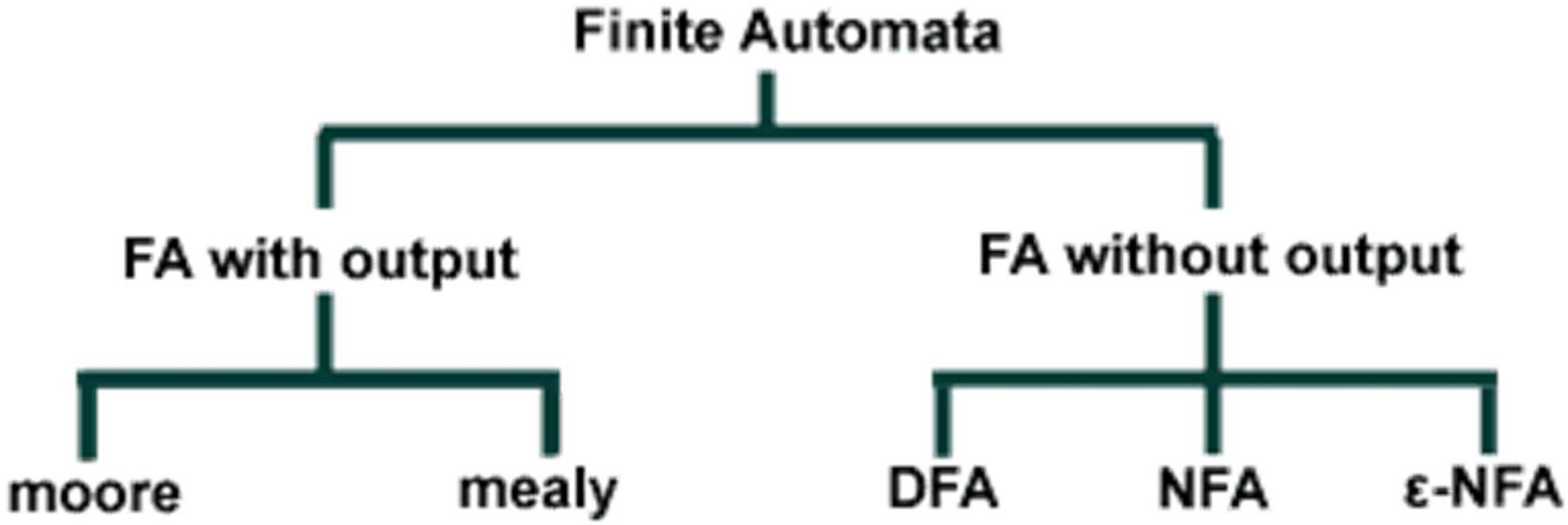


Finite automata with output machines do not have final state/states. Machine generates an output on every input.

Finite Automata with Outputs

↳ **Mealy Machine**

It has a 6-tuple representation.

$M = (Q, \Sigma, \Delta, \delta, \lambda, q_0)$

Q: Finite non-empty set of states

Σ: Input alphabet

Δ: Output alphabet

$\delta: Q \times \Sigma \rightarrow Q$

$\lambda: Q \times \Sigma \rightarrow \Delta$

q_0: Initial state

Output depends on the present state & present input

↳ Moore Machine

$$M = (Q, \Sigma, \Delta, \delta, \lambda, q_0)$$

Q :

Σ :

Δ :

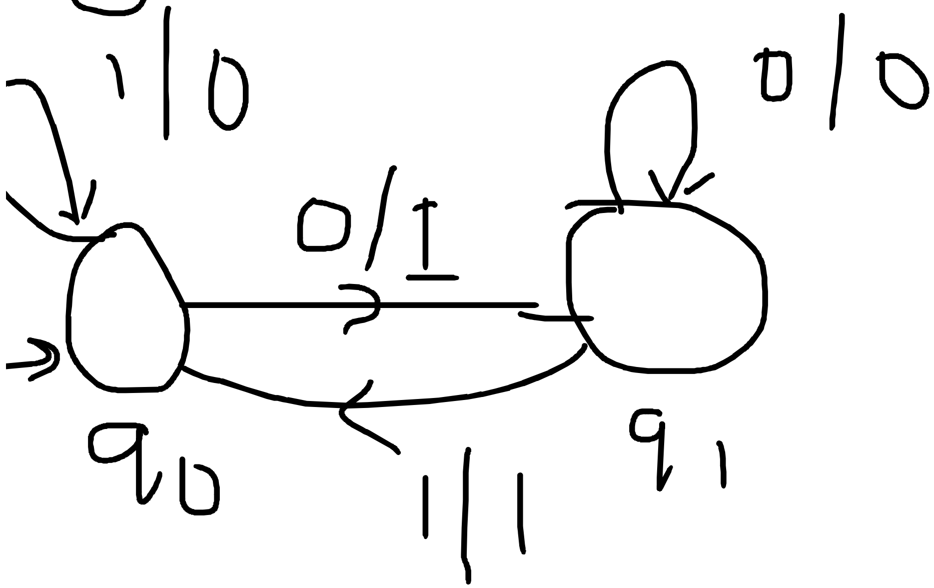
δ :

