Theory of Computation: CS-202
Finite Automata

Content

Finite Automata

Deterministic Finite Accepters

- Examples

Non Deterministic Finite Accepters

- Examples

Deterministic Finite Accepters

Definition

A deterministic finite accepter or dfa is defined by the quintuple

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

where Q is a finite set of internal states,

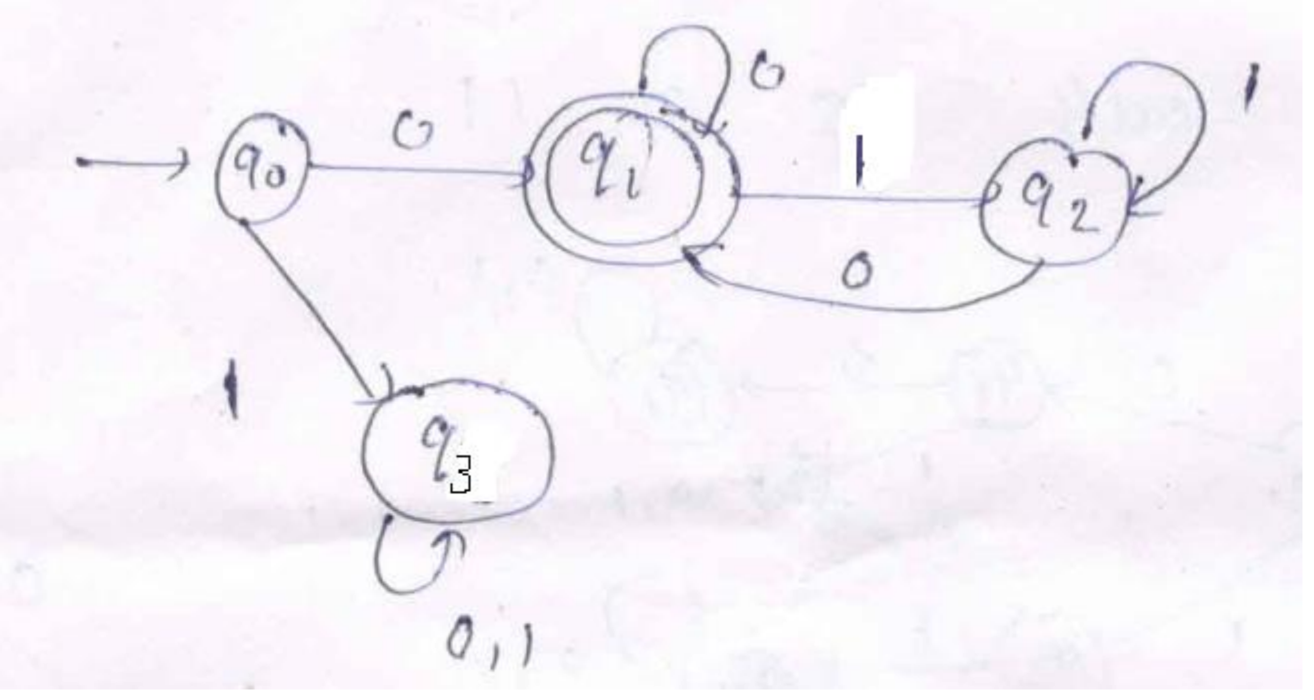
Σ is a finite set of symbols called the input alphabet,

$\delta: Q \times \Sigma \to Q$ is a total function called the transition function,

