CS & IT ENGINEERING

Theory of Computation
Finite Automata

Lecture No. 9

By- DEVA Sir

01 DFA-Model X (Start/End/Contain)

02 DFA-Model XI (Multiple Conditions)

03. DFA - Model - XII (Position based)

04 DFA-Model XIII (Decimal Equivalent)

05 DFA-Model XIV (Advanced)

06 DFA-Model XV (Simple)

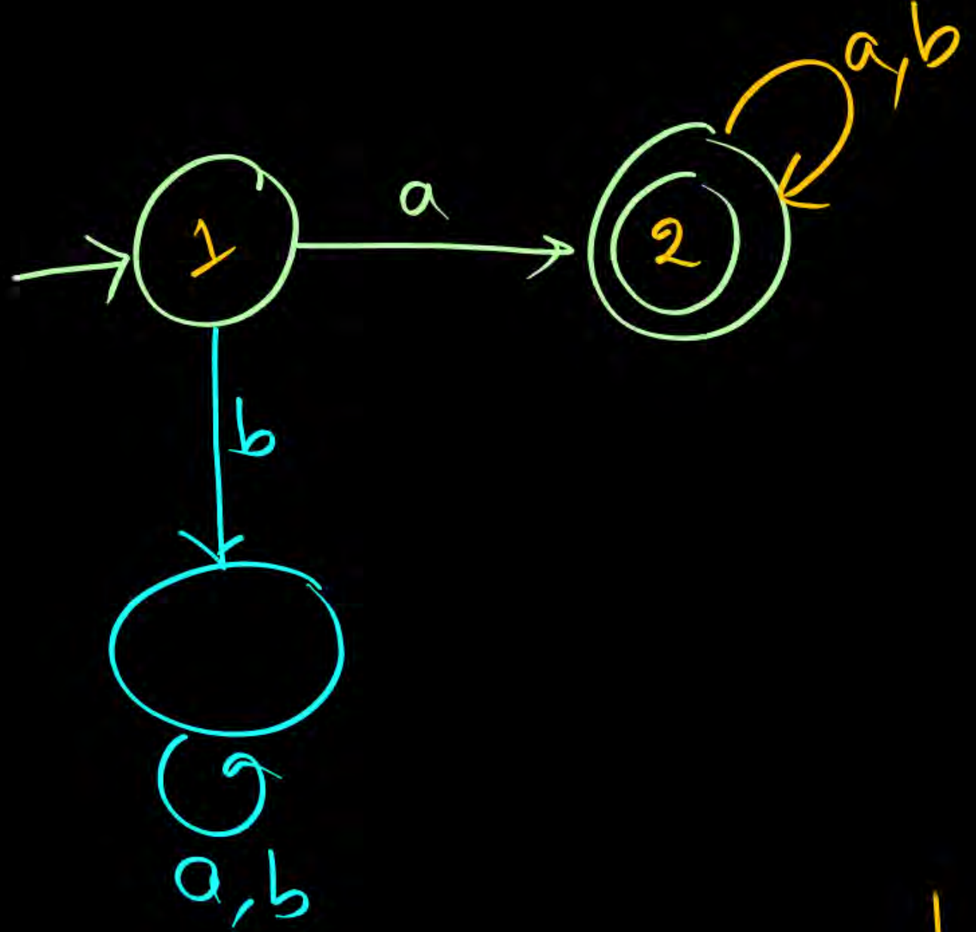
1st Step : Focus on Min String

2nd Step : cover Missing transitions to make DFA

See your language

Model-X:

1. L = a(a+b)*



Min = a

$= (|a|+1) + 1$ ← Dead

$= 2 + 1$

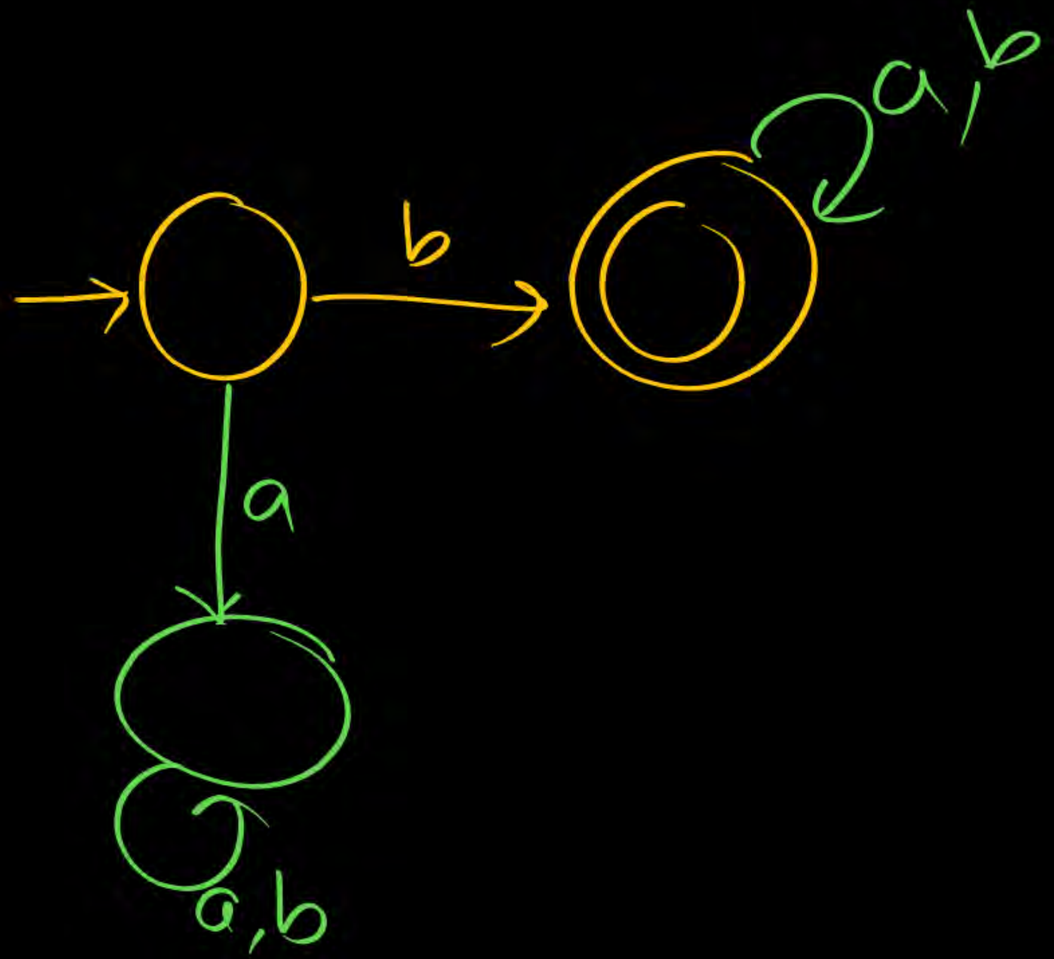
= 3 states

1 —a→ ?

2 —a→ ?

2 —b→ ?

