Eliminating ε - Transitions

NFA with ε or ε-NFA can be converted to NFA or NFA without ε or null move.

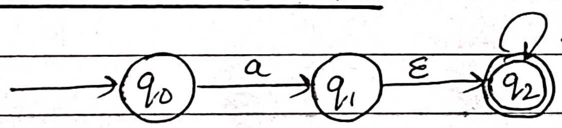
1. Episilon closure :-

* For each state q in the NFA, find the set of all states reachable from q by following zero or more epsilon transitions.
* This set is called the epsilon closure of q, denoted as ε- closure (q).

2. Remove ε transition :-

* Create a NFA without epsilon transition
* The states of the new NFA will be sets of states from the original NFA, representing the epsilon closure of each state.
* For each state S in the new NFA and each input symbol a:
  - → Find the set of states (T) that can be reached from any state in S by following a transition on a.
  - → Add a transition from S to ε- closure (T) on symbol a in the New NFA.

Example Convert ε- NFA to NFA



First find ε- closure for q_0, q_1, q_2

Solution

ε- closure $(q_0) = \{q_0\}$

ε- closure $(q_1) = \{q_1, q_2\}$

ε- closure $(q_2) = \{q_2\}$

Now find δ' transition for each input :-

$\delta'(q_0,a) = \varepsilon\text{-closure}(\delta(\hat{\delta}(q_0,\epsilon)),a))$
$= \varepsilon\text{-closure}(\delta(\varepsilon\text{-closure}(q_0,a))$
$= \varepsilon\text{-closure}(\delta(q_0,a))$
$= \varepsilon\text{-closure}(q_1)$
$= \{q_1,q_2\}$

$\delta'(q_0,b) = \varepsilon\text{-closure}(\delta(\varepsilon\text{-closure}(q_0),b)))$
$= \varepsilon\text{-closure}(\delta(q_0,b))$
$= \phi$

$\delta'(q_1,a) = \varepsilon\text{-closure}(\delta(\varepsilon\text{-closure}(q_1),a)))$
$= \varepsilon\text{-closure}(\delta(q_1,q_2),a)$
$= \varepsilon\text{-closure}(\delta(q_1,a) \cup \delta(q_2,a))$
$= \varepsilon\text{-closure}(\phi \cup \phi)$
$= \phi$

$\delta'(q_1,b) = \varepsilon\text{-closure}(\delta(\varepsilon\text{-closure}(q_1,b)))$
$= \varepsilon\text{-closure}(\delta(q_1,q_2),b)$
$= \varepsilon\text{-closure}(\delta(q_1,b) \cup \delta(q_2,b))$
$= \varepsilon\text{-closure}(\phi \cup q_2)$
$= q_2$

$\delta'(q_2,a) = \varepsilon\text{-closure}(\delta(\varepsilon\text{-closure}(q_2,a)))$
$= \varepsilon\text{-closure}(\delta(q_2,a))$
$= \phi$

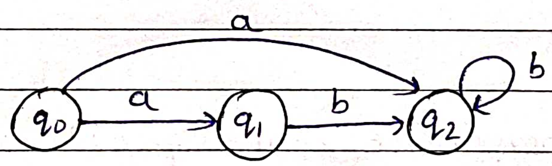
$\delta'(q_2,b) = \varepsilon\text{-closure}(\delta(\varepsilon\text{-closure}(q_2,b)))$
$= \varepsilon\text{-closure}(\delta(q_2,b))$
$= q_2$

δ' transitions :-

$\delta'(q_0, a) = q_0, q_1$
$\delta'(q_0, b) = \phi$
$\delta'(q_1, a) = \phi$
$\delta'(q_1, b) = q_2$
$\delta'(q_2, a) = \phi$
$\delta'(q_2, b) = q_2$

Transition Table :-

States	a	b
$\rightarrow q_0$	$\{q_1, q_2\}$	ϕ
$* q_1$	ϕ	$\{q_2\}$
$* q_2$	ϕ	$\{q_2\}$



* State q_1 and q_2 becomes the final state as ε- closure of q_1 and q_2 contain the final state q_2. The NFA can be shown by the following transition diagram shown above.