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Subject: TOC

Introduction to formal Language And FA.

*** Formal Language :-**

"A formed language is set of string of symbol together with a set of rules that are specific to it."

*** Alphabet :-**

- A subset of string over an alphabet is a language.
- An alphabet is a finite, non empty set of symbols.
- Σ symbol is used for an alphabets.
- Common Alphabet include :

  $\Sigma\{0, 1\}$, the binary alphabet

  $\Sigma\{A, B, \ldots Z\}$, set of uppercase letters.

  $\Sigma\{0, 1, 2 \ldots 9\}$, the decimal alphabets.

*** String :-**

- A string is a finite sequence of symbols from alphabets.

e.g. 10110 is a string from binary alphabet

520 is a string from decimal alphabet.

'MAN' is a string from roman alphabet.

*** Kleene closure :-**

Given alphabet Σ, the kleene closure of Σ is a language given by

$$\Sigma^* = \Sigma^0 \cup \Sigma^1 \cup \Sigma^2 \ldots$$

$\Sigma^0 \rightarrow \epsilon$, $\Sigma^1 \rightarrow$ string of length 1, $\Sigma^2 \rightarrow$ string of length 2.

e.g.

1. If $\Sigma = \{x\}$ then

   $\Sigma^* = \{\epsilon, x, xx, \ldots\}$

2. If $\Sigma = \{0, 1\}$ then

* Finite Automata :

→ "Finite automata is also called as Finite state machine"
A finite state machin is mathematical model for actual physical process. By considering possible inputs on which these m/c can work, we can analyse their strength & weakness"

Finite automata is used for solving several common types of computer algorithm. Some of them are (Applications) of FA

1. Design of digital circuit
2. String matching
3. Commⁿ protocol for inforⁿ exchange.
4. Lexical analyzer of compiler.
5. Control of lift & working m/c.

* Limitation of Finite Automata :

- it cann't be used for computation
- It cann't be modified it's own input
- It cann't be used for context free Grammer/language
- It cann't be used for recursive.

* DFA - Deterministic Finite Automata :

" Deterministic finite Automata is a quintuple.

$$M = (Q, \Sigma, \delta, q_0, F), \text{ where}$$

Q is a set of states

Σ is a set of alphabet.

$q_0 \in Q$ is the initial state.

$F \subseteq Q$ is the set of final state. and

δ is the transition function, is fⁿ from $Q \times \Sigma$ to Q.

Representation of DFA.

$M = \{Q, \Sigma, \delta, q_0, F\}$, where

$Q = \{q_0, q_1\}$

$\Sigma = (0, 1)$

$F = \{q_1\}$

* NFA - Non-deterministic finite Automata.

→ " A Non-deterministic finite Automata is a 5 tuple

$M = (Q, \Sigma, \delta, q_0, F)$

where, Q = A finite set of state.

Σ = A finite set of input.

δ = A transition function from $Q \times \Sigma$.

q_0 = start / initial state.

F = set of final / accepting state.

Representation of NFA ÷

$(\{q_0, q_1, q_2\}, \{0,1\}, \delta, q_0, \{q_2\})$

$Q = q_0, q_1, q_2$

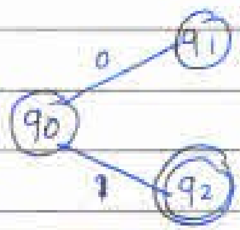
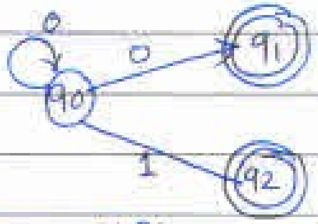
$\Sigma = (0,1)$

δ = tran^{n} function

q_0 = q_0 start state.

F = q_2 final state.

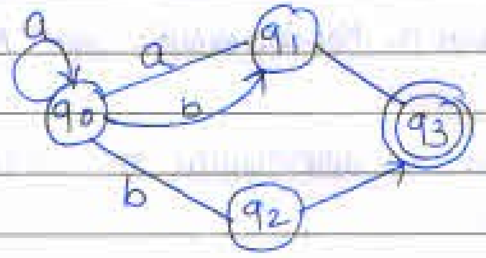
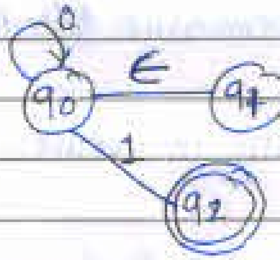
* Compare DFA and NFA.

Sr No	DFA	Sr No	NFA
1.	it stand for Deterministic finite Automata	1.	it stands for Non-deterministic finite Automata
2.	it is deterministic in nature	2.	It is non-deterministic in nature.
3.	DFA may have one final state	3	NFA can have multiple final state.
4.	DFA has single transition for each i/p	4.	NFA can have multiple transition for i/p.
5.	 DFA. as there are single transition for 0 input	5.	 NFA. As there are 2 transition for 0 input } 2 final state
6	it has more nos of state	6	it has fewer nos of state
7.	easy to design	7	difficult to design

* NFA with ∈ transition :

- NFA stand for Non-deterministic Finite Automata.
- ∈ is a null symbol.
- An ∈ transition allows transition on ∈ (or no input)
- ∈ (epsilon) is also called as empty string
- It means that machine can make transition without any i/p.