λ : $Q \rightarrow \Delta$

q_0 :

Output depends only on the present state.

1



2

Example of a Mealy Machine

Present state	Next state			
	0		1	
	state	output	state	output
$\rightarrow q_1$	q_3	0	q_2	0
q_2	q_1	1	q_4	0
q_3	q_2	1	q_1	1
q_4	q_4	1	q_3	0

Let $w = 0111$

$$\rightarrow q_1 \xrightarrow{0/0} q_3 \xrightarrow{1/1} q_1 \xrightarrow{1/0} q_2 \xrightarrow{1/0} q_4$$

i/p 0111
o/p 0100

$\Big\}$ n-length input will generate n-length output.

One o/p

Example of Moore Machine

Present state	Next state 0	Next state 1	Output
$\rightarrow q_0$	q_3	q_1	0
q_1	q_1	q_2	1
q_2	q_2	q_3	0
q_3	q_3	q_0	0

Let $w = 0111$

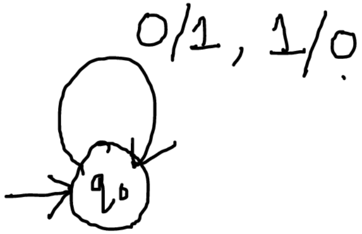
$$\rightarrow \underset{0}{q_0} \xrightarrow{0} \underset{0}{q_3} \xrightarrow{1} \underset{0}{q_0} \xrightarrow{1} \underset{1}{q_1} \xrightarrow{1} \underset{0}{q_2}$$

i/p = 0111
o/p = 00010

If length of input is n, then the Moore machine will have n+1 length o/p.

Q// Design a Mealy ~~mach~~ and Moore machine to find 1's complement.

Mealy Machine

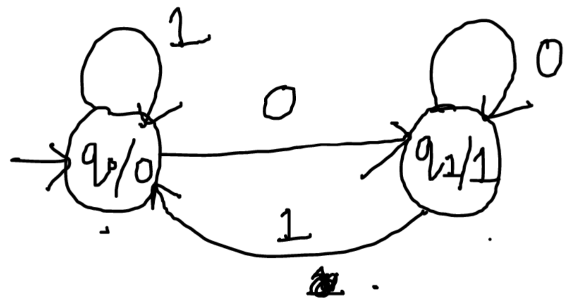


1001

$$\rightarrow q_0 \xrightarrow[0]{1} q_0 \xrightarrow[1]{0} q_0 \xrightarrow[1]{0} q_0 \xrightarrow[0]{1} q_0$$

$|i/p| = n$, $|o/p| = n$

Moore Machine



w = 1001

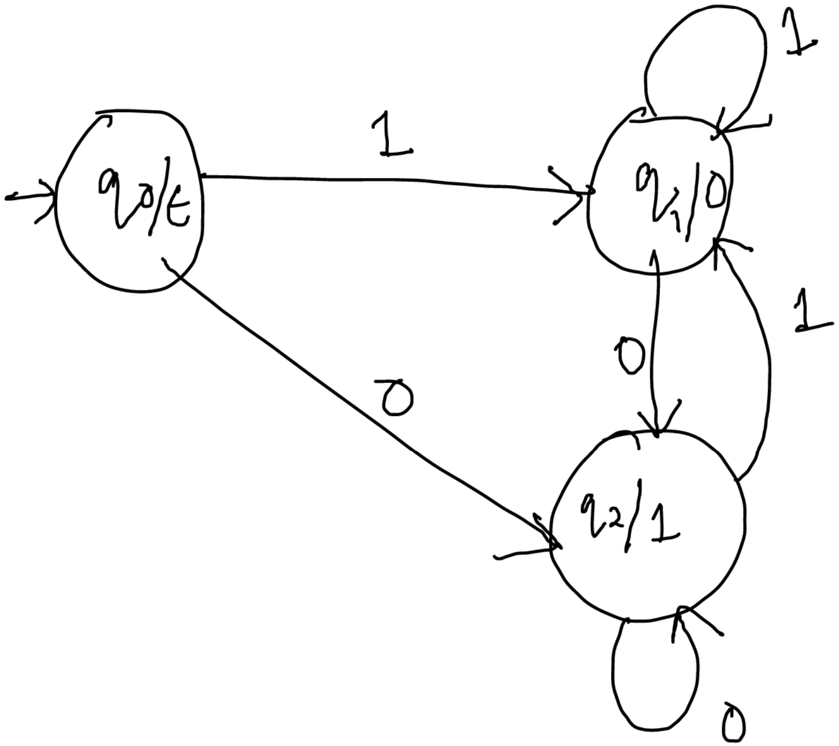
$$\rightarrow q_0 \xrightarrow{1} q_0 \xrightarrow{0} q_1 \xrightarrow{0} q_1 \xrightarrow{1} q_0$$

