CS & IT ENGINEERING

Theory of Computation

Finite Automata:

Practice on DFA and NFA

Lecture No. 12

By- DEVA Sir

TOPICS TO BE COVERED

01 ε-NFA

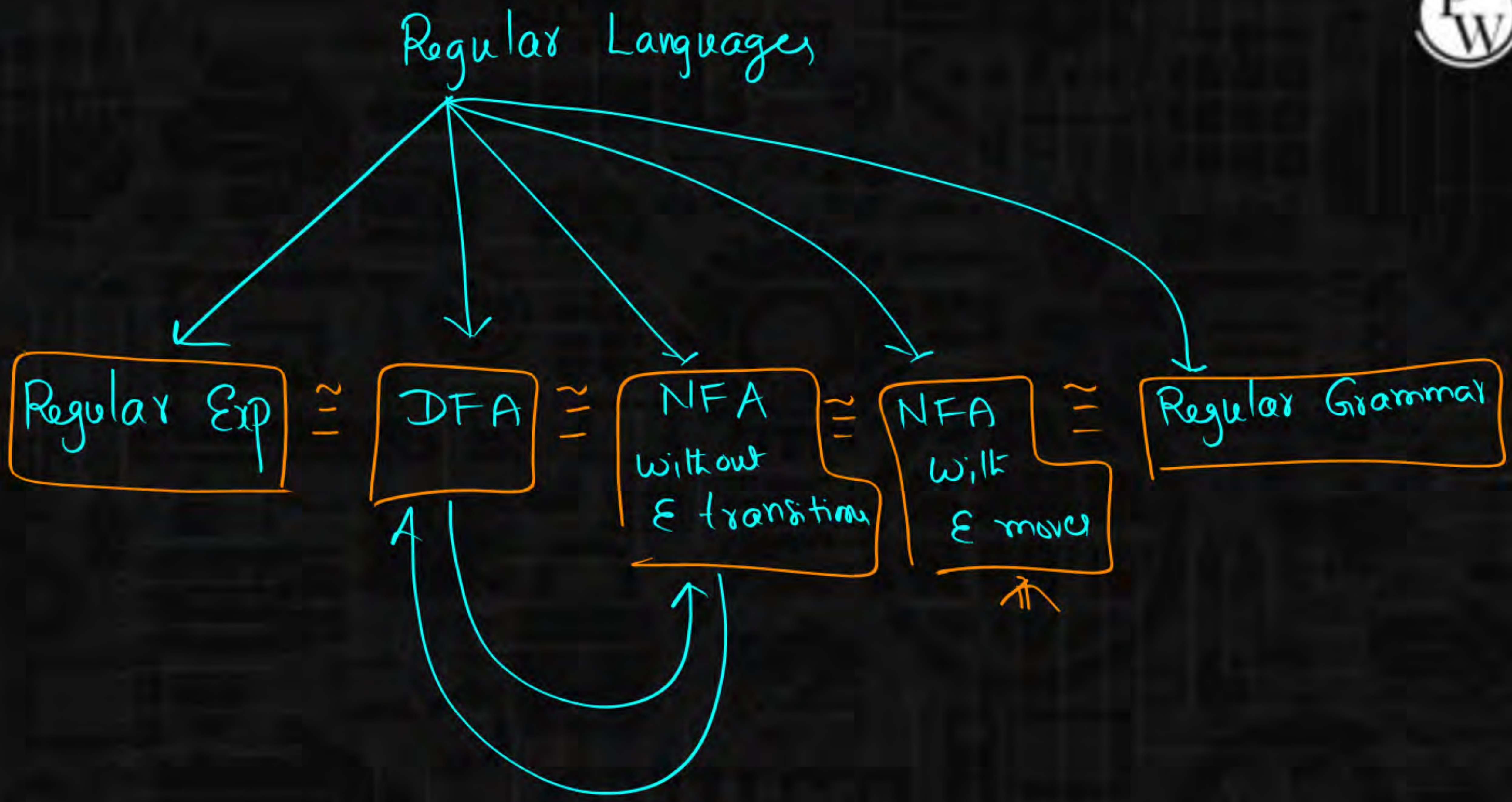
02 NFA, DFA practice

03

04

05

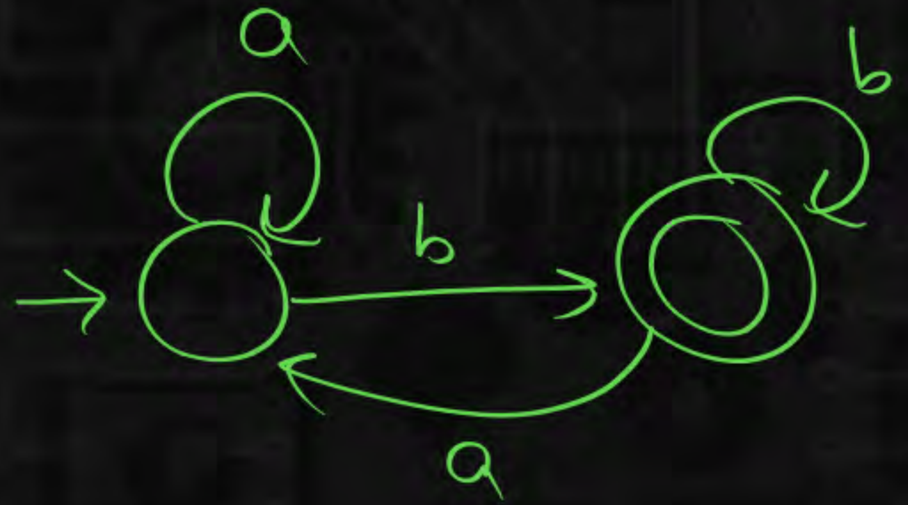
NFA Vs DFA


Regular Languages
Regular Exp
≅
DFA
≅
NFA without ε transitions
≅
NFA with ε moves
≅
Regular Grammar

NFA

DFA

$$\delta : Q \times \Sigma \rightarrow Q$$

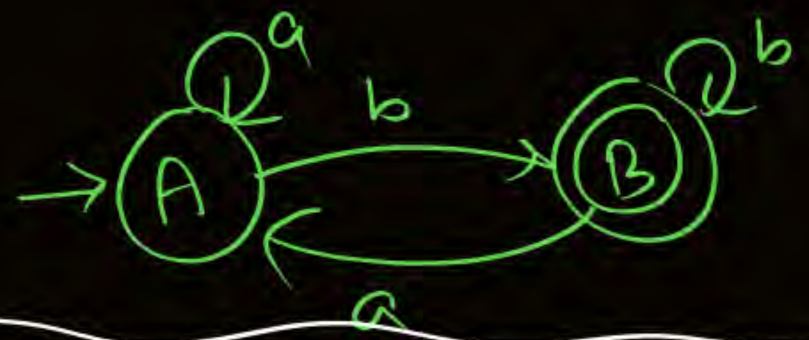


NFA
(without ε moves)

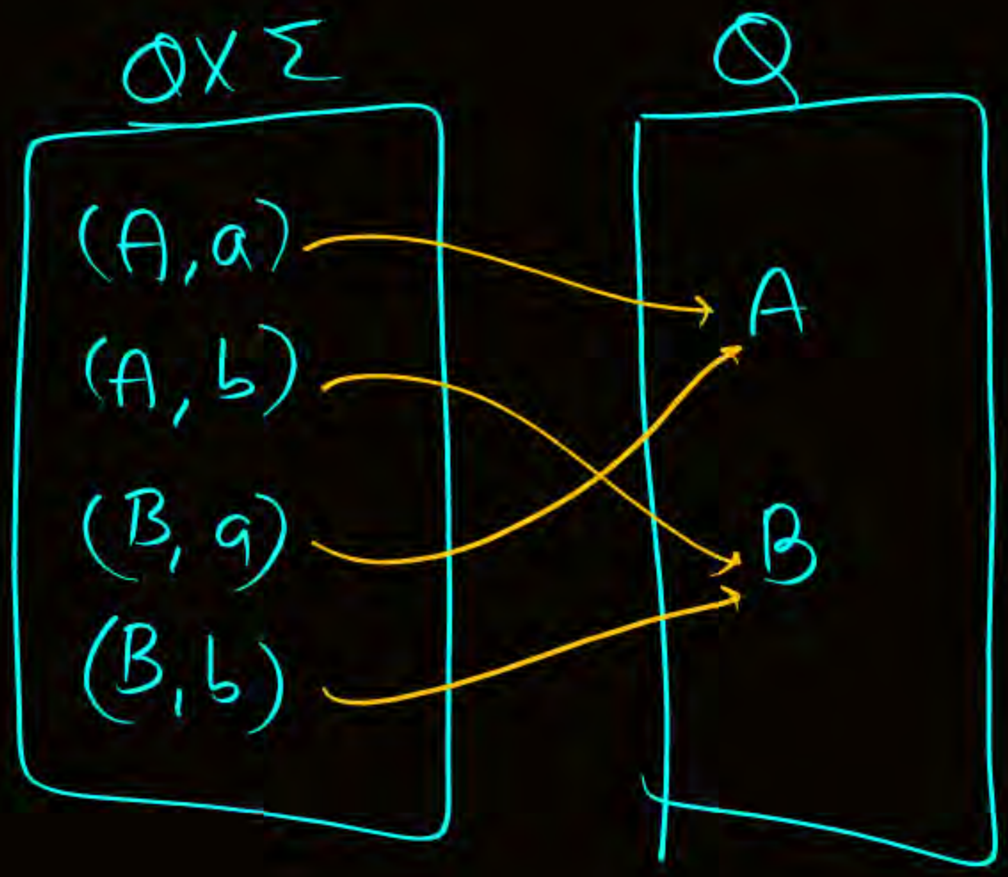
$$\delta : Q \times \Sigma \rightarrow 2^{Q}$$

NFA
(with ε-moves)

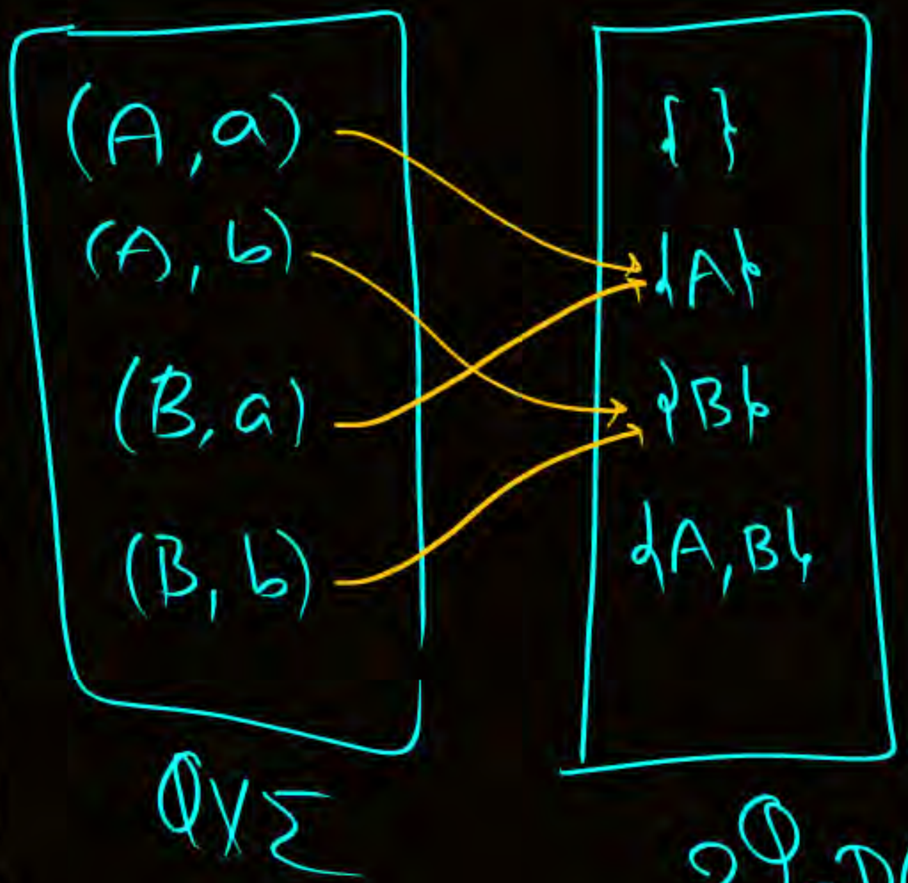
$$\delta : Q \times \Sigma \cup \{\varepsilon\} \rightarrow 2^{Q}$$