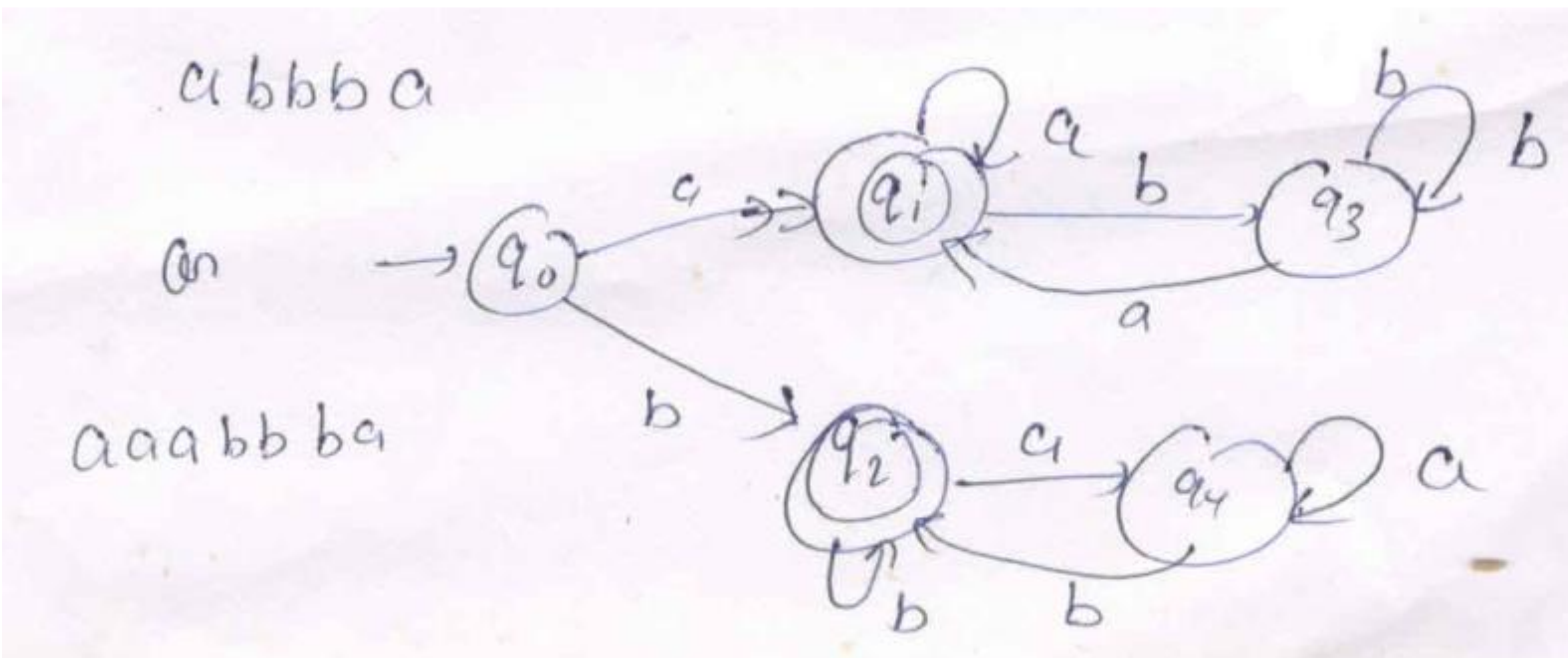
$q_0 \in Q$ is the initial state,

$F \subseteq Q$ is a set of final states.