q_0	q_0	q_1	q_1	q_0
0	0	1	1	0

$|i/p| = n$

$|o/p| = n+1$

Moore Machine (Another way)



1001

$$\rightarrow q_0 \xrightarrow{1} q_1 \xrightarrow{0} q_2 \xrightarrow{0} q_2 \xrightarrow{1} q_1$$

$$\epsilon \quad 0 \quad 1 \quad 1 \quad 0$$

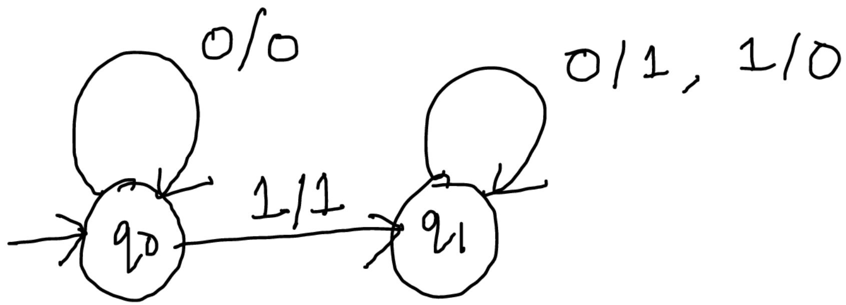
2's Complement : Mealy Machine

i/p 00100101100

11011010011
1

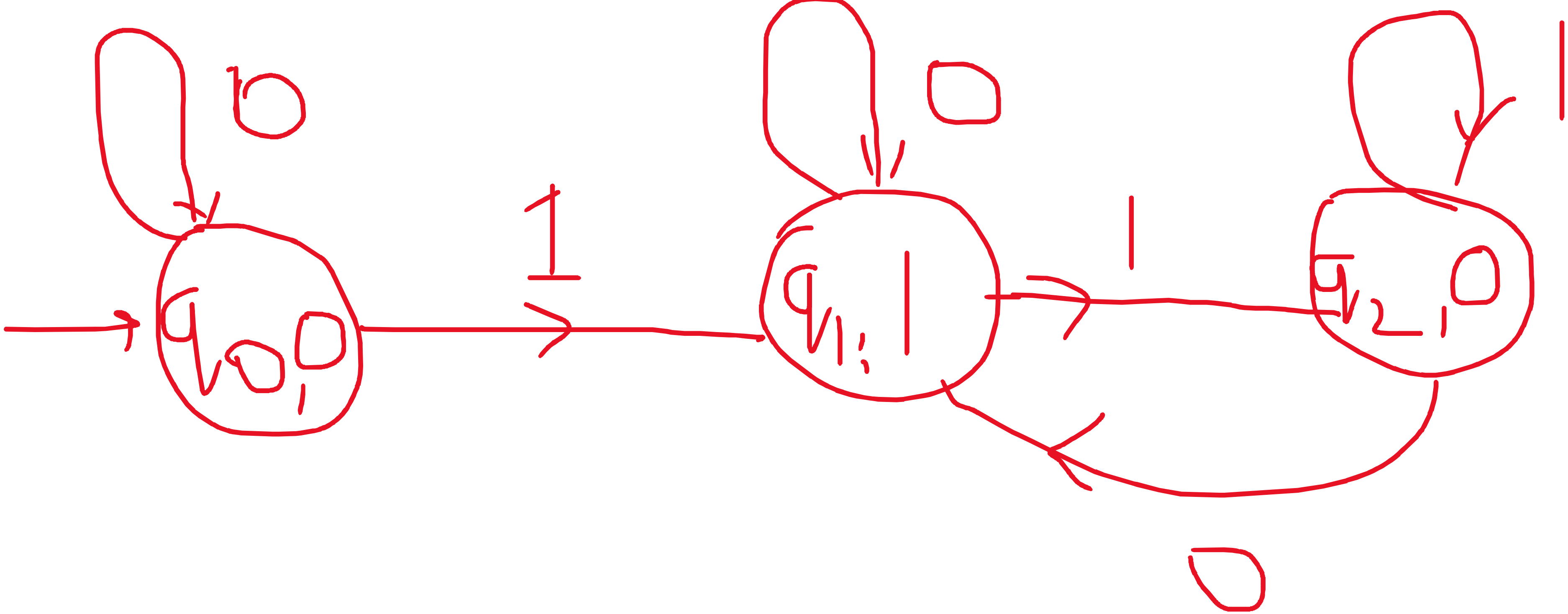
o/p 11011010$\boxed{1}$00

1's complement

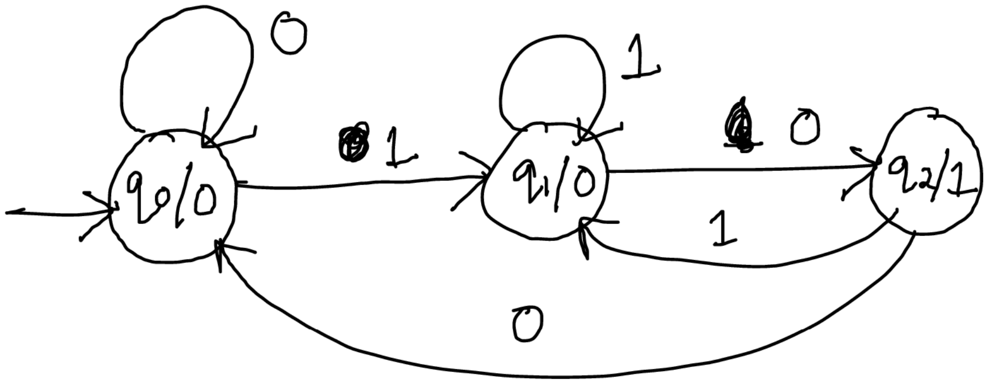


