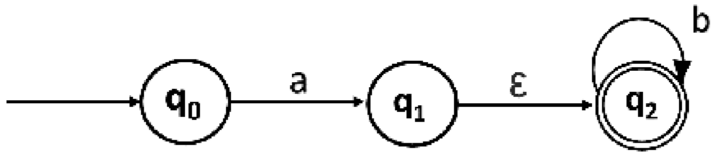
Eliminating ε Transitions

NFA with ε can be converted to NFA without ε, and this NFA without ε can be converted to DFA. To do this, we will use a method, which can remove all the ε transition from given NFA. The method will be:

1. Find out all the ε transitions from each state from Q. That will be called as ε-closure{q1} where qi ∈ Q.
2. Then δ' transitions can be obtained. The δ' transitions mean a ε-closure on δ moves.
3. Repeat Step-2 for each input symbol and each state of given NFA.
4. Using the resultant states, the transition table for equivalent NFA without ε can be built.

Example:

Convert the following NFA with ε to NFA without ε.



Solutions: We will first obtain ε-closures of q0, q1 and q2 as follows:

> ε-closure(q0) = {q0}
> ε-closure(q1) = {q1, q2}
> ε-closure(q2) = {q2}

Now the δ' transition on each input symbol is obtained as:

> δ'(q0, a) = ε-closure(δ(δ^(q0, ε),a))
> = ε-closure(δ(ε-closure(q0),a))
> = ε-closure(δ(q0, a))
> = ε-closure(q1)
> = {q1, q2}
>
> δ'(q0, b) = ε-closure(δ(δ^(q0, ε),b))
> = ε-closure(δ(ε-closure(q0),b))

$= \varepsilon\text{-closure}(\delta(q0, b))$
$= \Phi$

Now the δ' transition on q1 is obtained as:

$\delta'(q1, a) = \varepsilon\text{-closure}(\delta(\delta\wedge(q1, \varepsilon),a))$
$= \varepsilon\text{-closure}(\delta(\varepsilon\text{-closure}(q1),a))$
$= \varepsilon\text{-closure}(\delta(q1, q2), a)$
$= \varepsilon\text{-closure}(\delta(q1, a) \cup \delta(q2, a))$
$= \varepsilon\text{-closure}(\Phi \cup \Phi)$
$= \Phi$

$\delta'(q1, b) = \varepsilon\text{-closure}(\delta(\delta\wedge(q1, \varepsilon),b))$
$= \varepsilon\text{-closure}(\delta(\varepsilon\text{-closure}(q1),b))$
$= \varepsilon\text{-closure}(\delta(q1, q2), b)$
$= \varepsilon\text{-closure}(\delta(q1, b) \cup \delta(q2, b))$
$= \varepsilon\text{-closure}(\Phi \cup q2)$
$= \{q2\}$

The δ' transition on q2 is obtained as:

$\delta'(q2, a) = \varepsilon\text{-closure}(\delta(\delta\wedge(q2, \varepsilon),a))$
$= \varepsilon\text{-closure}(\delta(\varepsilon\text{-closure}(q2),a))$
$= \varepsilon\text{-closure}(\delta(q2, a))$
$= \varepsilon\text{-closure}(\Phi)$
$= \Phi$

$\delta'(q2, b) = \varepsilon\text{-closure}(\delta(\delta\wedge(q2, \varepsilon),b))$
$= \varepsilon\text{-closure}(\delta(\varepsilon\text{-closure}(q2),b))$
$= \varepsilon\text{-closure}(\delta(q2, b))$
$= \varepsilon\text{-closure}(q2)$
$= \{q2\}$

Now we will summarize all the computed δ' transitions:

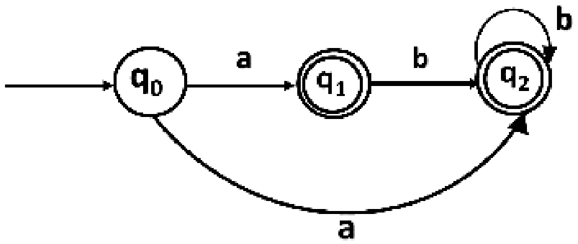
$\delta'(q0, a) = \{q0, q1\}$
$\delta'(q0, b) = \Phi$
$\delta'(q1, a) = \Phi$
$\delta'(q1, b) = \{q2\}$
$\delta'(q2, a) = \Phi$
$\delta'(q2, b) = \{q2\}$

The transition table can be:

States	**a**	**b**

→q0	{q1, q2}	Φ
*q1	Φ	{q2}
*q2	Φ	{q2}

State q1 and q2 become the final state as ε-closure of q1 and q2 contain the final state q2. The NFA can be shown by the following transition diagram:



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