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Moore machines and mealy machines, Conversion from Mealy to Moore and vice versa

Chapter - 2: Regular languages and finite automata

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Content

Introduction to Finite State Machines with Output

Finite Automata produce accept/reject, but some models produce output for each input.

Two such machines are:

- Moore Machine: Output depends only on current state
- Mealy Machine: Output depends on current state and input

Moore Machine – Definition

A Moore Machine is a 6-tuple:
$M = (Q, \Sigma, \Delta, \delta, \lambda, q_o)$

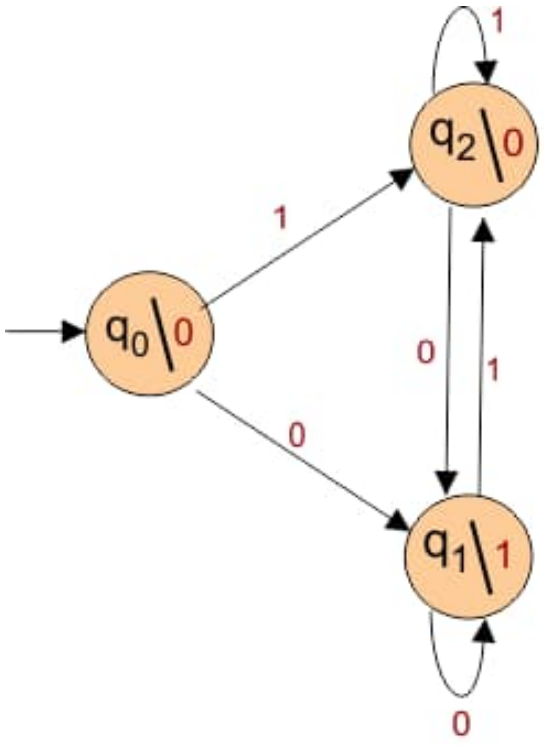
Where:

- Q = set of states
- Σ = input alphabet
- Δ = output alphabet
- $\delta: Q \times \Sigma \rightarrow Q$ (transition function)
- $\lambda: Q \rightarrow \Delta$ (output function)
- q_o = initial state

✅ Output depends on state only

Moore Machine – Example

Design a Moore machine to generate 1's complement of a given binary number.



1's Complement in Moore Machine

States	Output	Input "0"	Input "1"
q0	0	q2	q1
q1	0	q2	q1
q2	1	q2	q1

Mealy Machine – Definition

A Mealy Machine is a 6-tuple:

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

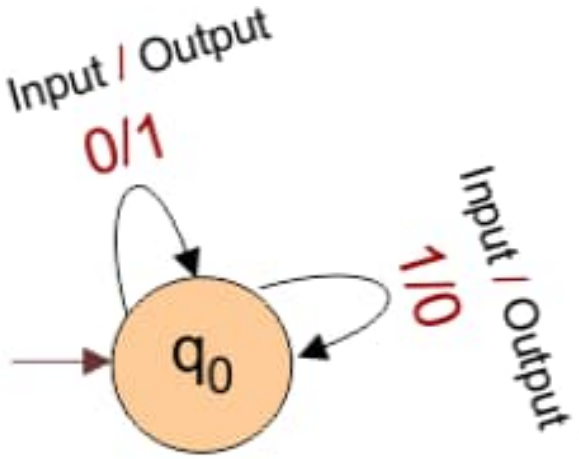
Where:

- Q = set of states
- Σ = input alphabet
- Δ = output alphabet
- $\delta: Q \times \Sigma \rightarrow Q$ (transition function)
- $\lambda: Q \times \Sigma \rightarrow \Delta$ (output function depends on state and input)
- q_o = initial state