The approach goes as follows:

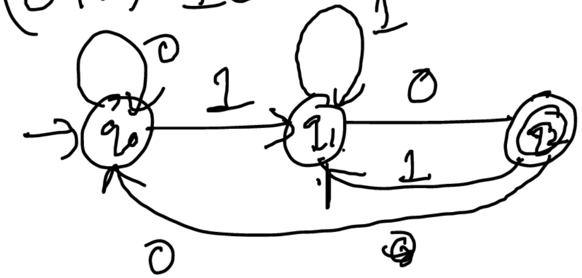
Start from right to left.
Ignore all 0's.
When 1 comes ignore it and then take 1's complement of every digit


0
1
0
1
1
0
$q_0, 0$
$q_1, 1$
$q_2, 0$

Moore Machine



$(0+1)^* 10$

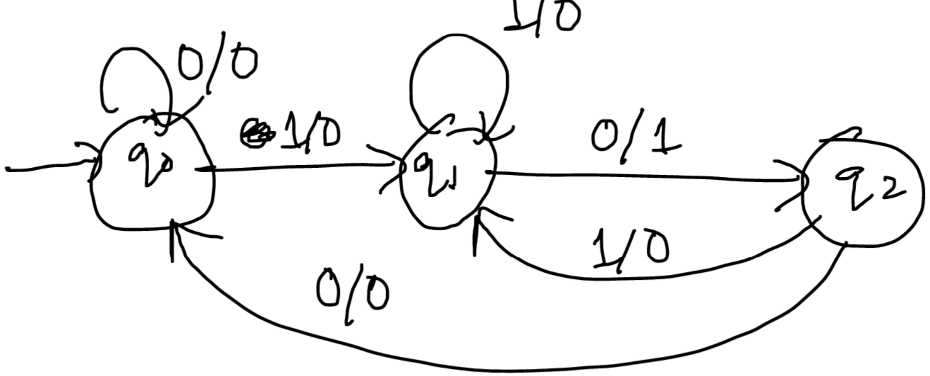


110

~~101~~

100

Mealy Machine



Design a Moore & Mealy machine

Q11) ~~Find~~ to Count the number of occurrences of 10 in a binary string.

