* Symbol $\{a, b, c, 1, 2, 3\}$

The basic building block of a language (smallest unit).

* Alphabet

A finite set of symbol $\Sigma(a, b)$

* String

Collection / sequence of alphabets.

if $\Sigma(a, b)$

String = $\{a, b, aa, ab, ba, bb \dots\}$

→ Length = 2

String = $\{aa, ab, ba, bb\}$.

* Language

→ Collection of all the possible strings.

Q1) $\Sigma(a, b)$

(i) L_1 = strings of length 2.

$L_1 = \{aa, ab, ba, bb\}$

NOTE

If length of string = zero

$$\boxed{\Sigma^0 = \varepsilon}$$

epsilon

LANGUAGE

- **FINITE**
  $\{aa, ab, ba, bb\}$
  {Length of 2}
- **INFINITE**
  $\{aa, aaa, aaaa \ldots\}$
  {at least 1 a}

---

* AUTOMATA

Automata is a mathematical model or a machine to check if the string given is a part of the language.

AUTOMATA

- **FA** {FINITE AUTOMATA}
- **PDA** {PUSH DOWN AUTOMATA}
- **LBA** {LINEAR BOUND AUTOMATA}
- **TM** {TURING MACHINE}

* POWER OF SIGMA

→ Σ (Sigma) represents the total Alphabets.

→ $\boxed{\text{Minimum power} = 0}$

Σ^0 → Set of all strings with length zero.

$\Sigma^0 = \varepsilon$

P°

→ Σ^1 = set of all strings with length 1.

P¹

$\Sigma^1 = \{a, b\}$

→ Σ^2 = S O A S W length 2

P²

$\Sigma^2 = \Sigma \cdot \Sigma = \{a, b\} \cdot \{a, b\} = \{aa, ab, ba, bb\}$

* KLEENE CLOSURE

$\boxed{\Sigma^*}$

→ Set of All the strings possible on $\{a, b\}$ including the ε string.

P5

Its an Infinite Automata

* POSITIVE & CLOSURE

→ Denoted by $\boxed{\Sigma^+}$.

→ It is the set of all strings possible on $\{a, b\}$ except the ε case.

Relation

$$\boxed{\Sigma^* = \Sigma^+ + \varepsilon}$$

L-5

* GRAMMAR

→ A grammar 'G' is defined as quadruple.

→ $G = \{V, T, P, S\}$

Set of rules to define a language
OR
Standard way to represent a language.

① Variable

② Terminal

③ Production Rule

④ Start Symbol.

* DFA

→ A deterministic finite automata is a type of finite automata in which the transition are deterministic.

→ It is denoted by a quintuple :

$$\boxed{A = (Q, \Sigma, \delta, q_0, F)}$$

Where,

$Q \rightarrow$ Set of all finite States;

$\Sigma \rightarrow$ Set of all alphabets.

$\delta \rightarrow$ Transition function or next state function
$(Q \times \Sigma \rightarrow Q)$

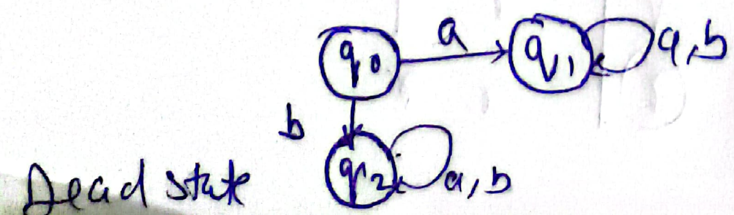
$q_0 \rightarrow$ Initial State / start state.

$F \rightarrow$ set of final states.

Example

Design a DFA for a language $\Sigma = (a, b)$
L = Strings start with a.

