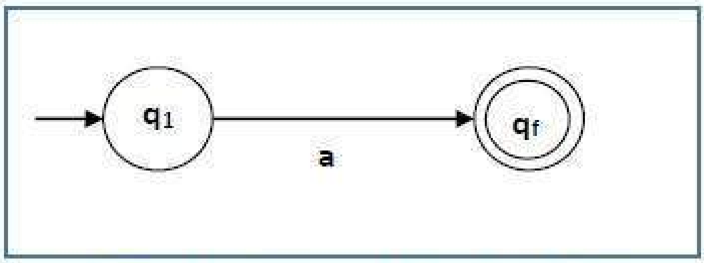
CONSTRUCTION OF AN FA FROM AN RE

Construction of an FA from an RE

We can use Thompson's Construction to find out a Finite Automaton from a Regular Expression. We will reduce the regular expression into smallest regular expressions and converting these to NFA and finally to DFA.

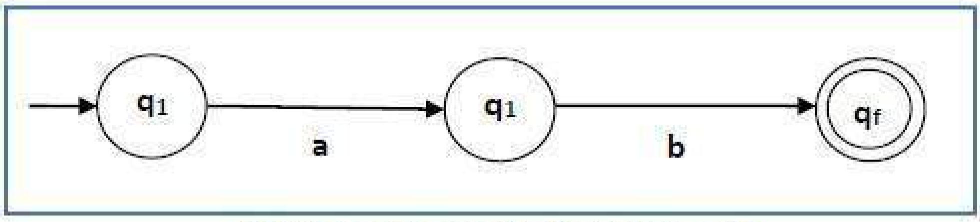
Some basic RA expressions are the following −

Case 1 − For a regular expression ‘a’, we can construct the following FA −



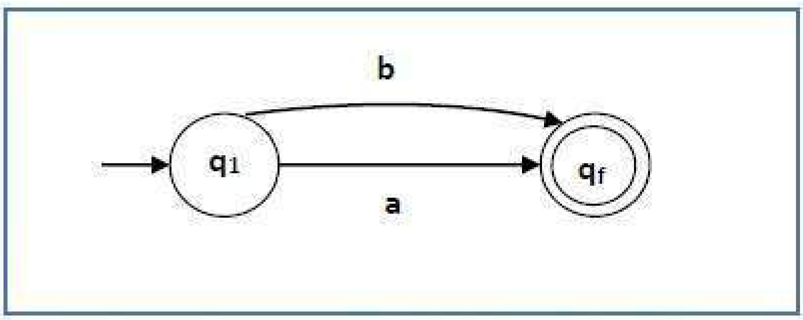
Finite automata for RE = a

Case 2 − For a regular expression ‘ab’, we can construct the following FA −



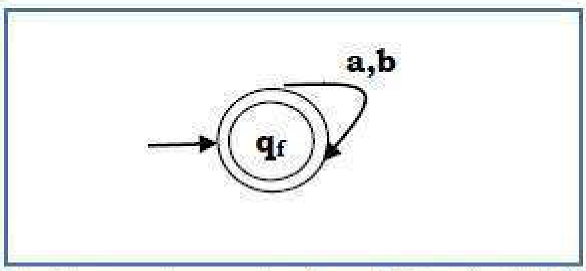
Finite automata for RE = ab

Case 3 − For a regular expression $a + b$, we can construct the following FA −



Finite automata for RE= (a+b)

Case 4 − For a regular expression $a + b*$, we can construct the following FA −



Finite automata for RE= (a+b)*

Method

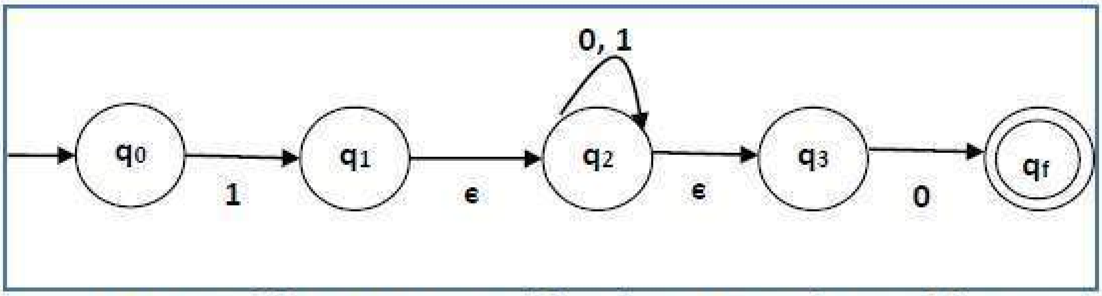
Step 1	Construct an NFA with Null moves from the given regular expression.
Step 2	Remove Null transition from the NFA and convert it into its equivalent DFA.