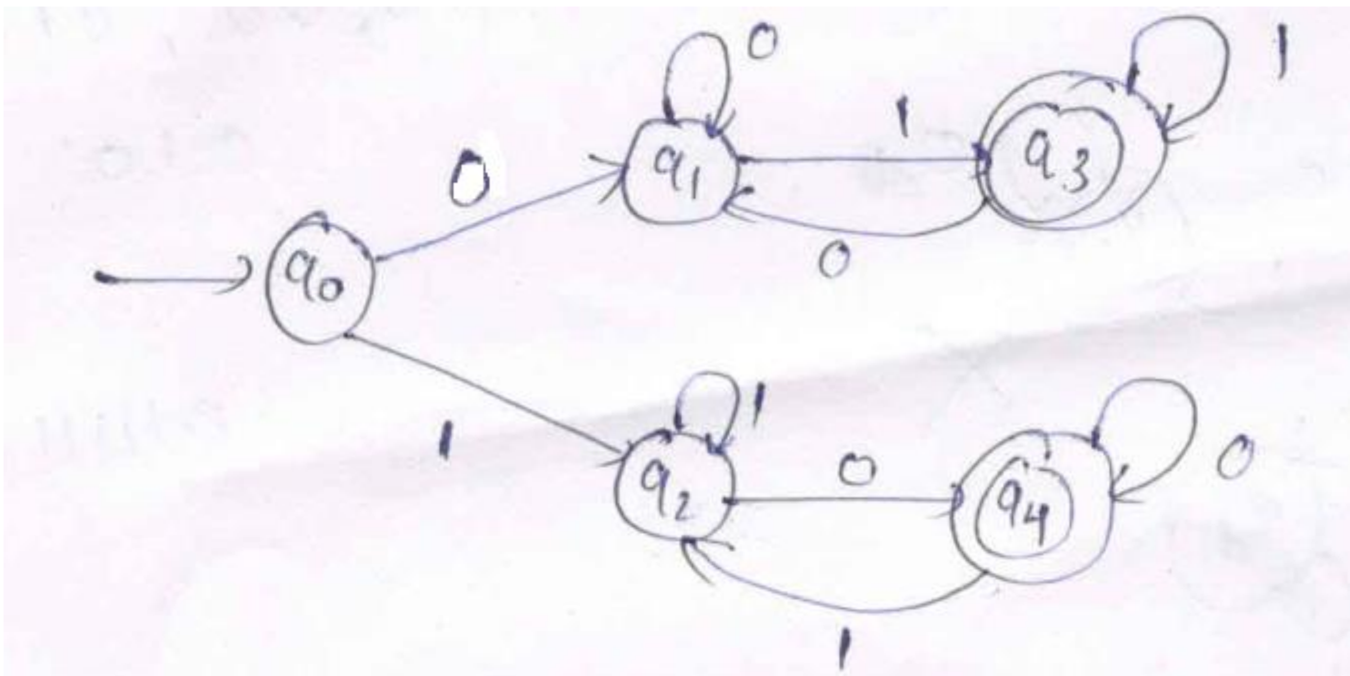
- Draw a DFA which accepts all the strings on $\Sigma=\{0,1\}$ which must start & end with '0'.



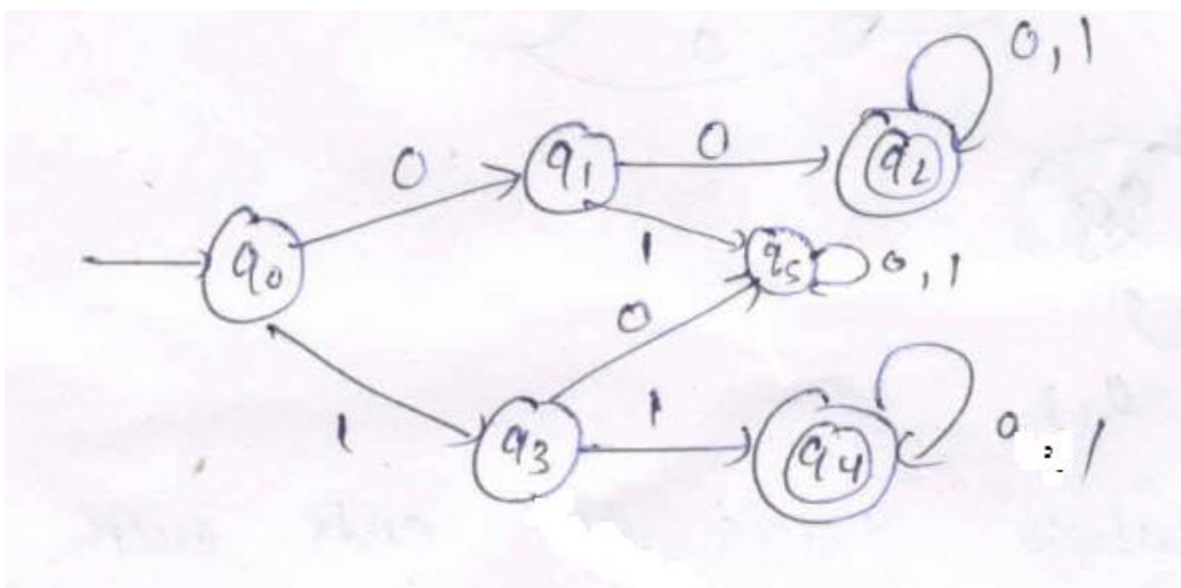
- Draw a DFA which accepts all the strings on Σ={a,b} which starts and ends with same symbol.



- Draw a DFA which accepts all the strings on $\Sigma=\{a,b\}$ which starts and ends with different symbol.