2. L = b(a+b)*



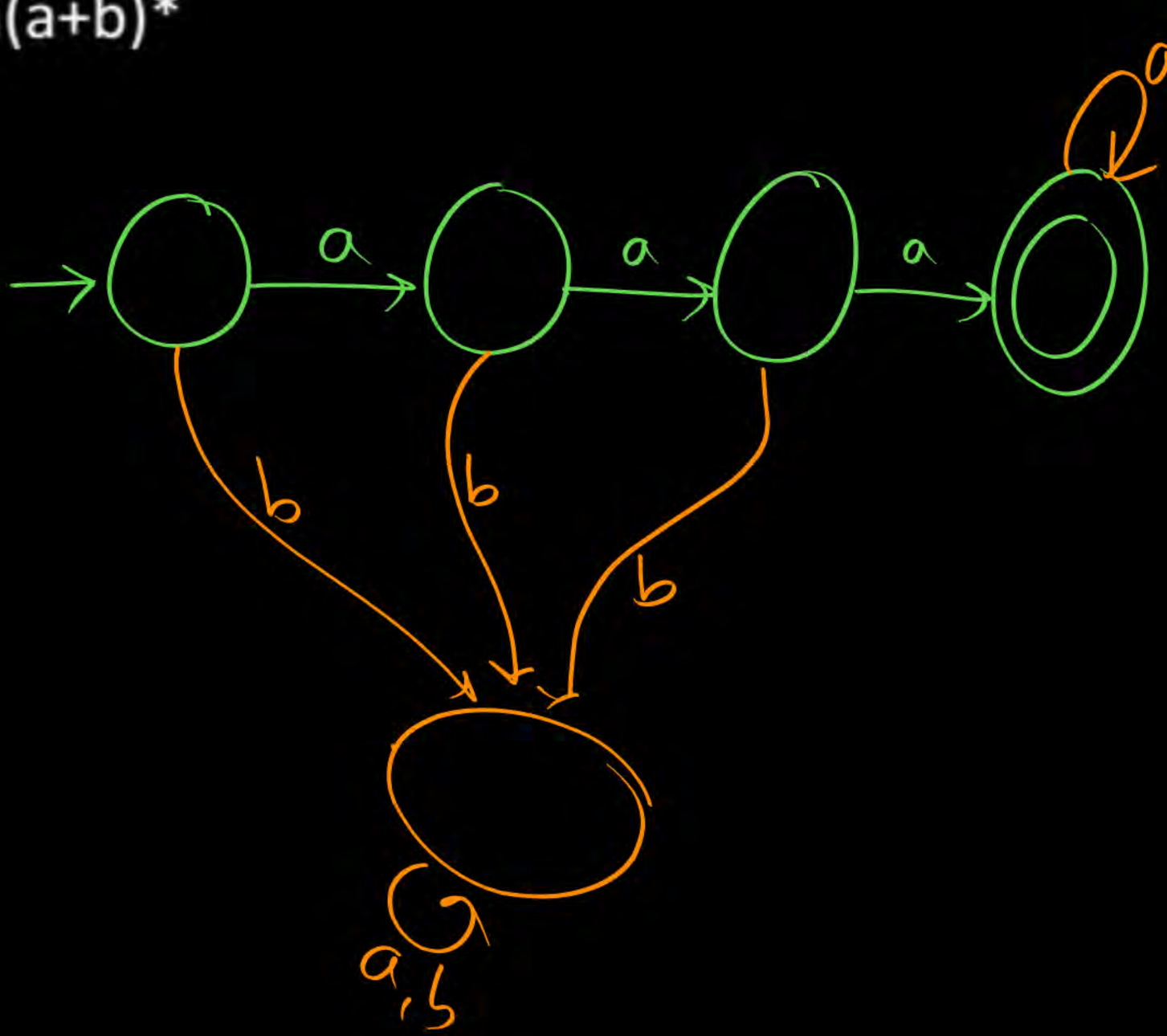
min = b

|b| + 2

1 + 2

3 states

3. L = aaa(a+b)*



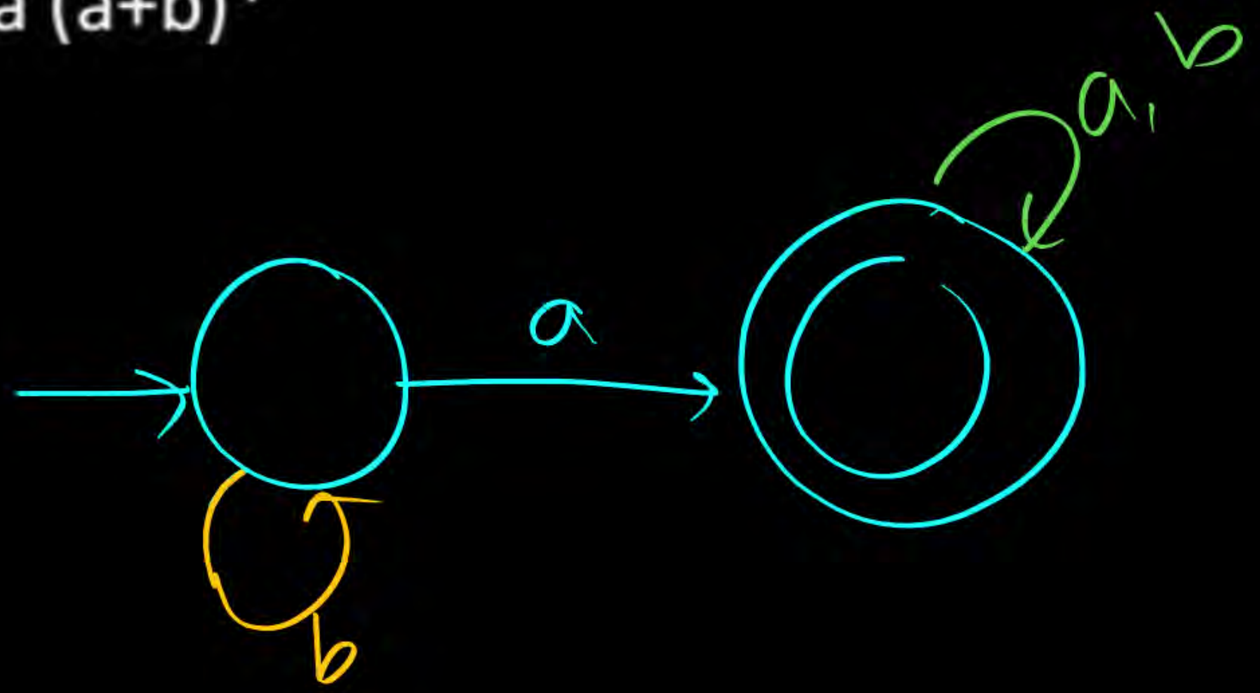
Min = aaa

|aaa| + 2

3 + 2

5 states

4. L = (a+b)*a (a+b)*



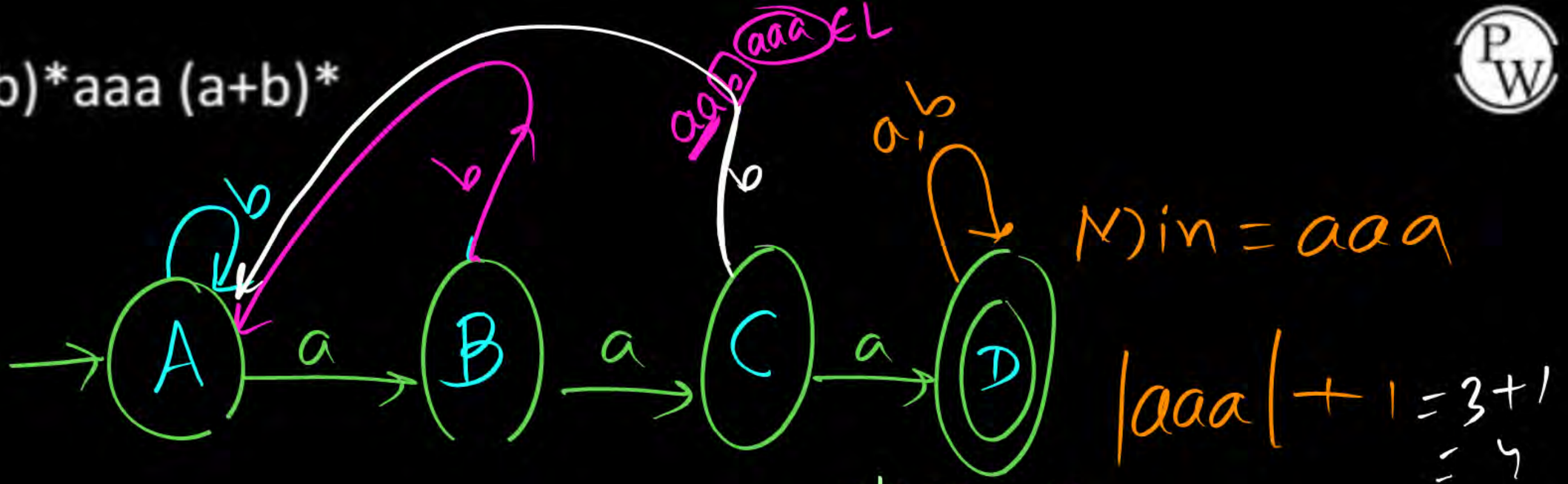