Problem

Convert the following RA into its equivalent DFA − 1 $(0 + 1)^*$ 0

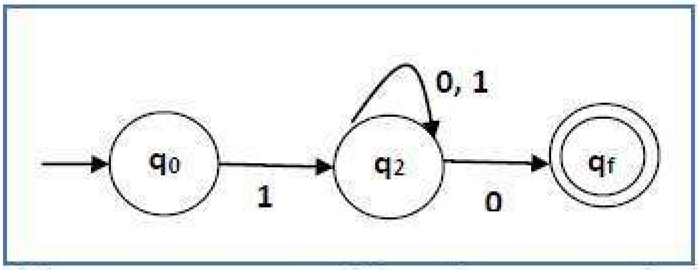
Solution

We will concatenate three expressions "1", "$(0 + 1)^*$" and "0"



NDFA with NULL transition for RA: 1 (0 + 1)* 0

Now we will remove the **ε** transitions. After we remove the **ε** transitions from the NDFA, we get the following −



NDFA without NULL transition for RA: 1 (0 + 1)* 0

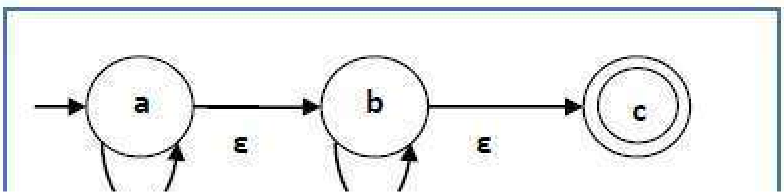
It is an NDFA corresponding to the RE: 1 $(0 + 1)^*$ 0. If you want to convert it into a DFA, simply apply the method of converting NDFA to DFA discussed in Chapter 1.

Finite Automata with Null Moves $(NFA - \varepsilon)$

A Finite Automaton with null moves $(FA - \varepsilon)$ does transit not only after giving input from the alphabet set but also without any input symbol. This transition without input is called a **null move**.

An NFA-ε is represented formally by a 5-tuple (Q, ∑, δ, q_0, F), consisting of

- **Q** − a finite set of states
- **∑** − a finite set of input symbols
- **δ** − a transition function δ : Q × $(\sum \cup \varepsilon)$ → 2^Q
- $\mathbf{q_0}$ − an initial state q_0 ∈ Q
- **F** − a set of final state/states of Q $(F \subseteq Q)$.



Finite automata with Null Moves

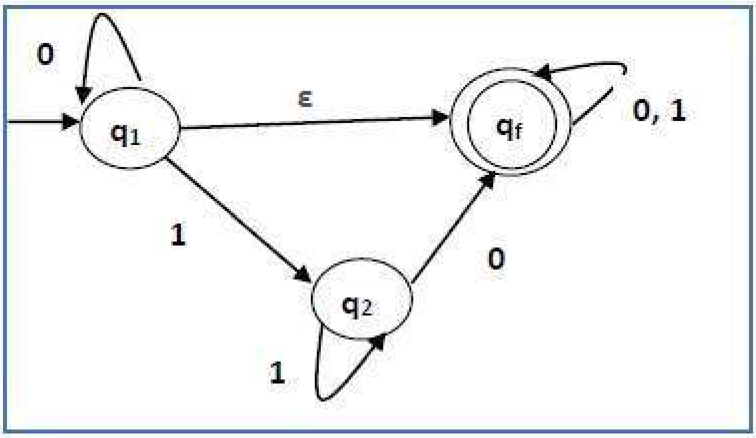
Removal of Null Moves from Finite Automata

If in an NDFA, there is ε-move between vertex X to vertex Y, we can remove it using the following steps −

- Find all the outgoing edges from Y.
- Copy all these edges starting from X without changing the edge labels.
- If X is an initial state, make Y also an initial state.
- If Y is a final state, make X also a final state.

Problem

Convert the following NFA-ε to NFA without Null move.