✅ Output occurs during transition

Mealy Machine – Example

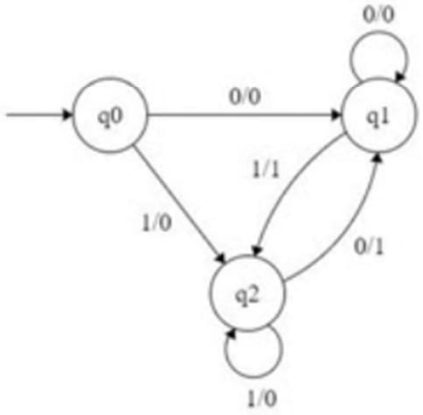
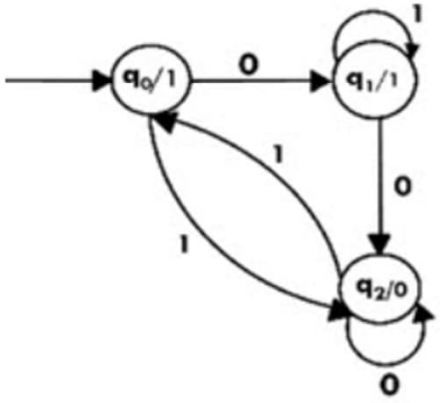
Design a Mealy machine to generate the first complement of any given binary input.



1st Complement in Mealy Machine

Input	1	1	1	0	0
State	q0	q0	q0	q0	q0
Output	0	0	0	1	1

Moore vs Mealy – Comparison Table

Mealy Machine	Moore Machine
Output depends on present state as well as present input.	Output depends only upon the present state.
If input changes, output also changes.	If input changes, output does not change.
Less number of states are required.	More states are required.
Asynchronous output generation.	Synchronous output and state generation.
Output is placed on transition.	Output is placed on state.
It is difficult to design.	Easy to design.
	

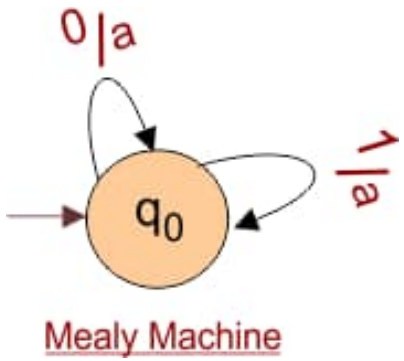
Conversion: Mealy → Moore

Steps:

1. For each (state, input) with unique output, create a new Moore state
2. Adjust transitions to link these new states
3. Assign outputs to the new states accordingly
4. Initial output added before processing input

Conversion: Mealy → Moore Example

Consider the following Mealy Machine



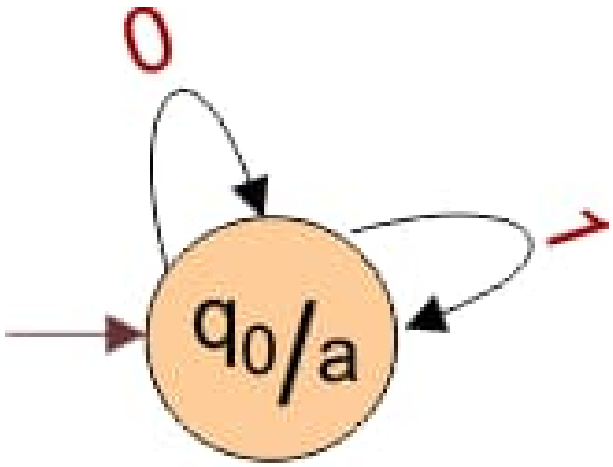
Mealy Machine

As in the above Mealy Machine,

- q0 is the start state, (0,1) are inputs, and “a” is the output.
- Every entering input in the state q0 having the similar output “a”.
- So, simply cut the output “a” over the arrow and place it along with the state “q0”.