- Draw a DFA which accepts all the strings on $\Sigma=\{0,1\}$ which starts with '00' or '11'.



Practice Problems

1. Draw a DFA which accepts all the strings on $\sum=\{0,1\}$ which never ends with '100'.

2. Draw a DFA which accepts all the strings on $\sum=\{0,1\}$ which contains sub-string '00'.

1. Draw a DFA over $\Sigma=\{a,b\}$ which accepts all the strings of length 2.

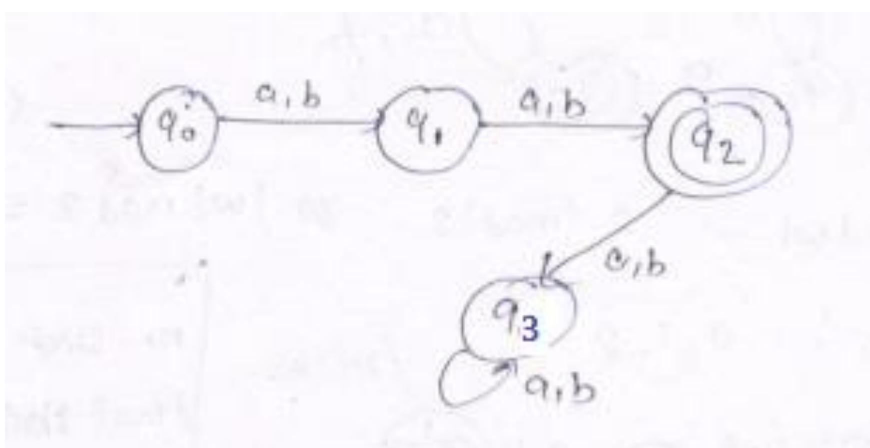
Input strings

b	a	a

not accepted by given DFA.

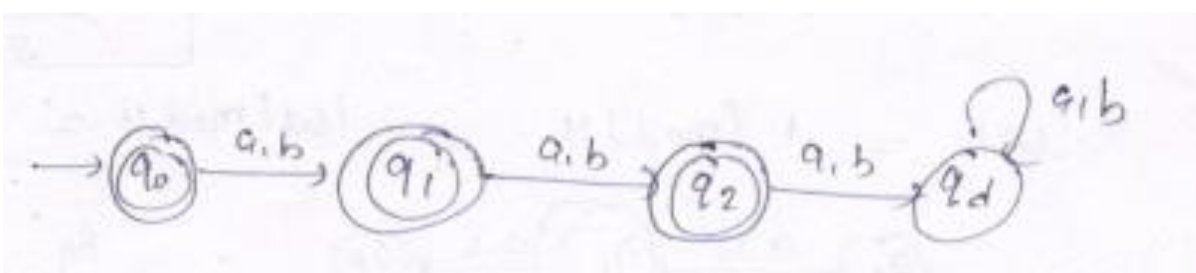
a	b

Accepted



2. Draw a DFA over $\Sigma=\{a,b\}$ which accepts all the strings of length less or equal to '2'.

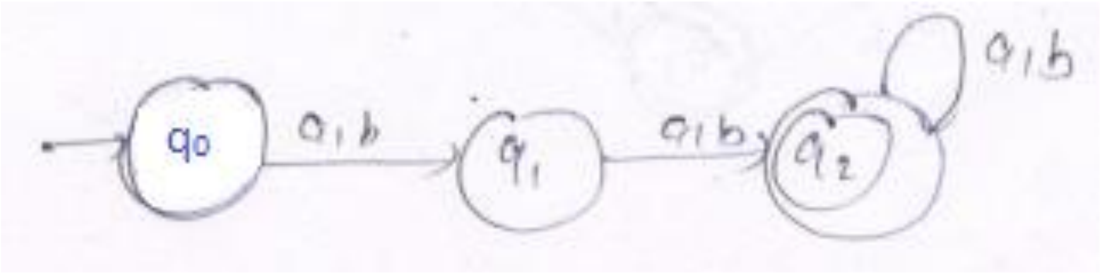
Input string			
	b		Accepted by given DFA.
	b	a	Accepted