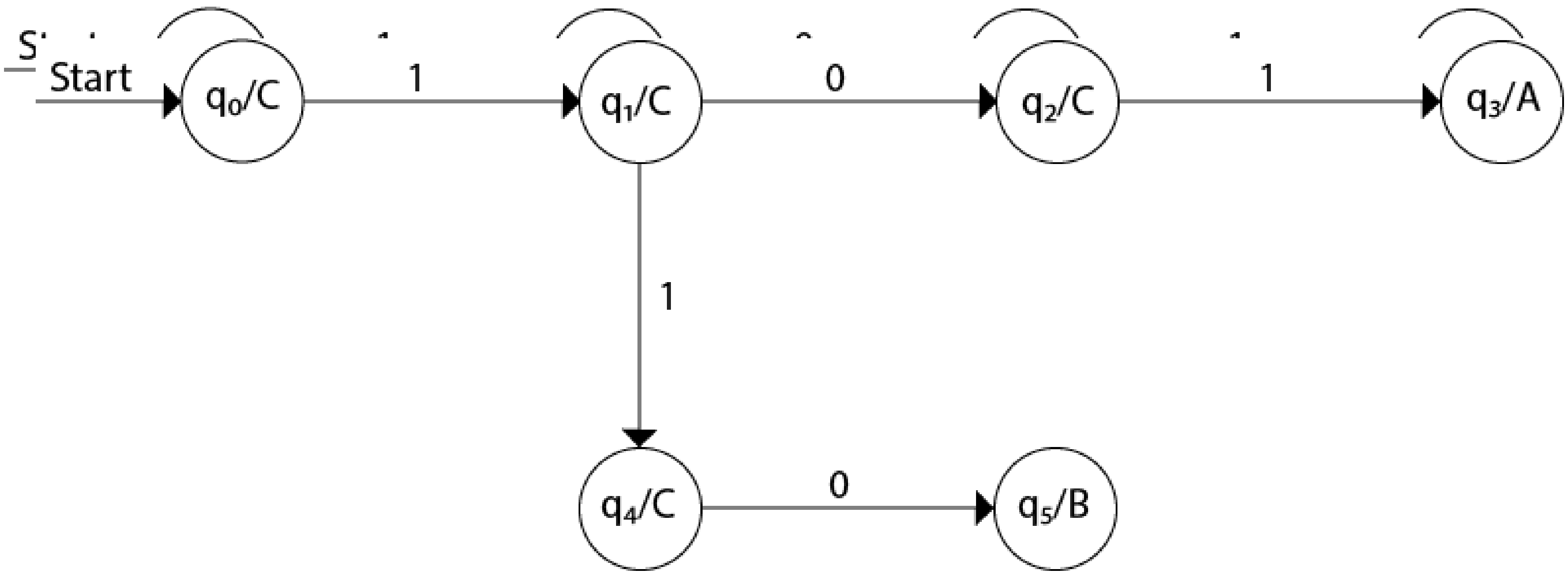
i/p 00011001010100

o/p 00000100101010

i/p 0 0 0 1 1 0 0 1 0 1 0 0

0 0 0 0 0 1 0 0 1 0 1 0

Design a Moore machine for a binary input sequence such that if it has a substring 101, the machine output A, if the input has substring 110, it outputs B otherwise it outputs C.