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

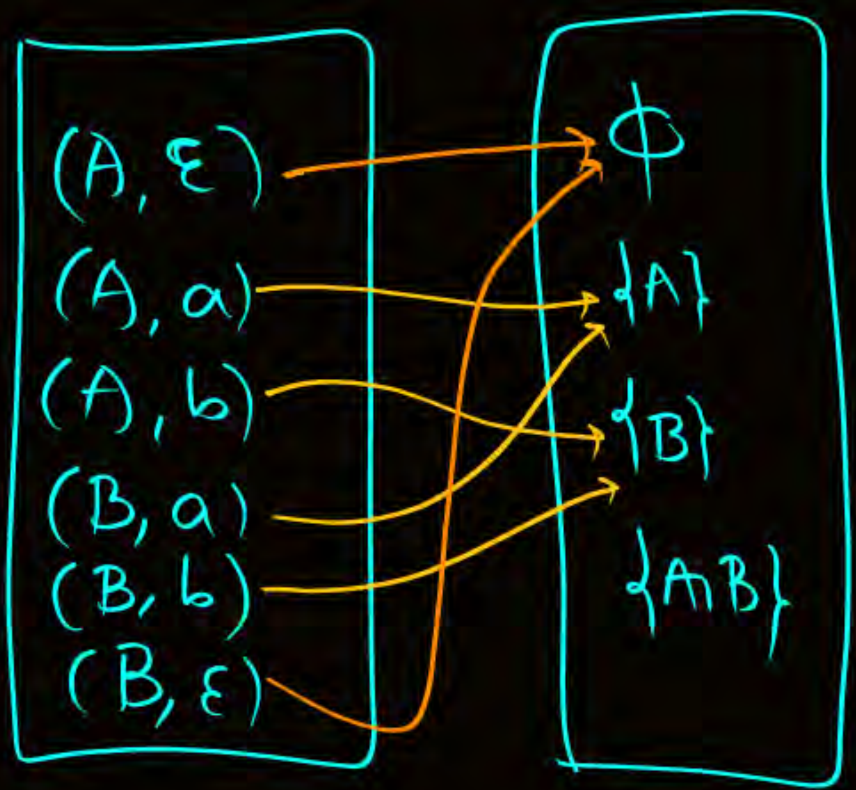


$\delta: Q \times \Sigma \to 2^Q$

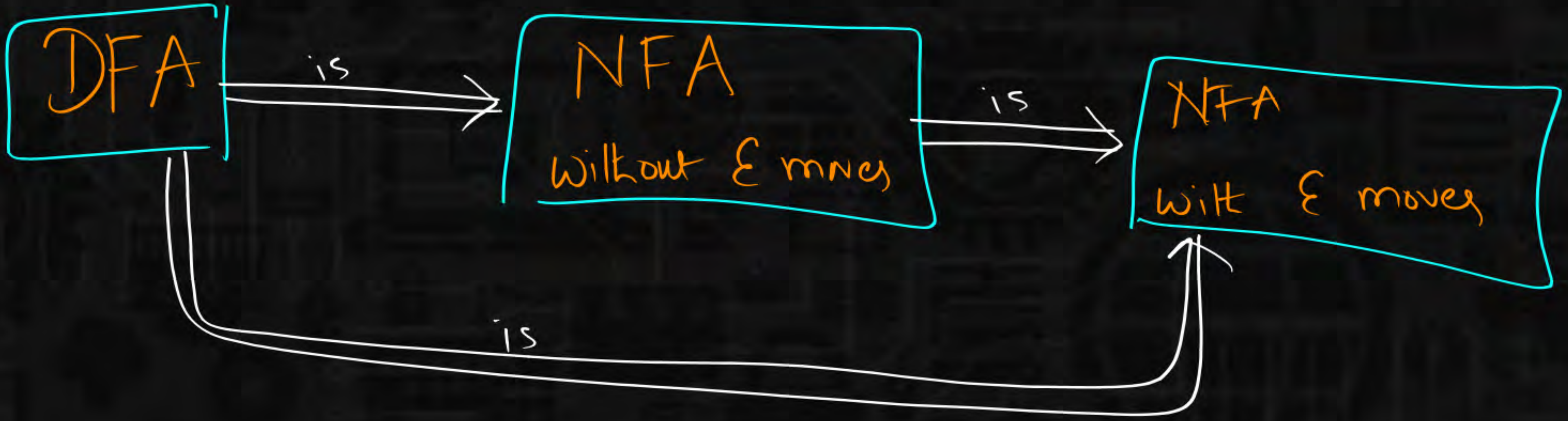


$2^Q = \mathcal{P}(Q)$

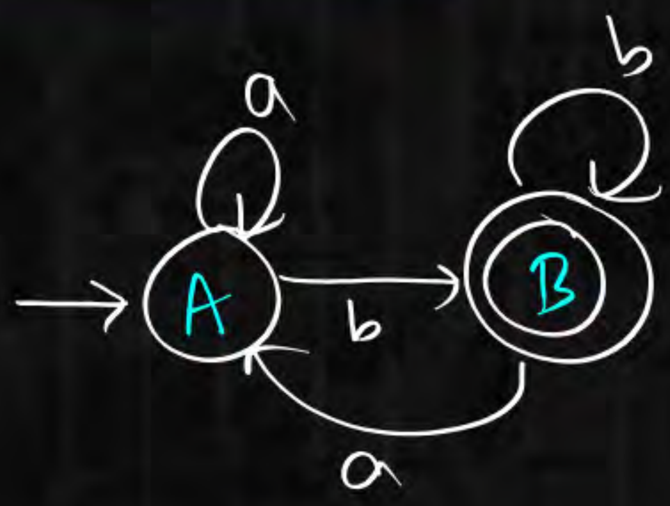
$\delta: Q \times \Sigma_\varepsilon \to 2^Q$



NFA



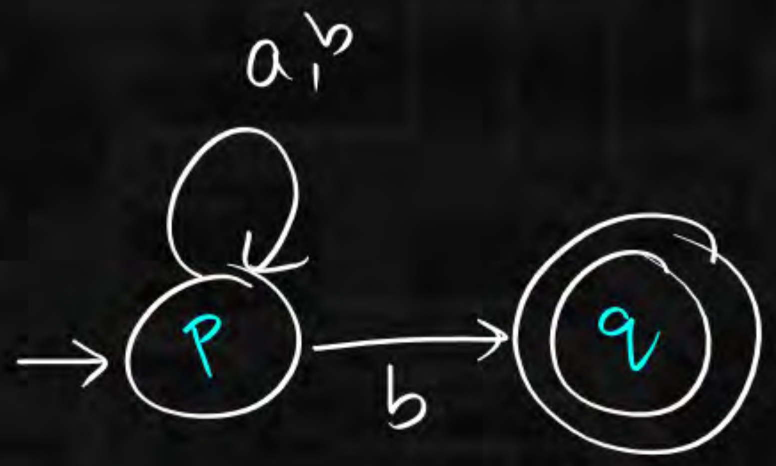
NFA



DFA ✓

NFA without ε ✓

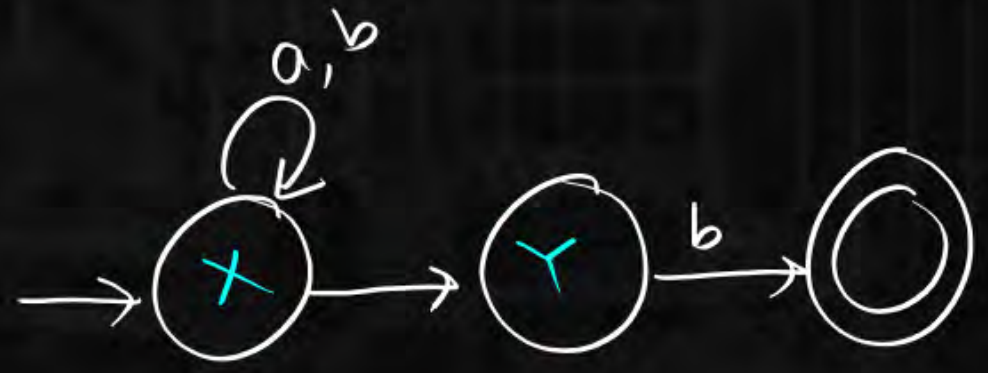
NFA with ε move ✓



DFA ✗

NFA without ε ✓

NFA with ε ✓



DFA ✗

NFA without ε move ✗

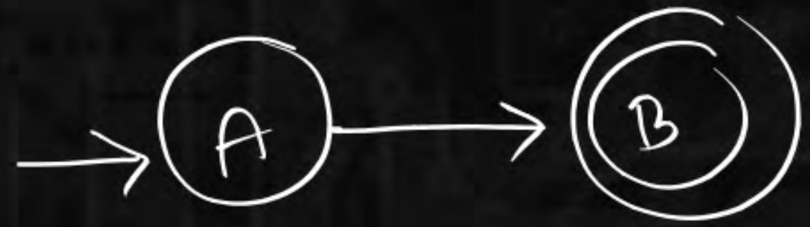
NFA with ε move

$\delta(X, \varepsilon) = \{Y\}$

L

ε- NFA

1



$L = \{\varepsilon\}$

How many paths for $w = \varepsilon$?

1) A

2) $A \xrightarrow{\varepsilon} \underbrace{B}_{\text{final}}$

NFA

*** (2)

$$\rightarrow A \xrightarrow{a} B \qquad L = \{a\}$$

$A \xrightarrow{\varepsilon}$ no tran

transition (1) $\delta(A, \varepsilon) = \phi$ there is no transition on ε from A

$\delta \rightarrow$ Transition

path (2) $\hat{\delta}(A, \varepsilon) = A$

$\hat{\delta} \rightarrow$ extended transition (path)

$$A \xRightarrow{\epsilon} A$$

NFA

(3)

$L = \phi$

Path : zero or more sequence of transitions

Is ε accepted ?

↳ not accepted

Path : A

$$\boxed{\hat{\delta}(A, \varepsilon) = A}$$

From A, by reading string ε, halts at A

$$\delta(A, \varepsilon) = \phi$$

$$\hat{\delta}(A, \varepsilon) = A$$

NFA

4. $\rightarrow A \longrightarrow B$ $\qquad L = \phi$

$$\delta(A, \varepsilon) = B$$

Paths:

$$\hat{\delta}(A, \varepsilon) = \{A, B\}$$

$A \overset{\varepsilon}{\Longrightarrow} A$

$A \overset{\varepsilon}{\Longrightarrow} B$

1. A — Zero transitions
2. $A \xrightarrow{\varepsilon} B$ — one transition

NFA

$S \qquad \rightarrow A \xrightarrow{\varepsilon} B \xrightarrow{\varepsilon} C$

$L = \phi$

$\delta(A, \varepsilon) = B$

$\delta(B, \varepsilon) = C$

$\delta(C, \varepsilon) = \phi$

Transitions

$\hat{\delta}(A, \varepsilon) = \{A, B, C\}$

$A \xRightarrow{\varepsilon} A \quad : \quad A$

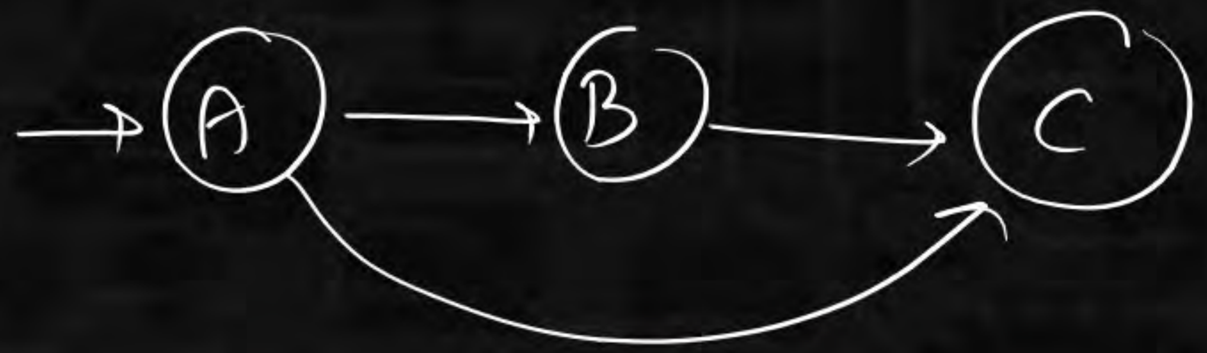
$A \xRightarrow{\varepsilon} B \quad : \quad A \xrightarrow{\varepsilon} B$

$A \xRightarrow{\varepsilon} C \quad : \quad A \xrightarrow{\varepsilon} B \xrightarrow{\varepsilon} C$

