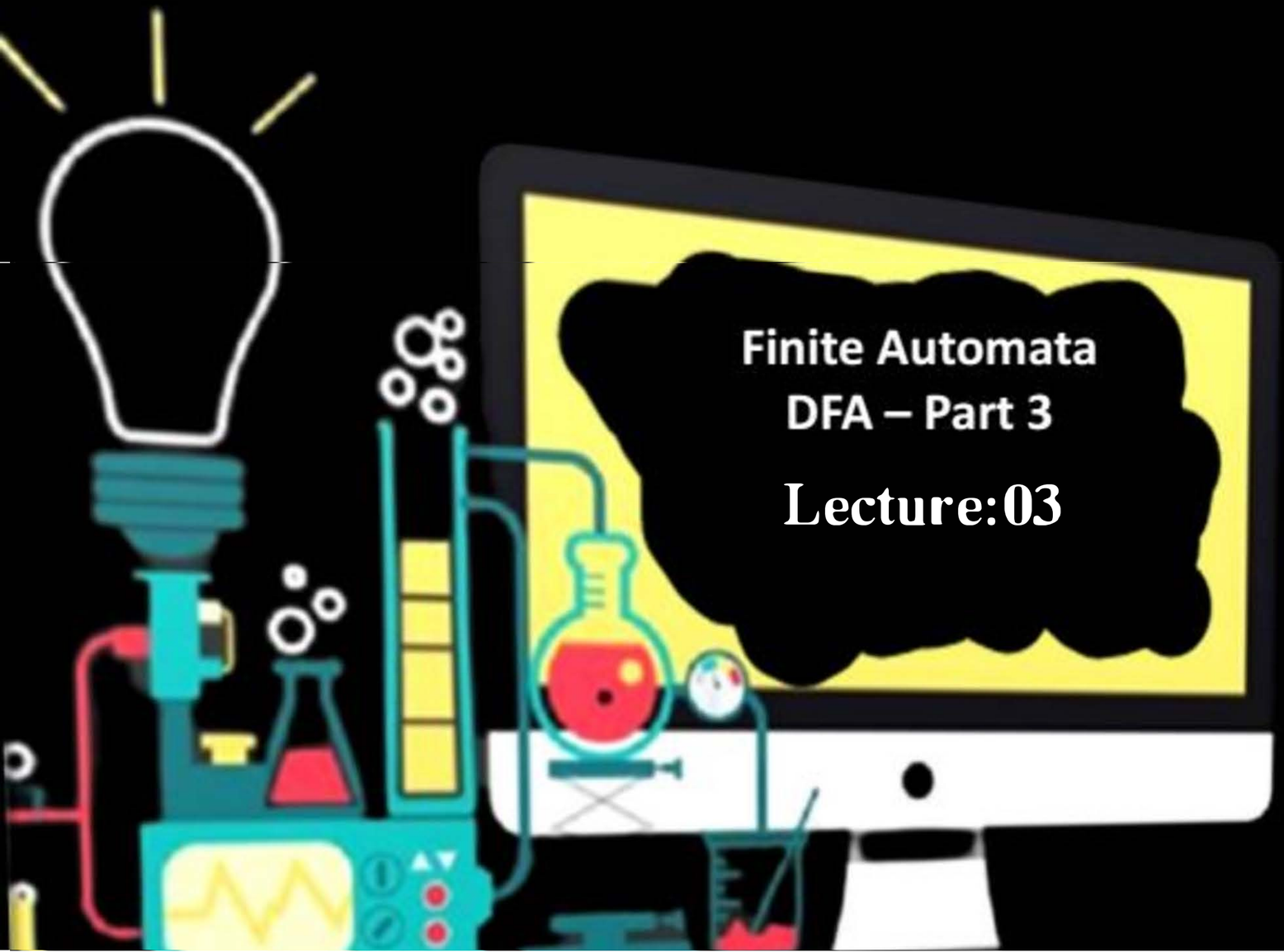
CS & IT Engineering



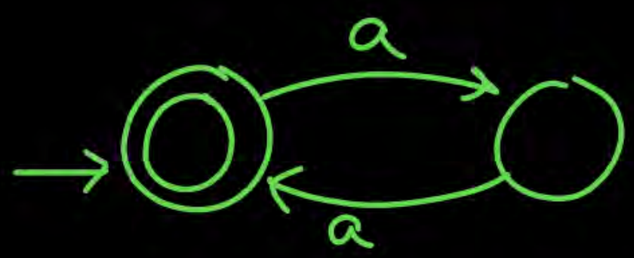
Deva sir

Topics: To Be Covered

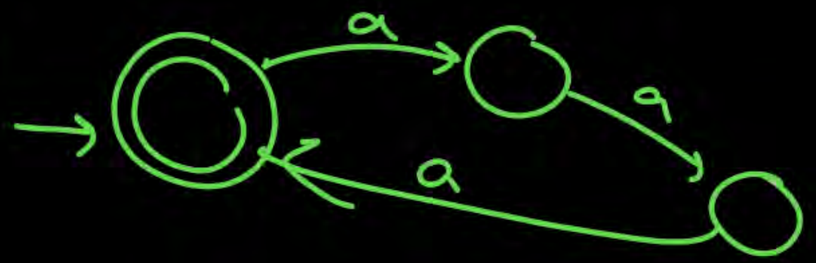
↳ Model III onwards

Model-V [languages over 1 symbol]

(21) $L = (aa)^* = \{\varepsilon, a^2, a^4, a^6, \ldots\}$



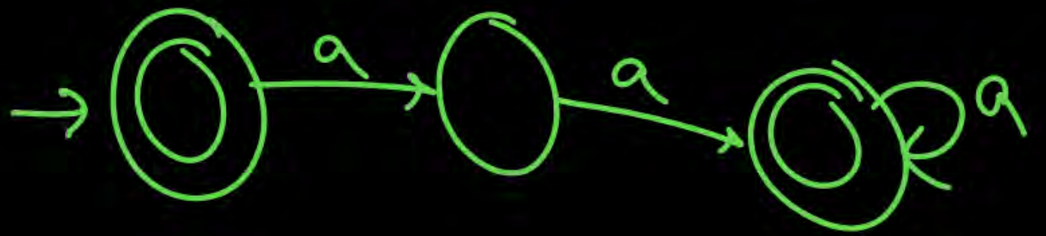
(22) $L = (aaa)^* = \{\varepsilon, a^3, a^6, a^9, \ldots\}$



