Deterministic Finite Automata

FINITE AUTOMATA

A finite automaton is a simple model of a computer

- it is a language recognition device
- theory of finite automaton can be applied in the construction of the lexical analyzer component of a compiler

Deterministic Finite Automaton (DFA)

- Simple language recognition device
- Operation of a DFA is completely determined by the input
- Strings are fed into the device by means of an input tape, which is divided into squares with one symbol inscribed in each square
- Finite control – can sense what symbol is written at any position on the input tape by means of a movable reading head.

Definition:

A <u>deterministic finite automaton (DFA)</u> is a quintuple
$M = (K, \Sigma, \delta, s, F)$ where

- K is a finite set of states,
- Σ is an alphabet,
- $s \in K$ is the initial (start) state,
- $F \subseteq K$ is the set of the final states; and
- δ, the transition function, is a function from
  $K \times \Sigma$ to K

The rules in which the automaton M picks the next state are encoded into the transition function

Example:

DFA $M = (K, \Sigma, \delta, s, F)$

$K = (q_0, q_1)$

$\Sigma = \{a,b\}$

$s = q_0$

$F = \{q_0\}$

δ is defined as

q	σ	$\delta(q,\sigma)$
q_0	a	q_0
q_0	b	q_1
q_1	a	q_1
q_1	b	q_0

A **<u>configuration of a DFA</u>** is determined by the current state and the unread part of the input string. A configuration is any element of $K \times \Sigma^*$

- $(q_1, w_1) \vdash_M (q_2, w_2)$ iff $w_1 = \sigma w_2$ for some symbol $\sigma \in \Sigma$ and $\delta(q_1, \sigma) = q_2$
- $\vdash^*_M$ $(q_1, w_1) \vdash^*_M (q_2, w_2)$ after 0 or more steps
- A string $w \in \Sigma^*$ is said to be accepted iff there is a state $q \in F$ such that
- $(s, w) \vdash^*_M (q, e)$
- Finally, the language accepted by M, denoted by L(M) is the set of all strings accepted by M.

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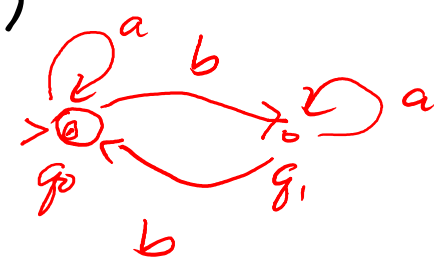

$w = abab$

$(q_0, abab) \vdash_M (q_0, bab)$

$\vdash_M (q_1, ab)$

$\vdash (q_1, b)$ $\quad abab \in L(M)$

$\vdash (q_0, e)$

$w = aab$

$(q_0, aab) \vdash (q_0, ab)$

$\vdash (q_0, b)$ $\quad aab \notin L(M)$

$\vdash (q_1, e)$

$L(M) = \{w \in \{a,b\}^* \mid w$ has even number of b's $\}$

A DFA can be represented by **<u>state transition diagram</u>**.

A state diagram is a directed graph. States are represented by nodes, and there is an arrow labeled with σ from node q to node $q1$ whenever $\delta(q,\sigma)=q1$. Final states are indicated by double circles and the initial state is shown by >.

State transition diagram of a DFA

- There is exactly one transition corresponding to each element of Σ, one each state in K.
- Every arc is labeled using one and only one element in Σ.