3. Draw a DFA over $\Sigma=\{a,b\}$ which accepts all the strings of length greater or equal to '2'.

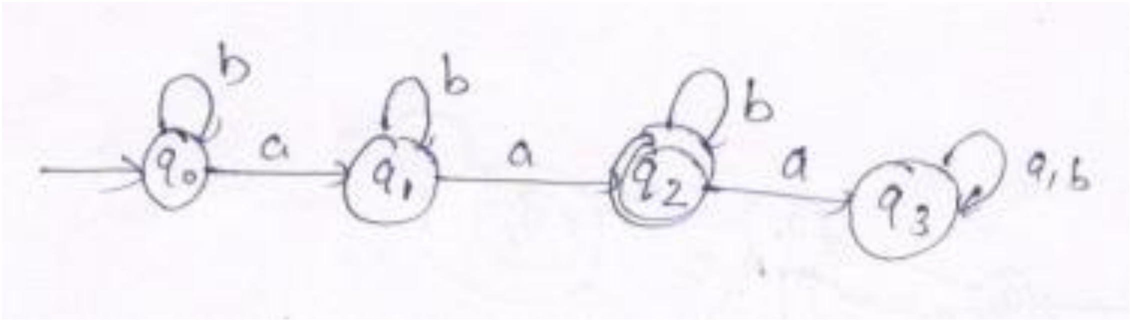
Input string

	b	**a**	**a**	**b**	**b**	**b**



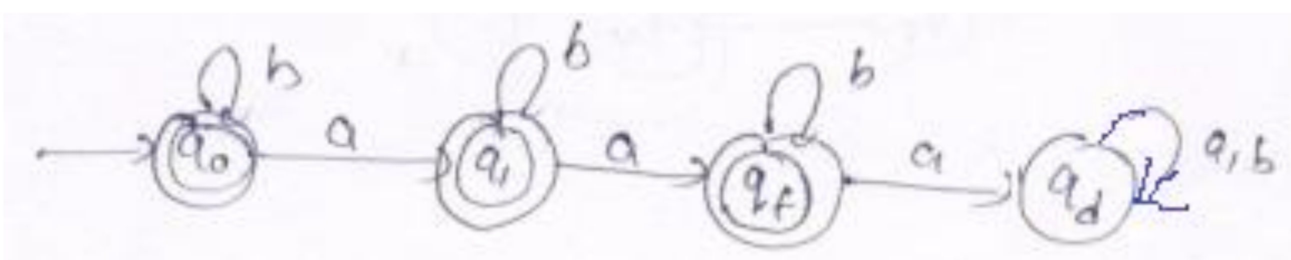
4. Draw a DFA over $\Sigma=\{a,b\}$ which accepts all the strings 'w' in which $n_a(w)=2$.

Input string	b	a	a	b	a	b	Not accepted
	b	a	b	b	a	b	Accepted



5. Draw a DFA over $\Sigma=\{a,b\}$ which accepts all the strings 'w' in which $n_a(w) \leq 2$.

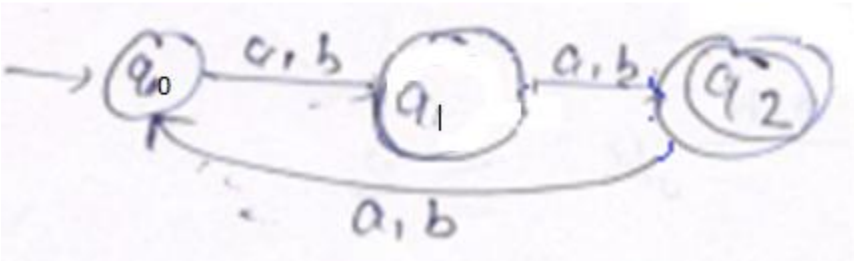
Input string							
Input string	b	a	a	b	a	b	Not accepted
	b	a	b	b	b	b	Accepted