Paths

NFA

6



$L = \phi$

$A \xrightarrow{\varepsilon} B$

$A \xrightarrow{\varepsilon} C$

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

$\delta(B, \varepsilon) = C$

$\delta(C, \varepsilon) = \phi$

$\hat{\delta}(A, \varepsilon) = \{A, B, C\}$

$A \overset{\varepsilon}{\Longrightarrow} A$

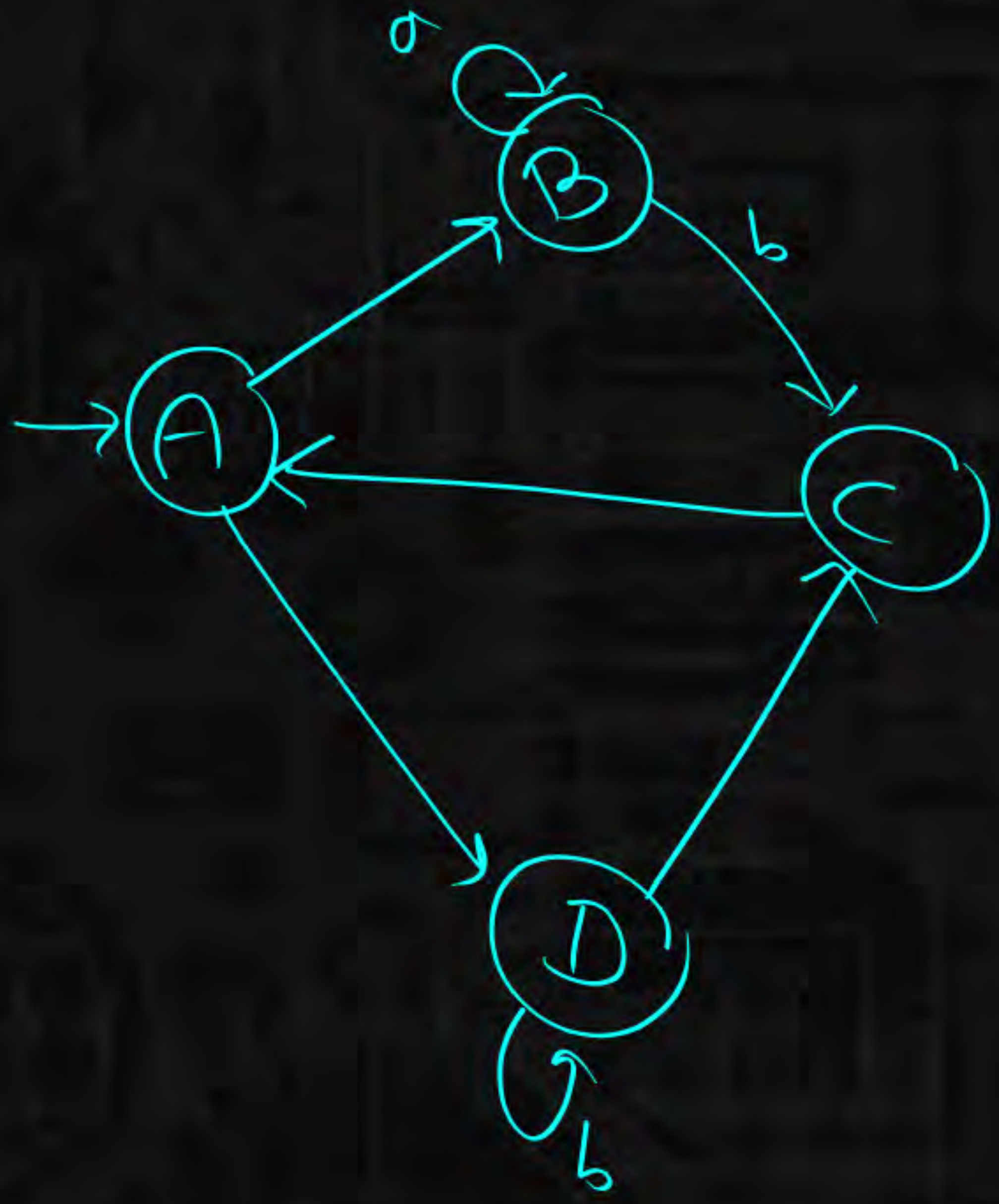
$A \overset{\varepsilon}{\Longrightarrow} B$

$A \overset{\varepsilon}{\Longrightarrow} C$

$A \rightarrow B \rightarrow C$

$A \rightarrow C$

7) ε-closure of state $q = \hat{\delta}(q, \varepsilon)$ ***



1) $\varepsilon\text{-closure}(A) = \hat{\delta}(A, \varepsilon) = \{A, B, C, D\}$

2) $\varepsilon\text{-closure}(B) = \{B\}$

3) $\varepsilon\text{-closure}(C) = \{C, A, B, D\}$

4) $\varepsilon\text{-closure}(D) = \{D, C, A, B\}$

5) $\delta(A, \varepsilon) = \{B, D\}$

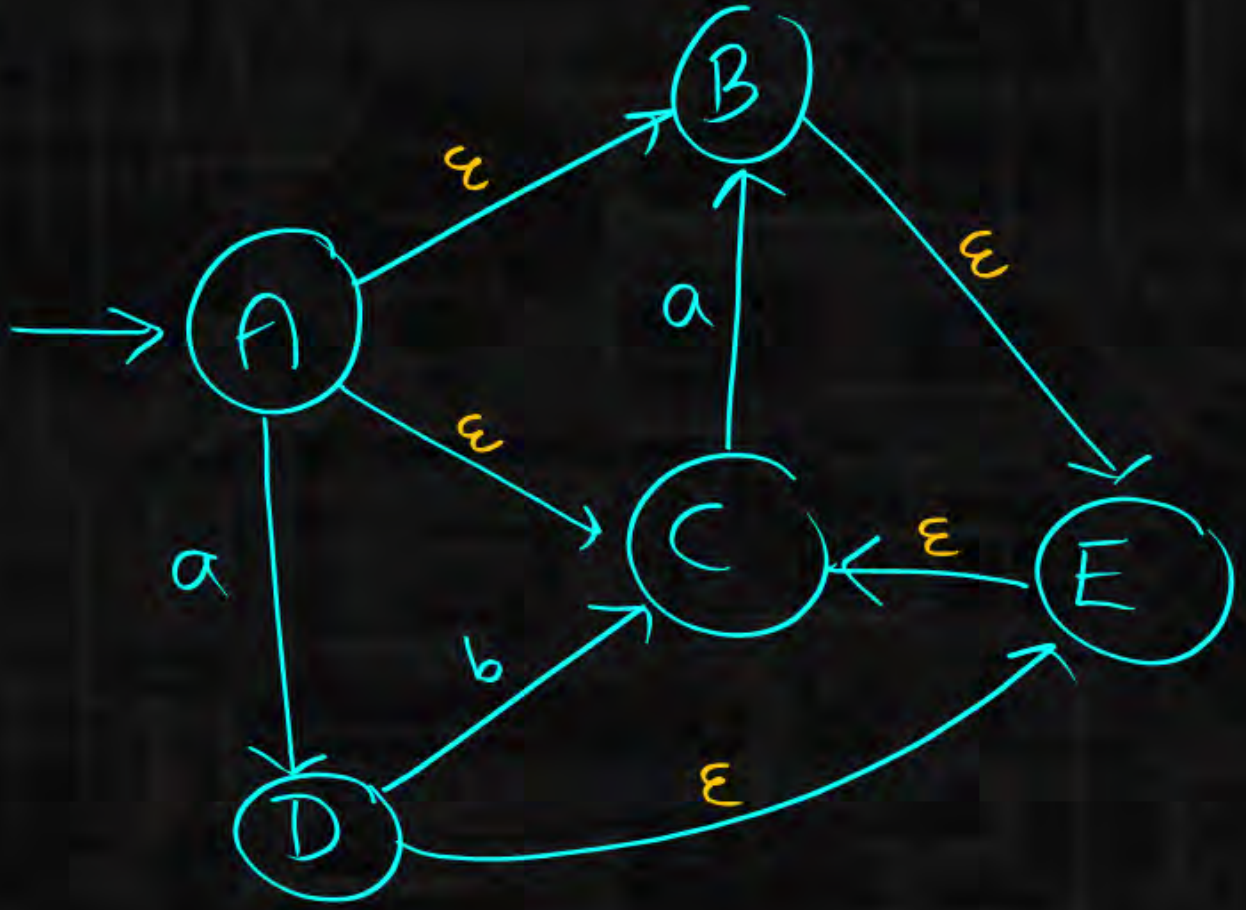
6) $\delta(B, \varepsilon) = \phi$

7) $\delta(C, \varepsilon) = A$

8) $\delta(D, \varepsilon) = C$

NFA

(8) ***



$\epsilon\text{-clo}(A) = \{A, B, C, E\}$

$\epsilon\text{-clo}(B) = \{B, C, E\}$

$\epsilon\text{-clo}(C) = \{C\}$

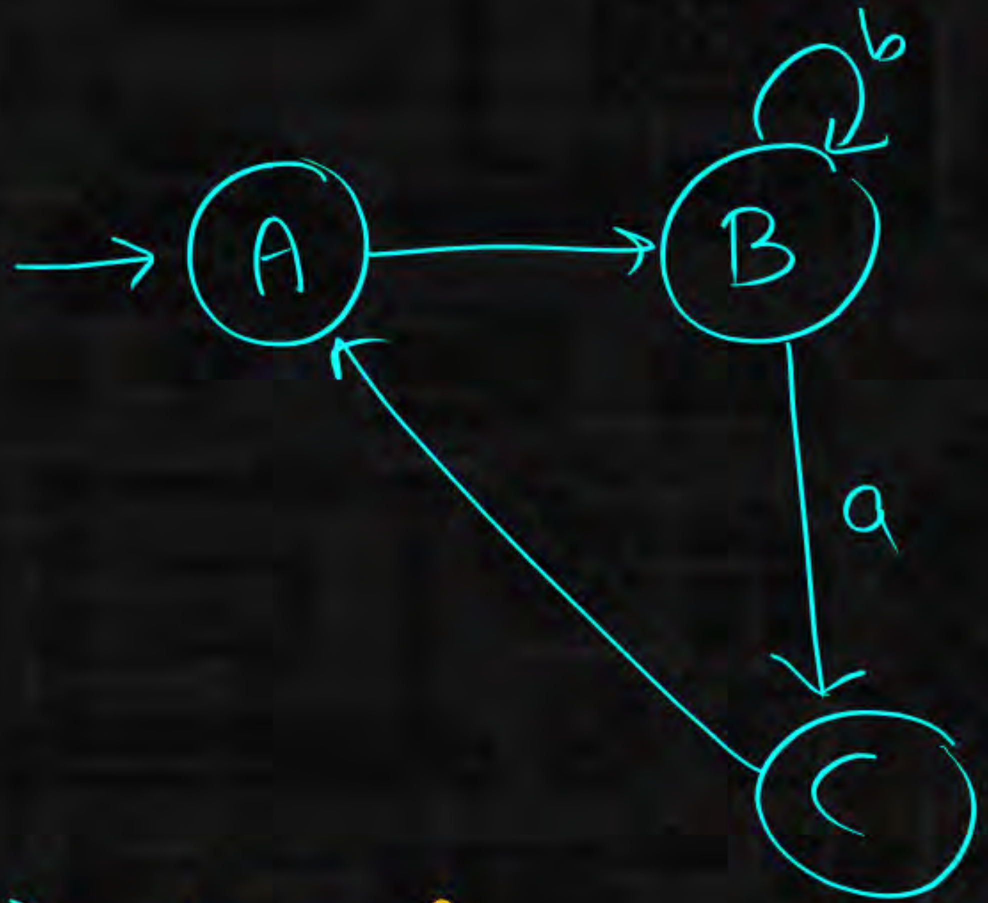
$\epsilon\text{-clo}(D) = \{D, C, E\}$

$\epsilon\text{-clo}(E) = \{E, C\}$

ϵ-closure(q) : Set of states where each state is reachable $\underbrace{\text{without reading any string}}_{\text{(By reading } \epsilon)}$ from q

NFA

9 ***



$\varepsilon a = a$

$a\varepsilon = a$

$a\varepsilon\varepsilon = a$

$\hat{\delta}(A, aba) = ?$

$A \xRightarrow{aba} ?$

$A \xrightarrow{\varepsilon} B \xrightarrow{a} C \longrightarrow A \longrightarrow B \xrightarrow{b} B$

$B \xrightarrow{a} \boxed{C}$ Halt

$\boxed{C} \longrightarrow \boxed{A}$ Halt

$\boxed{A} \longrightarrow \boxed{B}$ Halt

① $\hat{\delta}(A, aba) = \{A, B, C\}$

② $\hat{\delta}(B, ab) = \{B\}$

③ $\hat{\delta}(C, bba) = \{C, A, B\}$

$B \xrightarrow{a} C \longrightarrow A \longrightarrow B \xrightarrow{b} \boxed{B}$ Halt

$B \xRightarrow[ab]{a\varepsilon\varepsilon b} B$

$$\delta(q, \boxed{})$$

symbol or ε

$$\xrightarrow{\varepsilon}$$

$$\xrightarrow{a}$$

$$\xrightarrow{b}$$

$$\cancel{\xrightarrow{ab}}$$

$$\hat{\delta}(q, w)$$

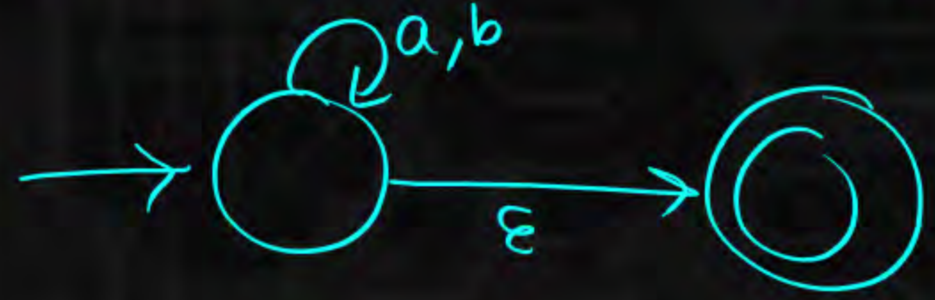
ε a b aa ab ...

any string

NFA

Identify language accepted by NFA.

