

Deterministic Finite Automata

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Wednesday 30th November, 2016

- Any physical body or machine, or animal, or even solar system, which changes its **states** with time, can be represented by Automata.
- Given any initial state and final state, we can think of intermediate discrete states, through which transition have taken place.
- **Objective:** Use automata to model the behaviour of computer, and other real life machines, having finite states or assumed to have finite states.
- **Automata theory:** Abstract mathematical representation of computational procedures. FA is used in design of lexical analyzers in compilers, for searching patterns in arbitrarily large texts, natural language processing, text processing, etc.
- FA is simplest computing model, it is a restricted program without variables.
- FA shares its features with computer. It has finite – a very limited memory, present in CPU only.

Finite Automata

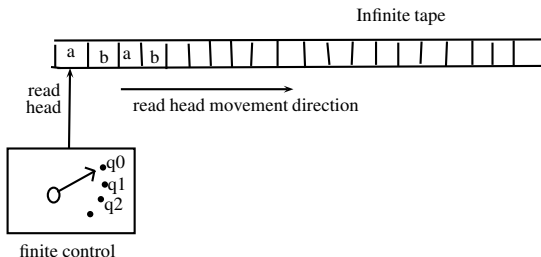


Figure 1: Finite Automaton

- A finite automaton has finite set of states Q it can undergo, an alphabet set Σ , a set of accepting or final states F , where $F \subseteq Q$, a starting state s , and a transition function δ , where $\delta : Q \times \Sigma = Q$. Thus, a FA $M = (Q, \Sigma, \delta, s, F)$.
- If a FA is in state p and makes a transition to state q on reading of symbol $a \in \Sigma$, then this transition is represented as $\delta(p, a) = q$.

- If there is an input $w = abcd$ on tape, and transitions are like this: $\delta(p, a) = q, \delta(q, b) = r, \delta(r, c) = s, \delta(s, d) = t$. Thus, at the begin we have state and input as $(p, abcd)$, which is called as initial **configuration** or **ID**(Instantaneous description) of the FA.
- The sequence of transitions through which it will go are:
 $(p, abcd) \vdash_M (q, bcd) \vdash_M (r, cd) \vdash_M (s, d) \vdash_M (t, \epsilon)$ or we can say that configuration $(p, abcd)$ goes to configuration (t, ϵ) through zero or more transitions, written as: $(p, abcd) \vdash_M^* (t, \epsilon)$; the symbol \vdash is called “derives.”
- The language of M :
 $L = L(M) = \{w | w \in \Sigma^*, (p, abcd) \vdash_M^* (t, \epsilon), \text{ and } t \in F\}$, \vdash_M^* is transitive relation, and defined as $\vdash_M: Q \times \Sigma^* \rightarrow Q \times \Sigma^*$
- Given any input symbol and current state there is a definite next state. Thus, given a start state, and input string it is possible to determine entire behaviour of a FA. Hence, this FA is called DFA (deterministic FA).

- What is regular expressions and FA for:

$Q = \{q_0, q_1, q_2\}$, $\Sigma = \{0, 1\}$, $F = \{q_1\}$, and δ is given as:

current state	input	
	0	1
q_0	q_0	q_1
q_1	q_0	q_2
q_2	q_2	q_1

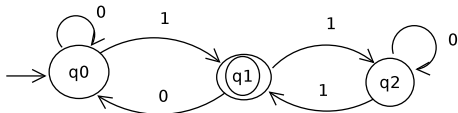


Figure 2: Transition diagram of corresponding FA.

Regular expression = $0^*1(0^+1 + 10^*1)^*$

- Which of following are FA? Justify.
 - 1 Digital computer,
 - 2 analog computer,
 - 3 digital voltmeter,
 - 4 analog voltmeter,
 - 5 chemical reaction,
 - 6 interaction of radiation with matter,
 - 7 transformation of water into vapor.