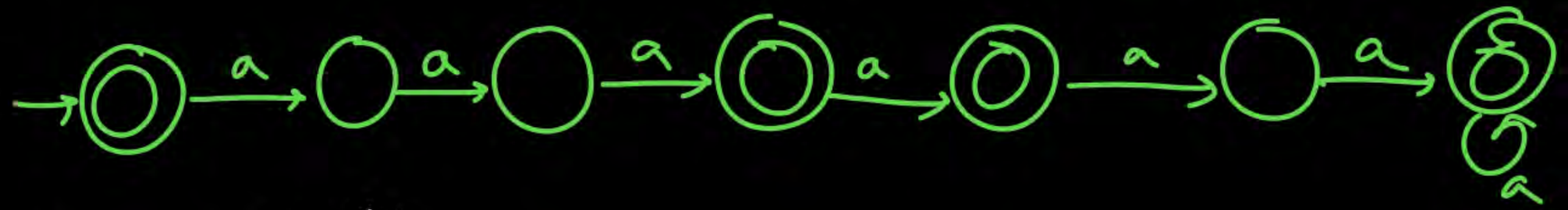
(23) $L = (aa+aaa)^*$

$= \{\varepsilon, a^2, a^3, a^4, a^5, \ldots\}$

$= a^* - \{a\}$

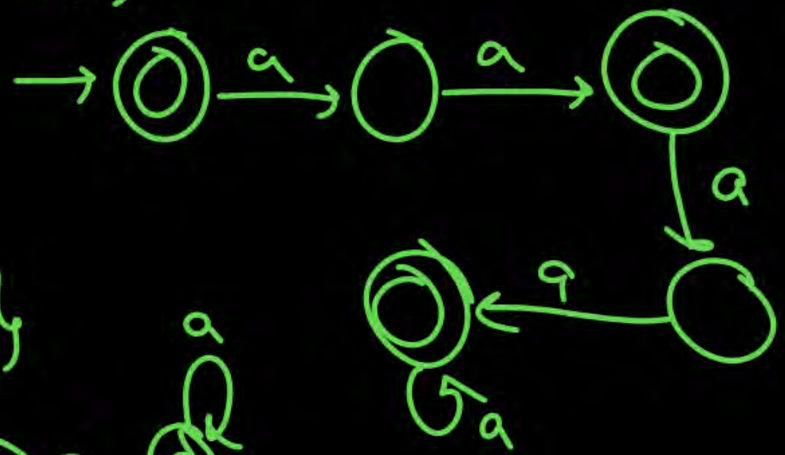


(24) $L = (aaa + aaaa)^* = (a^3 + a^4)^* = \{\varepsilon, a^3, a^4, \boxed{a^6}, a^7, a^8, a^9, \ldots\}$



(25) $L = (aa + a^5)^*$

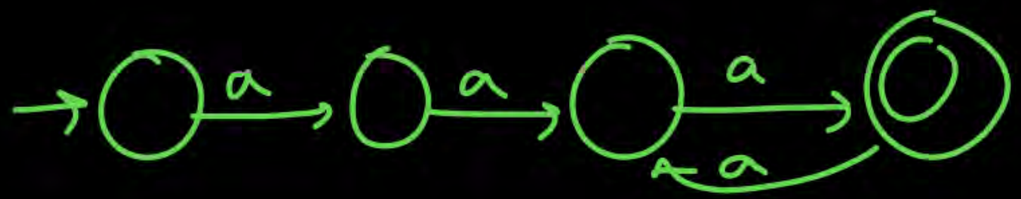
$= \{\varepsilon, a^2, \boxed{a^4}, a^5, a^6, a^7, a^8, a^9, \ldots\}$



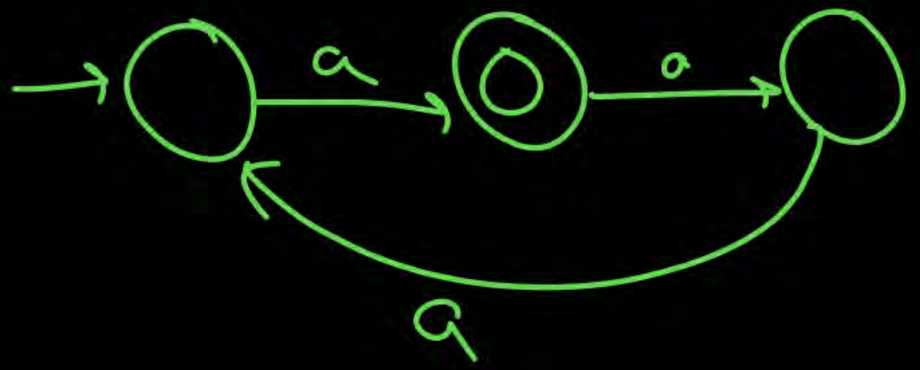
(26) $L = (a^3 + a^5)^*$

$= \{\varepsilon, a^3, a^5, a^6, \boxed{a^8}, a^9, a^{10}, \ldots\}$

(27) $L = \{ a^{2n+3} \} = \{ a^3, a^5, a^7, a^9, \ldots \}$



(28) $L = \{ a^{3n+1} \} = \{ a^1, a^4, a^7, a^{10}, \ldots \}$



(29) $\{a^{Kn+C}\} \Rightarrow$ Case I ($K > C$) : K states

Case II ($K \leq C$) : $C+1$ states

$n \geq 0$

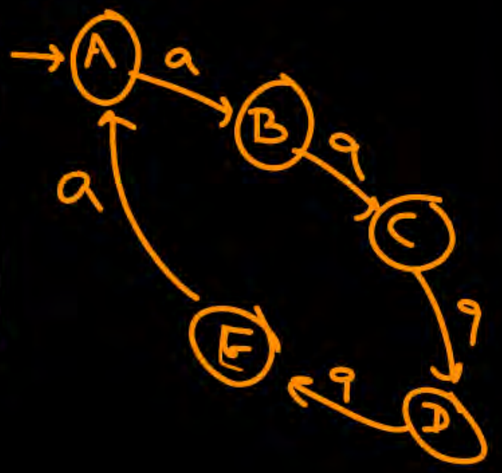
K, C are constants

Case I : $K > C$

C represents remainder

a^{5n+0} A is final	a^{5n+3} D is final
a^{5n+1} B is final	a^{5n+4} E is final
a^{5n+2} C is final	

5 states (K states)



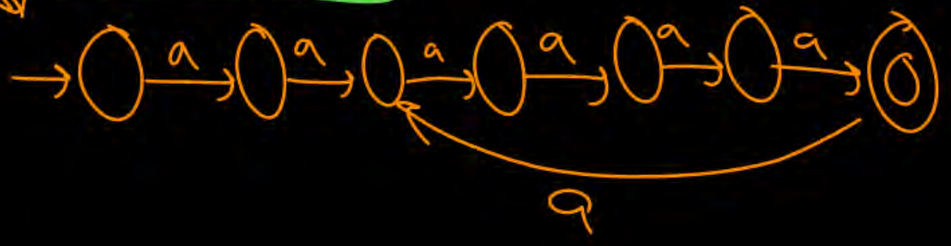
Case II : $K \leq C$

$C+1$ states

a^{5n+5} → 6 states

a^{5n+6} → 7 states

a^{5n+7} → 8 states



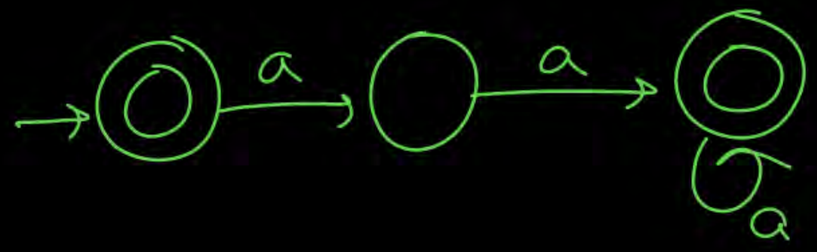
(30) $\{a^{Prime}\}^* \Rightarrow \{a^{Prime}\}^0 \cup \{a^{Prime}\}^1 \cup \{a^{Prime}\}^2 \cup \ldots$

$\{a^2, a^3, a^5, a^7, a^{11}, \ldots\}^* = \{\varepsilon, a^2, a^3, a^4, a^5, a^6, \ldots\}$

