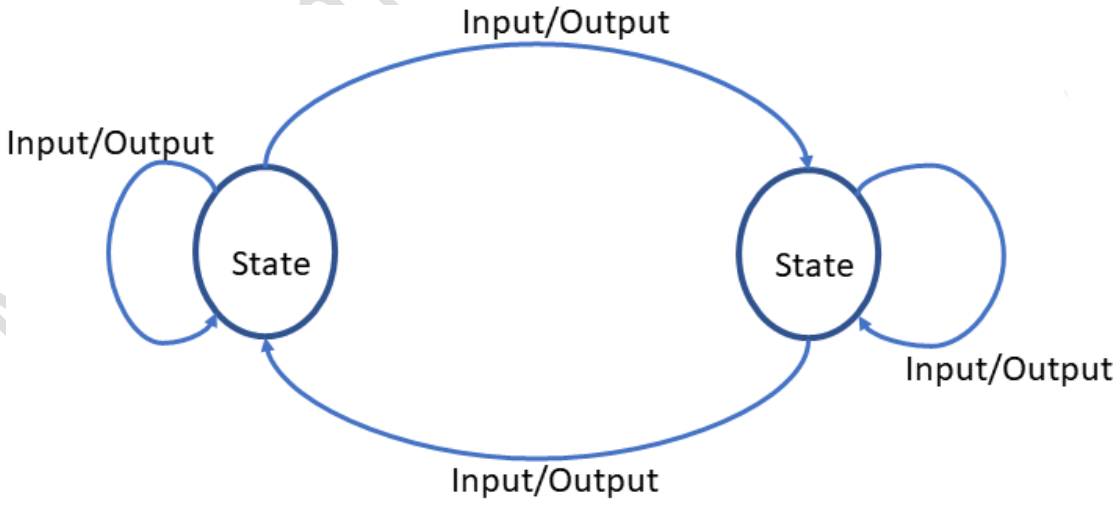
Mealy Machine

In the theory of computation, a **Moore machine** is a finite-state machine whose output values are determined only by its current state. This is in contrast to a **Mealy machine**, whose output values are determined both by its current state and by the values of its inputs. In other words, A **Mealy machine** is a machine in which output symbol depends upon the present input symbol and present state of the machine. In the **Mealy machine**, the output is represented with each input symbol for each state separated by /. **Mealy machines** are finite-state machines that act as transducers or translators, taking a string on an input alphabet and producing a string of equal length on an output alphabet.

- It does not accept or reject an input string.
- It shows output on transition.
- There are no accept states in a Mealy machine because it is not a language recognizer, it is an output producer.
- Its output will be the same length as its input.

Mealy machine can be described by 6 parameters/tuples $(Q, \sum, q_0, \Delta, \lambda, \delta)$ where,

Parameter Name	Description
Q	is a finite set of states
Σ	is a finite set of symbols called the input alphabet
q_0	is the initial state from where any input is processed ($q_0 \in Q$)
Δ	is a finite set of symbols called the output alphabet
λ	is the output transition function where $\lambda: Q \times \sum \rightarrow \Delta$
δ	is the input transition function where $\delta: Q \times \sum \rightarrow Q$



Generic Mealy model

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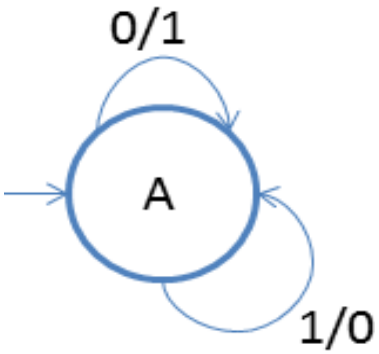
Example of Mealy Machine

Example 1:

Design Mealy machine for 1's complement.

The following Mealy machine takes the one's complement of its binary input. In other words, it flips each digit from a 0 to 1 or from 1 to 0. So, we can see that every '0' will be replaced by '1' and vice-versa.



Eg. Suppose string is 10001 and we will start parsing from left to right. Every 0 will be replaced by 1 and vice versa. So, we will get the output as = 01110.

Example 2:

Design a Mealy machine for 2's complement.

Solution:

2's complement is a mathematical operation on binary numbers. It is used for computation as a method of signed number representation. Its complement with respect to 2^N defines the two's complement an N-bit number.

