CS & IT ENGINEERING

THEORY OF COMPUTATION

DFA, NFA, ϵ-NFA

Lecture No.- 05

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Recap of Previous Lecture

Topic ????? DFA Drawback

NFA ⇒ DFA

NFA → DFA

$(Q, \Sigma, q_0, F, \delta)$

$\delta : Q \times \Sigma \to 2^Q$

min 1 ... 2 max

NFA ⇒ DFA

Topics to be Covered

Topic ∈-NFA

Topic ?? ∈-NFA ⇒ NFA

Topic ?? ∈-NFA ⇒ DFA

Topic ?? Meady m/c, Moore m/c

Topic : ϵ -NFA

NOTE: Construction of ∈ - NFA is easy than NFA

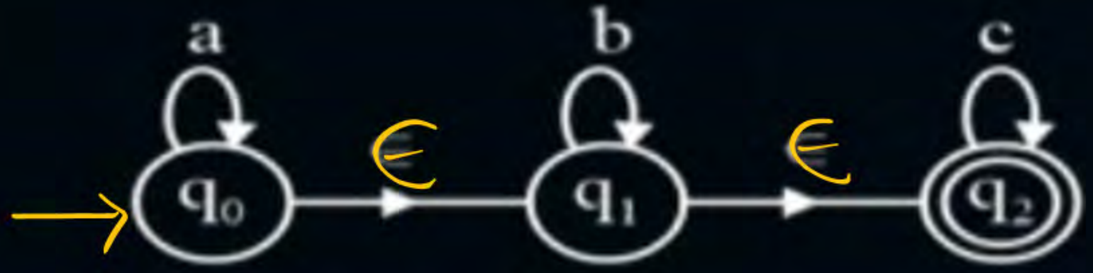
$$\{Q, \Sigma, q_0, F, \delta\}$$

Q	-	Finite number of states (set of state)
Σ	-	Input alphabet
q_0	-	initial state
F	-	Set of final states
δ	-	transition function

$$\delta: Q \times \Sigma \cup \{\in\} \rightarrow 2^Q$$

Topic : ϵ -NFA

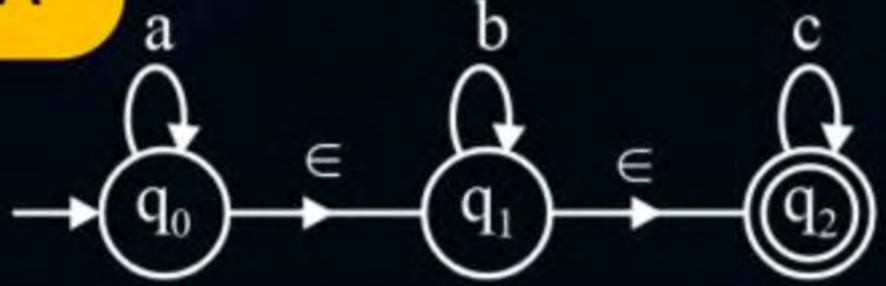
$L = \{a^n b^m c^k / n, m, k \geq 0\}$ construct $\in$-NFA for L



$\in$NFA

Topic : ϵ -NFA

ϵ-NFA



Topic : ε-NFA to NFA

$L = \{a^n b^m c^k \mid n, m, k \geq 0\}$

Topic : ϵ -NFA

⇒ NFA

While converting ∈-NFA into NFA (without ∈) the following are the possibilities

1. No. of states are same
2. Initial state is same
3. Final state may changes (may increase)
4. Transitions may changes

Topic : Conversion from ∈-NFA to NFA

Transitions of NFA is

$\delta^1 (q_1, a) = \in$-closure (δ($\in$-closure (q),a)

Topic : Conversion from ∈-NFA to NFA

Transitions of NFA is

$\delta^1 (q_1, a) = \in$-closure (δ($\in$-closure (q),a)

Topic : Conversion from ∈-NFA to NFA

∈-closure (q) = set of all states which are reachable from state q by reading only ∈.

