
| q0 | b | q1 |
| q1 | a | q1 |
| q1 | b | q0 |

L(M) is the set of all strings in {a, b}*, that have an even number of *b*s

If the M is given the string *aabba*

The initial configuration is $(q_0, aabba)$ *then we have*

1. $(q_0, aabba) \rightarrow (q_0, abba)$
   $\rightarrow (q_0, bba)$
   $\rightarrow (q_1, ba)$
   $\rightarrow (q_0, a)$
   $\rightarrow (q_0, e)$

*Therefore* $(q_0, aabba)$ *after multiple moves reaches* $(q_0, e)$

*Hence the string aabba is accepted by M*

Ex 2: Check if the string *baabbb* is accepted, the previous *M* or not

# Deterministic Finite Transducer

Is a device much like DFA, except that its purpose is not to accept strings or languages.

But to transform input string into output strings

It starts in a designated state and moves from state to state depending on the input like DFA.

On each step however it emits a string of zero or more symbols depending on the current state and input symbol.

State diagram is similar to that of a DFA except that the label on an arrow will have *a/w,* meaning if the input symbol is *'a'* follow this arrow and emit *'w'.*