Finite Automata to Regular Expression

What is DFA in regular expression?

In regular expressions, DFA stands for Deterministic Finite Automaton. It is a theoretical model used to recognize patterns or strings in each input.

There are two methods to convert DFA to RE:

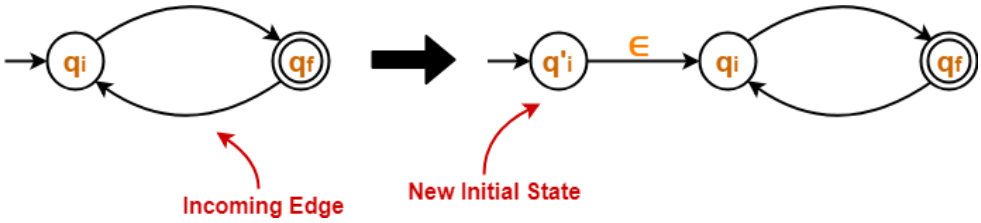
1. **Arden's method (using Arden's Lemma)**
2. **State elimination method.**

❑ State Elimination Method

Rule 1

There must be only one initial state, and there should not be any incoming edges to it.

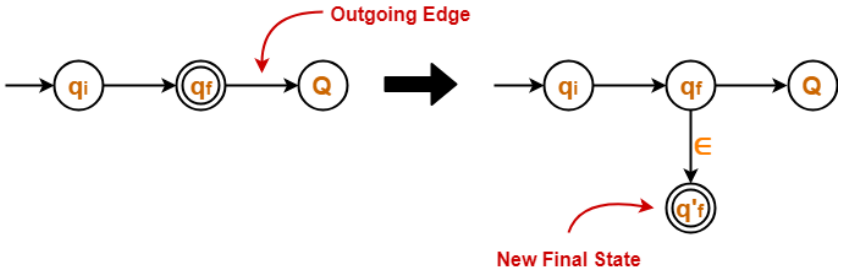
If there is more than one initial state, convert all initial states to non-initial states and create a new single initial state. If there are incoming edges to the initial state, create a new initial state with no incoming edges. For example:



Rule 2

From the final state, there should be no outgoing edges.

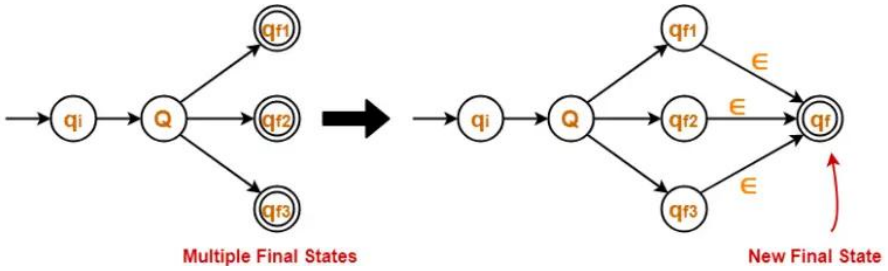
If there are outgoing edges from the final state, convert all final states to non-final states and create a new final state having no outgoing edges. For example:



Rule 3

There must be only one final state.

If there is more than one final state, convert all final states to non-final states and create a new single final state. For example:

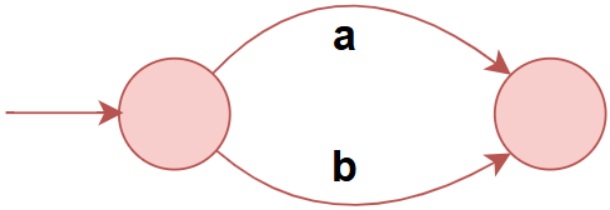


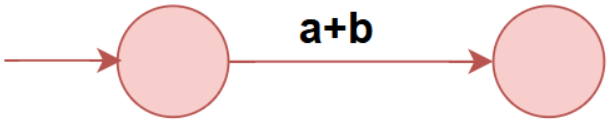
Rule 4

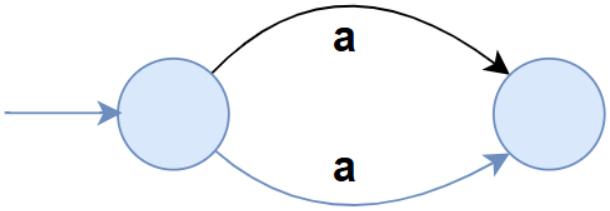
After verifying rules 1 to 3, all intermediate states are eliminated one by one. We can eliminate these intermediate states in any order.