#Q. Construct an equivalent NFA for the following ε-NFA

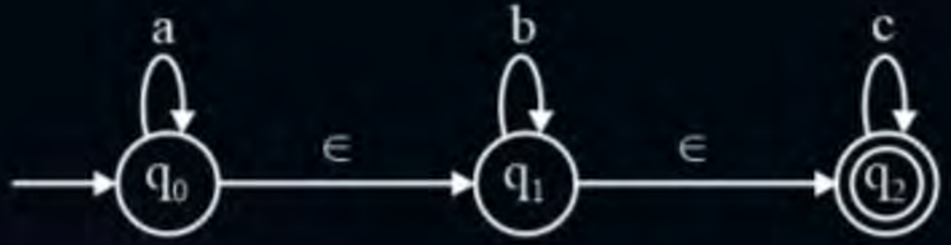
$\epsilon\text{-closure}(q_0) = \{q_0, q_1, q_2\}$

$\epsilon\text{-closure}(q_1) = \{q_1, q_2\}$

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

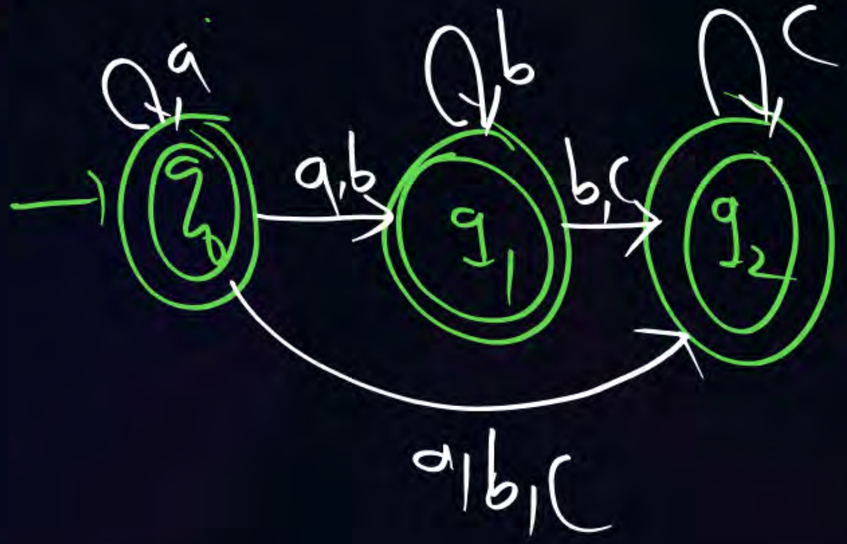
min DFA = 4

#Q. Construct an equivalent NFA for the following ε-NFA



ε-NFA

NFA =>



NFA	a	b	c
→ q_0	$\{q_0,q_1,q_2\}$	$\{q_1,q_2\}$	$\{q_2\}$
q_1	-	$\{q_1,q_2\}$	q_2
q_2	-	-	q_2

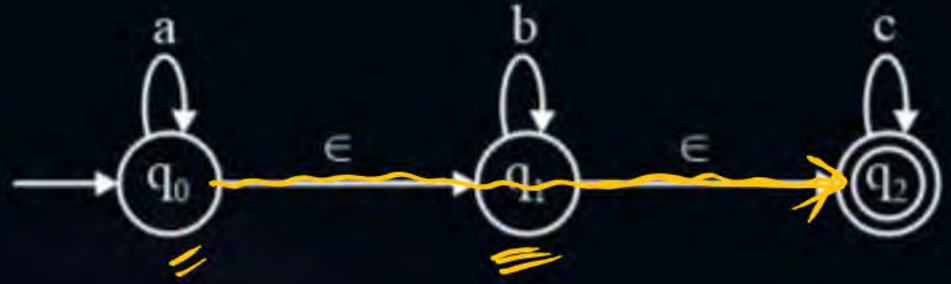
(4)

(5)

	a	b	c
→ q_0	$[q_0,q_1,q_2]$	$[q_1,q_2]$	q_2
$[q_0,q_1,q_2]$	$[q_0,q_1,q_2]$	$[q_1,q_2]$	q_2
$[q_1,q_2]$	$q_{D:5}$	$[q_1,q_2]$	q_2
q_2	$q_{D:5}$	$q_{D:5}$	q_2
$q_{D:5}$	$q_{D:5}$	$q_{D:5}$	$q_{D:5}$