Min = a

|a| + 1

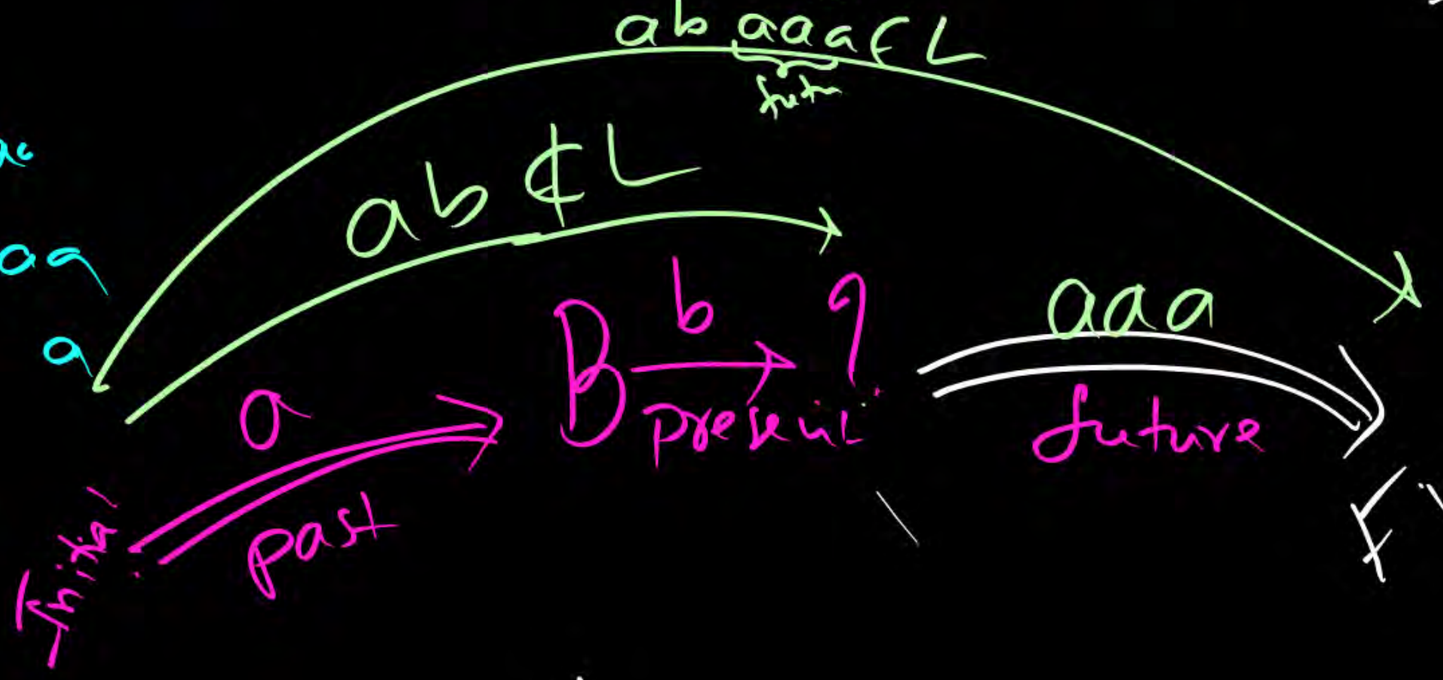
= 1 + 1

= 2 states

5. L = (a+b)*aaa (a+b)*

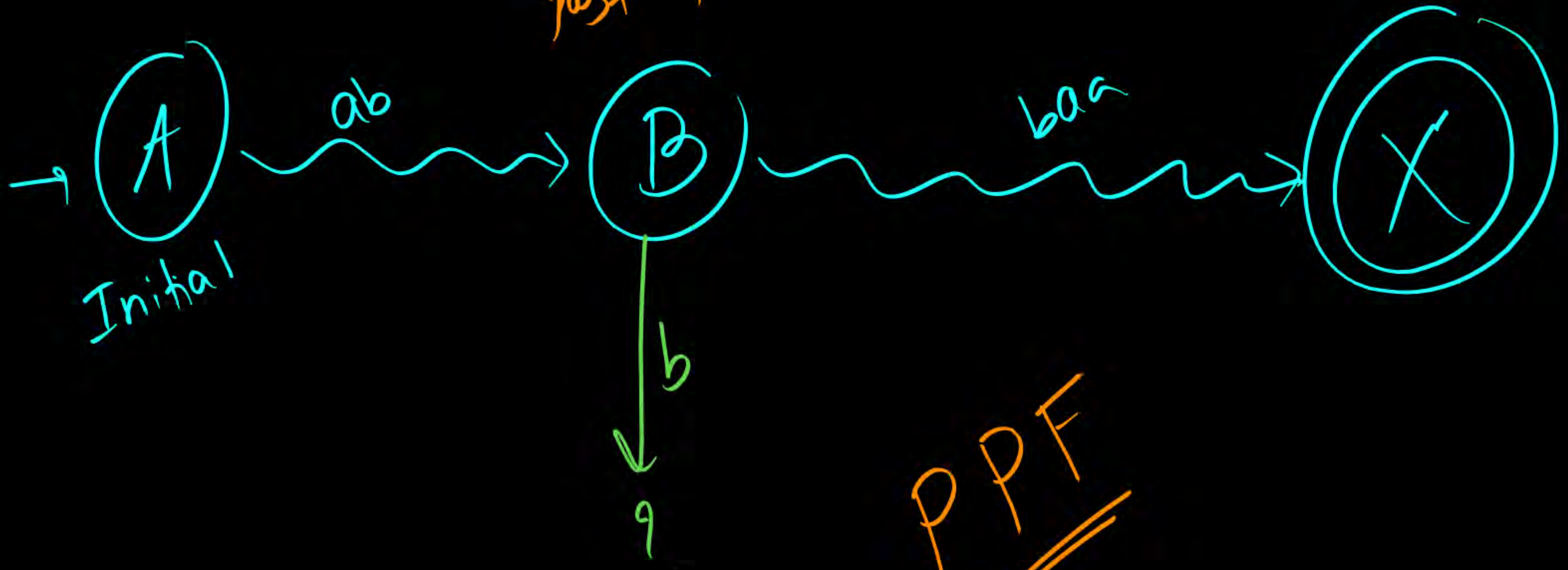


A: I am waiting for a
B: I am " " aa
C: I am " " a
D: I am final



ab b future ∈ L ?