$(a^2 + a^3 + a^5 + a^7 + a^{11} + \ldots)^*$

↓

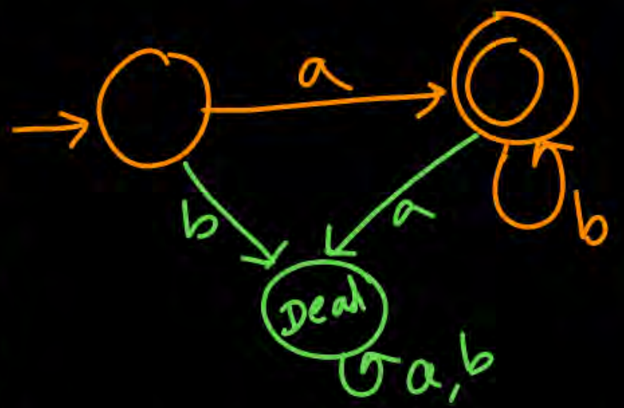
except "a", all strings possible



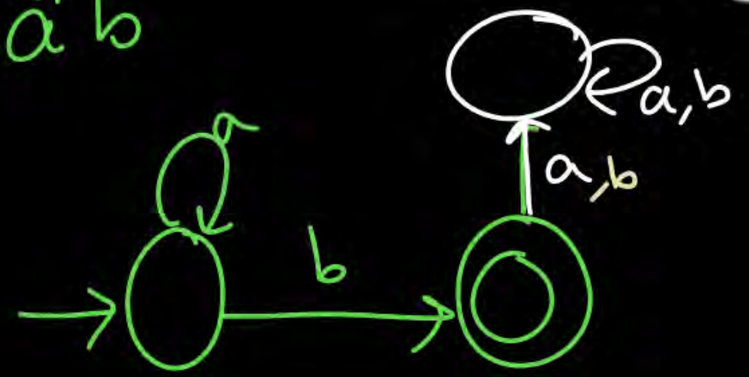
Model-VII [Sequence Based]