1.



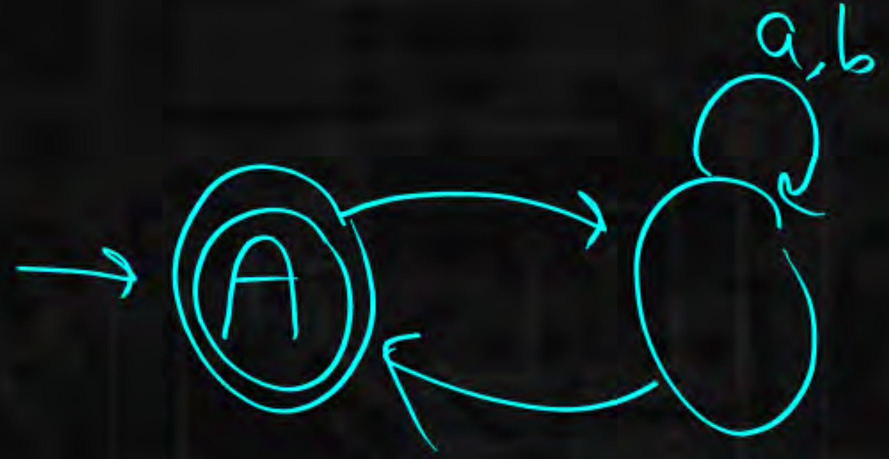
$L = (a+b)^*$

ε ✓
a ✓
b ✓
aa ✓
ab ✓
ba ✓
⋮

2.

$L = (a+b)^*$

3.



$L = (a+b)^*$

ε: $\underline{A}$

a: $A \xrightarrow{a} \underline{A}$

b: $A \xrightarrow{\varepsilon} B \xrightarrow{b} B \xrightarrow{\varepsilon} \underline{A}$ $\qquad \varepsilon b \varepsilon = b$

fin

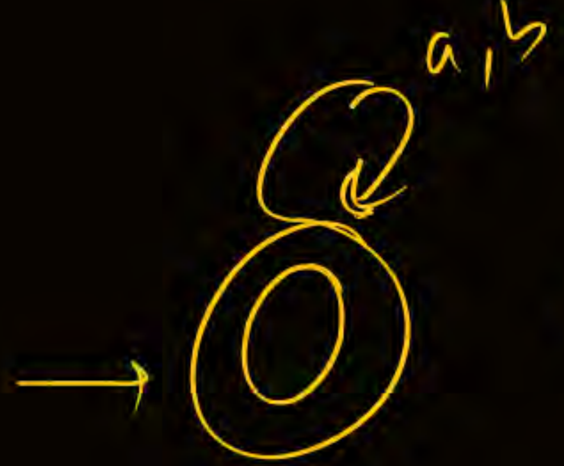
aa: $A \xrightarrow{a} A \xrightarrow{a} A$

ab: $A \xrightarrow{a} A \longrightarrow B \xrightarrow{b} B \longrightarrow \underline{A}$ $\qquad a \varepsilon b \varepsilon = ab$

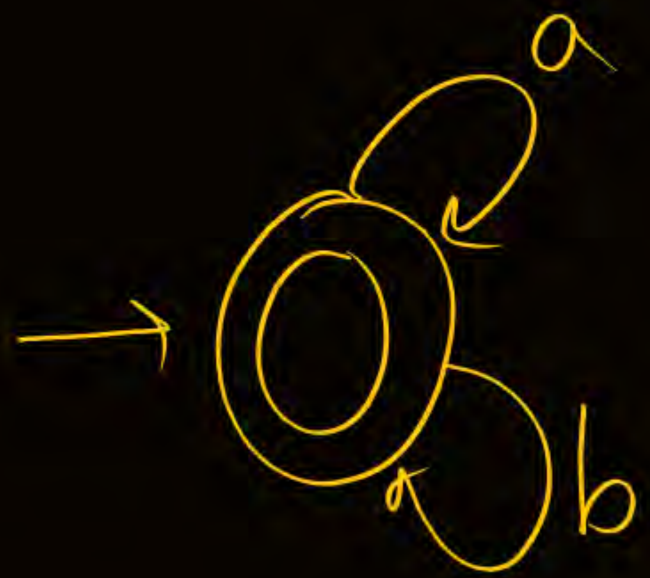
ba: $A \longrightarrow B \xrightarrow{b} B \longrightarrow A \xrightarrow{a} \underline{A}$ $\qquad \varepsilon b \varepsilon a = ba$

bb: $A \longrightarrow B \xrightarrow{b} B \xrightarrow{b} B \longrightarrow A$

⋮

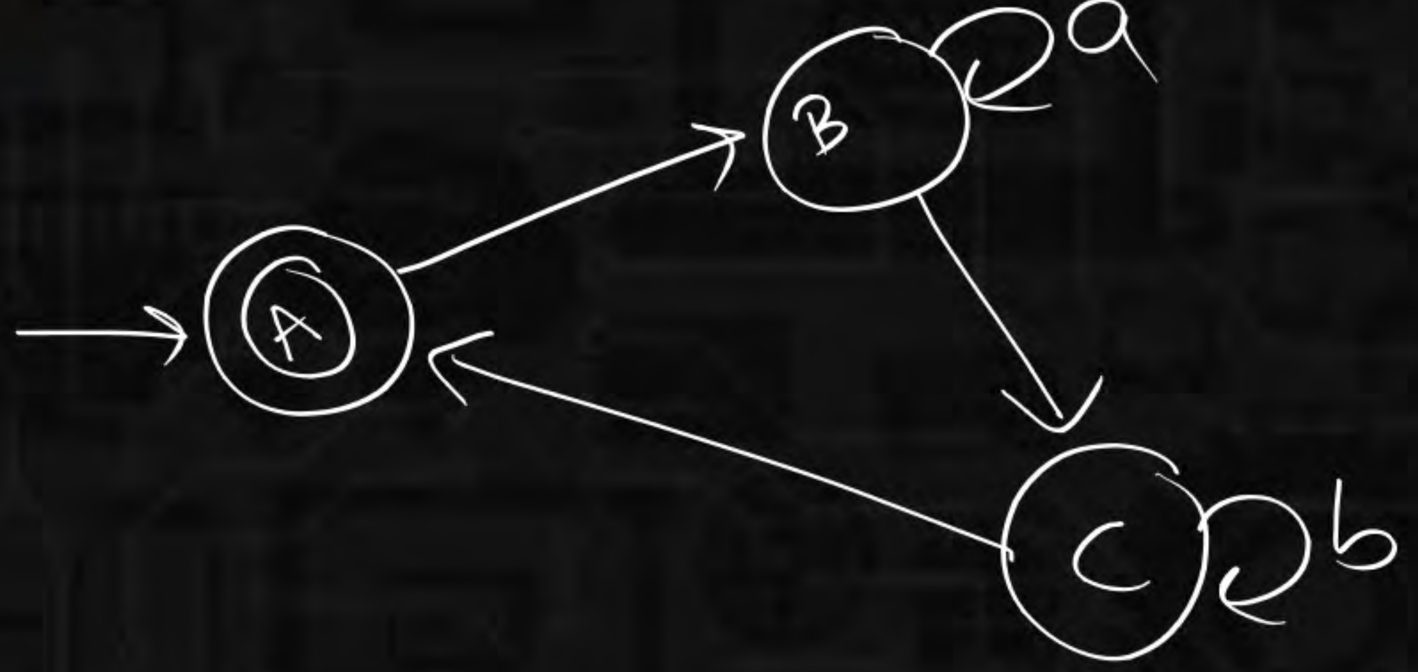


$(a+b)^*$



NFA

4



ε ✓

a ✓

b ✓

aa ✓

ab ✓

ba : εεbεεaεε ✓

$= (a+b)^*$

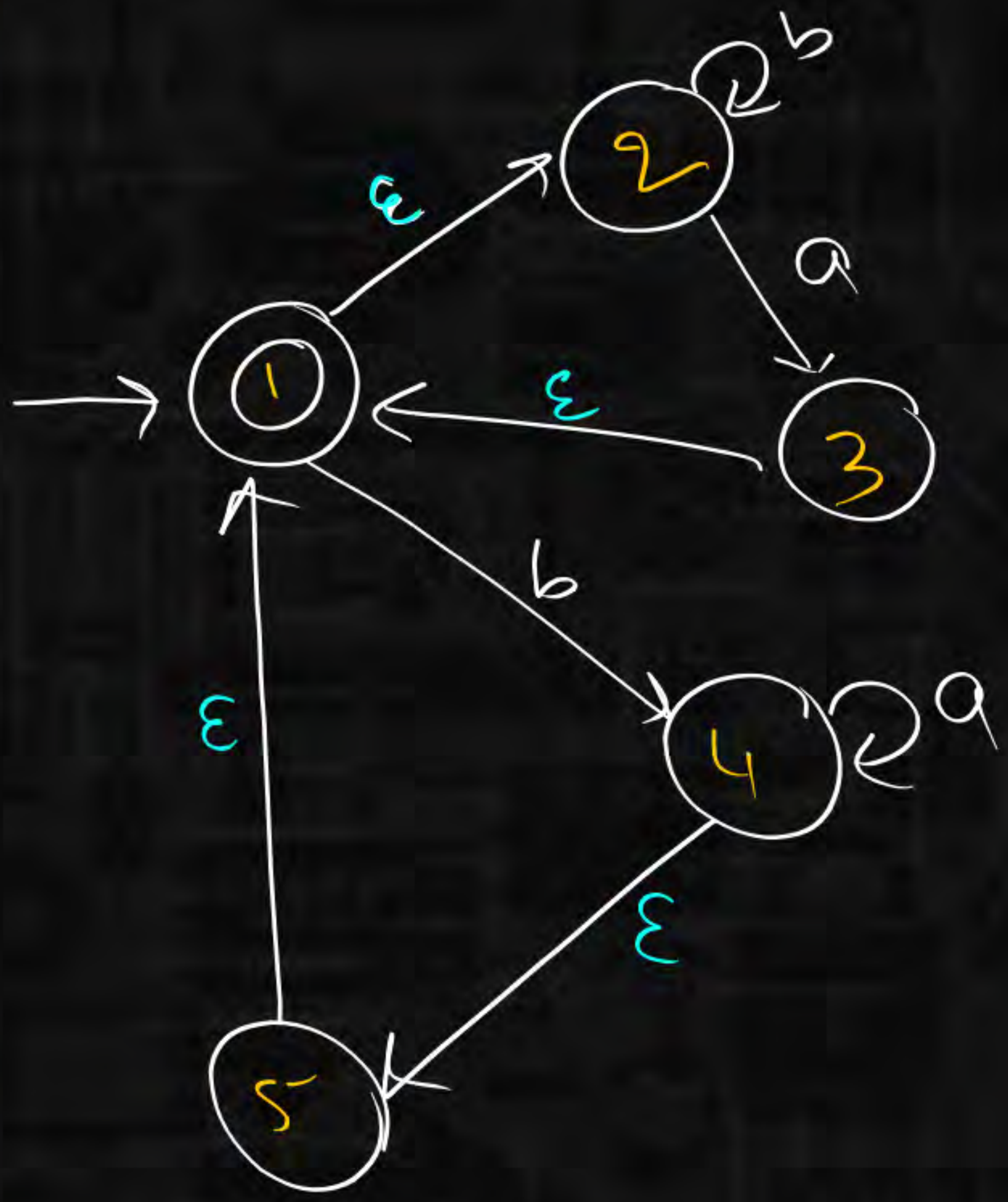
NFA

$$
\begin{tikzcd}
\varepsilon\text{-NFA} \arrow[r, "\text{Algo}"] \arrow[rr, bend right=40, "\text{Algo}"'] & \text{NFA} \arrow[l, bend right=50, "\text{By def}"'] \arrow[r, "\text{Algo}"] & \text{DFA} \arrow[l, bend right=50, "\text{By def}"'] \arrow[ll, bend left=60, "\text{By def}"]
\end{tikzcd}
$$