past pm



PPF

Start _ end _ Contain

Dead state required

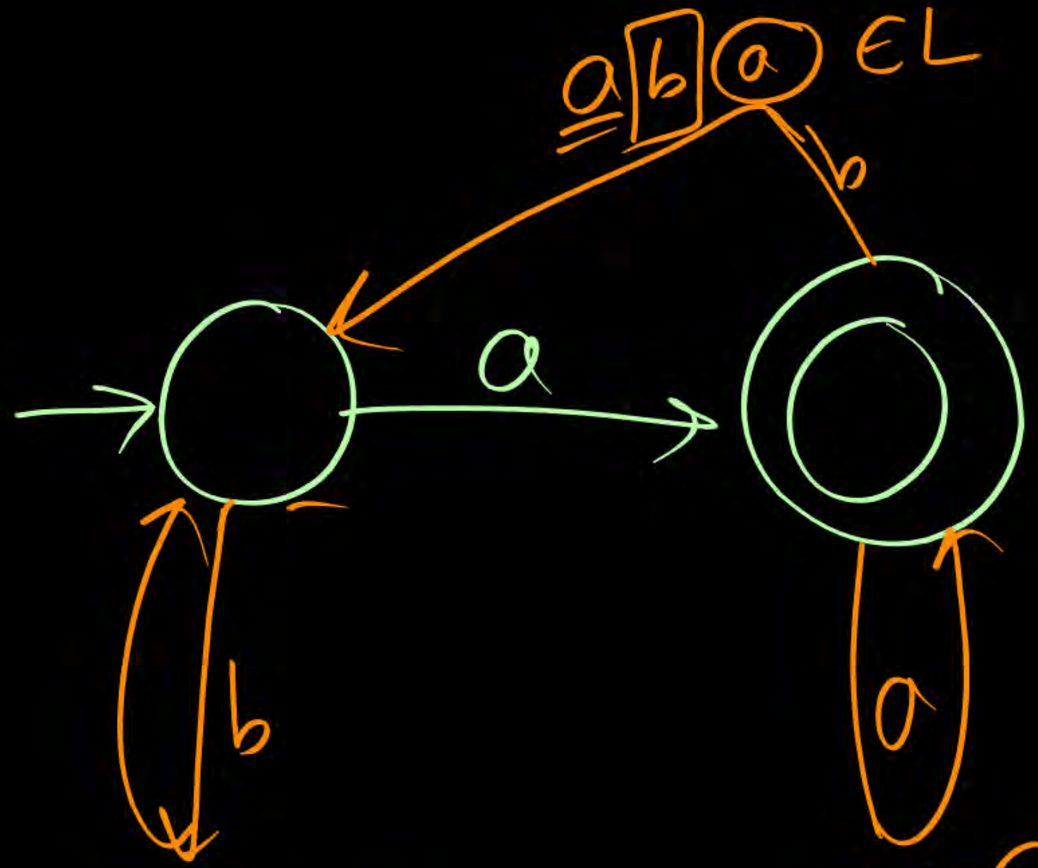
Exactly

At most

Dead state is not required

Atleast

6. L = (a+b)*a



a b a ∈ L

ε b a

a a ∈ L

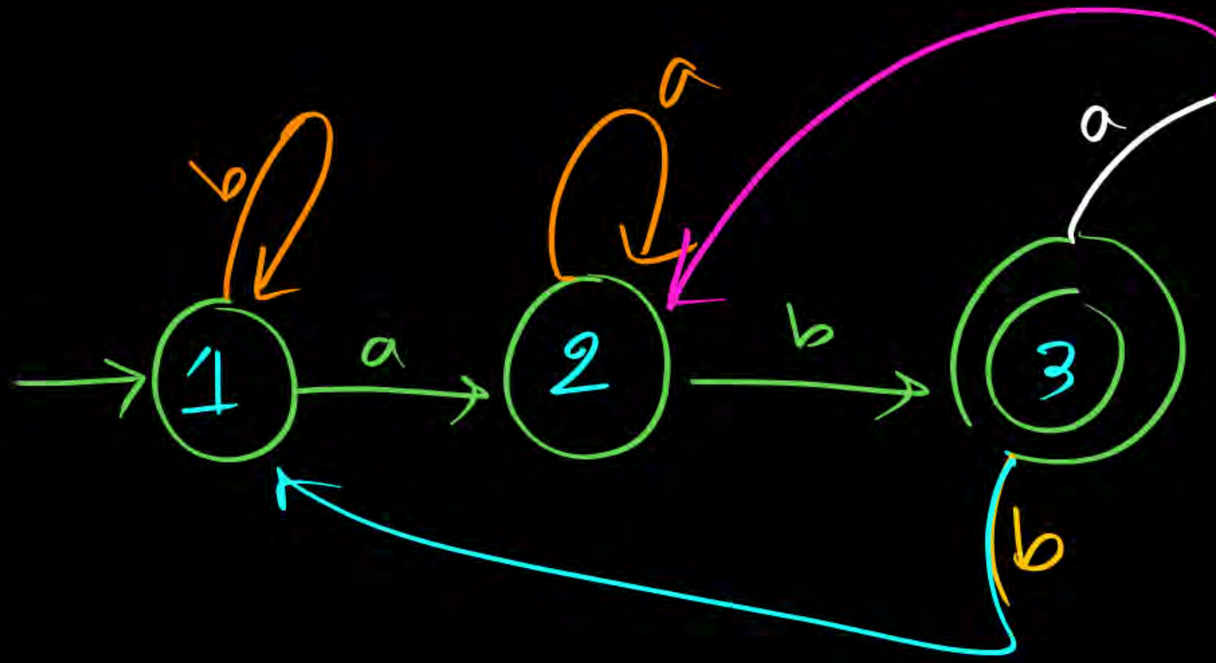
future is not required

Min = a

|a| + 1

= 2 states

7. L = (a+b)*ab



Min = ab

|ab| + 1

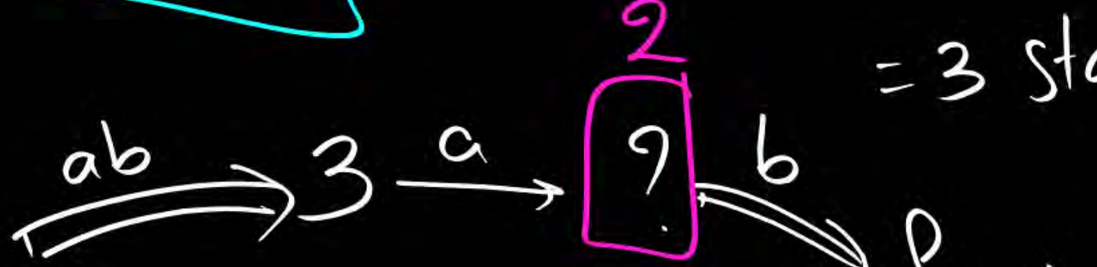
2 + 1

= 3 states

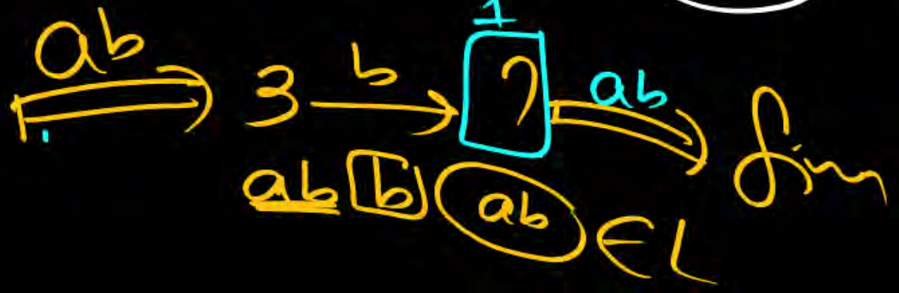
1 : waiting for ab

2 : " " b

3 : Ends with ab (final)