(31) ab^*

(32) a^*b



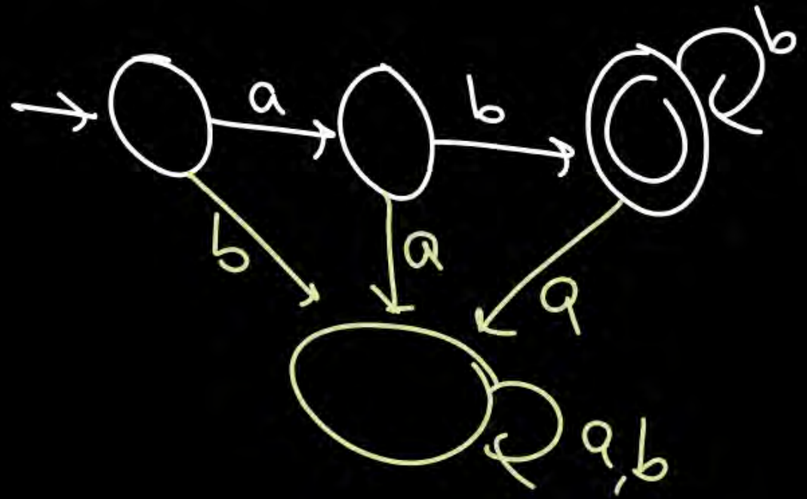
(32) a^*b



(33) ab^+

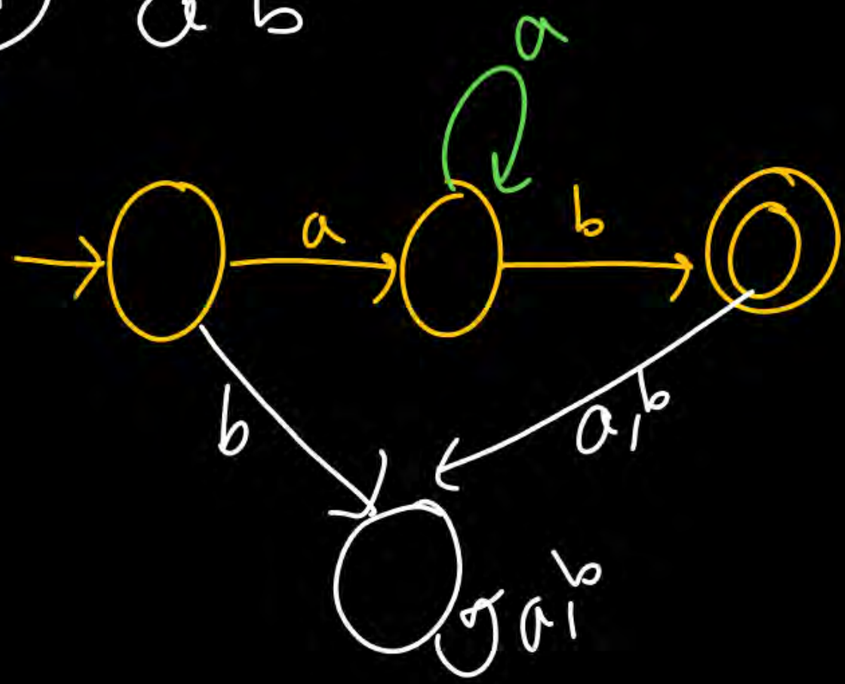
abb^*

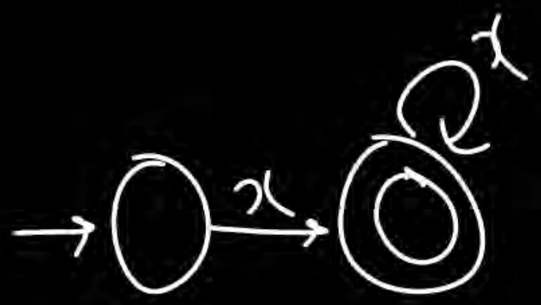
min = ab



(34) a^+b

aa^*b





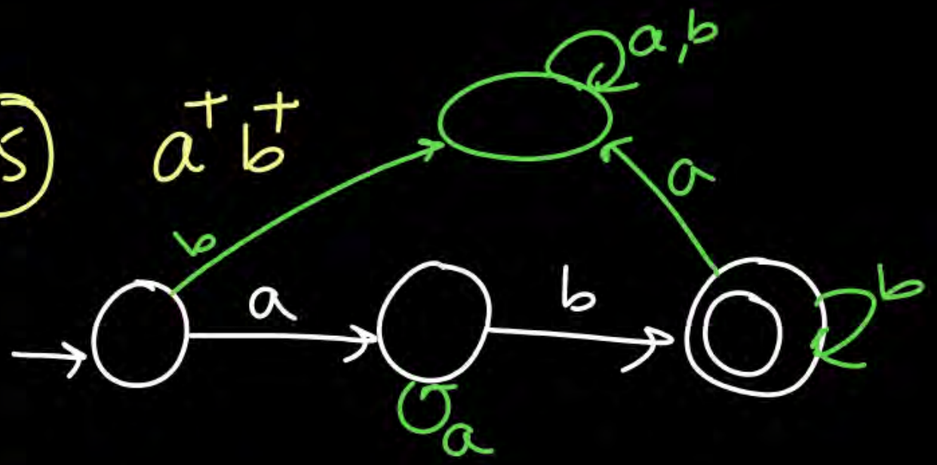
$$x^+ = x\boxed{x^*}$$

$$\boxed{x^*}$$

DFA

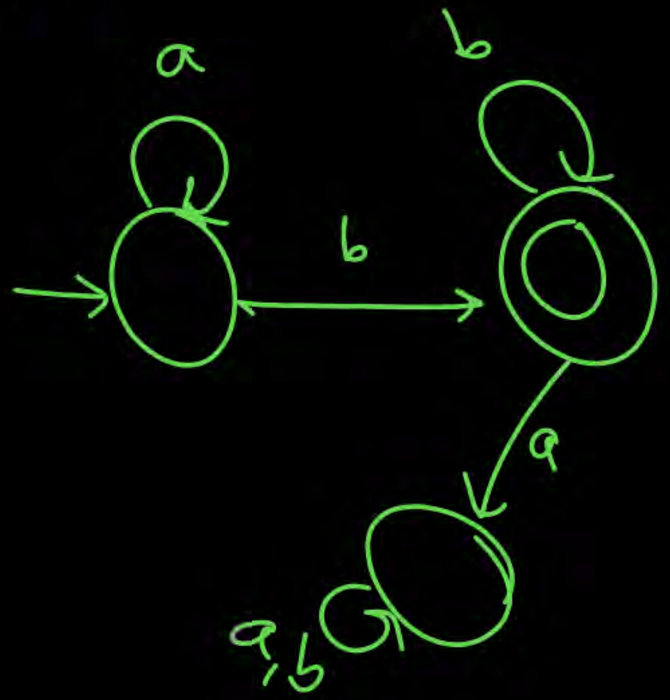
35 a^+b^+

min=ab



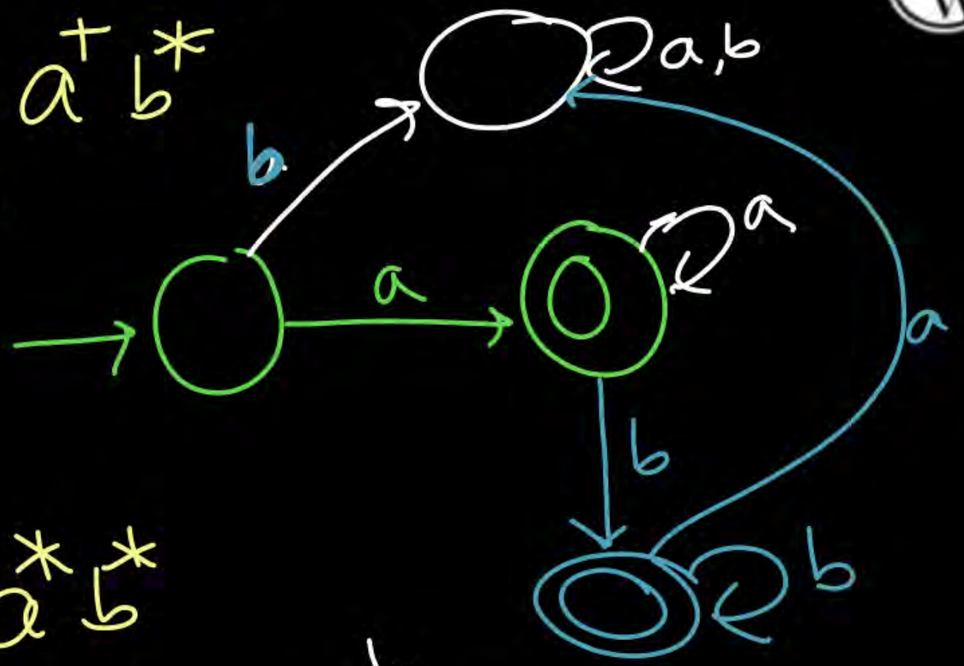
36 a^*b^+

min=b

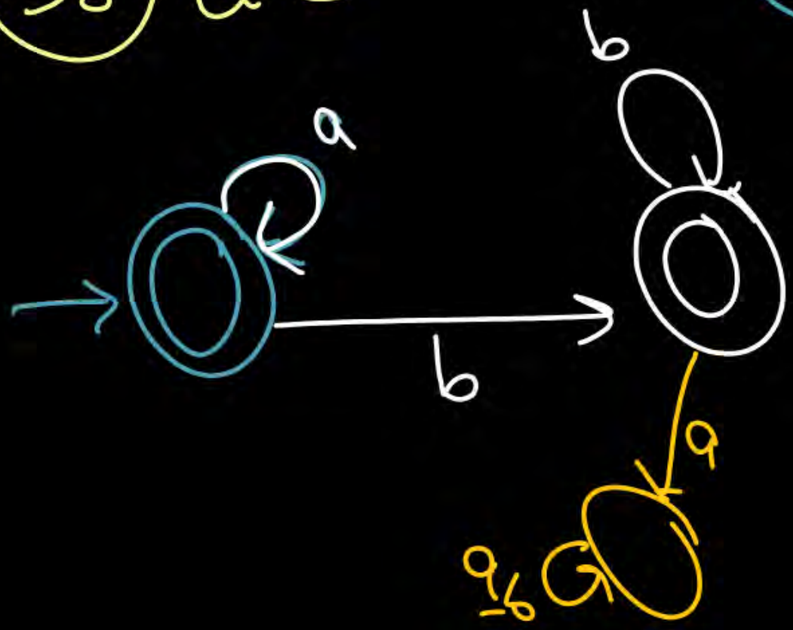


37 a^+b^*

min=a

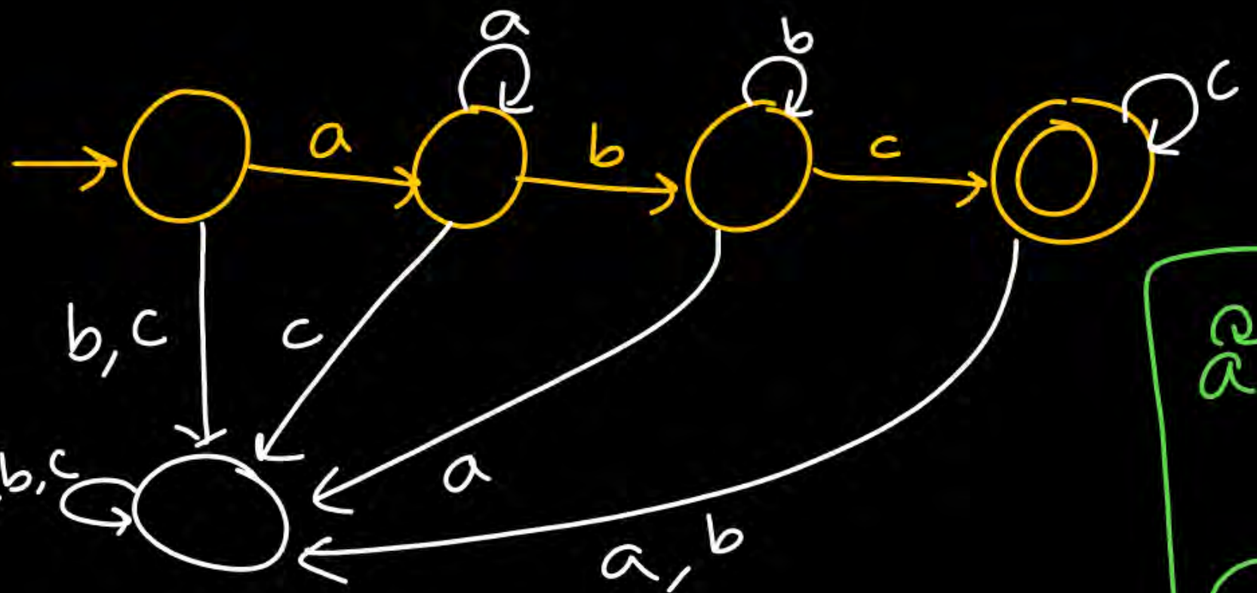


38 a^*b^*



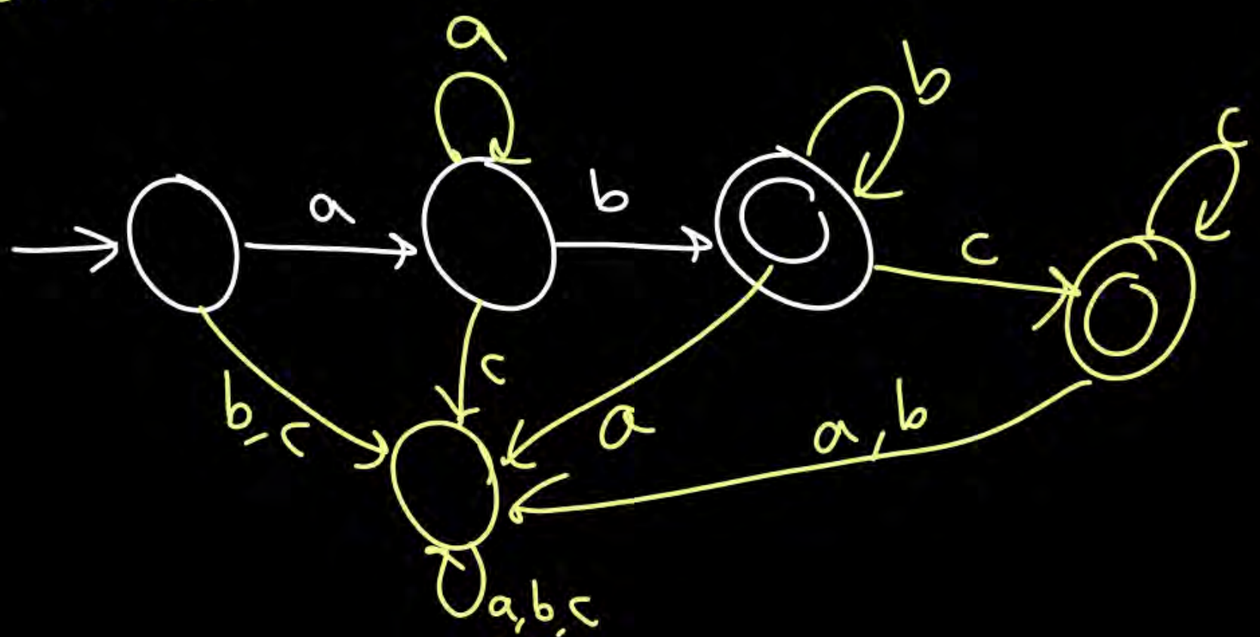
(39) $a^+b^+c^+$

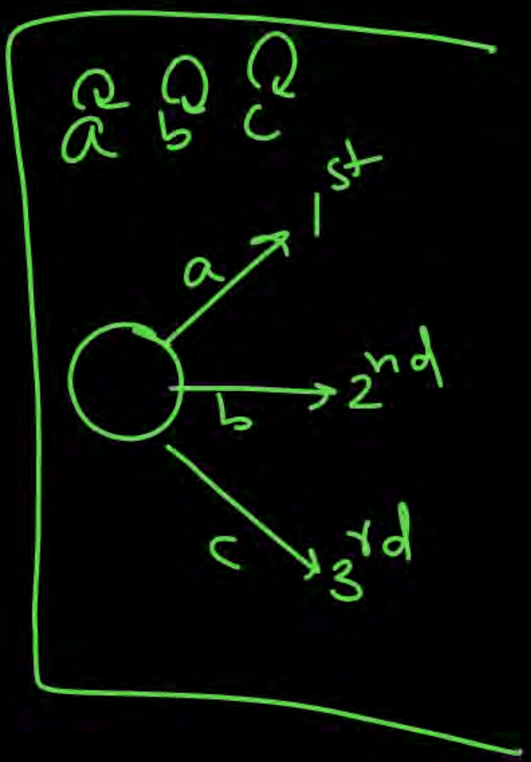