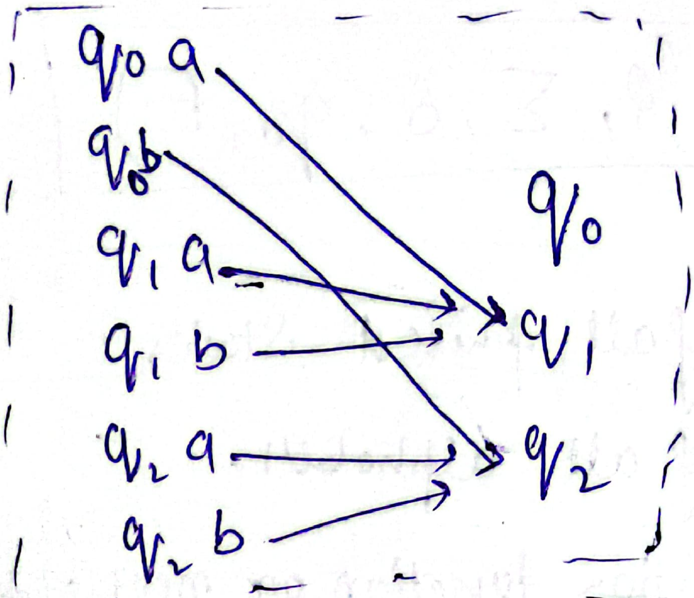
$L = \{a, aa, aaa, ab\}$



Transition:

$$Q \times \Sigma \rightarrow Q$$

$$\begin{matrix} q_0 \\ q_1 \\ q_2 \end{matrix} \times (a, b) \rightarrow Q$$



TRANSITION TABLE

→ Transition table is the table of the transition function

- We use an arrow to point the initial state
- We encircle all the final state.

Example

δ	a	b
$\rightarrow p$	q	p
q	r	p
r	r	r

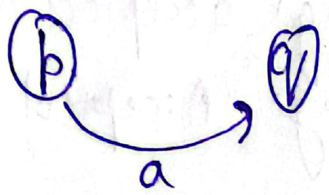
*STATE TRANSITION GRAPH (Diagram)

- A STG is diagramatical representation of a DFA :

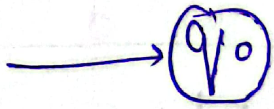
POINTS TO REMEMBER

① Every state in Q is represented by a node.

② If $\delta(p, a) = q$ then there is an arc from p to q labelled a.

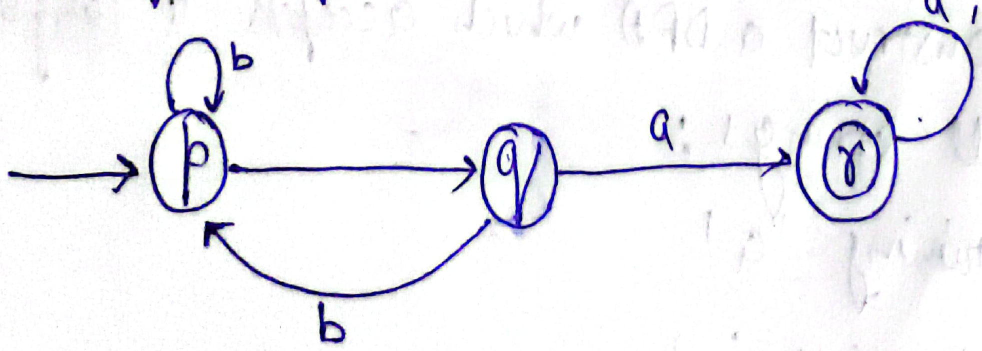


③ There is an arrow with no source into initial state q_0.



④ Final state are indicated by double circle

Ex → Diagram of previous table



* LANGUAGE OF DFA

A string $x \in \Sigma^*$ is said to be accepted by a DFA, A when you apply the string x in the initial state and DFA reaches to a final state.

* The set of All strings accepted by DFA, A is said to be language Accepted by A and is denoted by L(A).

That is,

$$\boxed{L(A) = \{x \in \Sigma^* / \hat{\delta}(q_0, x) \in F\}}$$