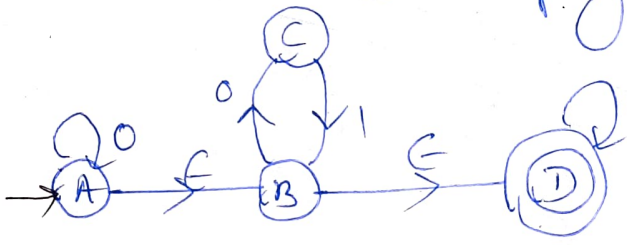
Lecture-57

Epsilon NFA / ϵ-NFA

ϵ means empty string.



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

$\delta : Q \times \Sigma \cup \{\epsilon\} \longrightarrow 2^Q$

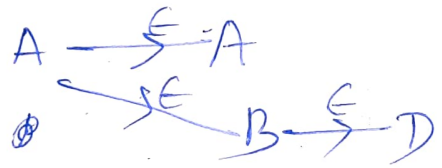
If δ removes ϵ then $Q \times \Sigma \to 2^Q$ i.e. NFA

So every NFA is ϵ-NFA

ϵ-NFA is different that the ordinary NFA in the sense that if we look at any transition that may even contain ϵ.

If I am in some state, if I see some input or without seeing anything I can reach at one state. on a state, without seeing anything, a transition is possible. we are going to a state.

ϵ-closure of A (what are all the states which you can reach only on seeing ϵ from A)



ϵ-closure(A) = {A, B, D}

we have seen before DFA, NFA and now seeing ϵ-NFA.

Now question is which one is powerful. we have already seen than DFA $\cong$ NFA. (DFA and NFA are equivalent in power bcoz every DFA is nothing but NFA therefore I can convert every NFA to DFA.)

DFA $\cong$ NFA $\cong$ ϵ NFA

Every NFA is ϵNFA. So All powers are equivalent.

Now Convert ϵ-NFA to NFA.

	0	1
A	{A, B, C, D}	{D}
B	{C, D}	{D}
C	{ϕ}	{B, D}
D	{D}	{D}

A NFA

State-transition table.

(A, 0)

ϵ^* 0 ϵ^*

A → A → A → A, B, C, D

B → C → C

D → D → D

(A, 1)

ϵ^* 1 ϵ^*

A → A → ϕ → ϕ

B → ϕ → ϕ

D → D → D → D

(B, 0)

ϵ^* 0 ϵ^*

B → B → C → C

D → D → D → D

(B, 1)