6. Draw a DFA over $\sum=\{a,b\}$ which accepts all the strings 'w' in which $|w|$ mod 3= 2.

Input string

b	a	a	b	a



Mod 3 , Remainder: 0, 1, 2

String length	Remainder
0	0
1	1
2	2
3	0
4	1
5	2
.	.
.	.
8	2

Nondeterministic Finite Accepters

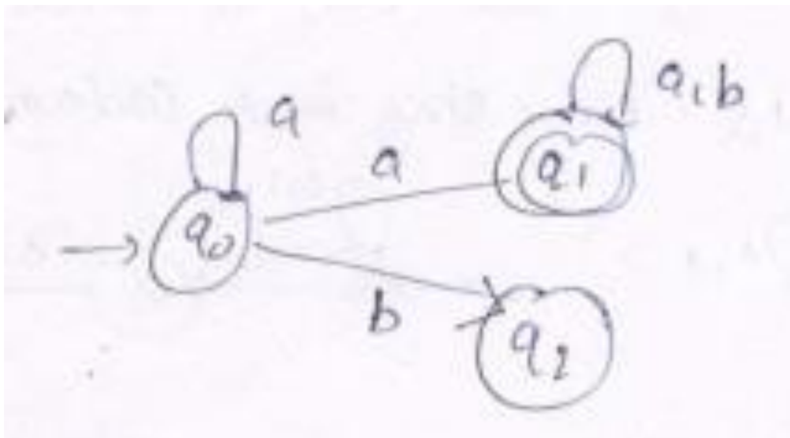
A nondeterministic finite accepter or nfa is defined by the quintuple

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

where Q is a finite set of internal states,
Σ is a finite set of symbols called the input alphabet,
$q_0 \in Q$ is the initial state,
$F \subseteq Q$ is a set of final states.
$\delta: Q \times (\Sigma \cup \{\lambda\}) \rightarrow 2^Q$