2. **Design a moore machine to count occurance of "ab" as substring.**

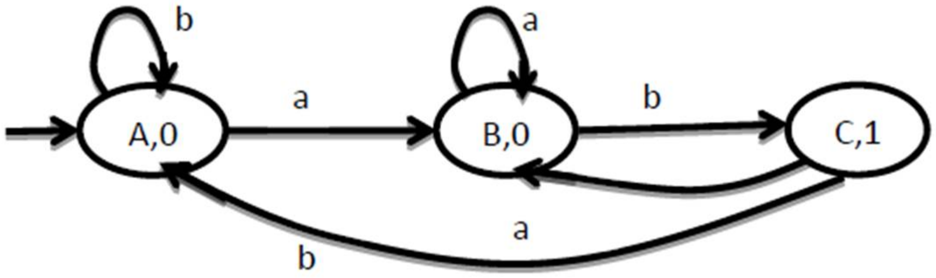
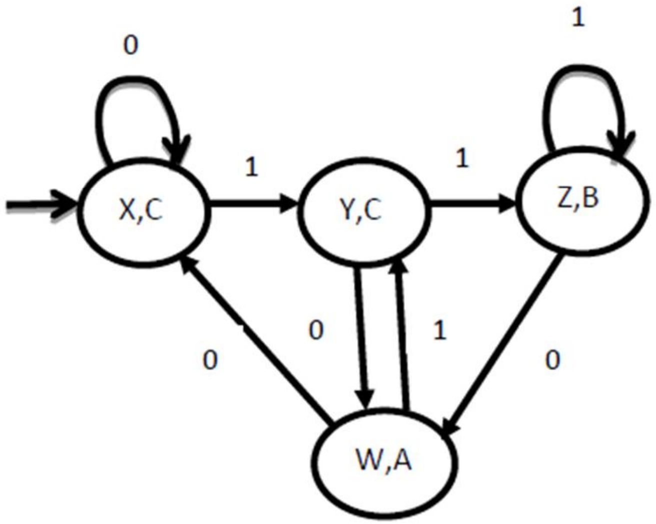
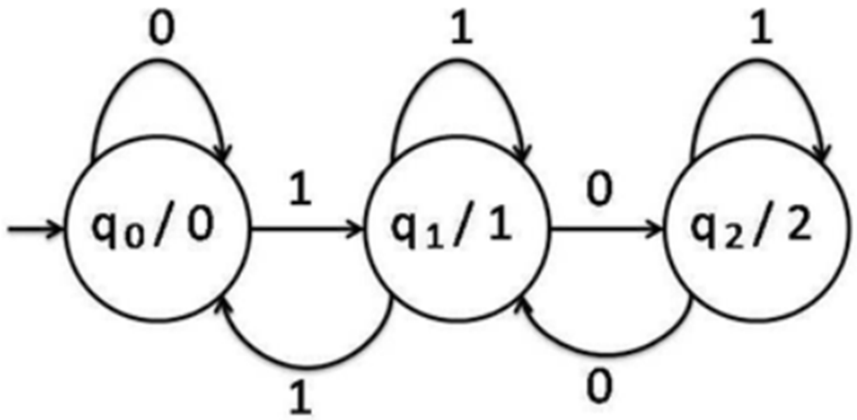


Fig. 2.39 Moore M/c to count occurances of ab

3. **Construct a moore machine that takes set of all strings over {0, 1} and produces 'A' if i/p ends witg '10' or produces 'B' if i/p ends with '11' otherwise produces 'C'.**

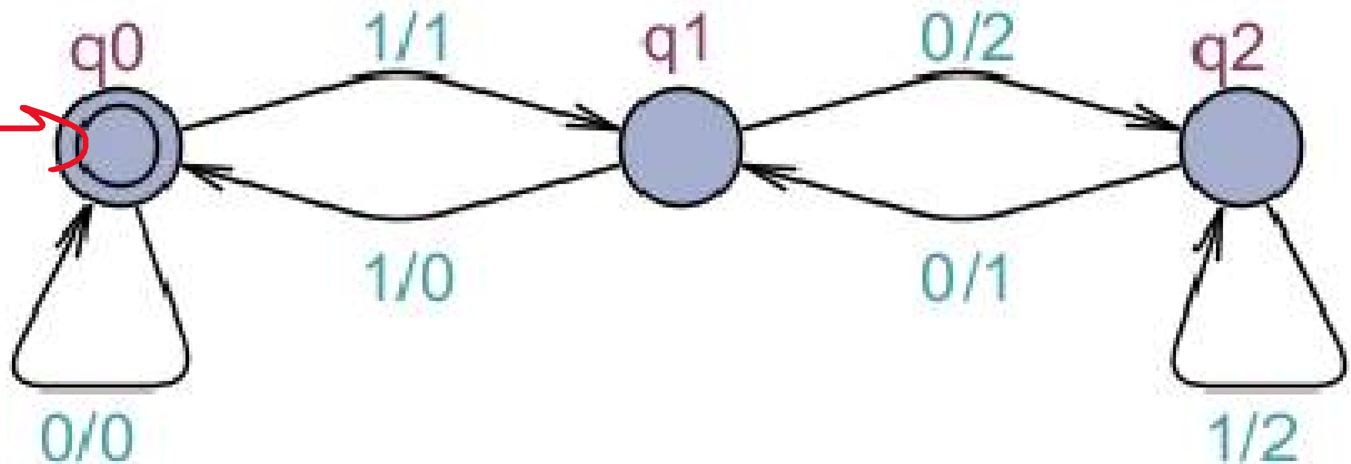


Moore Machine mod 3



Mealy Machine mod 3

non Final



Q// Convert the following Moore Machine to an equivalent Mealy machine.