min = abc



(40) $a^+b^+c^*$

min = ab





DFA

H.D

41. $a^{+}b^{*}c^{+}$

42. $a^{*}b^{+}c^{+}$

43. $a^{*}b^{*}c^{+}$

44. $a^{*}b^{+}c^{*}$

45. $a^{+}b^{*}c^{*}$

46. $a^{*}b^{*}c^{*}$

47. $b^{+}a^{+}$

48. $b^{+}c^{*}a^{+}$

49. $a^{*}c^{*}b^{+}$

50. $b^{*}a^{*}$

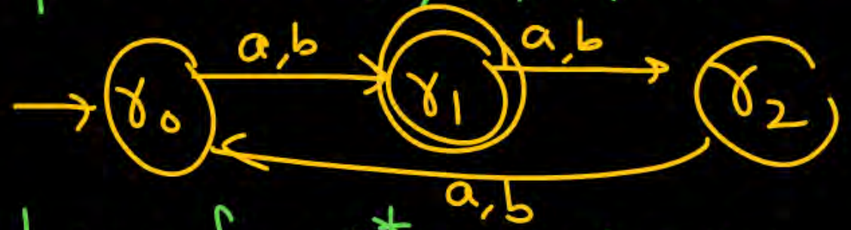
DFA

Model-VII [Divisible / Modulo / Remainder]

(S1) $\{w \mid w \in \{a,b\}^*, |w| \text{ is divisible by } 3\}$

0 mod 3
1 mod 3
2 mod 3

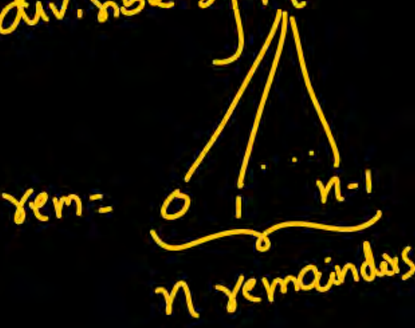
(S2) $\{w \mid w \in \{a,b\}^*, |w| \% 3 = 1\}$



(S3) $\{w \mid w \in \{a,b\}^*, |w| \% 3 = 2\}$

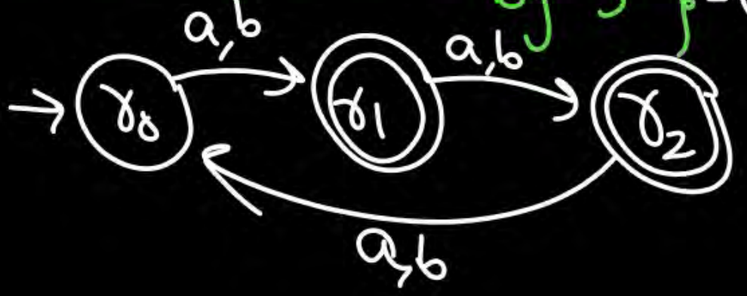
Note:

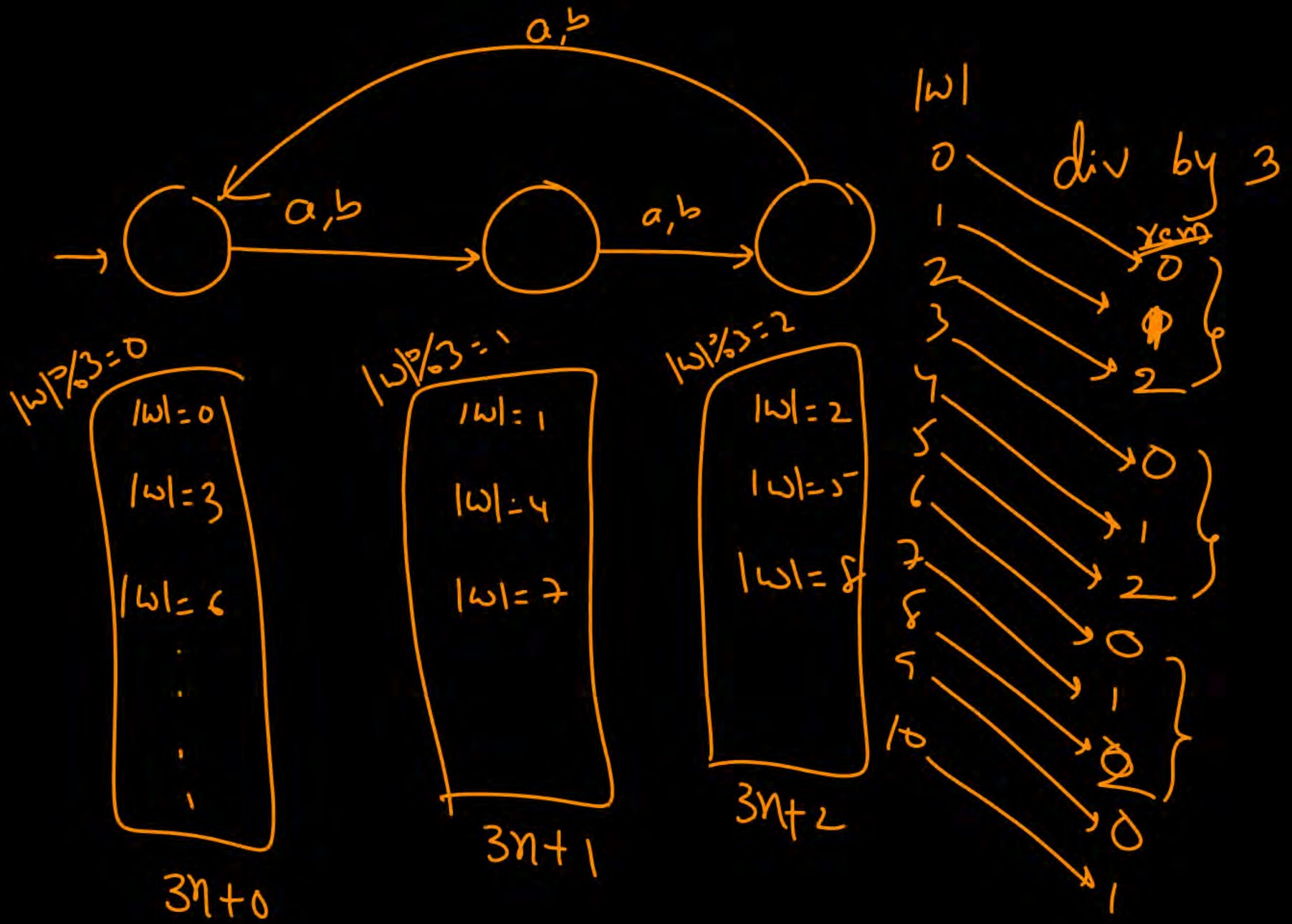
$|w|$ is divisible by n



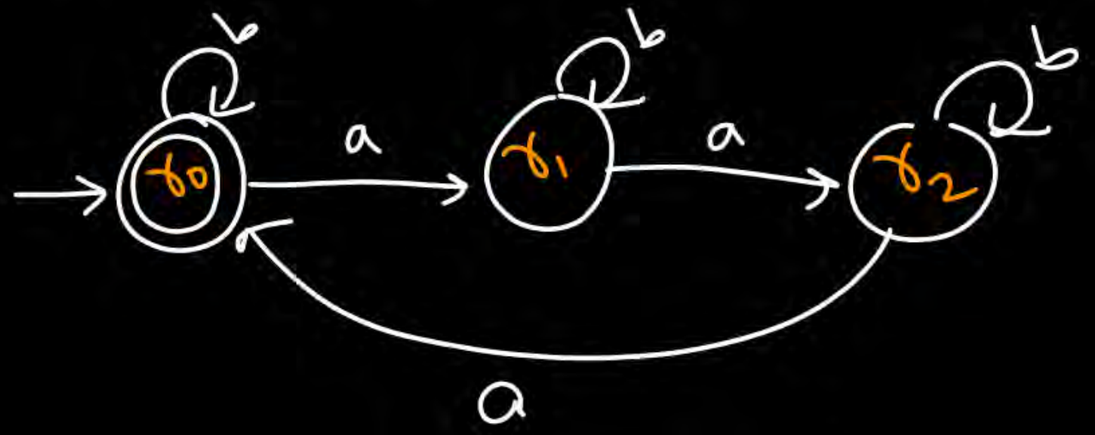
n states

(S4) $\{w \mid w \in \{a,b\}^*, |w| \text{ is not div by } 3\} = \overline{(S1)}$




a,b
a,b
a,b
|w|%3=0
|w|=0
|w|=3
|w|=6
3n+0
|w|%3=1
|w|=1
|w|=4
|w|=7
3n+1
|w|%3=2
|w|=2
|w|=5
|w|=8
3n+2
|w|
div by 3
0
1
2
3
4
5
6
7
8
9
10
0
1
2
0
1
2
0
1
0
1

(55) $\{w \mid w \in \{a,b\}^*, n_a(w) \text{ is divisible by } 3\}$



q_1 is final

(56) $\{w \mid w \in \{a,b\}^*, n_a(w)\%3 = 1\}$

q_2 is final

(57) $\{w \mid \quad , n_a(w)\%3 = 2\}$

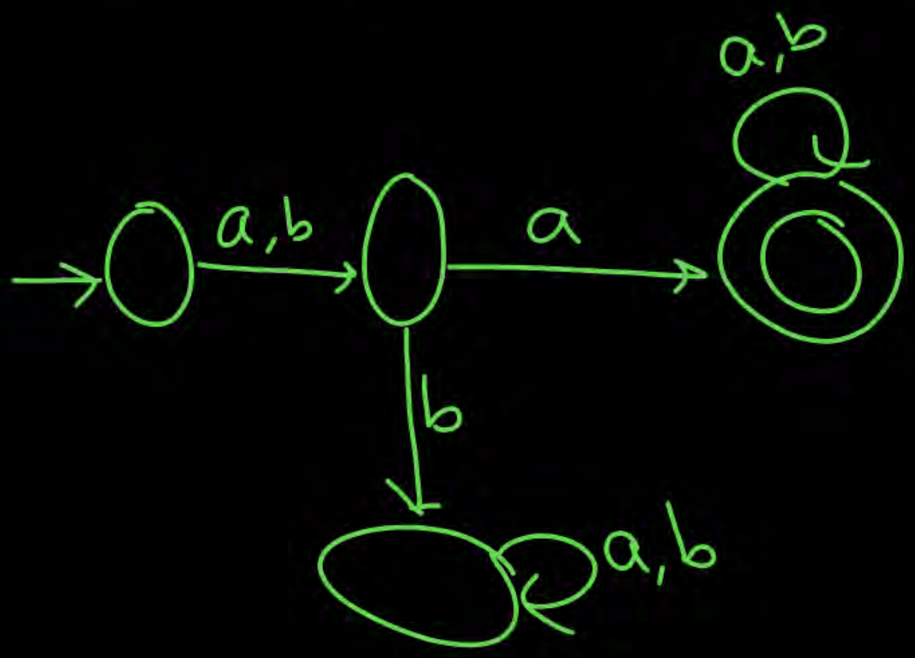
(58) $\{w \mid \quad , n_a(w)\%3 \neq 0\}$

q_1 and q_2 are final

Modul- VIII [Position Based]