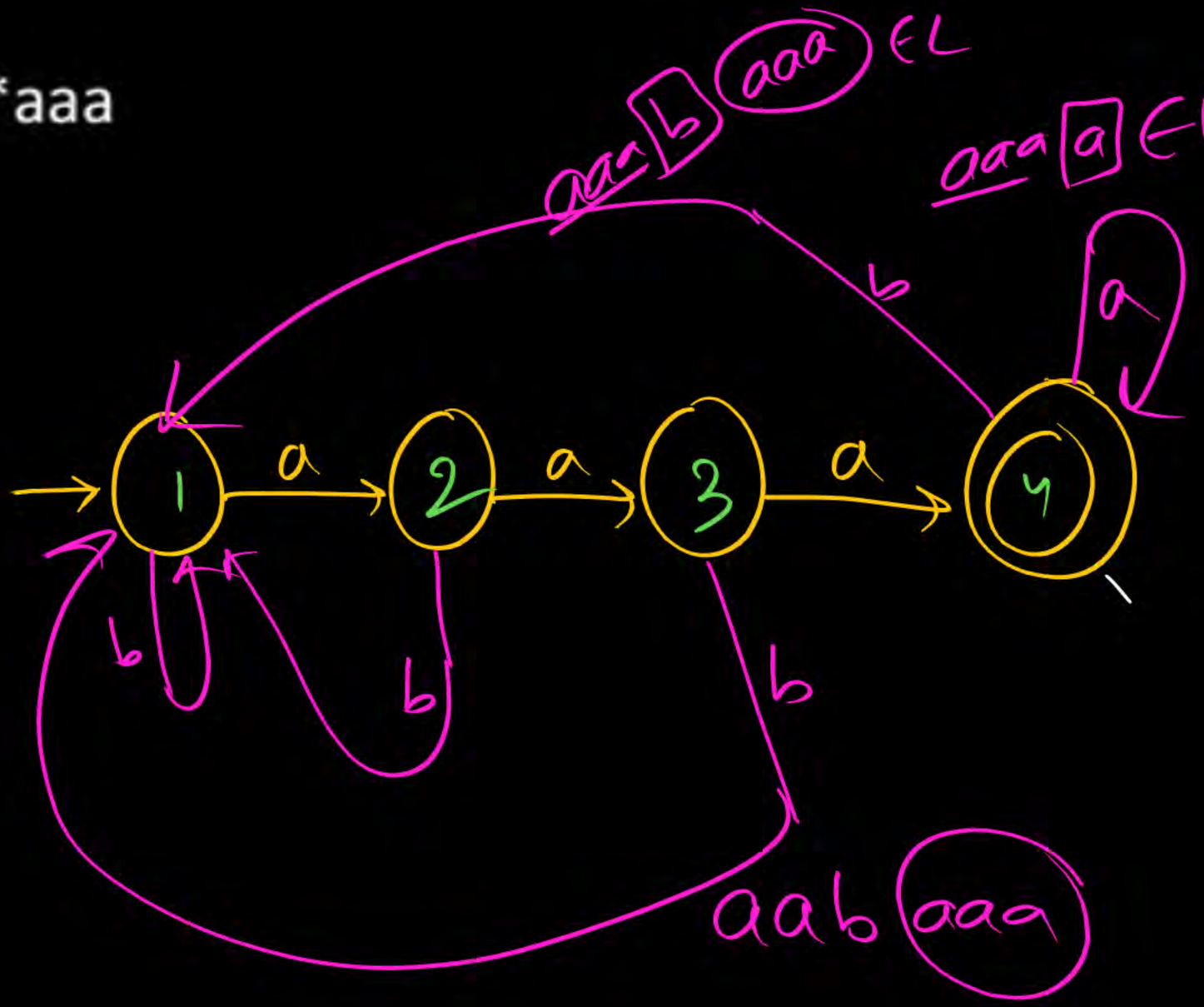


ab a b ∈ L



ab b ab ∈ L

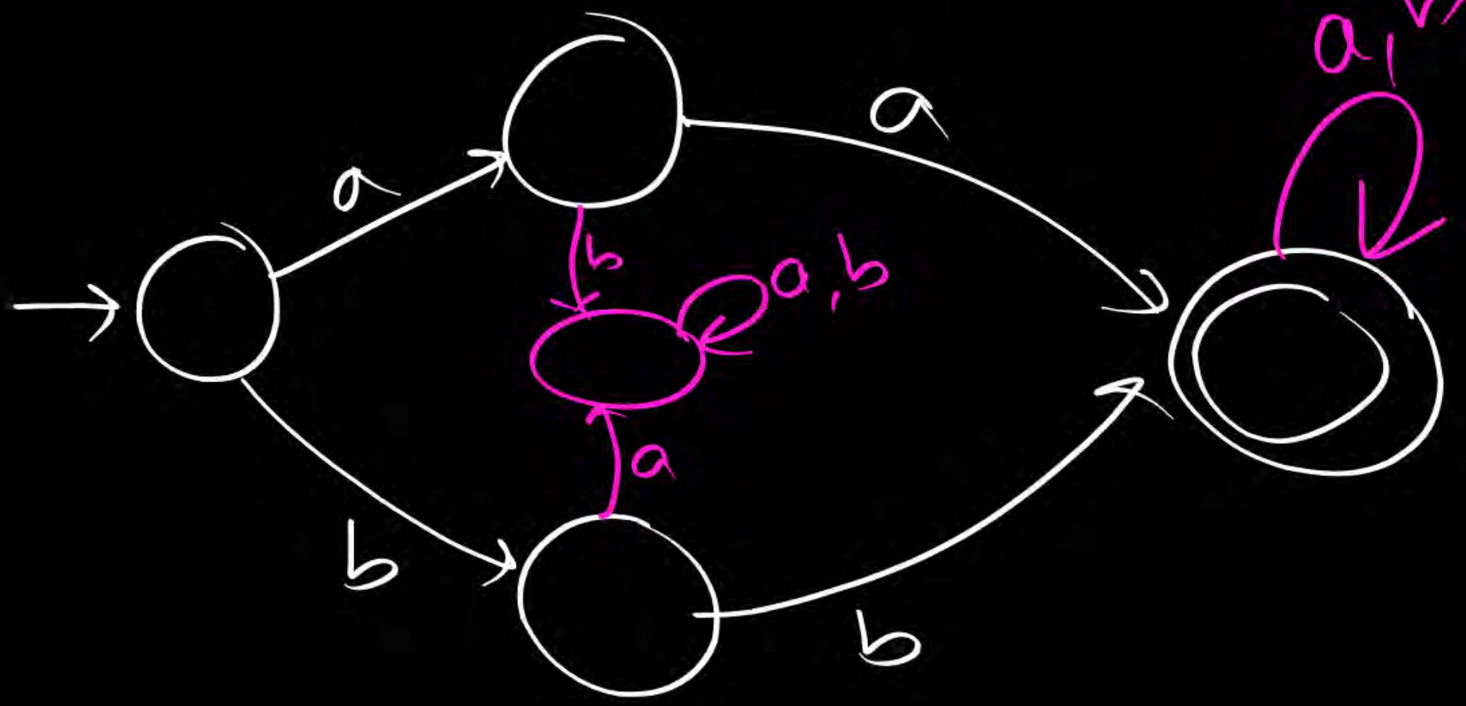
8. L = (a+b)*aaa



|aaa|+1

3+1 = 4 states

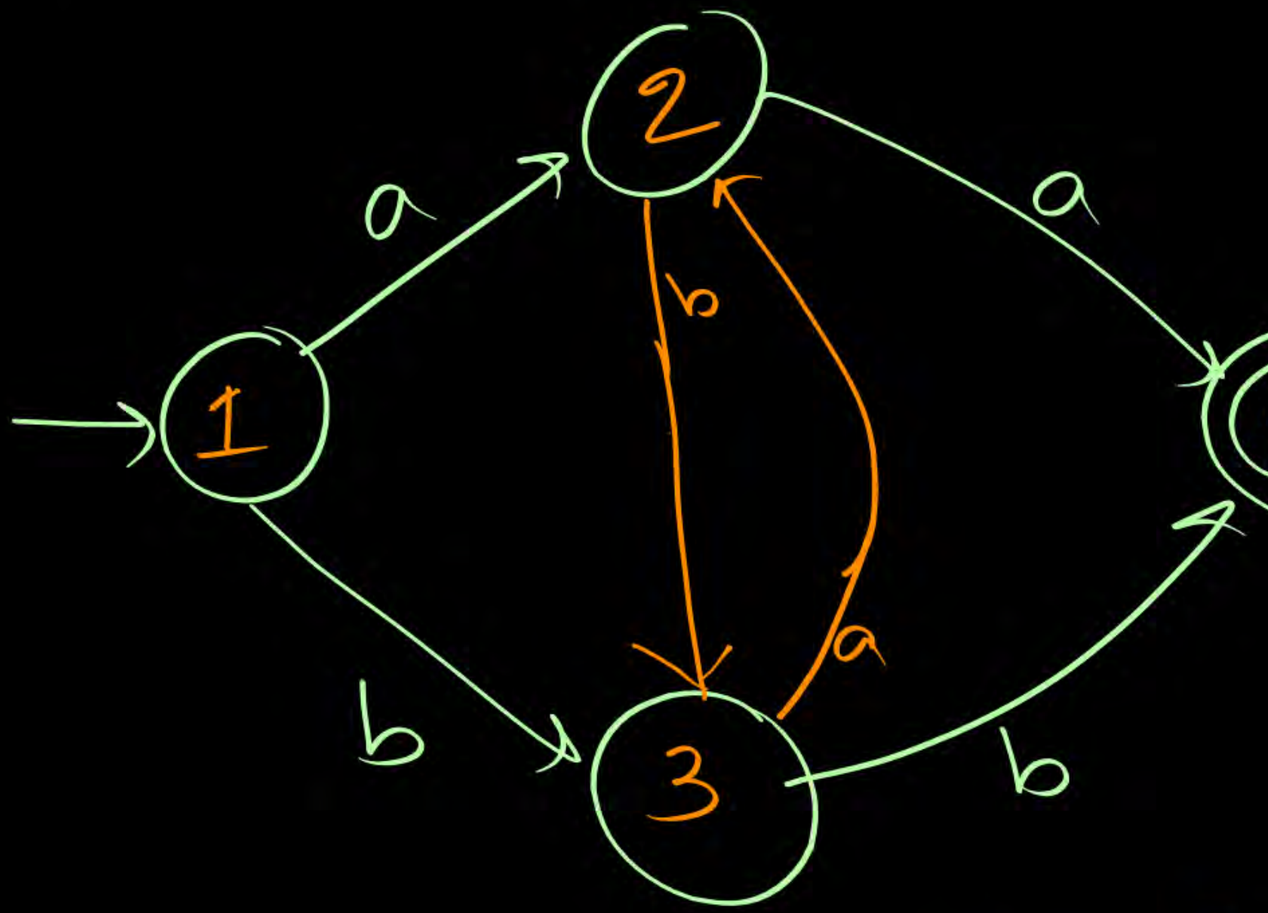
9. L = (aa+bb) (a+b)*



Min = aa, bb

= 5 states

10. L = (a+b)*(aa+bb) (a+b)*

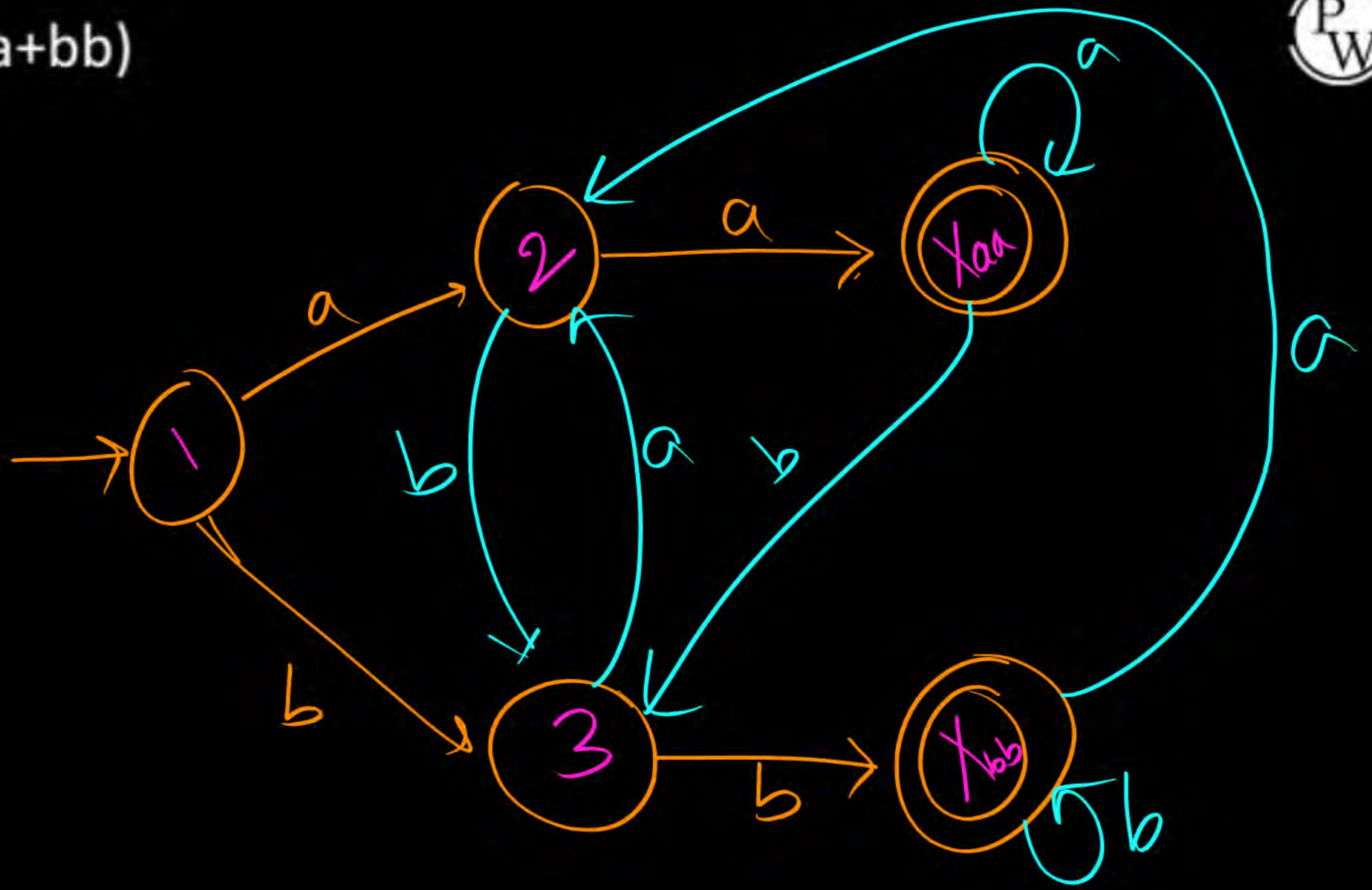


min = aa, bb

a b b ∈ L

b → 3 a → ba a ∈ L

11. L = (a+b)*(aa+bb)