(i)

Present state	Next state 0	Next state 1	Output
$\rightarrow q_0$	q_3	q_1	0
q_1	q_1	q_2	1
q_2	q_2	q_3	0
q_3	q_3	q_0	0

Ans The corresponding Mealy machine is

Present state	Next state 0: state	0: output	1: state	1: output
$\rightarrow q_0$	q_3	0	q_1	1
q_1	q_1	1	q_2	0
q_2	q_2	0	q_3	0
q_3	q_3	0	q_0	0

(ii)

Present state	Next state 0	Next state 1	output
$\rightarrow q_1$	q_1	q_2	0
q_2	q_1	q_3	0
q_3	q_1	q_3	1

Ans The corresponding Mealy machine is

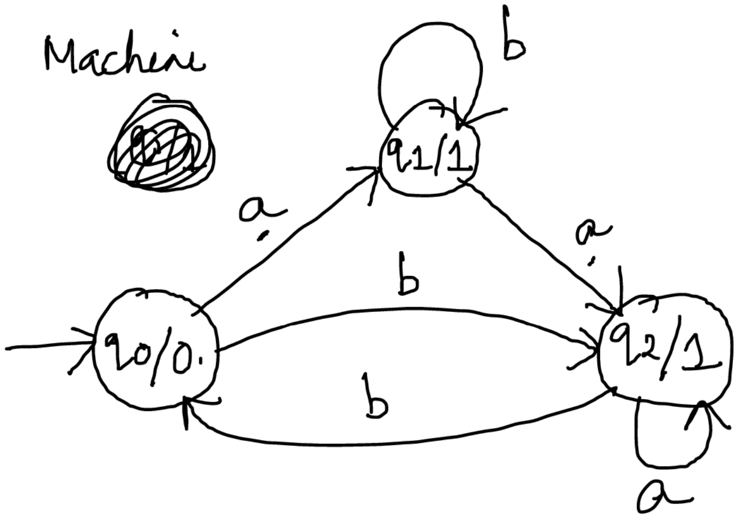
Present state	Next state 0		Next state 1	
	state	output	state	output
$\rightarrow q_1$	q_1	0	q_2	0
q_2	q_1	0	q_3	1
q_3	q_1	0	q_3	1

Here, the rows corresponding to q_2 & q_3 are identical. Hence, they are identical. We can remove one of them.

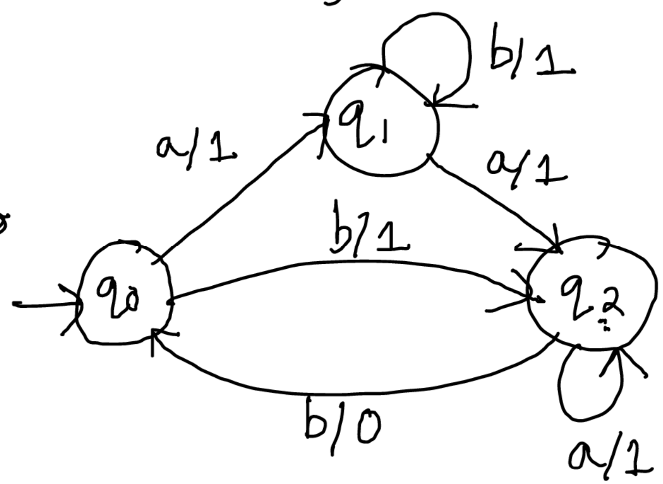
Therefore the updated resultant Mealy machine is

Present State	Next State 0: State	Next State 0: Output	Next State 1: State	Next State 1: Output
$\rightarrow q_1$	q_1	0	q_2	0
q_2	q_1	0	q_2	1

(iii) Moore Machine



The respective Mealy machine is



Q) Convert the following ~~Moore~~ Mealy machine into its equivalent Moore Machine

Present State	Next state			
	0		1	
	State	O/P	State	O/P
$\rightarrow q_1$	q_3	0	q_2	0
q_2	q_1	1	q_4	0
q_3	q_2	1	q_1	1
q_4	q_4	1	q_3	0

Here q_2 & q_4 are associated with multiple outputs.

Hence, these states need to be partitioned.