Solution

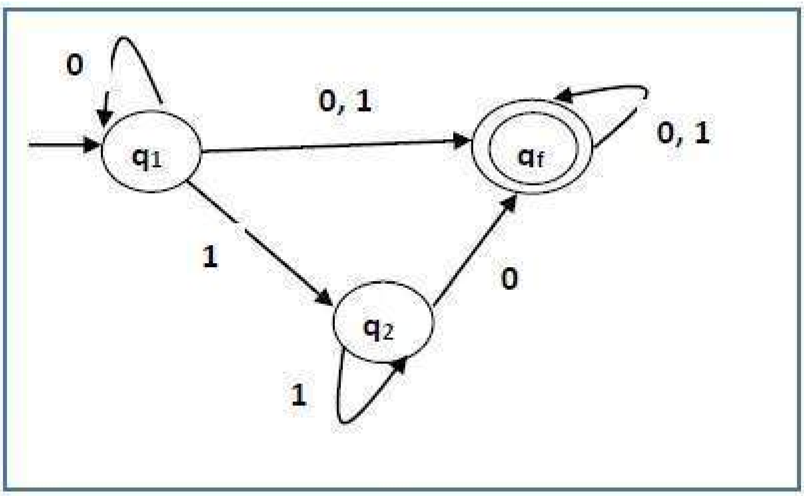
Step 1 −

Here the **ε** transition is between **q_1** and **q_2**, so let **q_1** is **X** and **q_f** is **Y**.

Here the outgoing edges from q_f is to q_f for inputs 0 and 1.

Step 2 −

Now we will Copy all these edges from q_1 without changing the edges from q_f and get the following FA −

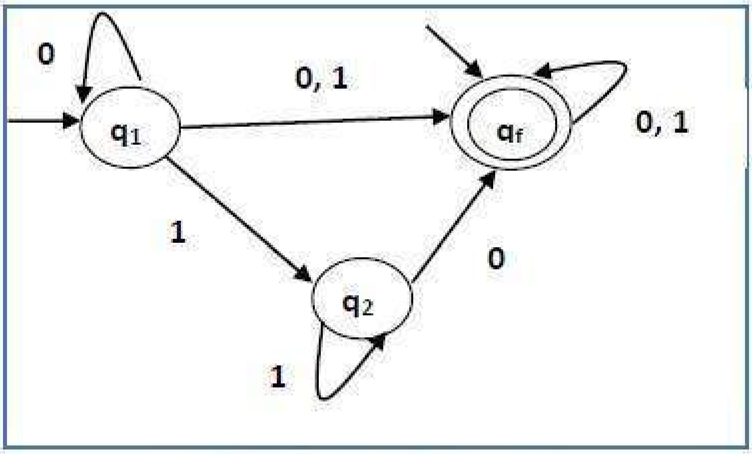


NDFA after step 2

Step 3 −

Here $\mathbf{q_1}$ is an initial state, so we make $\mathbf{q_f}$ also an initial state.

So the FA becomes −

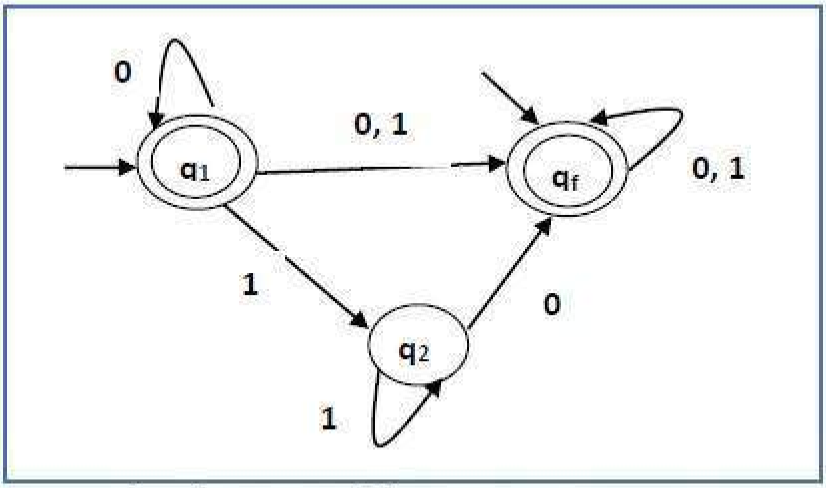


NDFA after Step 3

Step 4 −

Here $\mathbf{q_f}$ is a final state, so we make $\mathbf{q_1}$ also a final state.

So the FA becomes −



Final NDFA without NULL moves