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

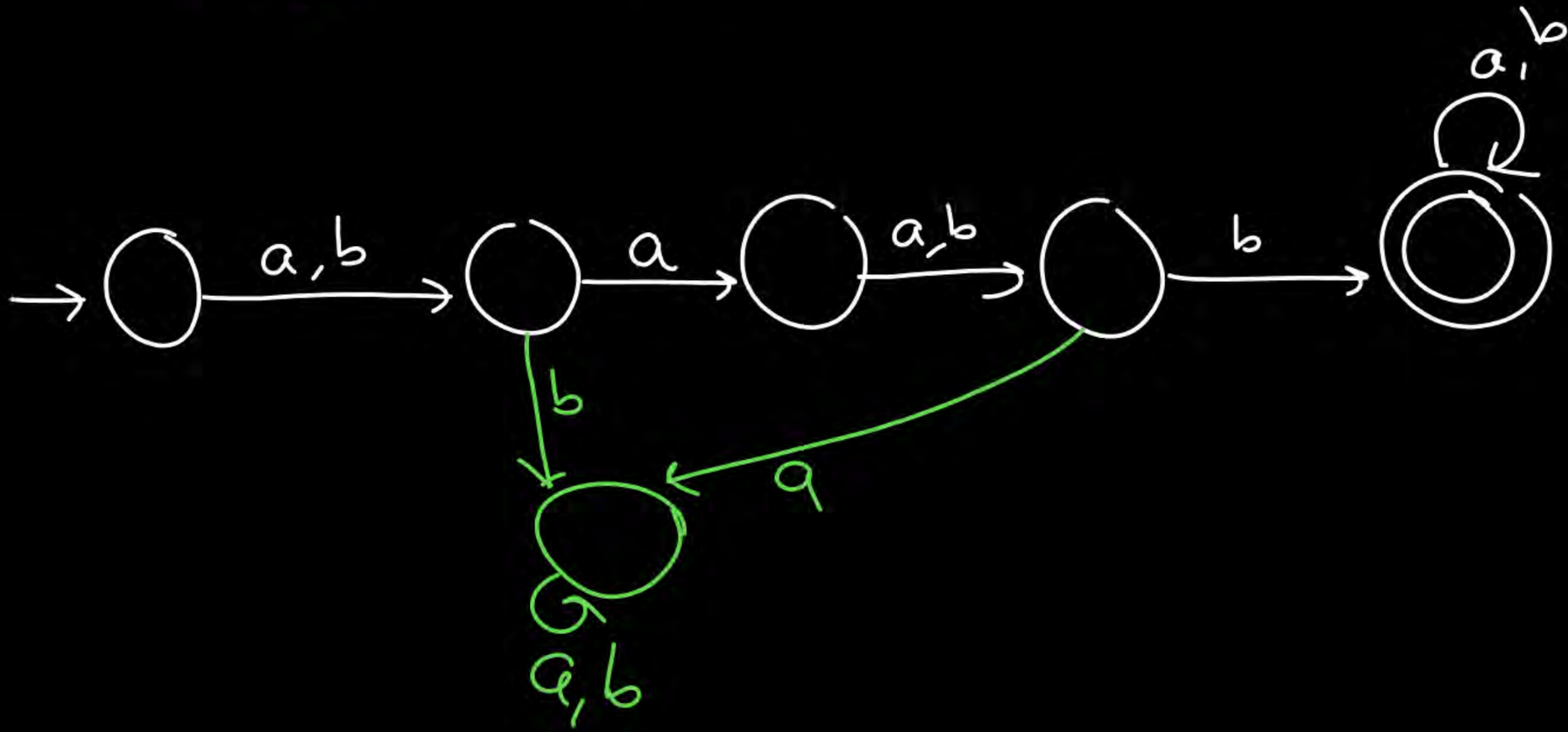
2nd symbol from LHS is 'a'
begin



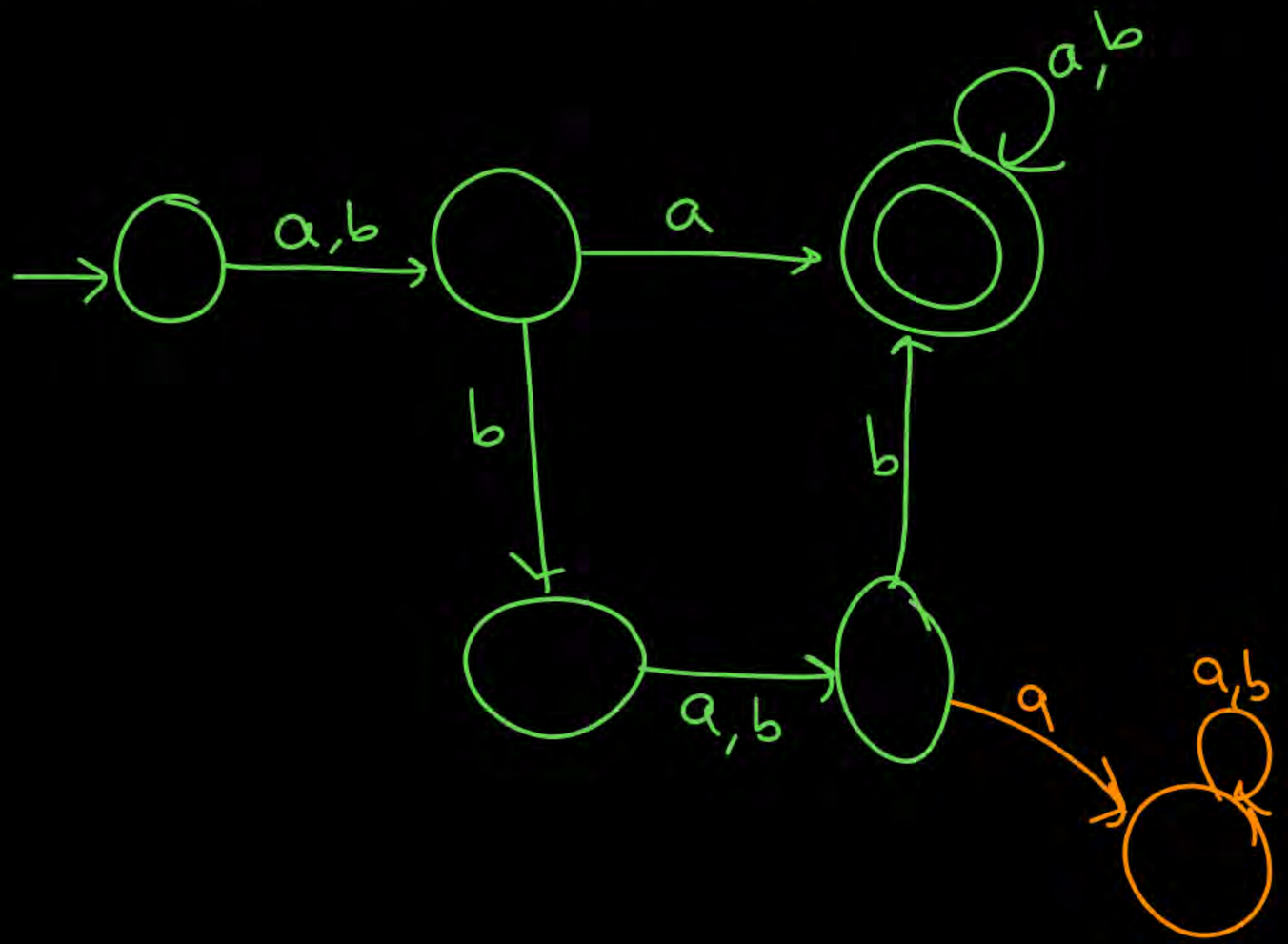
$$\underset{1st}{(a+b)}\ \underset{2nd}{a}\ (a+b)^*$$