Therefore the updated transition table of the given Mealy machine is

Present state	Next state 0		Next state 1	
	state	o/p	state	o/p
$\rightarrow q_1$	q_3	0	q_{20}	0
q_{20}	q_1	1	q_{40}	0
q_{21}	q_1	1	q_{40}	0
q_3	q_{21}	1	q_1	1
q_{40}	q_{41}	1	q_3	0
q_{41}	q_{41}	1	q_3	0

The transition table of the resultant Moore machine is

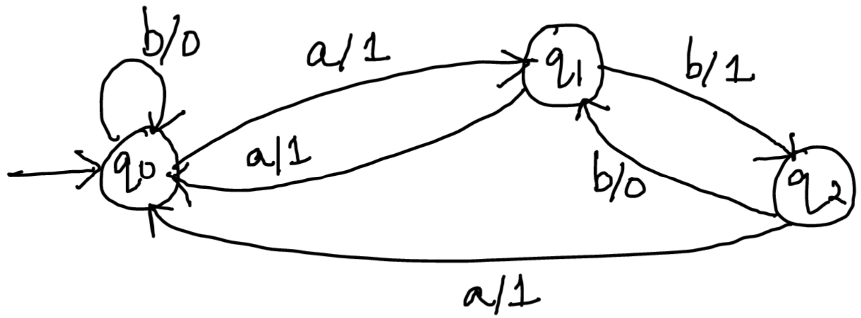
Present state	Next state 0	Next state 1	Output
$\rightarrow q_1$	q_3	q_{20}	1
q_{20}	q_1	q_{40}	0
q_{21}	q_1	q_{40}	1
q_3	q_{21}	q_1	0
q_{40}	q_{41}	q_3	0
q_{41}	q_{41}	q_3	1

Here, the output of the initial state is 1, which needs to be 0. Therefore, the final Moore machine is:

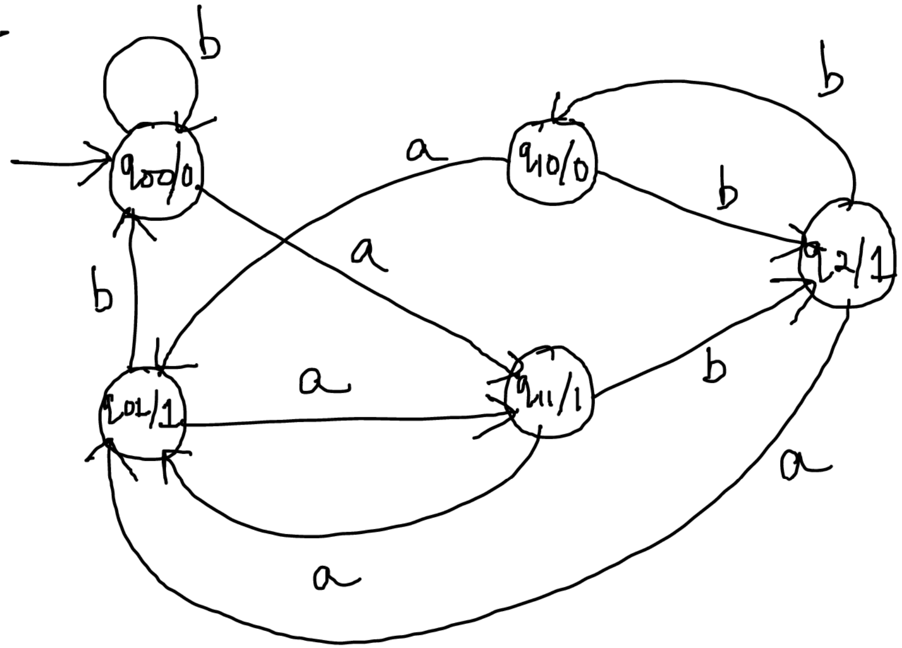
PTO

Present state	Next state 0	Next state 1	Output
$\rightarrow q_0$	q_3	q_{20}	0
q_1	q_3	q_{20}	1
q_{20}	q_1	q_{40}	0
q_{21}	q_1	q_{40}	1
q_3	q_{21}	q_1	0
q_{40}	q_{41}	q_3	0
q_{41}	q_{41}	q_3	1

Q1 Convert the following Mealy machine into an equivalent Moore machine.



Ans



Mealy → Moore

If Mealy machine ~~will ha~~ has n states and m outputs, then ~~the resultant Moore machine will have m*n states.~~

in the worst case the resultant Moore machine will ~~have~~ have $\boxed{m*n}$ states.

NOTE*: ~~m~~ m*n+1 states are also possible if an extra initial state is added with output ϵ.

Moore → Mealy

~~n states~~

If Moore Machine has n states, then the resultant ~~Mealy~~ Mealy machine will have ~~at mo~~ at most $\boxed{n}$ states.