Model-II : [Multiple conditions, Remainder]

4 states

① $\{w \mid w \in \{a,b\}^*, n_a(w) \text{ is div by } 2, n_b(w) \text{ is div by } 2\}$

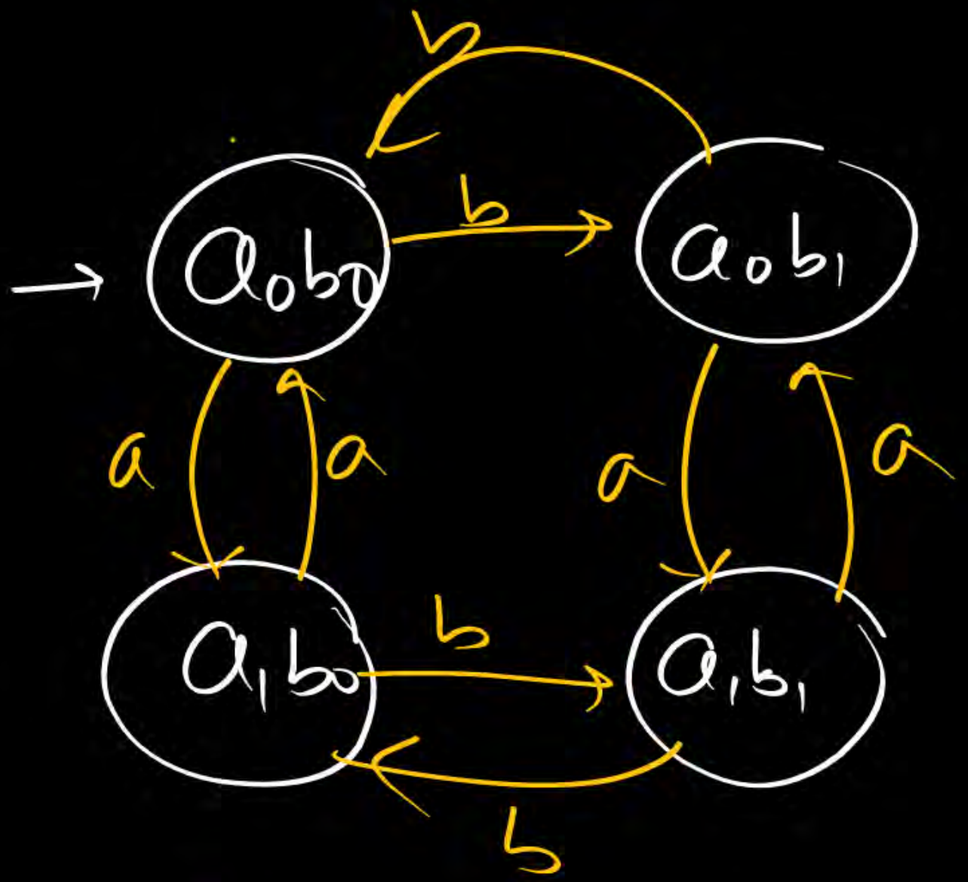
② $\{w \mid w \in \{a,b\}^*, n_a(w) \text{ is div by } 2 \text{ OR } n_b(w) \text{ is div by } 2\}$

③ $\{w \mid$ " , " But not "

④ $\{w \mid$ " , $n_a(w)$ is div by 2 [AND / OR / BUT NOT] $n_b(w)$ is div by 3$\}$

2 × 3 = 6 states

(1)