Logic: -

First calculate 1's complement of binary number, convert 1 to 0 and 0 to 1 and then add 1 to it. For example, if binary number is 1011 then its 1's complement is 0100 and its 2's complement is 0101. 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.

Design Mealy machine:

1. Take initial state A.
2. If there are n number of zeros at initial state, it will remain at initial state.
3. Whenever first input 1 is found then it gives output 1 and go to state B.
4. In state B, if input is zero, output will be 1; and if input is 1 then output will be 0.
5. And then set state B as final state.

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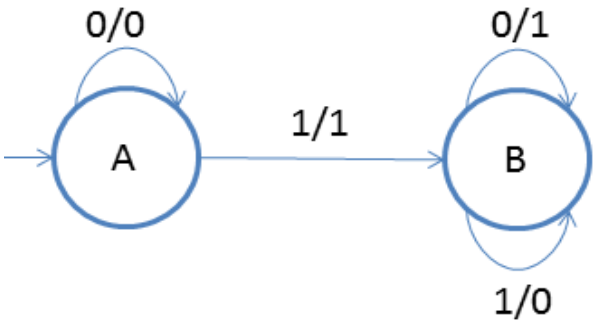


Eg. 1:

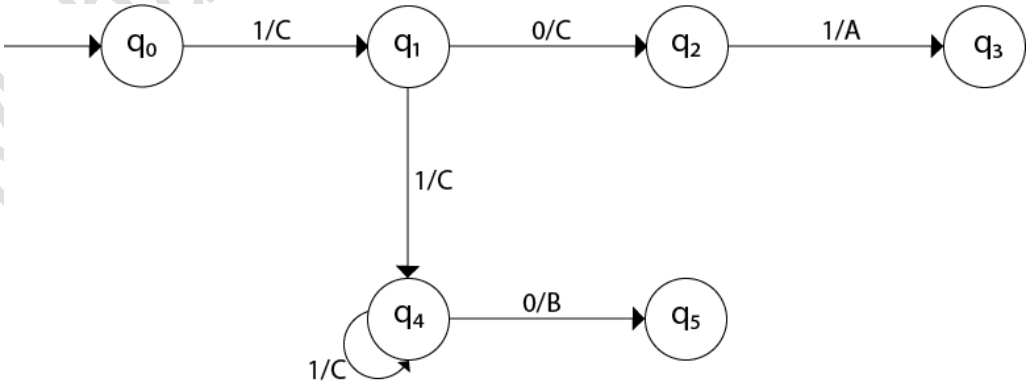
1. Let's take 001 and we know that its 2's complement is (110+1 = 111).
2. So, scan from right to left.
3. On state A '1' came first to go to state B and in output write 1.
4. On state B replace '0' with '1' and vice-versa.
5. So finally, we got 111 as output.
6. Be aware that the output is also printed in right to left order.

Eg. 2:

1. Let's take 01 and we know that its 2's complement is (10+1 = 11).
2. So, scan from right to left.
3. On state A '1' came first to go to stage B and in output write 1.
4. On state B replace '0' with '1' and vice-versa.
5. So finally, we got 11 as output.
6. Be aware that the output is also printed in right to left order.

Example 3:
Design a Mealy 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.

Solution: For designing such a machine, we will check two conditions, and those are 101 and 110. If we get 101, the output will be A. If we recognize 110, the output will be B. For other strings the output will be C.
The partial diagram will be:



Now we will insert the possibilities of 0's and 1's for each state. Thus, the Mealy machine becomes:

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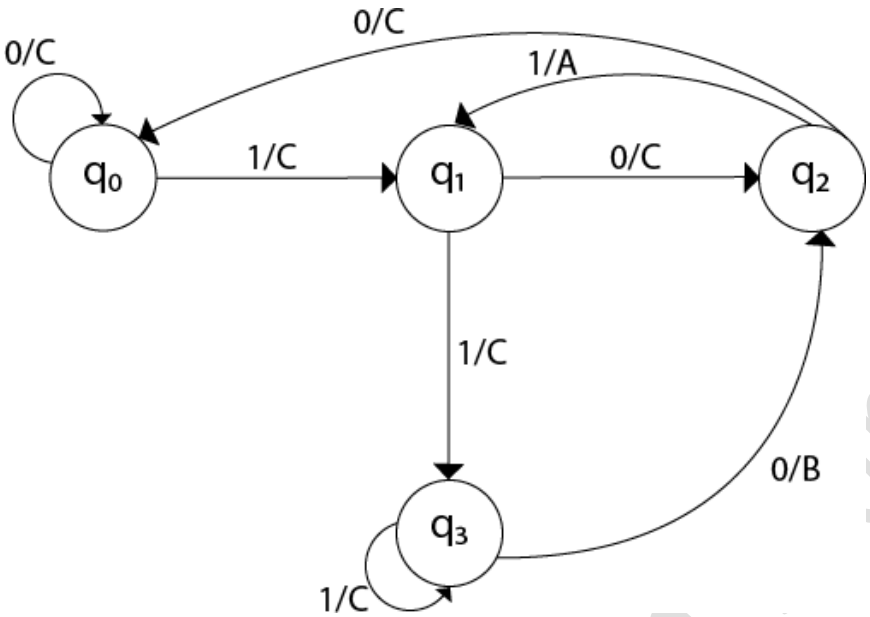
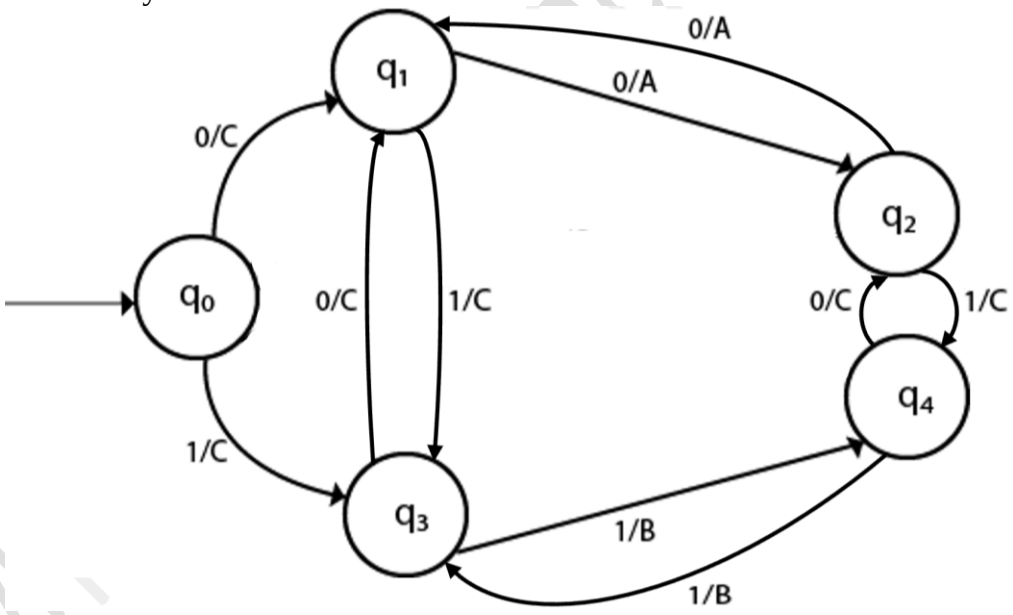


Example 4:
Design a mealy machine that scans sequence of input of 0 and 1 and generates output 'A' if the input string terminates in 00, output 'B' if the string terminates in 11, and output 'C' otherwise.

Solution: The Mealy machine will be:



HW 1. Construct a Mealy machine that takes a string of a's and b's as input and output is a binary string with a **1** at the position of every **second double letter**. For example, for ababbaab the machine produces 00001010 and for the input bbb the output string 011 is produced.

HW 2. Construct a Mealy machine that prints **a** whenever the sequence **01** is encountered in any input binary string.

HW 3. Design a Mealy machine accepting the language consisting of string from Σ, where Σ^*={a, b} and the strings should **end** with either **aa** or **bb**.

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The difference between the Mealy machine and Moore machine is as follows:

Mealy Machine	Moore Machine
Output depends both upon the present state and the present input.	Output depends only upon the present state.
Generally, it has fewer states than Moore Machine.	Generally, it has more states than Mealy Machine.
Output is placed on transitions.	Output is placed on states.
There is more hardware requirement for circuit implementation.	There is less hardware requirement for circuit implementation.
It is difficult to design.	Easy to design.

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