

NFA with ϵ moves is exactly same as NFA without ϵ moves.

But difference exist in the transition function δ . δ must include information about ϵ transitions.

NFA with ϵ -Moves has 6 tuples $(Q, \Sigma, \delta, q_0, F)$.

Where,

- Q = finite set of states.
- Σ = finite set input symbols.
- δ = transition function that maps $Q \times (\Sigma \cup \{\epsilon\})$ to 2^Q .
- q_0 = initial state.
- F = set of final states.

The non-deterministic finite automaton can be extended to include the transitions on null/empty input ϵ .

For example,



NFA with ϵ

In this NFA with epsilon,

- It accept an input string 'aabc'.

- Or string as number of a's followed by number of b's followed by number of c's.
- The string 'aabc' is accepted by the NFA by following the path with labels a, a, ϵ , b, ϵ , c.

Transition table for above NFA.

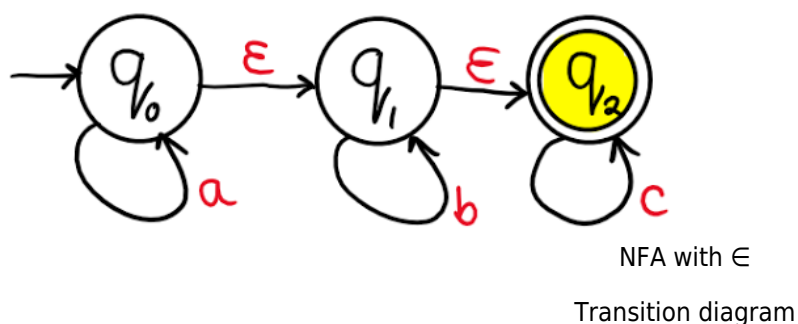
	a	b	c	ϵ
q ₀	q ₀	q ₁	q ₂	q ₁
q ₁	q ₁	q ₁	q ₂	q ₂
q ₂	q ₂	q ₂	q ₂	q ₂

ϵ -closure

ϵ -closure of a state q is a set of states following by all transitions of q that are labeled as ϵ .

- ϵ -closure (q₀) = (q₀, q₁, q₂)
- ϵ -closure (q₁) = (q₁, q₂)
- ϵ -closure (q₂) = (q₂)

NFA with ϵ to NFA without ϵ



Transition table NFA with ϵ

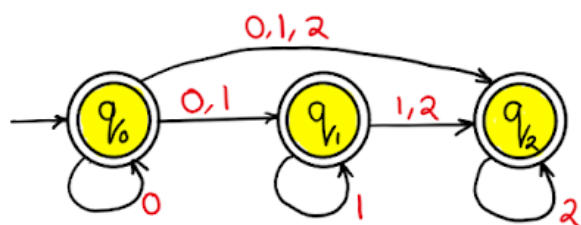
	a	b	c	ϵ
q ₀	q ₀	q ₁	q ₂	q ₁
q ₁	q ₁	q ₁	q ₂	q ₂
q ₂	q ₂	q ₂	q ₂	q ₂

First find out ϵ closure: ϵ -closure

- $(q_0) = (q_0, q_1, q_2)$
- ϵ -closure $(q_1) = (q_1, q_2)$
- ϵ -closure $(q_2) = (q_2)$

Transition table NFA without ϵ

State	a	b	c
$\rightarrow q_0$	$\{q_0, q_1, q_2\}$	$\{q_1, q_2\}$	$\{q_2\}$
q_1	\emptyset	$\{q_1, q_2\}$	$\{q_2\}$
q_2	\emptyset	\emptyset	$\{q_2\}$



NFA without ϵ

Transition diagram

Reference:

- "Introduction to the Theory of Computation" by Michael Sipser.

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