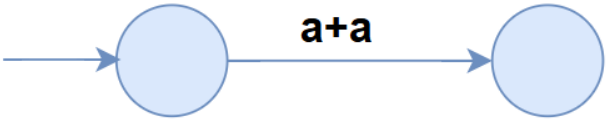
Finite Automata to Regular Expression

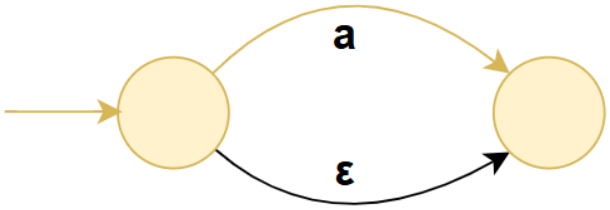
❑ Basic terminologies:

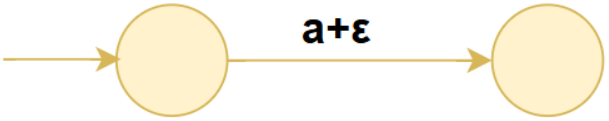


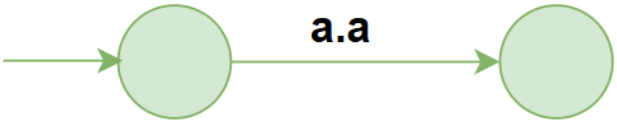


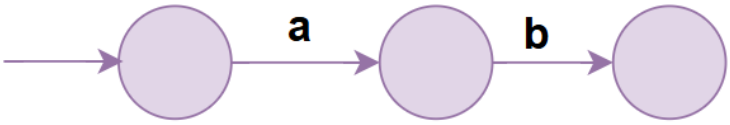


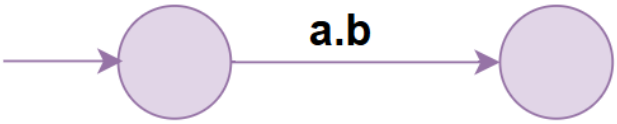


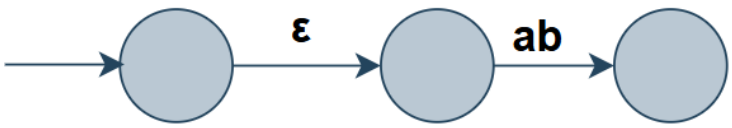


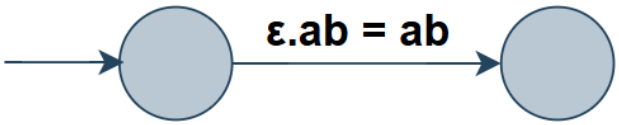








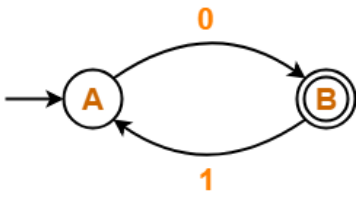




Finite Automata to Regular Expression

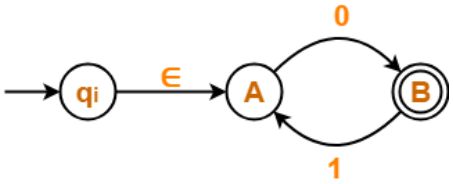
❑ Example Problems Based on FA → RE Conversion:

Problem-01: Find regular expression for the following DFA-

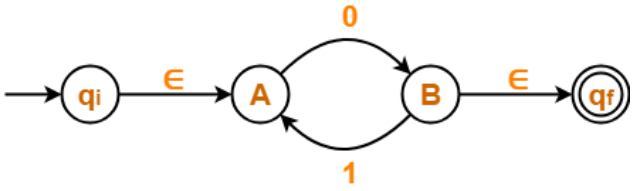


Solution-

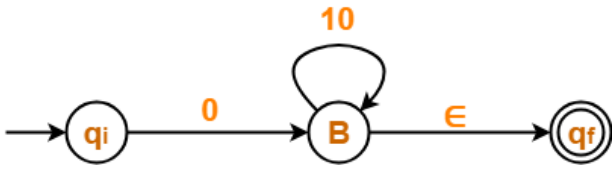
Step-01:



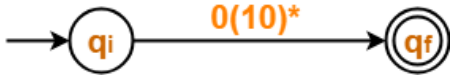
Step-02:



Step-03:

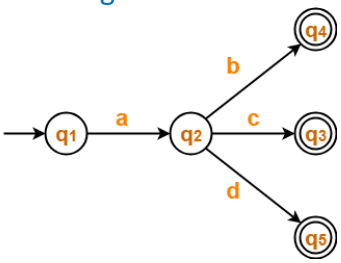


Step-04:



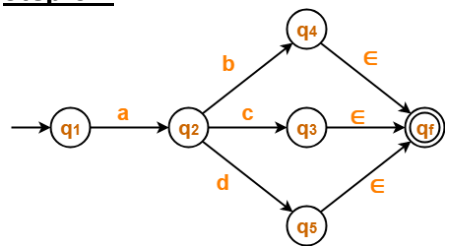
From here,
Regular Expression = 0(10)*

Problem-02: Find regular expression for the following DFA-

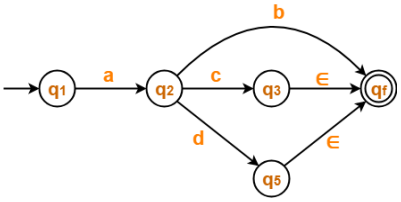


Solution-

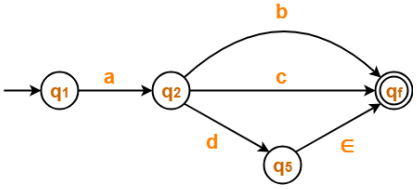
Step-01:



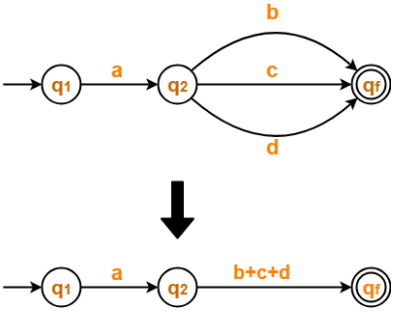
Step-02:



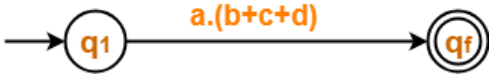
Step-03:



Step-04:



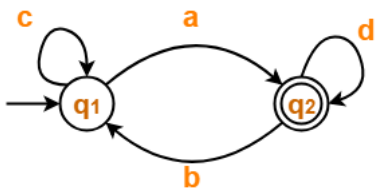
Step-05:



From here,
Regular Expression = a(b+c+d)

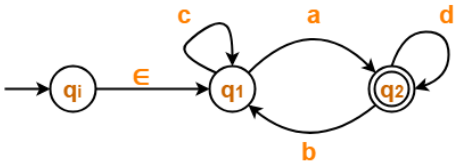
Finite Automata to Regular Expression

Problem-03: Find regular expression for the following DFA-

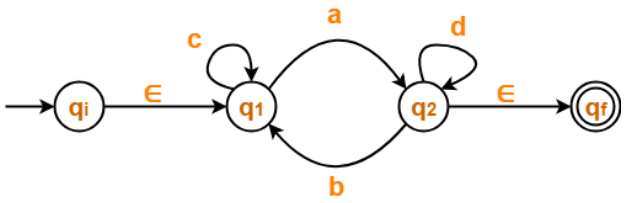


Solution-

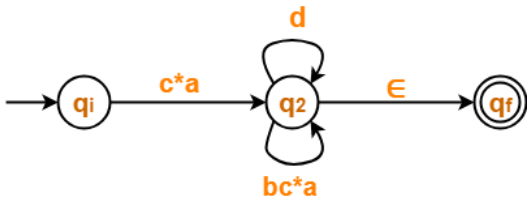
Step-01:



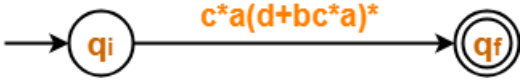
Step-02:



Step-03:



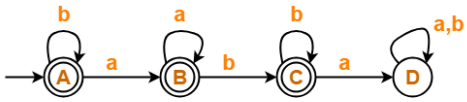
Step-04:



From here,

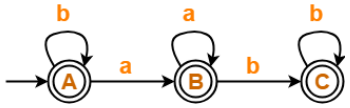
Regular Expression = c*a(d+bc*a)*

Problem-04: Find regular expression for the following DFA-

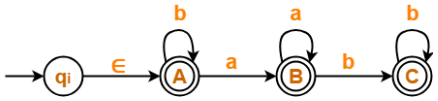


Solution-

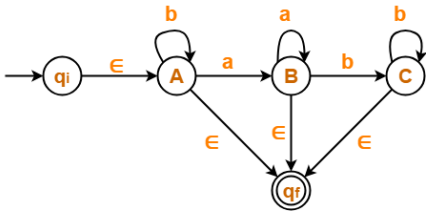
Step-01:



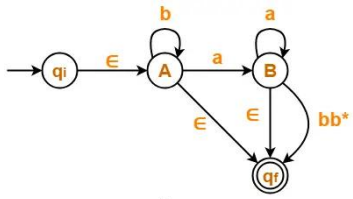
Step-02:

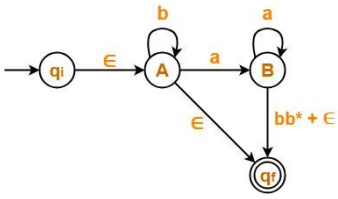


Step-03:

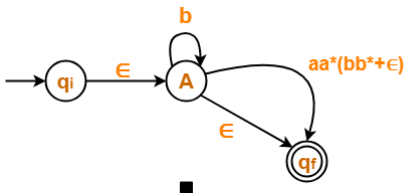


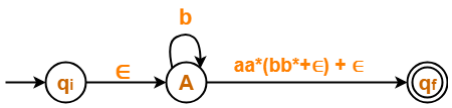
Step-04:



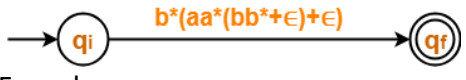


Step-05:





Step-06:

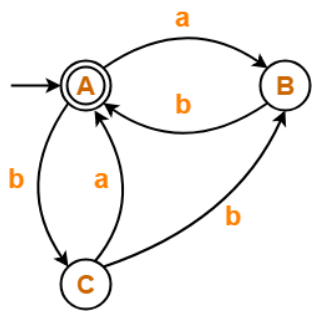


From here,

Regular Expression = b*(aa*(bb*+∈)+∈)

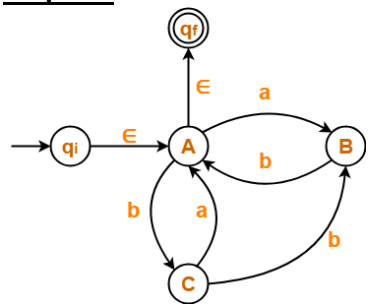
Finite Automata to Regular Expression

Problem-05: Find regular expression for the following DFA-

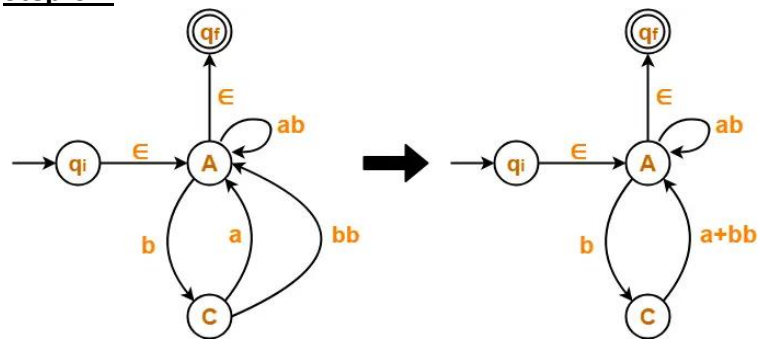


Solution-

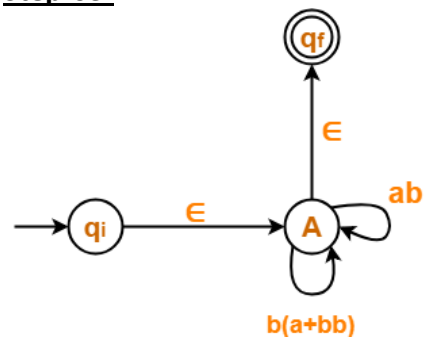
Step-01:



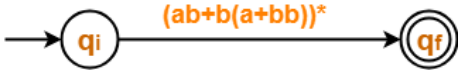
Step-02:



Step-03:

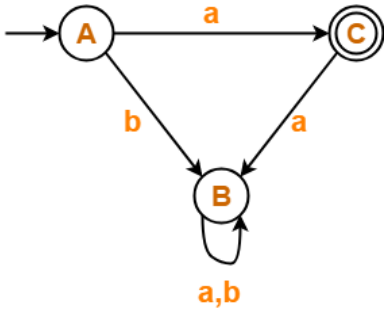


Step-04:



From here,
Regular Expression = (ab + b(a+bb))*

Problem-06: Find regular expression for the following DFA-



Solution-

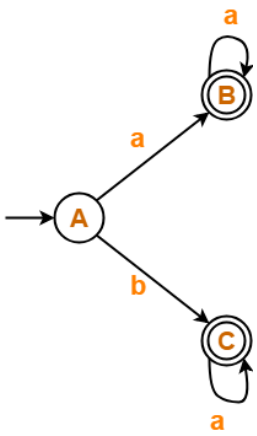
- State B is a dead state as it does not reach to the final state.
- So, we eliminate state B and its associated edges.

The resulting DFA is-

From here,
Regular Expression = a

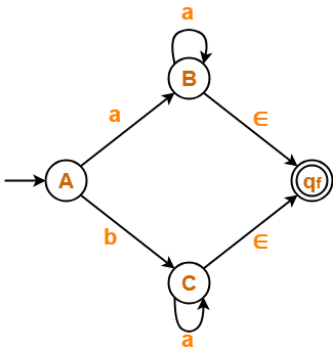
Finite Automata to Regular Expression

Problem-07: Find regular expression for the following DFA-

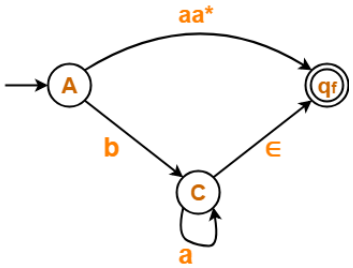


Solution-

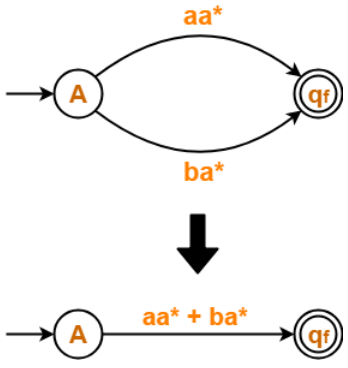
Step-01:



Step-02:



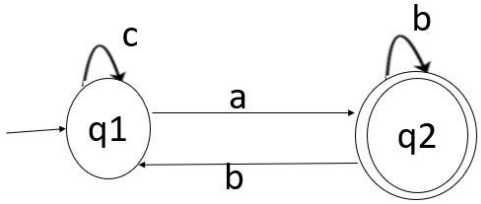
Step-03:



From here,

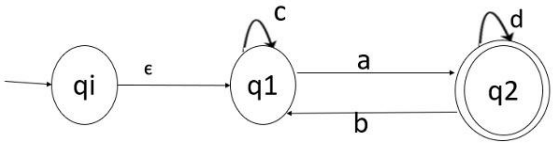
Regular Expression = aa* + ba*

Problem-08: Given a Finite Automata, we need to convert the Finite Automata into equivalent Regular Expression using the State Elimination Method.

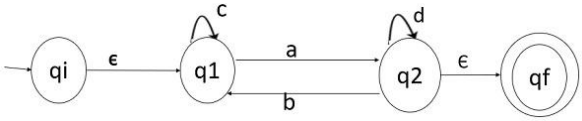


Solution:

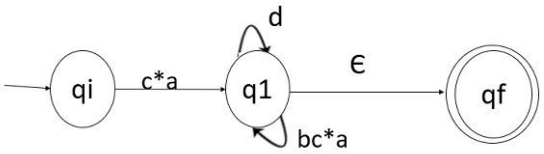
Step 1 – Initial state q1 has incoming edge. So, create a new initial state qi.



Step 2 – Final state q2 has outgoing edge. So, create a new final state.



Step 3 – Start eliminating intermediate states one after another.



Step 4- Now eliminate q2.

After eliminating q2 direct path from state qi to qf having cost.

From here,

Regular Expression =

c*a(d+bc*a) * ε=c*a(d+bc*a)*