* Compare NFA and NFA-∈

Sr NO	NFA	Sr NO	NFA-∈
1.	it stands for Non-deterministic Finite Automata without Epsilon ∈	1.	it stands for Non-deterministic Finite Automata with
2.	NFA is non-deterministic in nature	2.	NFA-∈ is non-deterministic in nature.
3.	There are no epsilon ∈ or Empty transition	3.	There is Epsilon ∈ or empty transition.
4.	NFA occupies less space	4.	NFA-∈ occupies more space.
5.		5.	

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Introduction to formal Lang & finite Automata

* Mealy Machine :-

- A mealy m/c M is defined as : o/p associated

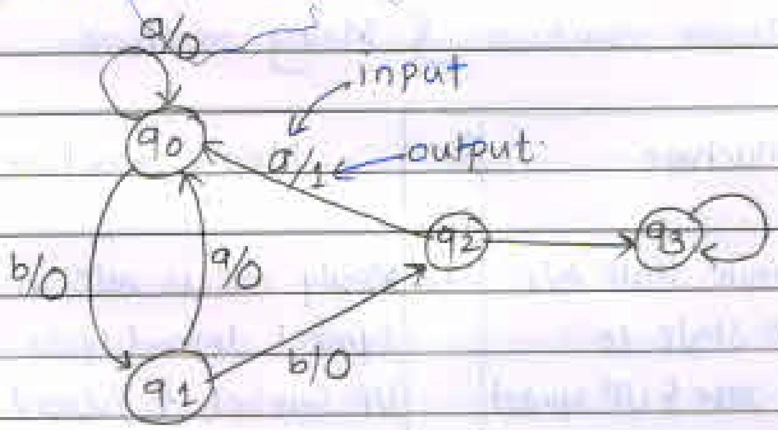
$$M = \{Q, \Sigma, O, \delta, \lambda, q_0\}$$

where,

- Q = A finite set of state.
- Σ = A finite set of i/p state.
- O = A finite set of o/p state
- δ = A transition function $\Sigma \times Q \to Q$
- λ = An output function $\Sigma \times Q \to O$
- q_0 = $q_0 \in Q$ is an initial state.

"Mealy machin is a machine in which output symbol depends upon the present i/p symbol and present state of machine."

e.g.



* Moore Machine :-

A moore machine M is defined as

$$M = \{Q, \Sigma, O, \delta, \lambda, q_0\}$$

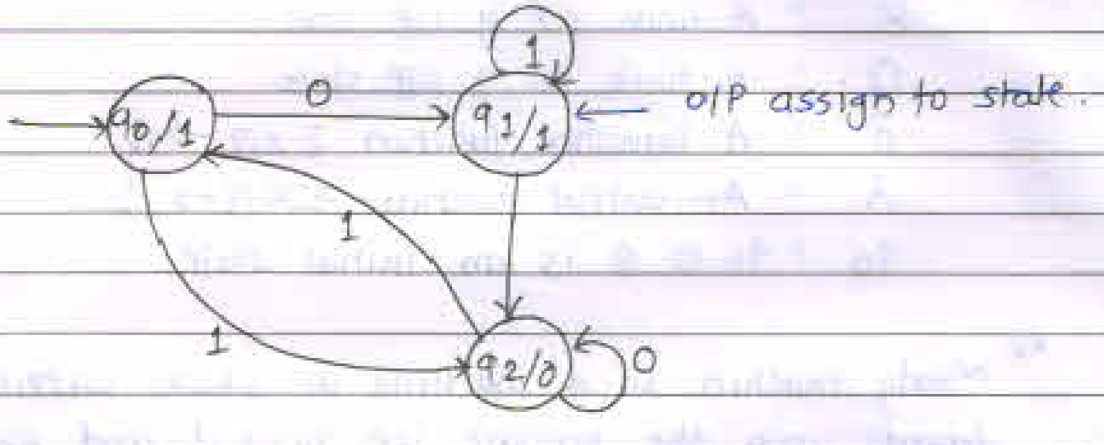
where,

- Q = A finite set of state
- Σ = A finite set of i/p alphabet
- O = A finite set of o/p alphabet
- δ = A transition function $\Sigma \times Q \to Q$
- λ = An output function $Q \to O$
- q_0 = $q_0 \in Q$ is an initial state.

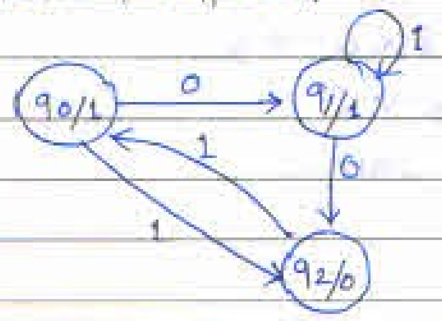
* Moore machine :-

"Moore machine is a finite state machine in which the next state is decided by current state & current i/p symbol"
The output symbol at given time depends only on present state of the machine.

e.g.



* Compare Moore machine & Mealy machine.

Sr NO	Moore machine	Sr NO	Mealy machine.
1.	Moore m/c is finite state m/c in which the next state is decided by current state & i/p symbol	1.	Mealy m/c is m/c in which o/p symbol depend upon the present i/p symbol & present state m/c.
2	output is associated with state $\lambda : Q \to O$	2	output is associated with transition $\lambda : \Sigma \times Q \to O$
3	Length of moore machine is one longer by mealy	3	Length of mealy m/c is shorter than moore
4.	Difficult to implement	4.	Easy to implement
5.	e.g 	5	e.g