#Q. Construct an equivalent NFA for the following ε-NFA

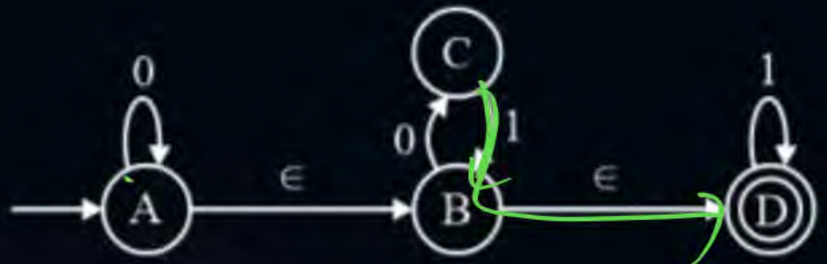
ε-NFA



NFA

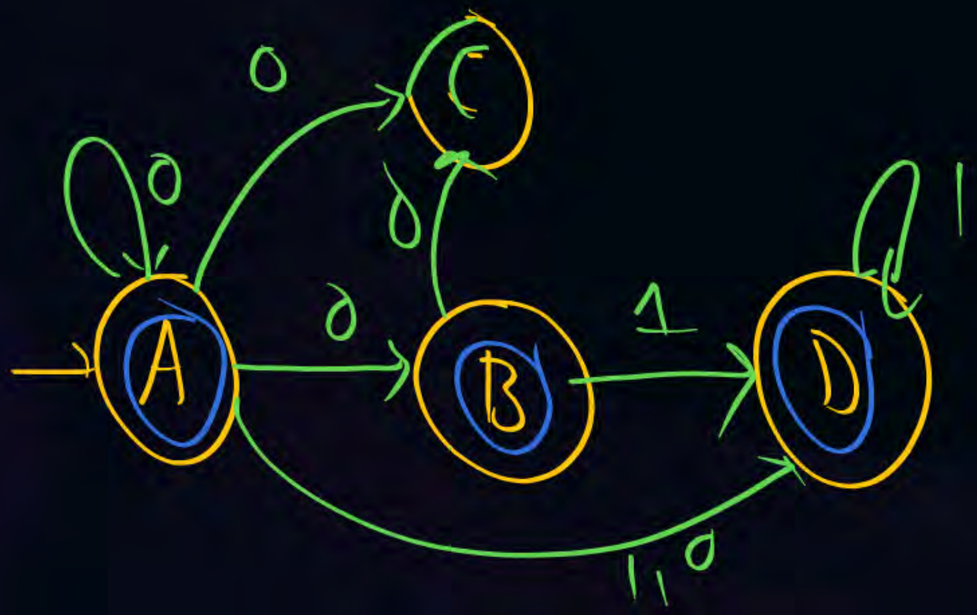
$\epsilon \cdot 0 = 0$

#Q. Construct an equivalent NFA for the following ε-NFA



ε-NFA

NFA



$\delta(A,0) = \{A, B, D, C\}$

$\delta(A,1) = \{D\}$

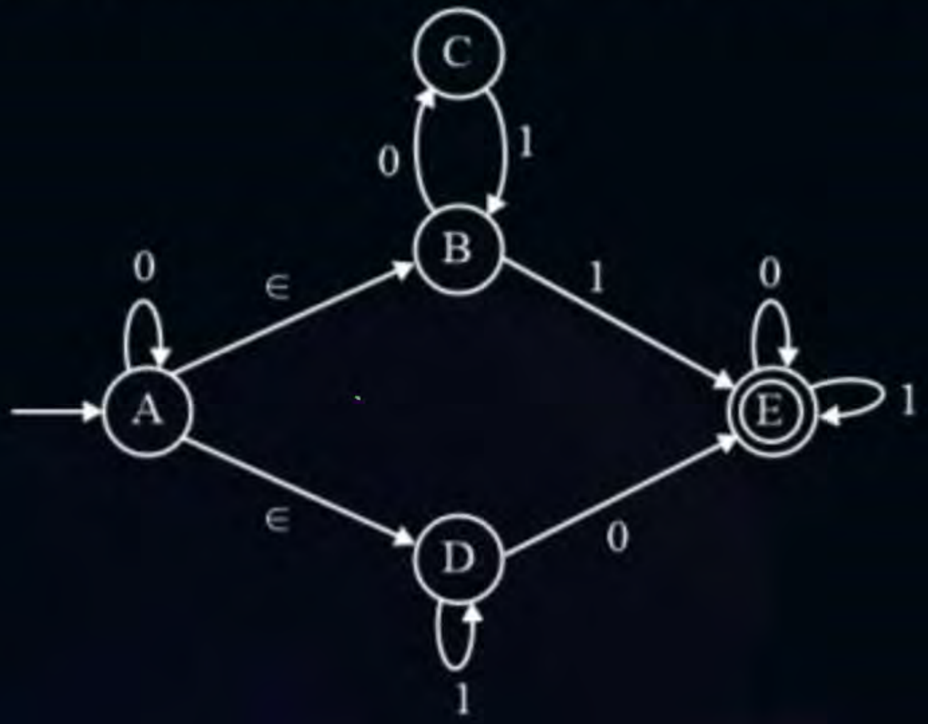
$\delta(B,0) = \{C\}$

$\delta(B,1) = \{D\}$

$\delta(C,1) = \{B, D\}$

$\delta(D,1) = \{D\}$

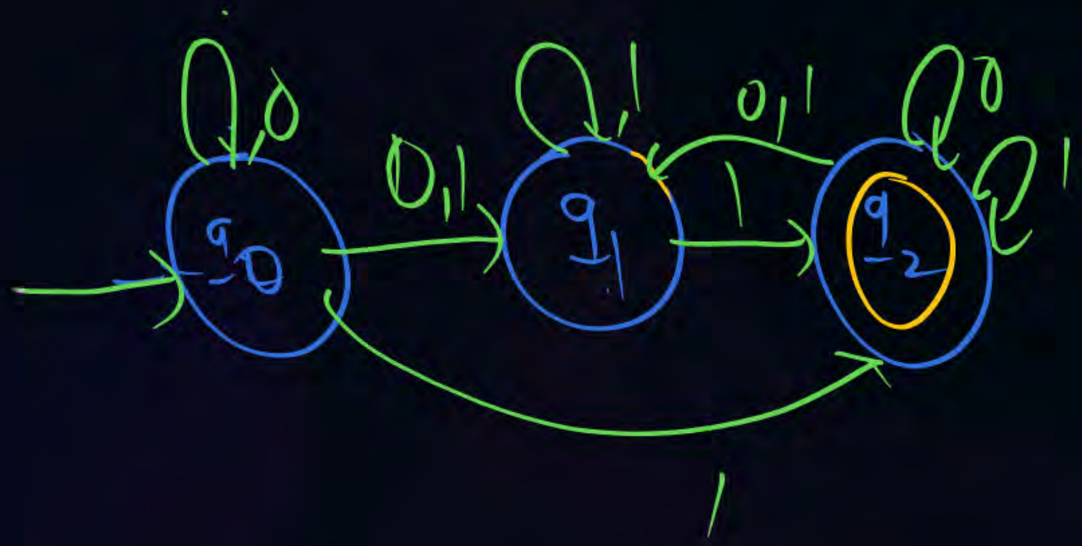
#Q. Construct an equivalent NFA for the following ε-NFA



Home work

#Q. Construct an equivalent NFA for the following ε-NFA

ϵ-NFA



$\delta(q_0, 0) = \{q_0, q_1\}$

$\delta(q_0, 1) = \{q_1, q_2\}$

$\delta(q_1, 1) = \{q_1, q_2\}$

$\delta(q_2, 0) = \{q_1, q_2\}$

$\delta(q_2, 1) = \{q_2, q_1\}$

Topic : Conversion from ∈-NFA to NFA

Transitions of NFA is

$\delta^1(q_0, a) = \in\text{-closure}(\delta(\in\text{-closure}(q), a))$

$\delta(q_0, a) = \in\text{-closure}(\delta((\in\text{-closure}(q_0), a))$

$\in\text{-closure}(\delta(q_0, a))$

$\in\text{-closure}(q_1) = \{q_0, q_1, q_2\}$

Topic : Conversion from ∈-NFA to NFA

Transitions of NFA is

$\delta^1 (q_1, a) = \in$-closure (δ(∈-closure (q),a)

$\delta(q_1, a) = \in$-closure(δ(∈-closure(q_1), a))

$\in$-clos[$\delta(q_0, q_1, q_2), a$]

$\in$-clos[$\delta(q_0,a) \cup \delta(q_1,a) \cup \delta(q_2,a)$]

$\in$-clos[$q_1 \cup \phi(b)$]

$\in$-clos[q_1]