NFA without ε moves

NFA

5



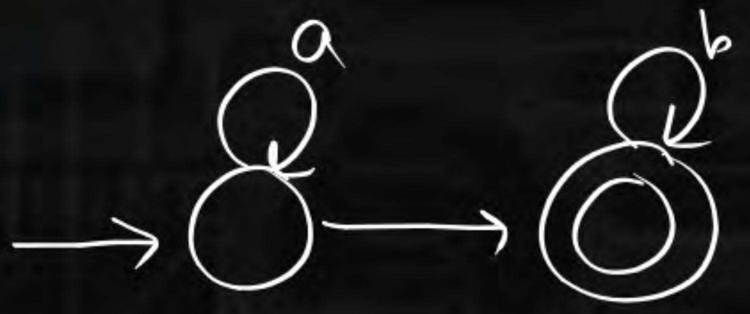
ab ✓

$1 \xrightarrow{\varepsilon} 2 \xrightarrow{a} 3 \xrightarrow{\varepsilon} 1 \xrightarrow{b} 4 \xrightarrow{\varepsilon} 5 \xrightarrow{\varepsilon} \underbrace{1}_{\text{final}}$

ε ✓
a ✓
b ✓
aa ✓
ab ✓
ba ✓
bb ✓
aaa ✓
aab ✓
aba ✓
abb ✓
baa ✓
⋮

NFA

6



ε ✓

a ✓

b ✓

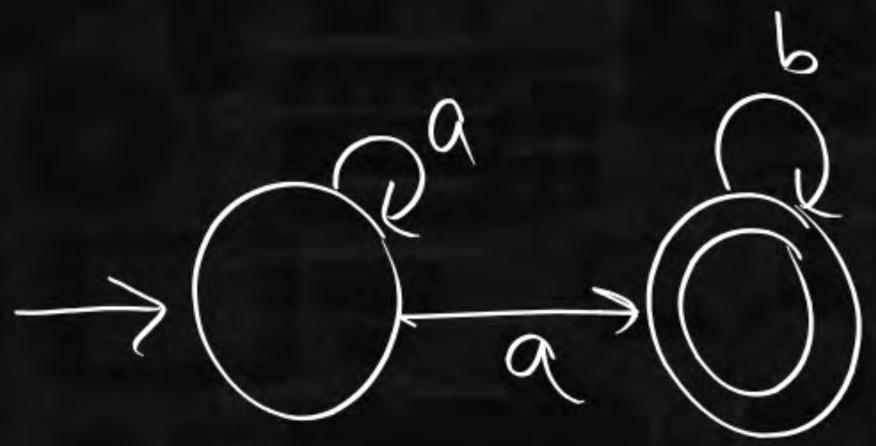
aa ✓

ab ✓

$\boxed{ba}$ ✗

$L = a^* b^*$

7



$L = a^* a b^*$

$= a^+ b^*$

Algo: NFA with ε moves $\Longrightarrow$ NFA without ε moves

(n states) (n states)

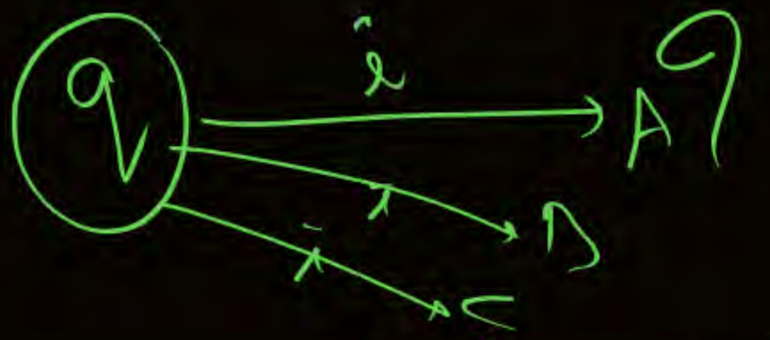
$$(Q, \Sigma, \delta, q_0, F) \Longrightarrow (Q, \Sigma, \delta', q_0, F')$$

Given

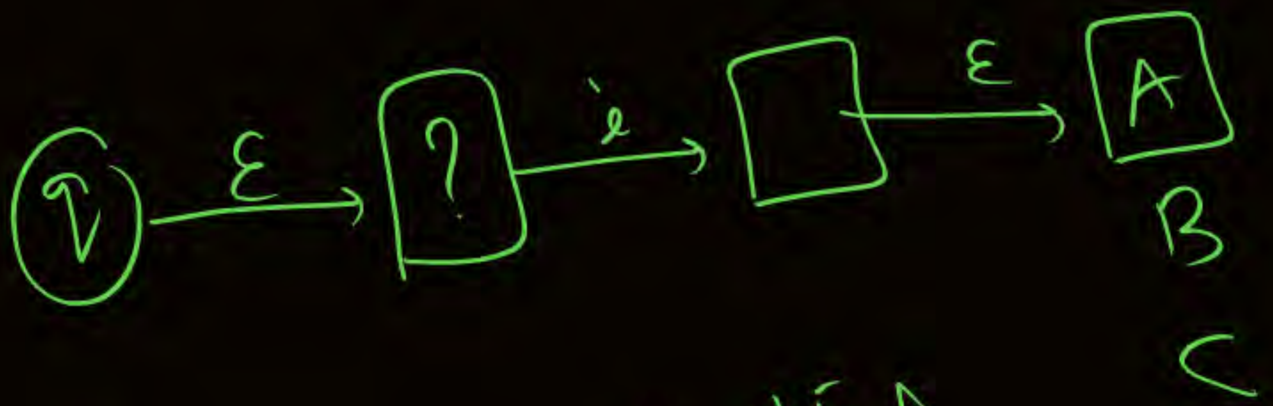
$$\delta'(q, i) = \underbrace{\varepsilon\text{-clo}\left[\underbrace{\delta\left(\underbrace{\varepsilon\text{-clo}(q)}_{1^{st}}, i\right)}_{2^{nd}}\right]}_{3^{rd}}$$

$\forall i \in \Sigma$

$\forall q \in Q$

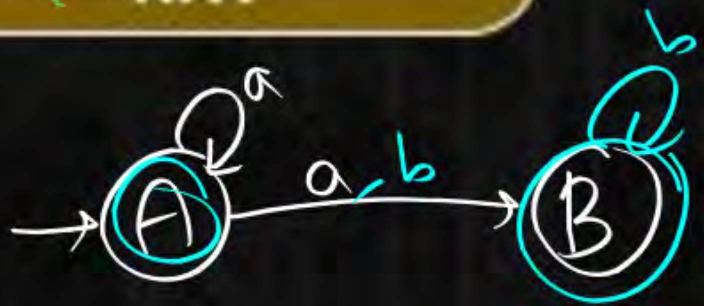


NFA
without ε move



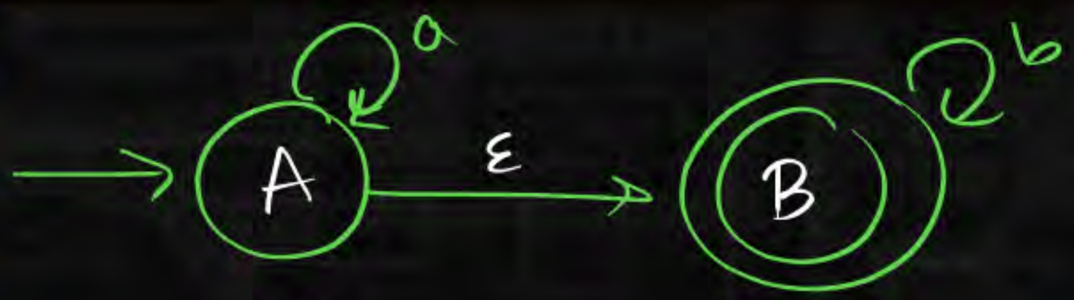
Using ε-NFA

ε- NFA



δ'

NFA without ε move



Given

δ

$\varepsilon\text{-clo}(A) = \{A, B\}$

$\varepsilon\text{-clo}(B) = \{B\}$

$\delta(A,a) = A$

$\delta(A,b) = \phi$

$\delta(B,a) = \phi$

$\delta(B,b) = B$

I) $\delta'(A,a) = \varepsilon\text{-clo}\left[\delta\left(\underbrace{\varepsilon\text{-clo}(A)}_{\{A,B\}}, a\right)\right] = \varepsilon\text{-clo}\left[\delta(\{A,B\}, a)\right]$

$= \varepsilon\text{-clo}\left[\underbrace{\delta'(A,a)}_{A} \cup \underbrace{\delta'(B,a)}_{\phi}\right] = \varepsilon\text{-clo}(A) = \{A, B\}$

II) $\delta'(A,b) = \varepsilon\text{-clo}\left[\delta\left(\underbrace{\varepsilon\text{-clo}(A)}_{\{A,B\}}, b\right)\right] = \varepsilon\text{-clo}(B) = \{B\}$

III) $\delta'(B,a) = \varepsilon\text{-clo}\left[\delta\left(\varepsilon\text{-clo}(B), a\right)\right] = \phi$

IV) $\delta'(B,b) = \{B\}$

NFA

$$\varepsilon\text{-NFA (n states)} \xrightarrow{\text{subset construct.}} \text{DFA (atmost } 2^n \text{ states)}$$

$$\varepsilon\text{-NFA (n states)} \xrightarrow{\text{Algo}} \text{NFA (n states)} \xrightarrow[\text{subset con.}]{\text{Algo}} \text{DFA}$$

$$\boxed{NFA \cong DFA}$$

Q

Let L = { w ∈ $(0 + 1)^*$ | w has even number of 1s}, i.e., L is the set of all bit strings with even number of 1s. Which one of the regular expressions below represents L? [2010: 2 Marks]

(A) $(0^*10^*1)^*$

(B) $0^*(10^*10^*)^*$

(C) $0^*(10^*1)^*0^*$

(D) $0^*1(10^*1)^*10^*$

Q

Let P be a regular language and Q be a context- free language such that $Q \subseteq P$. (For example, let P be the language represented by the regular expression $p^* q^*$ and Q be $\{p^n q^n \mid n \in N\}$. Then which of the following is ALWAYS regular?

[2011: 1 Mark]

(A) $P \cap Q$

(B) $\Sigma^* - P$

(C) $P - Q$

(D) $\Sigma^* - Q$

Q

Given the language $L = \{ab, aa, baa\}$, which of the following strings are in L^*?

1.	abaabaaabaa	2.	aaaabaaaa	
3.	baaaaabaaaab	4.	baaaabaa	[2012: 1 Mark]

(A) 1, 2 and 3

(B) 2, 3 and 4

(C) 1, 2 and 4

(D) 1, 3 and 4

Q

Consider the languages $L_1 = \phi$ and $L_2 = \{a\}$. Which one of the following represents $L_1 L_2^* \cup L_1^*$?

[2013: 1 Mark]

A $\{\varepsilon\}$

B ϕ

C a^*

D (ε, a)

Q

The length of the shortest string NOT in the language (over $\Sigma = \{a, b\}$) of the following regular expression is ________.

$$a^*b^*(ba)^*a^*$$

[2014-Set3: 1 Mark]

Q

Consider alphabet $\Sigma = \{0, 1\}$, the null/empty string λ and the sets of strings X_0, X_1 and X_2 generated by the corresponding non-terminals of a regular grammar. X_0, X_1 and X_2 are related as follows:

[2015-Set2: 2 Marks]

$$X_0 = 1X_1$$
$$X_1 = 0X_1 + 1X_2$$
$$X_2 = 0X_1 + \{\lambda\}$$

Which one of the following choices precisely represents the strings in X_0?

