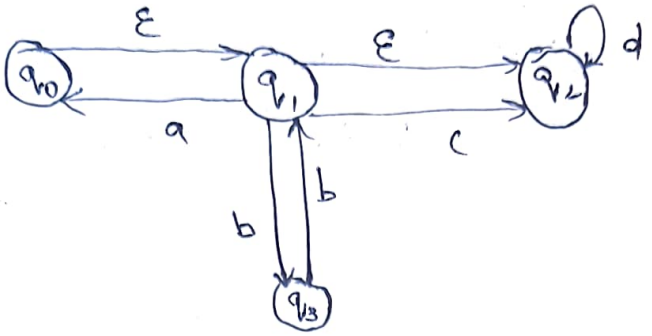
Convert ε NFA in to NFA without ε transition



Step 1 - find out all the epsilon transformation from each state of Q

Obtain ε - closure of each state

ε - closure $\{q_0\} \Rightarrow \{q_0, q_1, q_2\}$ New initial state of NFA

ε - closure $\{q_1\} \Rightarrow \{q_1, q_2\}$ New state of NFA

ε - closure $\{q_2\} = \{q_2\}$ New state of NFA

ε - closure $\{q_3\} = \{q_3\}$ New state of NFA

Step-2 find δ transition.

obtain δ transition for each state on each input symbols.

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

$= \varepsilon$ - closure $(\delta(q_0, a) \cup \delta(q_1, a) \cup \delta(q_2, a))$

$= \varepsilon$ - closure $(\phi \cup q_0 \cup \phi)$

$= \varepsilon$ - closure (q_0)

$= \{q_0, q_1, q_2\}$

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

$= \varepsilon\text{-closure}(\delta(q_0, b) \cup \delta(q_1, b) \cup \delta(q_2, b))$

$= \varepsilon\text{-closure}(\phi \cup q_3 \cup \phi)$

$= \varepsilon\text{-closure}(q_3)$

$= \{q_3\}$

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

$= \varepsilon\text{-closure}(\delta(q_0, c) \cup \delta(q_1, c) \cup \delta(q_2, c))$

$= \varepsilon\text{-closure}(\phi \cup q_2 \cup \phi$

$= \varepsilon\text{-closure}(q_2)$

$= \{q_2\}$.

$\delta'\{q_0, q_1, q_2\}, d) = \varepsilon\text{-closure}(\delta\{q_0, q_1, q_2\}, d]$

$= \varepsilon\text{-closure}(\delta(q_0, d) \cup \delta(q_1, d) \cup \delta(q_2, d))$

$= \varepsilon\text{-closure}(\phi \cup \phi \cup q_2)$

$= \varepsilon\text{-closure}(q_2)$

$= \{q_2\}$

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

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

$= \varepsilon\text{-closure}(q_0 \cup \phi)$

$= \varepsilon\text{-closure}(q_0)$

$= \{q_0, q_1, q_2\}$

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

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

$= \varepsilon\text{-closure}(q_3)$

$= \{q_3\}$

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

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

$= \varepsilon\text{-closure}(q_2 \cup \phi)$

$= \varepsilon\text{-closure}(q_2)$

$= \{q_2\}$

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

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

$= \varepsilon\text{-closure}(\phi \cup q_2)$

$= \varepsilon\text{-closure}(q_2)$

$= \{q_2\}$

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

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

$= \varepsilon\text{-closure}(\phi)$

$= \{\phi\}$

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

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

$= \varepsilon\text{-closure}(\phi)$

$= \{\phi\}$

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

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

$= \varepsilon\text{-closure}\{\phi\}$

$= \{\phi\}$

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

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

$= \varepsilon\text{-closure}(q_2)$

$= \{q_2\}$

$\delta'(\{q_3\}, a) = \varepsilon\text{-closure}(\delta(\{q_3\}, a))$

$= \varepsilon\text{-closure}(\delta(q_3, a))$

$= \varepsilon\text{-closure}(\phi)$

$= \{\phi\}$

$\delta'(\{q_3\}, b) = \varepsilon\text{-closure}(\delta(\{q_3\}, b))$

$= \varepsilon\text{-closure}(\delta(q_3, b))$

$= \varepsilon\text{-closure}(q_1)$

$= \{q_1, q_2\}$

$\delta'(\{q_3\}, c) = \varepsilon\text{-closure}(\delta(\{q_3\}, c))$

$= \varepsilon\text{-closure}(\delta(q_3, c))$

$= \varepsilon\text{-closure}(\phi)$

$= \{\phi\}$

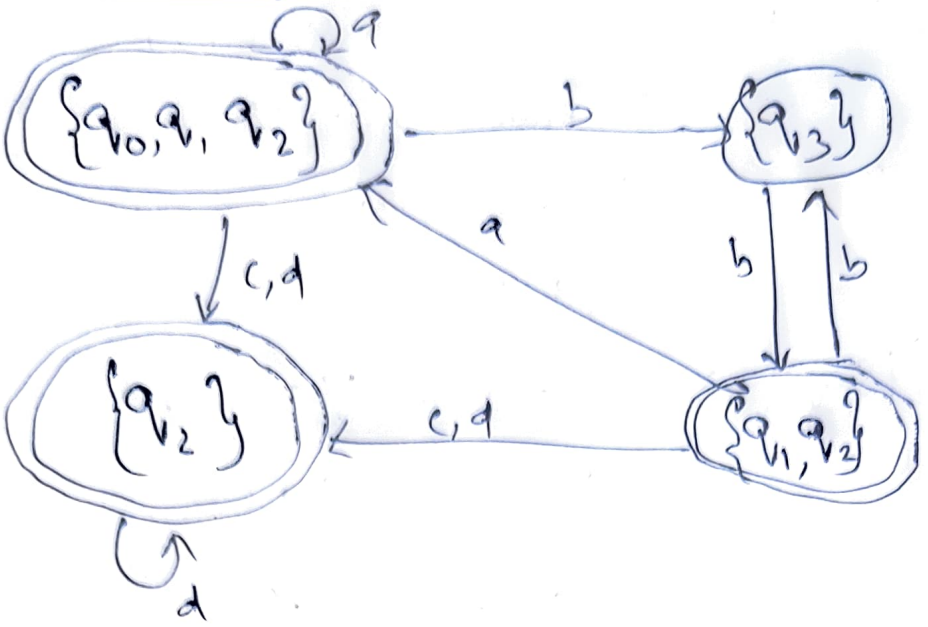
$\delta'(\{q_3\}, d) = \varepsilon\text{-closure}(\delta[\{q_3\}, d])$

$= \varepsilon\text{-closure}(\delta(q_3, c))$

$= \varepsilon\text{-closure}(\phi)$

$= \{\phi\}.$

State / input	a	b	c	d
$\rightarrow\{q_0, q_1, q_3\}$	$\{q_0, q_1, q_3\}$	$\{q_3\}$	$\{q_2\}$	$\{q_2\}$
$\{q_2, q_1\}$	$\{q_0, q_1, q_2\}$	$\{q_3\}$	$\{q_2\}$	$\{q_2\}$
$\{q_2\}$	$\{\phi\}$	$\{b\}$	$\{\phi\}$	$\{q_2\}$
$\{q_3\}$	$\{\phi\}$	$\{q_1, q_2\}$	$\{\phi\}$	$\{\phi\}$.


a
{q0, q1, q2}
b
{q3}
a
b
b
c, d
{q2}
c, d
{q1, q2}
d