$\in$-clos(q_1) = {q_0, q_1, q_2}

Topic : Conversion from ∈-NFA to NFA

Transitions of NFA is

$\delta^1 (q_1, a) = \in$-closure $(\delta(\in$-closure $(q), a)$

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

$\in\text{-closure}[\delta(q_0, q_2), a)]$

$[\delta(q_0, a) \cup (q_2, a)]$

$\in\text{-closure}[q_1] = \{q_0, q_1, q_2\}$

#Q. Construct an equivalent NFA for the following ε-NFA

ϵ-closure$(q_0) = \{q_0\}$

ϵ-closure$(q_1) = \{q_1, q_2, q_0\}$

ϵ-closure$(q_2) = \{q_2, q_0\}$

$\delta(q_0, a) = \{q_0, q_1, q_2\}$

$\delta(q_1, a) = \{q_0, q_1, q_2\}$

$\delta(q_2, a) = \{q_0, q_1, q_2\}$

$\epsilon \cdot \epsilon \cdot a = a$ $\quad a \cdot \epsilon \epsilon = a$

$a \cdot \epsilon = a$

$\epsilon \cdot a \cdot \epsilon = a$

#Q. Construct an equivalent NFA for the following ε-NFA

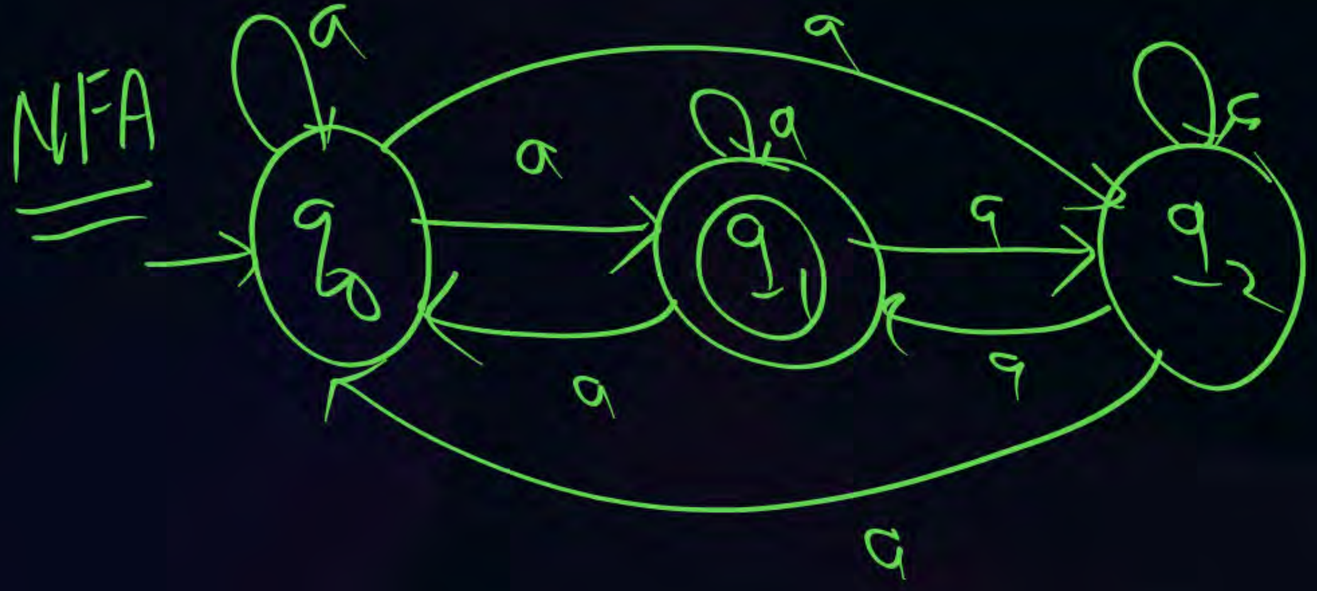
$\epsilon \cdot \epsilon \cdot a \cdot \epsilon\epsilon = a$

$\delta(q_0, a) = \{q_0, q_1, q_2\}$

$\delta(q_1, a) = \{q_0, q_1, q_2\}$

$\delta(q_2, a) = \{q_0, q_1, q_2\}$

NFA



(Q) What is the Complement of language accepted by following

ϵ-NFA.

$= \{a, a^2, a^3, a^4 \ldots\}$

C.L $= \{a, a^2, a^3, a^4 \ldots\}$

$\{\epsilon\}$

(a) $\{\}$

(b) $\{\epsilon\}$

(c) $\{a\}$

(d) None

#Q. How many states required to construct an equivalent minimized DFA for the following ∈-NFA.

Complete Language

min DFA

1

0,1

THANK - YOU