A. $10\,(0^* + (10)^*)1$

B. $10\,(0^* + (10)^*)^*1$

C. $1(0 + 10)^*1$

D. $10\,(0 + 10)^*1 + 110\,(0 + 10)^*1$

Q

Which one of the following regular expressions represents the language: *the set of all binary strings having two consecutive 0s and two consecutive 1s*?

[2016-Set1: 1 Mark]

(A) $(0+1)^*0011(0+1)^* + (0+1)^*1100(0+1)^*$

(B) $(0+1)^*(00(0+1)^*11 + 11(0+1)^*00)(0+1)^*$

(C) $(0+1)^*00(0+1)^* + (0+1)^*11(0+1)^*$

(D) $00(0+1)^*11 + 11(0+1)^*00$

Q

Which one of the following regular expression represents the set of all binary strings with an odd number of 1's?

[2020: 1 Mark]

(A) $(0^*10^*10^*)^*0^*1$

(B) $10^*(0^*10^*10^*)^*$

(C) $((0 + 1)^* 1(0 + 1)^*1)^*10^*$

(D) $(0^*10^*10^*)^*10^*$

Q

Which of the following regular expressions represents(s) the set of all binary numbers that are divisible by three? Assume that the strings $\in$ is divisible by three. [2021-Set2-MSQ: 2 Marks]

A. $(0^*(1(01^*0)^*1)^*)$

B. $(0 + 1(01^*0)^* 1)^*$

C. $(0 + 11 + 10(1 + 00)^*01)^*$

D. $(0 + 11 + 11(1 + 00)^*00)^*$

Q

Let w be any string of length n in $\{0, 1\}^*$. Let L be the set of all substrings of w. What is the minimum number of states in a non-deterministic finite automaton that accepts L?

[2010: 2 Marks]

A. $n-1$

B. n

C. $n+1$

D. 2^{n-1}

Q

The lexical analysis for a modern computer language such as Java needs the power of which one of the following machine models in a necessary and sufficient sense?

[2011: 1 Marks]

(A) Finite state automata

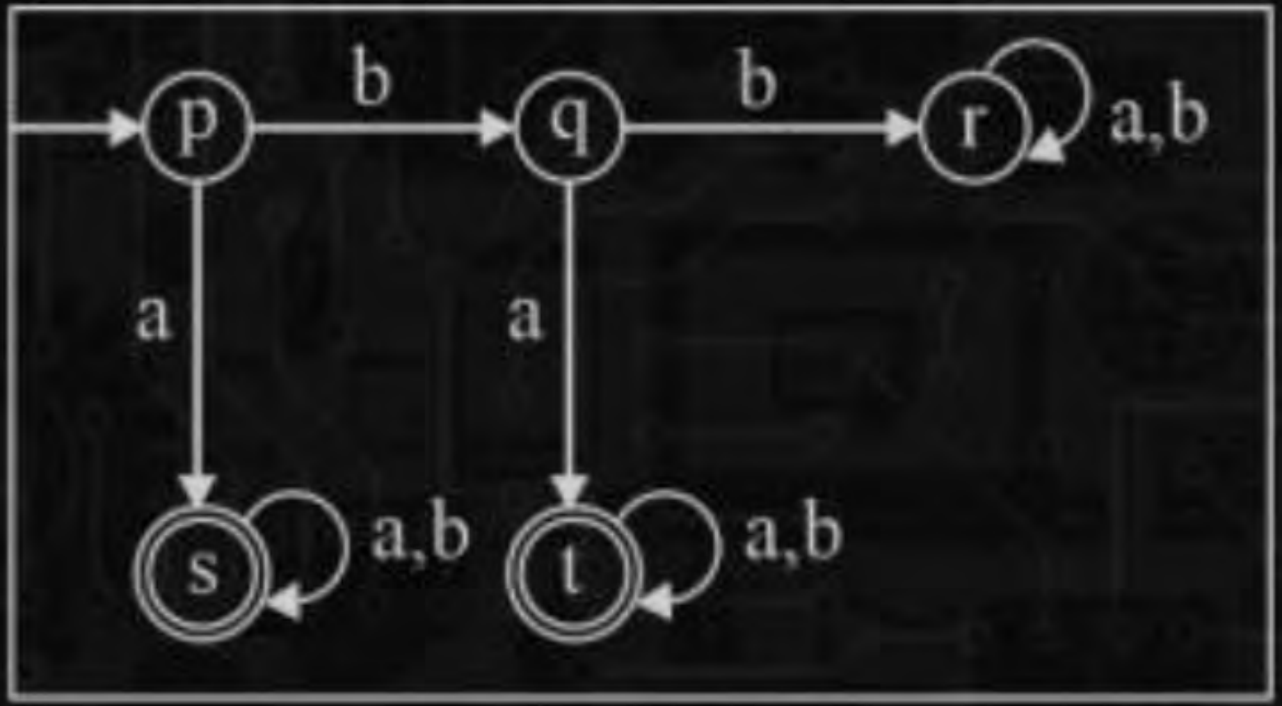
(B) Deterministic pushdown automata

(C) Non-deterministic pushdown automata

(D) Turing machine

Q

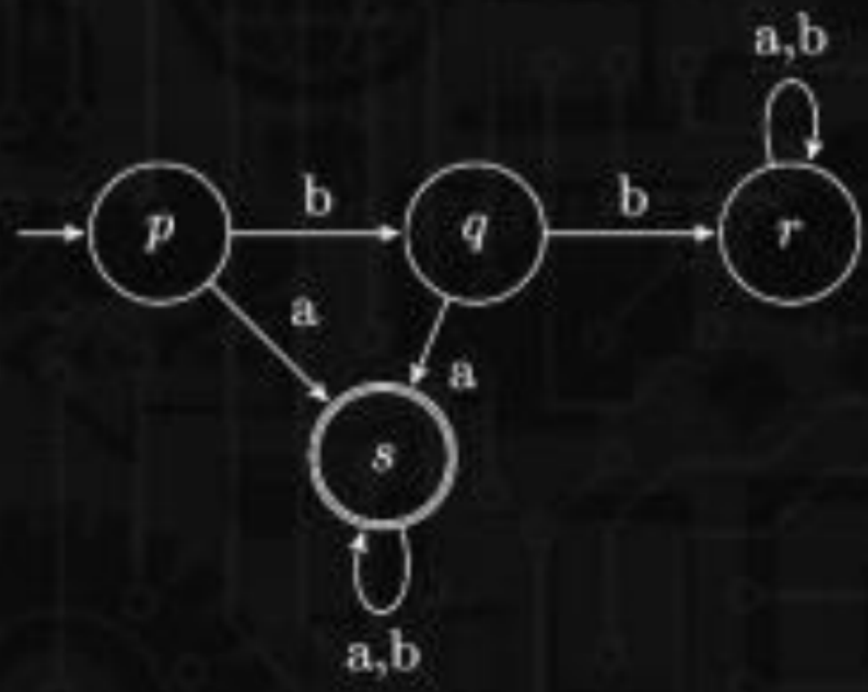
A deterministic finite automaton (DFA) D with alphabet $\Sigma = \{a, b\}$ is given below:



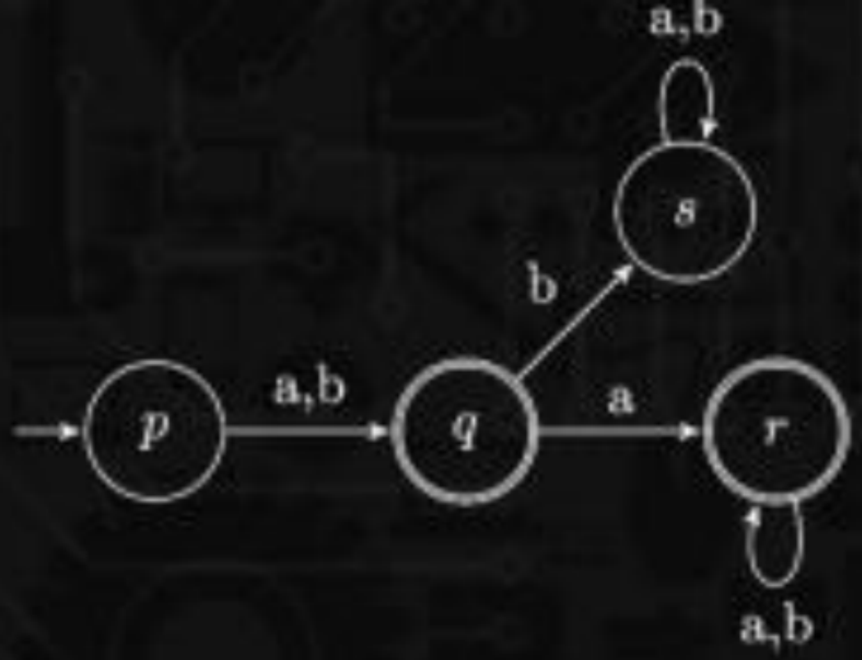
Which of the following finite state machines is a valid minimal DFA which accepts the same language as D?

[2011:2 Mark]

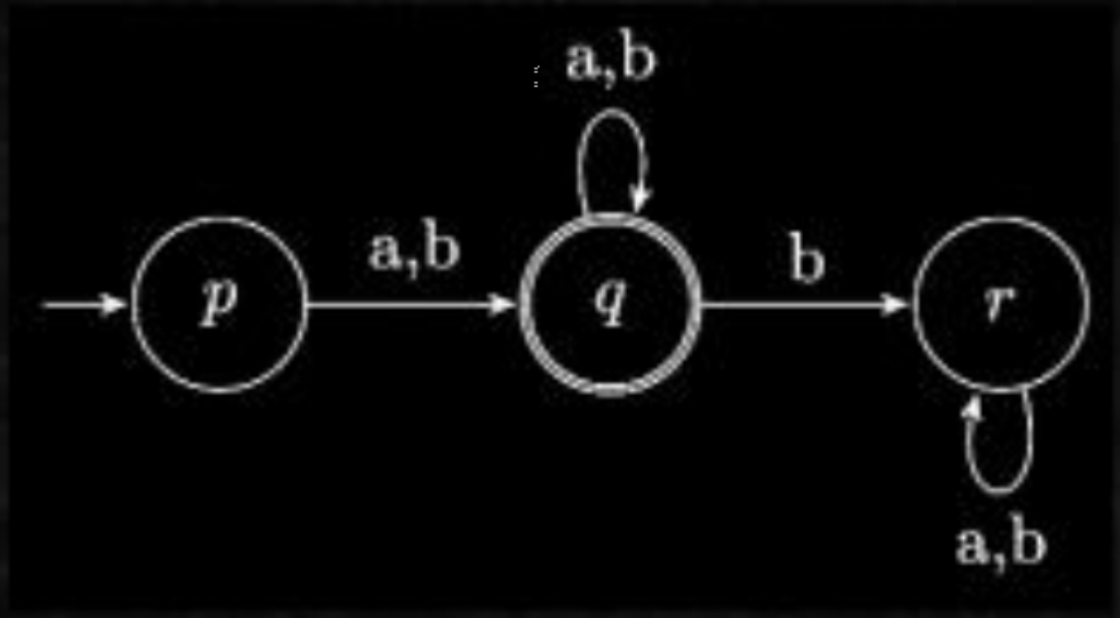
A



B



C

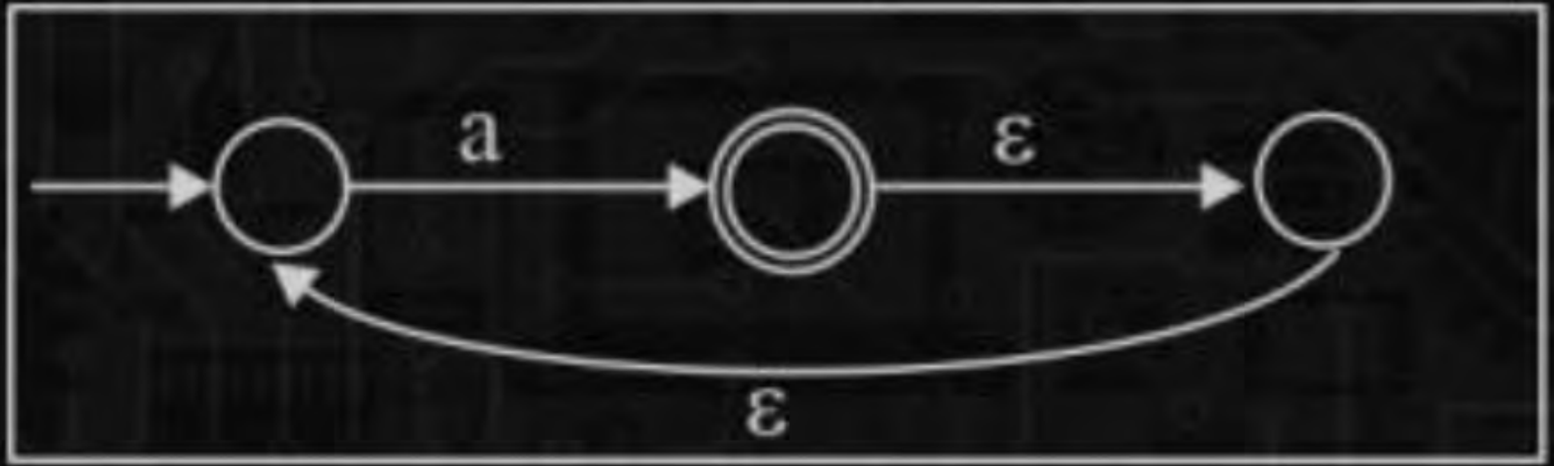


D

Q

What is the complement of the language accepted by the NFA shown below? Assume $\Sigma = \{a\}$ and ε is the empty string.