ϵ^* 1 ϵ^*

B → B → ϕ → ϕ

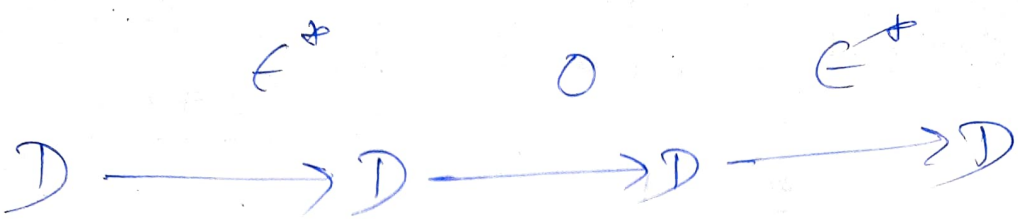
D → D → D → D

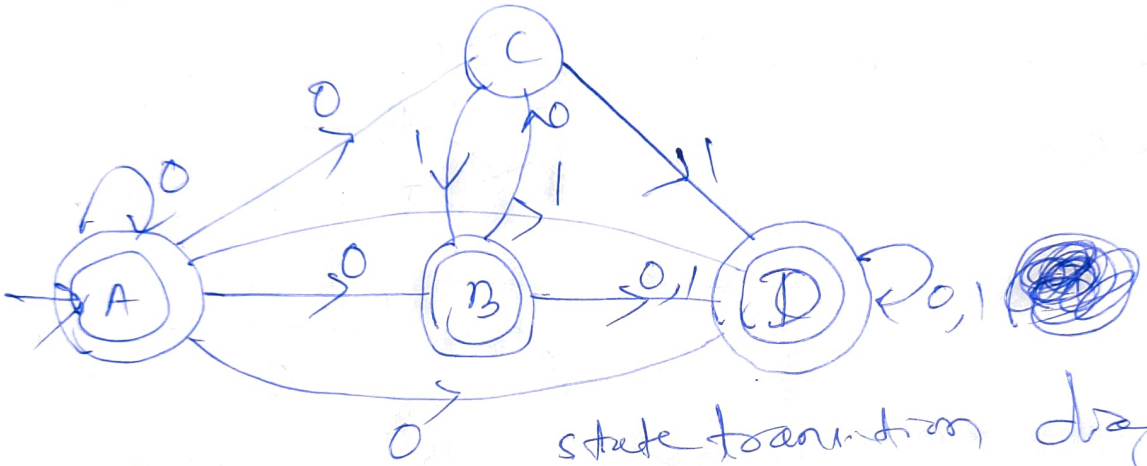
ϵ^* 0 ϵ^*

C → C → ϕ → ϕ

ϵ^* 1 ϵ^*

C → C → B → B, D





state transition diagram.

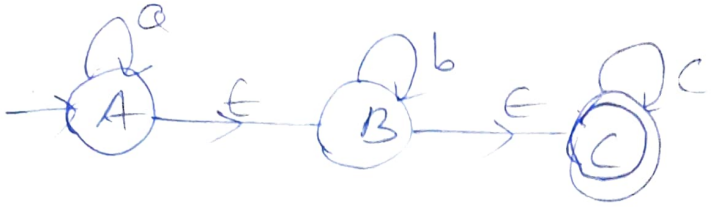
This is the NFA for the given ϵ-NFA.

1. No. of states are same.
2. Initial state is same.
3. The no. of final state may increase depending on if a state is going to reach final state only upon seeing ϵ.

I have to find the ϵ-closure of all states in ϵ-NFA.

Lecture-58

Conversion of ∈ NFA To NFA.



	a	b	c
A	{A, B, C}	{B, C}	{C}
B	{}	{B, C}	{C}
C	{}	{}	{C}

$\in^* \; a \; \in^*$

A → A → A → A
A → B → ϕ → B
A → C → ϕ → C

$\in^* \; b \; \in^*$

A → A → ϕ
A → B → B → B
A → C → ϕ → C

$\in^* \; c \; \in^*$

B → B → ϕ
B → C → C → C

$\in^* \; a \; \in^*$

C → C → ϕ

$\in^* \; b \; \in^*$

C → C → ϕ

$\in^* \; c \; \in^*$

C → C → C → C

$\in^* \; c \; \in^*$

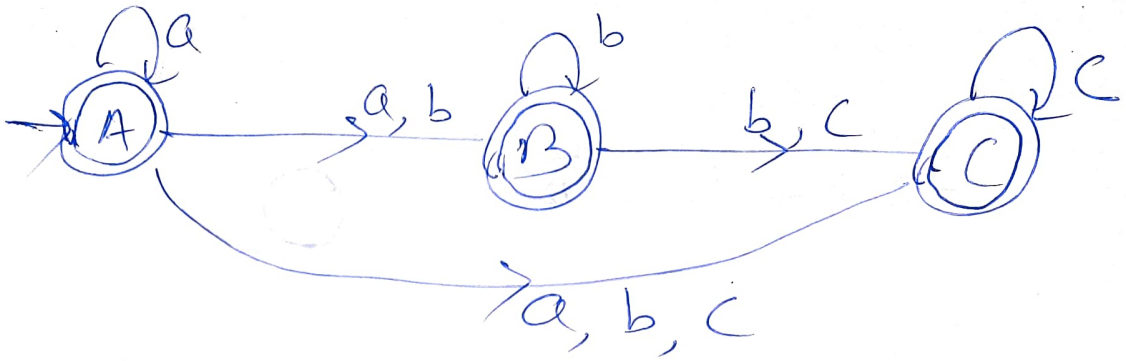
A → A → ϕ
A → B → ϕ
A → C → C → C

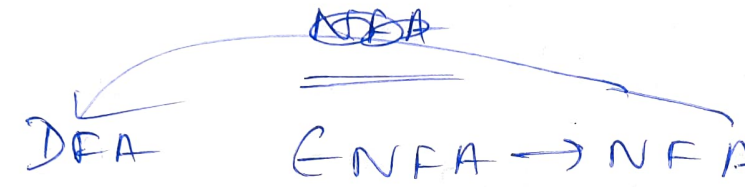
$\in^* \; a \; \in^*$

B → B → ϕ
B → C → ϕ

$\in^* \; b \; \in^*$

B → B → B → B
B → C → ϕ → C





we have converted ϵNFA to NFA. We can Convert NFA to DFA. So all the Finite Automata are equivalent in power.

DFA ≅ NFA ≅ ϵNFA