Conversion: Mealy → Moore Example

After conversion, the Moore Machine is given under



Moore Machine

Conversion: Moore → Mealy

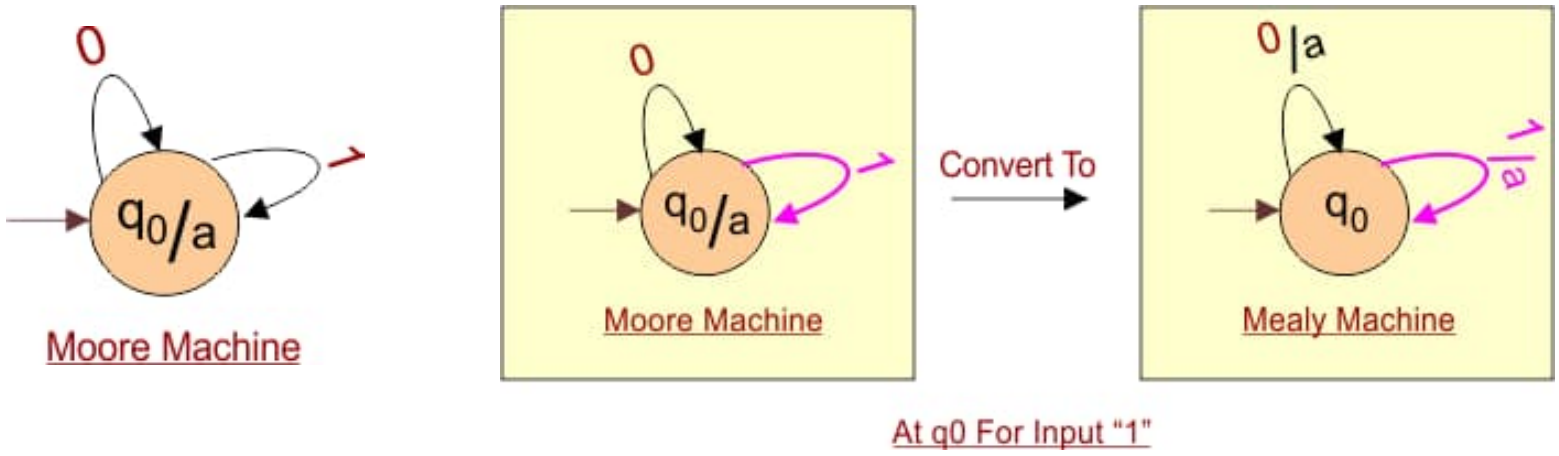
Steps:

1. Use the state output of the target state as transition output
2. No need to duplicate states
3. Output moves from states to transitions

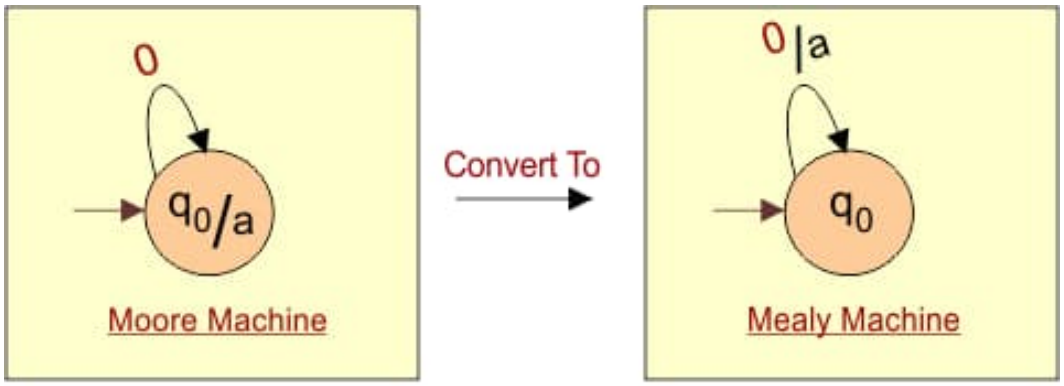
✅ Fewer states than Moore equivalent

Conversion: Moore to Mealy Example

Consider the following Moore Machine



At q0 For Input "1"



At q0 For Input "0"

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