[2012: 1 Mark]



A $\varnothing$

B $\{\varepsilon\}$

C a^*

D $\{a, \varepsilon\}$

Q

Consider the set of strings on $\{0, 1\}$ in which, every substring of 3 symbols has at most two zeros. For example, 001110 and 011001 are in the language, but 100010 is not. All strings of length less than 3 are also in the language. A partially complete DFA that accepts this language is shown below.

The missing arcs in the DFA are? [2012: 2 Marks]

A

	00	01	10	11	q
00	1	0			
01				1	
10	0				
11			0		

B

	00	01	10	11	q
00		0			1
01		1			
10				0	
11		0			

C

	00	01	10	11	q
00		1			0
01		1			
10			0		
11		0			

D

	00	01	10	11	q
00		1			0
01				1	
10	0				
11			0		

Q

Consider the DFA A given below:

Which of the following are **FALSE**?

1. Complement of L(A) is context-free.
2. $L(A) = L((11^*0 + 0)(0 + 1)^*0^*1^*)$
3. For the language accepted by A, A is the minimal DFA.
4. A accepts all strings over {0, 1} of length at least 2.

[2013: 1 Mark]

(A) 1 and 3 only

(B) 2 and 4 only

(C) 2 and 3 only

(D) 3 and 4 only

Q Which one of the following is TRUE? [2014-Set1: 1 Mark]

A) The language $L = \{a^n b^n \mid n \geq 0\}$ is regular.

B) The language $L = \{a^n \mid n \text{ is prime}\}$ is regular.

C) The language $L = \{w \mid w \text{ has } 3k + 1 \text{ b's for some } k \in \mathbb{N} \text{ with } \Sigma = \{a, b\}\}$ is regular.

D) The language $L = \{ww \mid w \in \Sigma^* \text{ with } \Sigma = \{0, 1\}\}$ is regular.

Q

Which of the regular expressions given below represent the following DFA?

I. $0^*1(1 + 00^*1)^*$

II. $0^*1^*1 + 11^*0^*1^*$

III. $(0 + 1)^*1$

[2014-Set1: 2 Mark]

(A) I and II only

(B) I and III only

(C) II and III only

(D) I, II, and III

Q

If $L_1 = \{a^n \mid n \geq 0\}$ and $L_2 = \{b^n \mid n \geq 0\}$, consider

I. $L_1 \cdot L_2$ is a regular language

II. $L_1 \cdot L_2 = \{a^n b^n \mid n \geq 0\}$

Which one of the following is CORRECT?

[2014-Set2: 1 Mark]

(A) Only I

(B) Only II

(C) Both I and II

(D) Neither I nor II

Q

Let $L_1 = \{\omega \in \{0,1\}^* \mid \omega$ has at least as many occurrences of (110) 's as (011)'s$\}$. Let $L_2 = \{\omega \in \{0,1\}^* \mid \omega$, has at least as many occurrences of (000)'s as (111)'s$\}$. Which one of the following is TRUE?

[2014-Set2: 2 Marks]

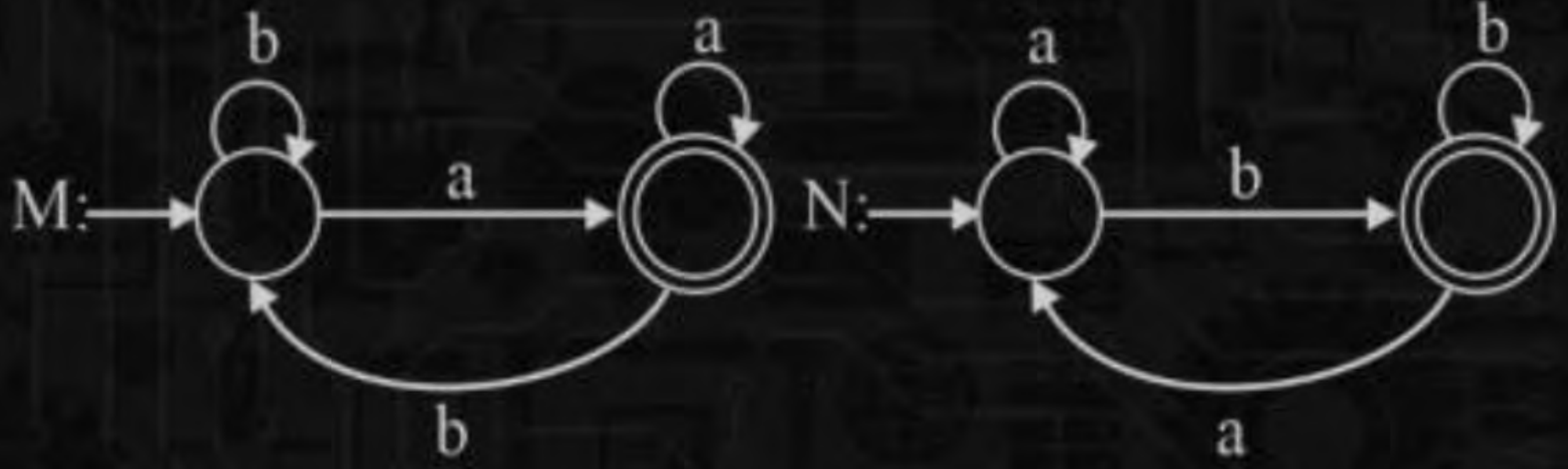
A. L_1 is regular but not L_2

B. L_2 is regular but not L_1

C. Both L_1 and L_2 are regular

D. Neither L_1 nor L_2 are regular

Q



Consider the DFAs M and N given above. The number of states in a minimal DFA that accepts the language $L(M) \cap L(N)$ is

[2015-Set1: 2 Marks]

Q

The number of states in the minimal deterministic finite automaton corresponding the regular expression $(0 + 1)^*(10)$ is______.

[2015-Set2: 2 Marks]

Q

Let L be the language represented by the regular expression $\Sigma^*0011\Sigma^*$ where $\Sigma = \{0, 1\}$.
What is the minimum number of states in a DFA that recognizes L'(complement of L)? [2015-Set3: 1 Mark]

A) 4

B) 5

C) 6

D) 8

Q

Which of the following languages is/are regular?

L_1: $\{wxw^R \mid w, x \in \{a, b\}^*$ and $|w|, |x| > 0\}$ w^R is the reverse of string w}

L_2: $\{a^n b^m \mid m \neq n$ and $m, n \geq 0\}$

L_3: $\{a^p b^q c^r \mid p, q, r \geq 0\}$

[2015-Set2: 2 Marks]

(A) L_1 and L_3 only

(B) L_2 only

(C) L_2 and L_3 only

(D) L_3 only

Q

The number of states in the minimum sized DFA that accepts the language defined by the regular expression $(0 + 1)^* (0 + 1) (0 + 1)^*$ is ______.

[2016-Set2: 1 Mark]

Q

Consider the following two statements:

I. If all states of an NFA are accepting states then the language accepted by the NFA is Σ^*.

II. There exists a regular language A such that for all language B, $A \cap B$ is regular. [2016-Set2: 2 Marks]

Which one of the following is CORRECT

A) Only I is true

B) Only II is true

C) Both I and II are true

D) Both I and II are false

Q

Consider the language L given by the regular expression $(a + b)^*b(a + b)$ over the alphabet $\{a, b\}$. The smallest number of states needed in a deterministic finite-state automaton (DFA) accepting L is ____.

[2017-Set1: 2 Marks]

Q

The minimum possible number of states of a deterministic finite automaton that accepts the regular language $L = \{w_1 a w_2 \mid w_1, w_2 \in \{a, b\}^*, |w_1| = 2, |w_2| \geq 3\}$ is ____.

[2017-Set2: 1 Mark]

Q

Let δ denote the transition function and $\hat{\delta}$ denote the extended transition function of the ε-NFA whose transition table is given below:

[2017-Set2: 2 Mark]

δ	ϵ	a	b
$\rightarrow q_0$	$\{q_2\}$	$\{q_1\}$	$\{q_0\}$
q_1	$\{q_2\}$	$\{q_2\}$	$\{q_3\}$
q_2	$\{q_0\}$	ϕ	ϕ
q_3	ϕ	ϕ	$\{q_2\}$

The $\hat{\delta}(q_2, aba)$ is

A) ϕ

B) $\{q_0, q_1, q_3\}$

C) $\{q_0, q_1, q_2\}$

D) $\{q_0, q_2, q_3\}$

Q

Let N be an NFA with n states. Let k be the number of states of a minimal DFA which is equivalent to N. Which one of the following is necessarily true?

[2018: 1 Mark]

(A) $k \geq 2^n$

(B) $k \geq n$

(C) $k \leq n^2$

(D) $k \leq 2^n$

Q

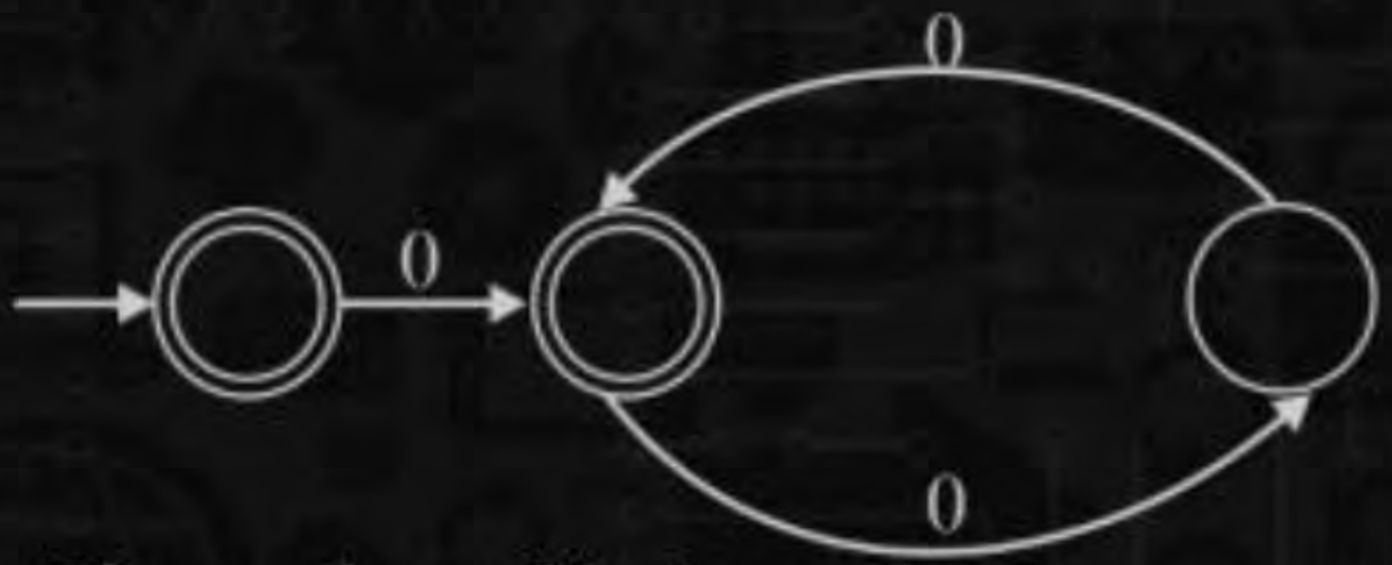
Given a language L, define L^i as follows:

$L^0 = \{\in\}$

$L^i = L^{i-1} \cdot L$ for all $i > 0$

The order of a language L is defined as the smallest k such that $L^k = L^{k+1}$.

Consider the language L_1 (over alphabet 0) accepted by the following automaton



The order of L_1 is ____.

[2018: 2 Marks]

Q

For $\Sigma = \{a, b\}$, let us consider the regular language $L = \{x \mid x = a^{2+3k} \text{ or } x = b^{10+12k}, k \geq 0\}$. Which one of the following can be a pumping length (the constant guaranteed by the pumping lemma) for L?