a_0b_0 = a_{even} b_{even}

a_0b_1 = a_{even} b_{odd}

a_1b_0 = a_{odd} b_{even}

a_1b_1 = a_{odd} b_{odd}

Note: I) If a_0b_0 is final ⇒ #a's = even & #b's = even

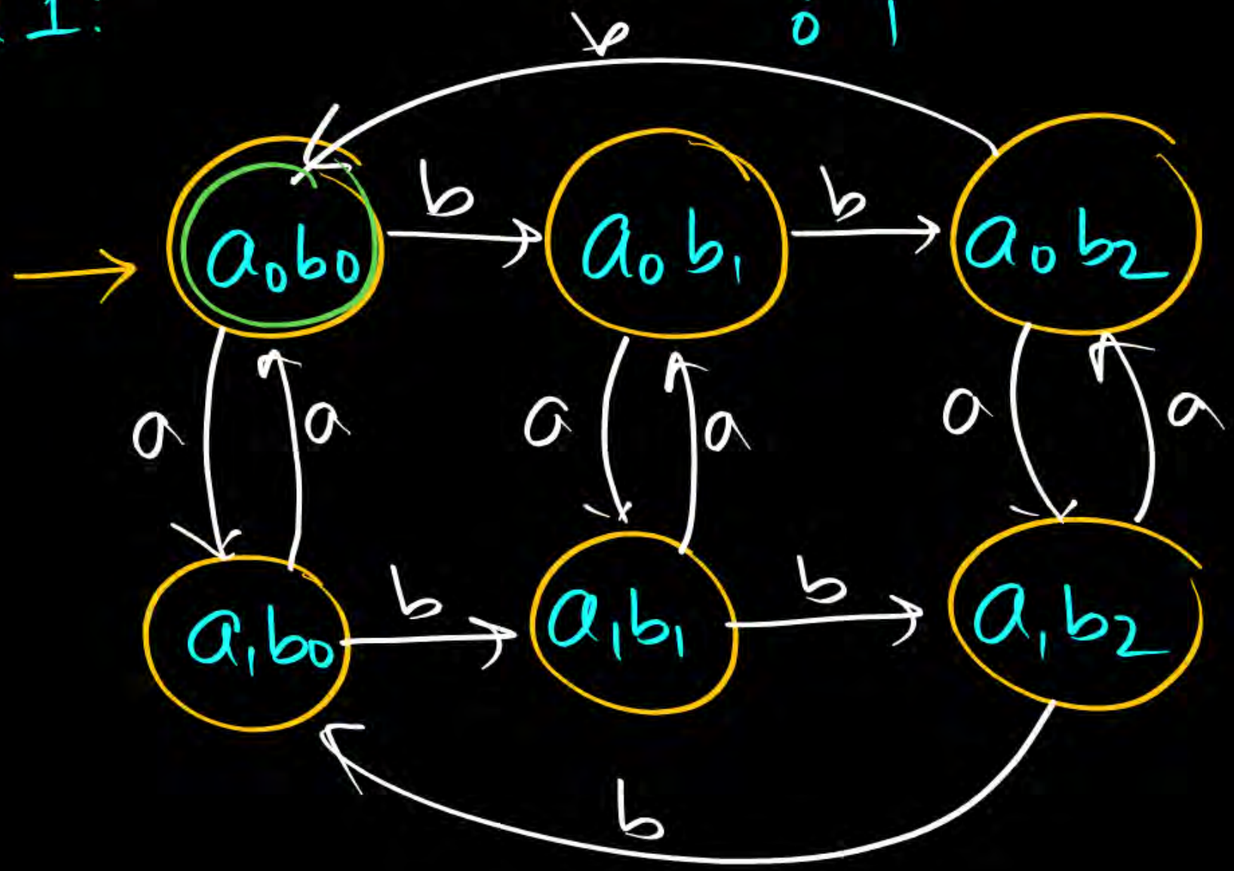
II) If a_1b_0 is final ⇒ #a's = odd & #b's = even

④ $\{w \mid w \in \{a,b\}^*,\ n_a(w)$ is div by 2 AND $n_b(w)$ is div by 3$\}$

$n_a(w)$: 0 | 1

$n_b(w)$: 0 | 1 | 2

Method 1:

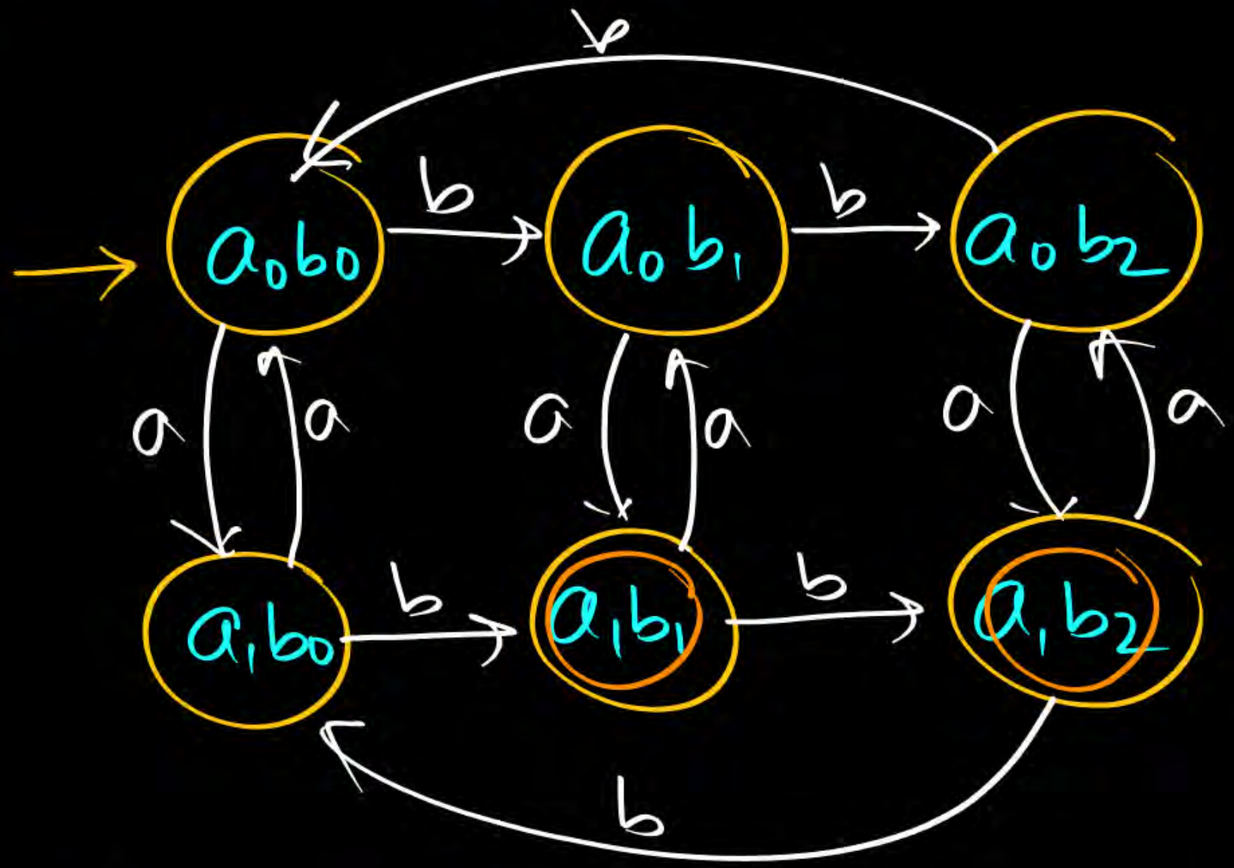


a_0
a_1

b_0
b_1
b_2

I) $\#a's \%2 = 1$ AND $\#b's \%3 \neq 0$ $\Rightarrow$ a_1b_1 and a_1b_2 are finals

($\#a's \%2 = 1$: a_1; $\#b's \%3 \neq 0$: b_1, b_2)



a_0, a_1

b_0, b_1, b_2

II) $\#a's \%2 = 0$ OR $\#b's \%3 = 1$ $\Rightarrow$ Finals : a_0b_0, a_0b_1, a_0b_2, a_1b_1

($\#a's \%2 = 0$: a_0; $\#b's \%3 = 1$: b_1)

(4) (i) #a's div by 2 AND #b's div by 3

↳ Final : a_0b_0

(4) (ii) #a's div by 2 OR #b's div by 3

↳ Finals : a_0b_0, a_0b_1, a_0b_2, a_1b_0

a_0 OR b_0

(4) (iii) #a's div by 2 But not #b's div by 3

a_0 b_1 or b_2

↳ Finals : a_0b_1, a_0b_2

④ $\{w \mid w \in \{a,b\}^*,\ n_a(w) \text{ is div by } 2 \text{ AND } n_b(w) \text{ is div by } 3\}$

$n_a(w)$ is div by 2 → FA_1

$n_b(w)$ is div by 3 → FA_2

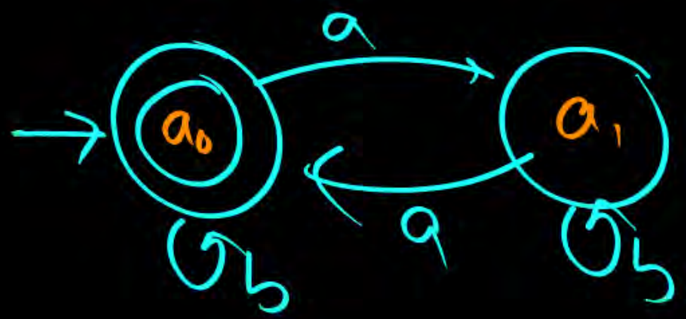
Method 2: Divide & Combine:

↳ Composition Method

$L_1 = \{w \mid w \in \{a,b\}^*,\ n_a(w) \text{ is div by } 2\}$ ⇒ 2 states

$L_2 = \{w \mid \quad n_b(w) \text{ is div by } 3\}$ ⇒ 3 states

FA_1 for L_1



FA_2 for L_2

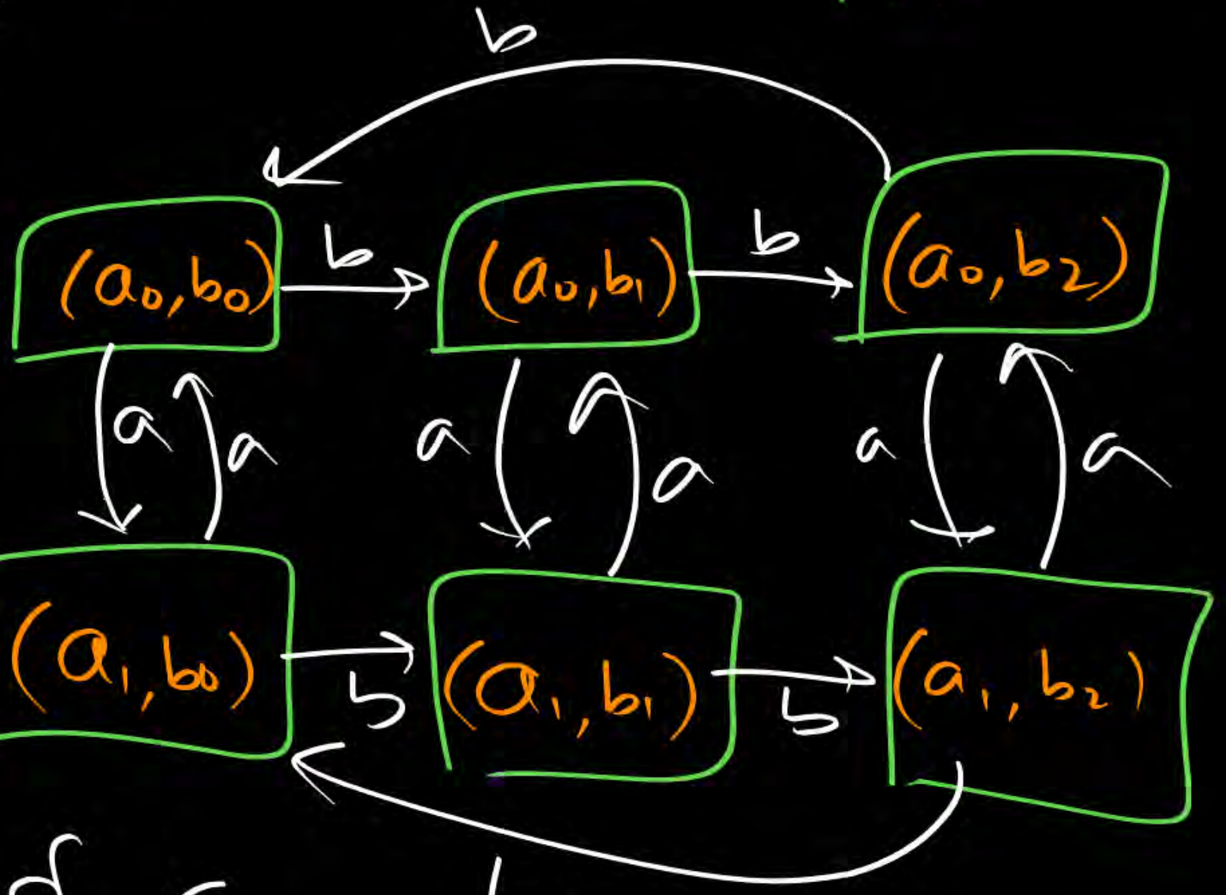
④ $\{w \mid w \in \{a,b\}^*,\ n_a(w)$ is div by 2 AND $n_b(w)$ is div by 3$\}$

FA_1 FA_2

Method 2: Divide & Combine:

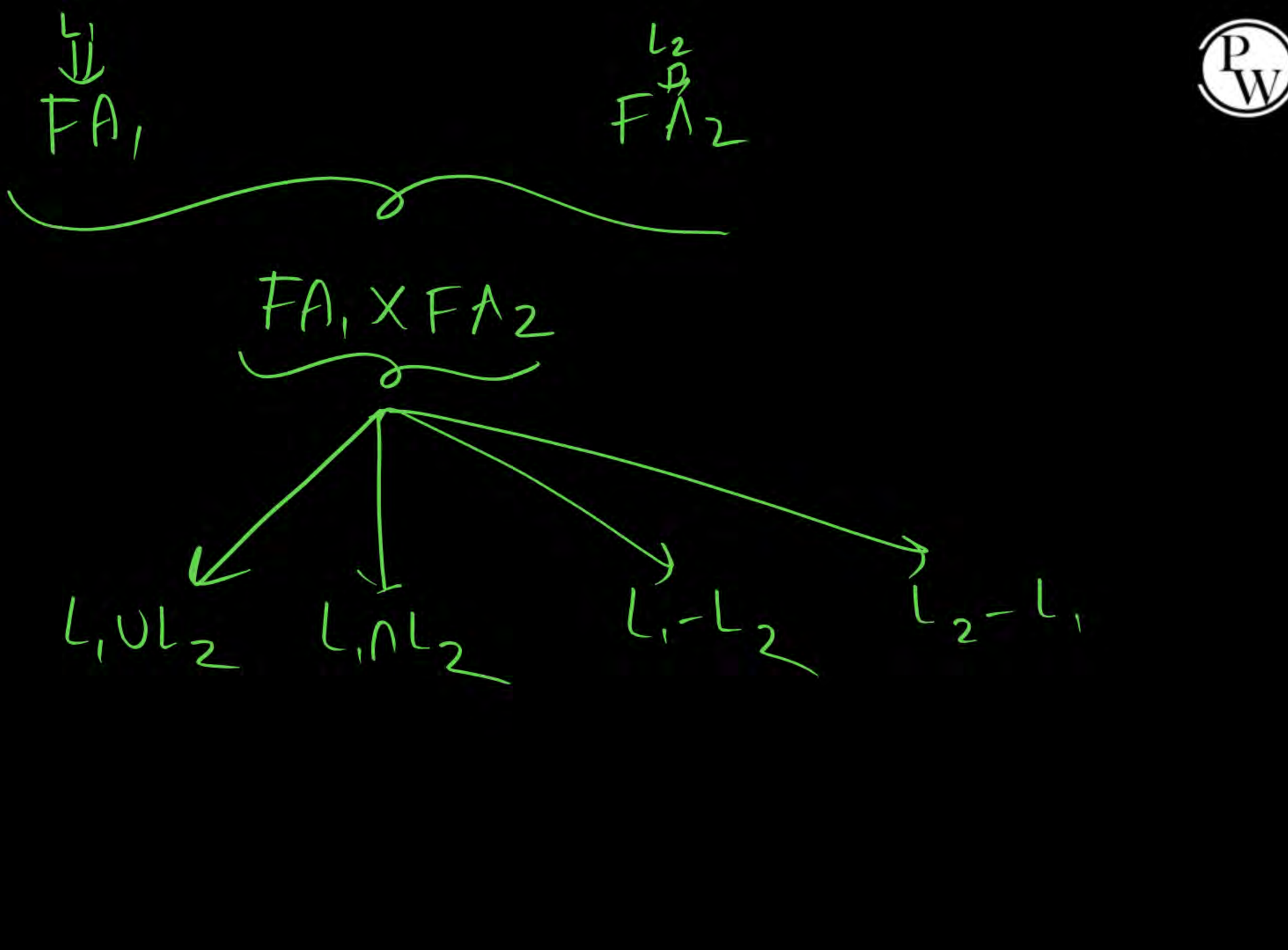
↳ Composition Method

$FA_1 \times FA_2 \Rightarrow$



$\delta((a_0,b_0), a) = [\delta_1(a_0,a), \delta_2(b_0,a)]$

a_1 b_0


L_1
FA_1
L_2
FA_2
$FA_1 \times FA_2$
$L_1 \cup L_2$
$L_1 \cap L_2$
$L_1 - L_2$
$L_2 - L_1$

Model-12: Position based

① $L = \{ w \mid w \in \{a,b\}^*,$ 2nd symbol of w is 'a' $\}$

② $L = \{ w \mid$ " , 3rd " " 'a' $\}$

*** ③ $L = \{ w \mid$ " , 2nd symbol of w from end is 'a' $\}$

④ $L = \{ w \mid$ " , 2nd symbol is 'a' AND 4th symbol is 'b' $\}$

⑤ $L = \{ w \mid$ " , 2nd symbol is 'a' OR 4th symbol is 'b' $\}$


THANK YOU
GW
SOLDIERS !