$\forall$ NFA $\exists$ a DFA

$\Rightarrow$ DFA $\subseteq$ NFA



$\delta(q_0,a)=\{q_0,q_1\}$

$\delta(q_2,b)=\{ \lambda\}$

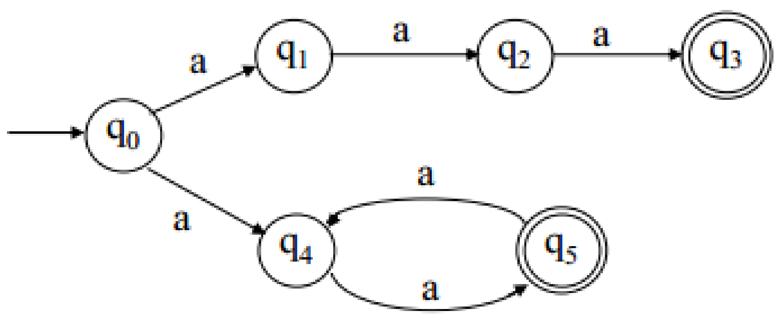
Transition graph

Transition Graph of an nfa $M = (Q, \Sigma, \delta, q_0, F)$

Vertex labeled with q_i: state $q_i \in Q$,

Edge from q_i to q_j labeled with a: $q_j \in \delta(q_i, a)$

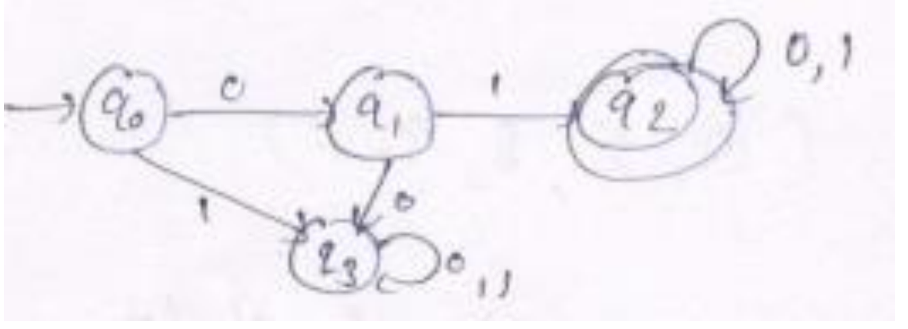
Example An nfa is shown as below



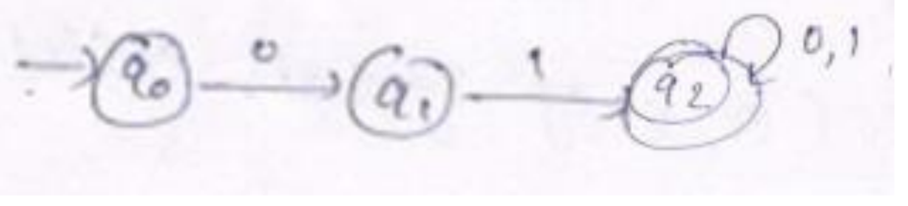
Examples

1. Draw NFA which accepts all the strings on $\sum=\{0,1\}$ which starts with ‘01’.

DFA



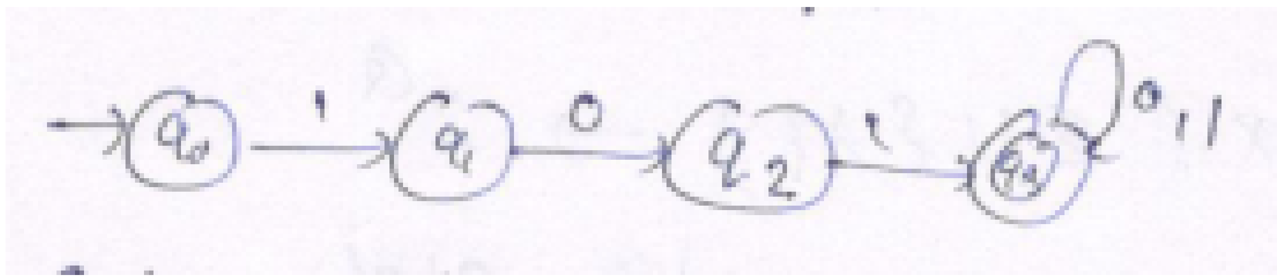
NFA



Examples

2. Design NFA which accepts all the strings on $\sum=\{0,1\}$ starting with '101'.

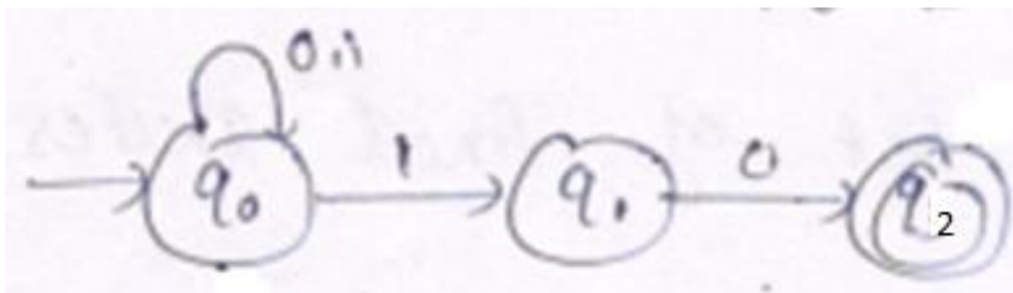
NFA



Examples

3. Design NFA which accepts all the strings on $\Sigma=\{0,1\}$ ending with ‘10’.

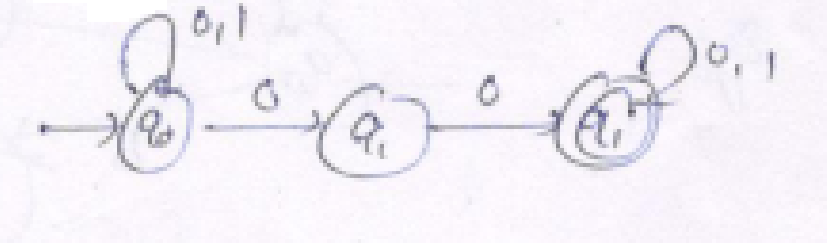
NFA



Examples

4. Design NFA which accepts all the strings on $\Sigma=\{0,1\}$ which contains substring '00'.

NFA



Suggested readings

1. An introduction to FORMAL LANGUAGES and AUTOMATA by PETER LINZ.
2. Introduction to Automata Theory, Languages, And Computation by JOHN E. HOPCROFT, RAJEEV MOTWANI, JEFFREY D. ULLMAN
3. Theory of computer science: automata, languages and computation **by** K.L.P MISHRA