[2019: 1 Mark]

(A) 9

(B) 24

(C) 3

(D) 5

Q

Let Σ be the set of all bijections from $\{1, ..., 5\}$ to $\{1, ..., 5\}$, where *id* denotes the identity function, i.e. $id(j) = j, \forall j$.
Let $\circ$ denote composition on functions.
For a string $x = x_1 x_2 ... x_n \in \Sigma^n, n \geq 0$, let $\pi(x) = x_1 \circ x_2 \circ ... \circ x_n$.
Consider the language $L = \{x \in \Sigma^* \mid \pi(x) = id\}$.
The minimum number of states in any DFA accepting L is _____.

[2019: 2 Marks]

Q

Consider the following language:

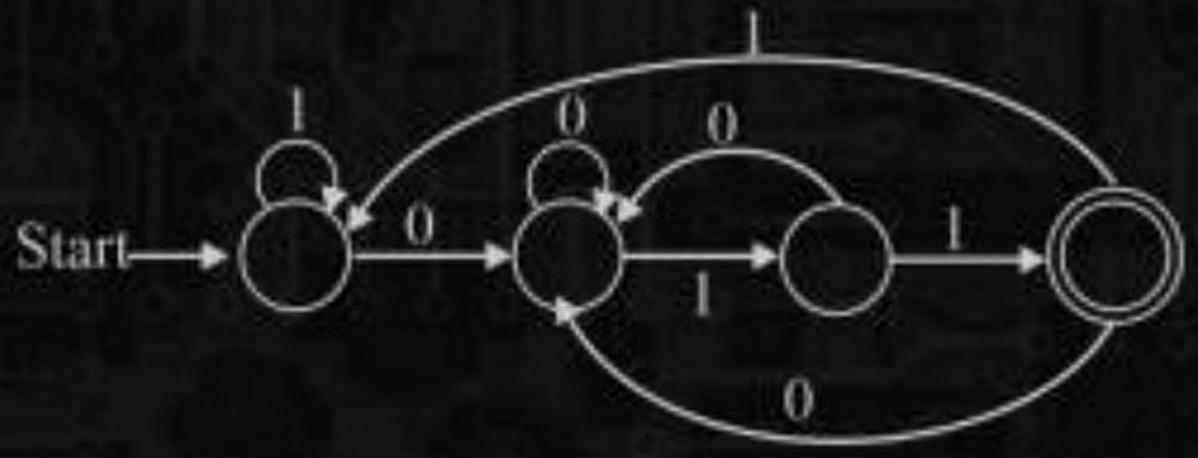
L = $\{x \in \{a, b\}^* |$ number of a's in x is divisible by 2 but not divisible by 3$\}$

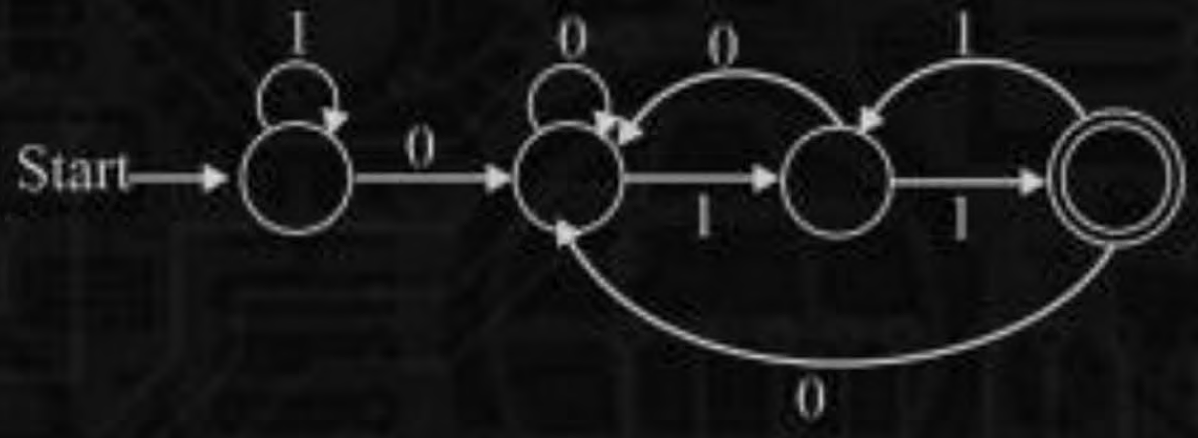
The minimum number of states in a DFA that accepts L is ____.

[2020: 2 Marks]

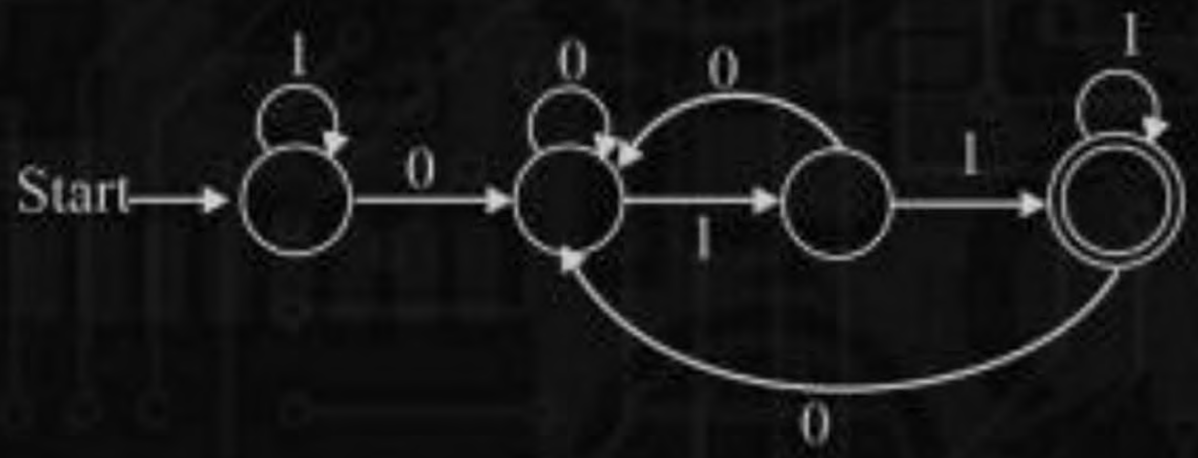
Q

Consider the following language:
$L = \{w \in \{0, 1\}^* \mid w$ ends with the substring $011\}$.
Which one of the following deterministic finite automata accepts L? [2021-Set1: 2 Marks]

A


B


C


D


Q

Let $L \subseteq \{0, 1\}^*$ be an arbitrary regular language accepted by a minimal DFA with k states. Which one of the following languages must necessarily be accepted by a minimal DFA with k states?

[2021-Set2: 1 Marks]

(A) $\{0, 1\}^* - L$

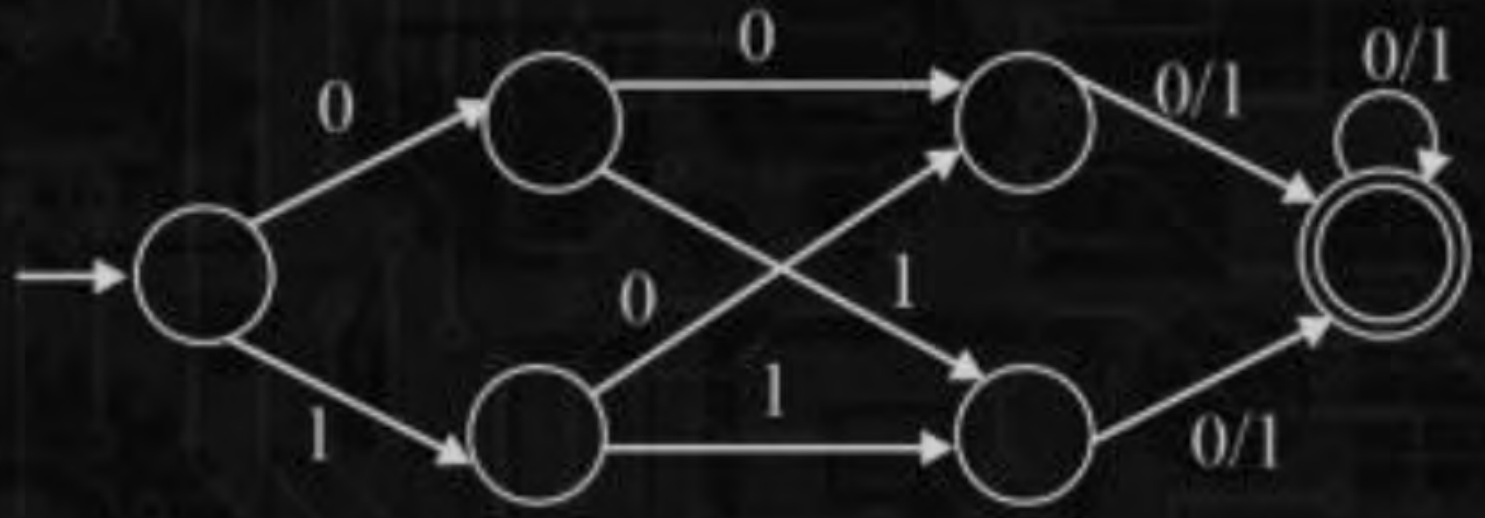
(B) $L \cup \{01\}$

(C) $L \cdot L$

(D) $L - \{01\}$

Q

Consider the following deterministic finite automaton (DFA).



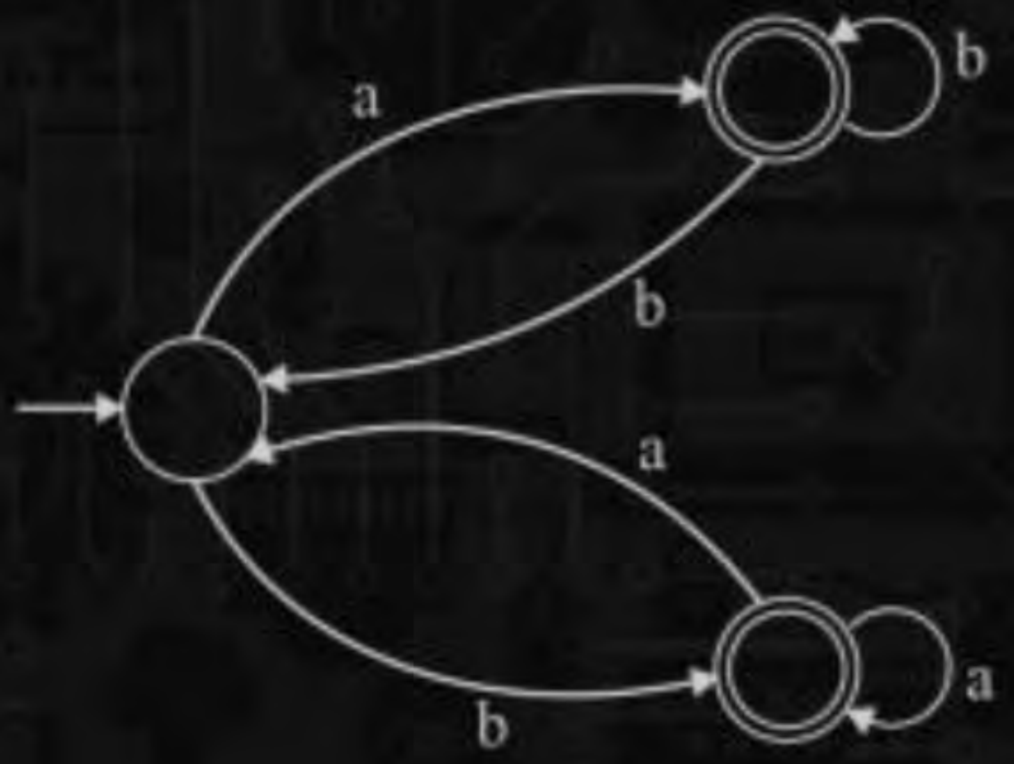
The number of strings of length 8 accepted by the above automaton is____.

[2021-Set2: 1 Marks]

Q

Which one of the following regular expressions correctly represents the language of the finite automaton given below?

[2022: 1 Mark]



(A) $ab^*bab^* + ba^*aba^*$

(B) $(ab^*b)^*ab + (ba^*a)^*ba^*$

(C) $(ab^*b + ba^*a)^*(a^* + b^*)$

(D) $(ba^*a + ab^*b)^*(ab^* + ba^*)$

Summary

→ NFA Vs DFA ✓

NFA with ε-moves ✓


THANK YOU GW
SOLDIERS !