$$(aa+ba)\,(a+b)^*$$

(60) $\{w \mid w \in \{a,b\}^*$, 2nd symbol is 'a' and 4th symbol is 'b' $\}$



(61) $\{w \mid w \in \{a,b\}^*,$ 2nd symbol is 'a' OR 4th symbol is 'b'$\}$



If 2nd symbol is 'a'
⇓
Don't look for 4th

If 2nd symbol is not 'a'
⇓
look for 4th symbol

Note : I) If n^{th} symbol from begin is 'a' then

$\Sigma = \{a, b\}$

$\Rightarrow$ (n+2) states in min DFA

*** II) If n^{th} symbol from end is 'a' then

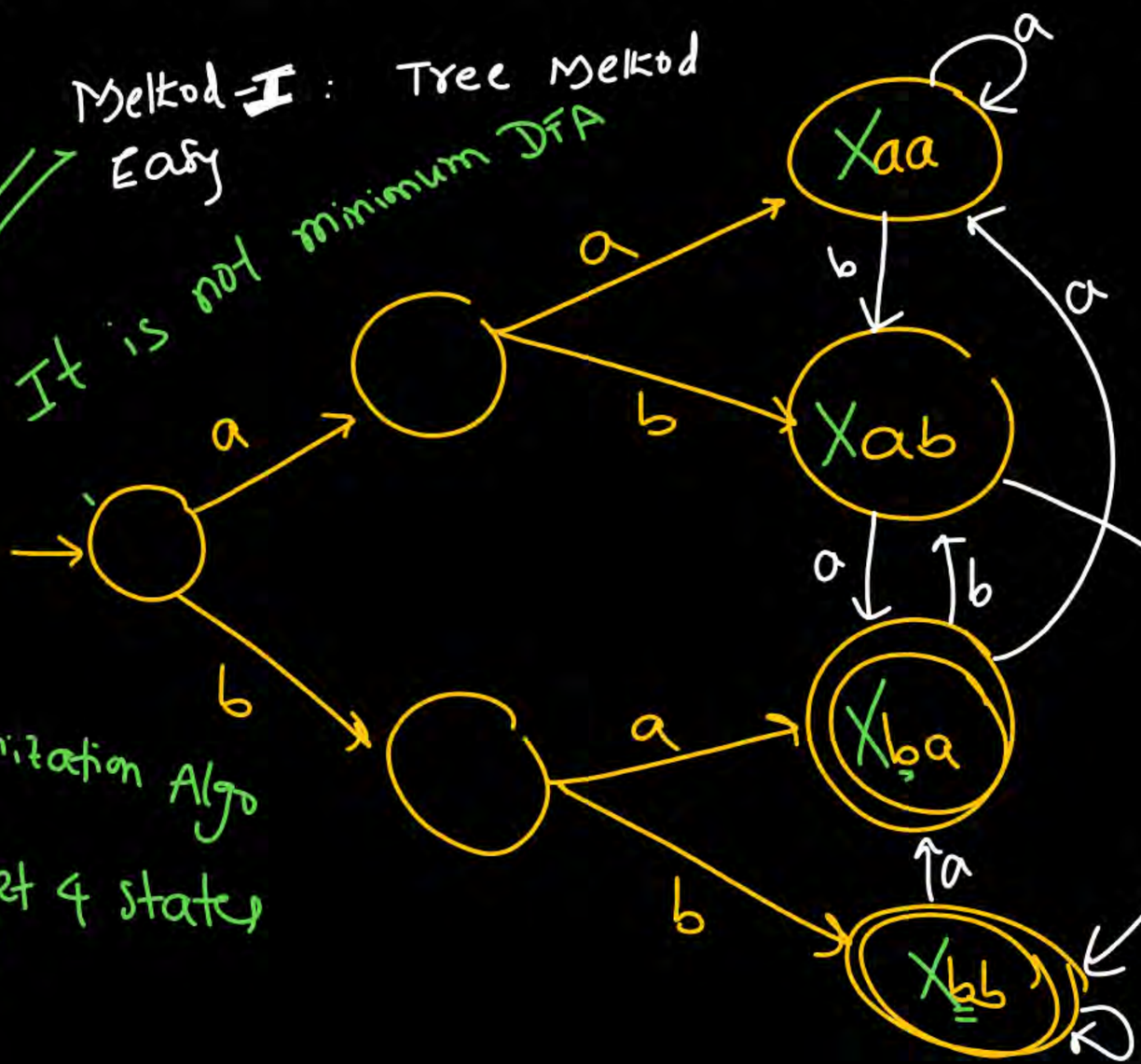
$\Rightarrow$ 2^n states in min DFA

(62) $\{w \mid w \in \{a,b\}^*,$ 2nd symbol of w from end is 'b'$\}$

$2^2 = 4$ states

Method-I : Tree Method
Easy

It is not minimum DFA



Apply minimization Algo
⇓
We will get 4 states

aa|a aa|b

(a+b)* b (a+b)

ab|a ab|b

2nd last last

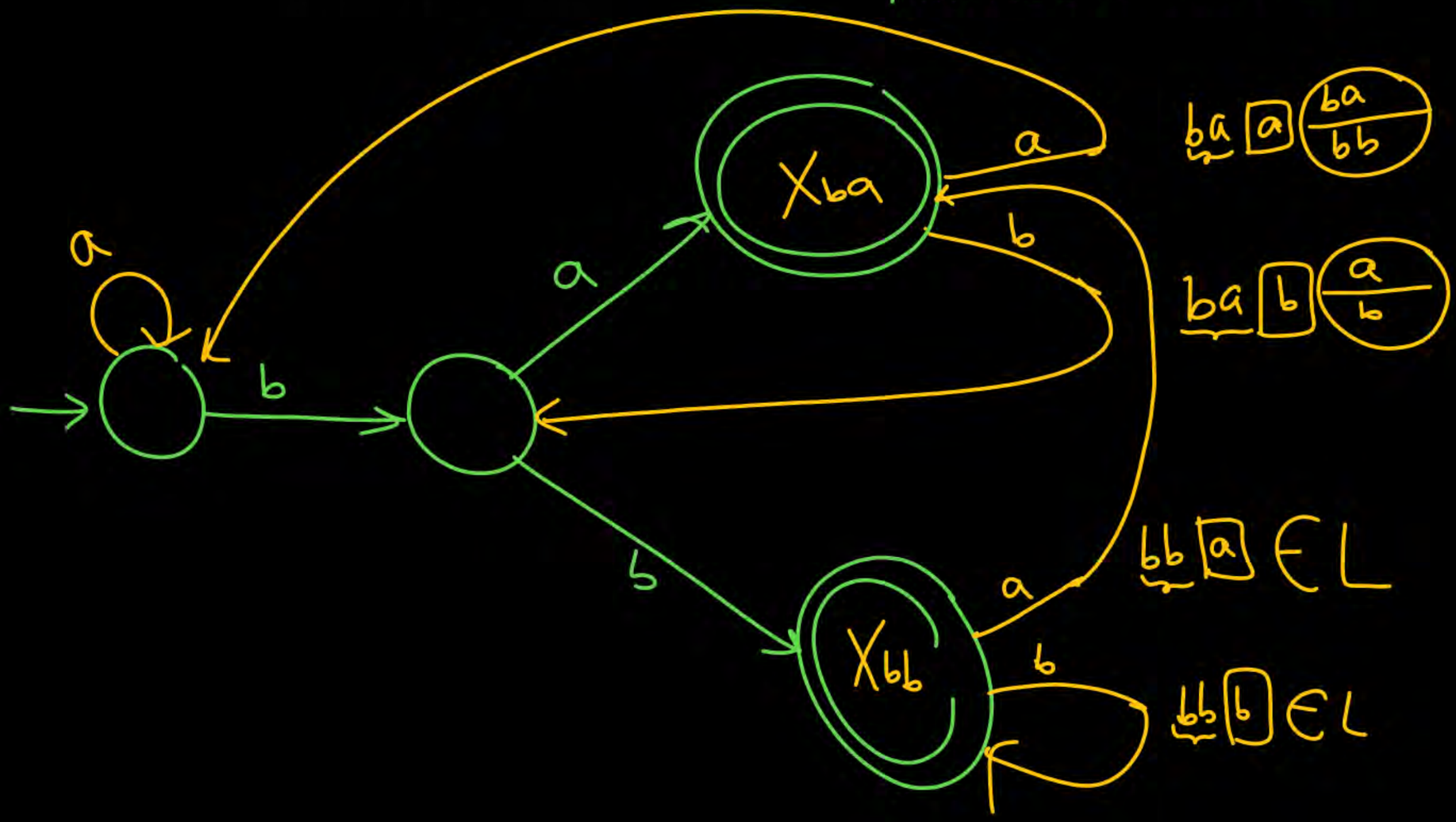
ba|a ba|b

last 2 symbols

bb|a bb|b

Method 2: $(a+b)^* b (a+b)$

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



(63) $\{w \mid w \in \{a,b\}^*,$ 3rd symbol from end is 'a'$\}$

↳ $2^3 = 8$ states in DFA

(64) 10^{th} symbol from end is 'a' over $\Sigma = \{a,b\}$

↳ $2^{10} = 1024$ states in DFA

Model-IX [compound / composition based]

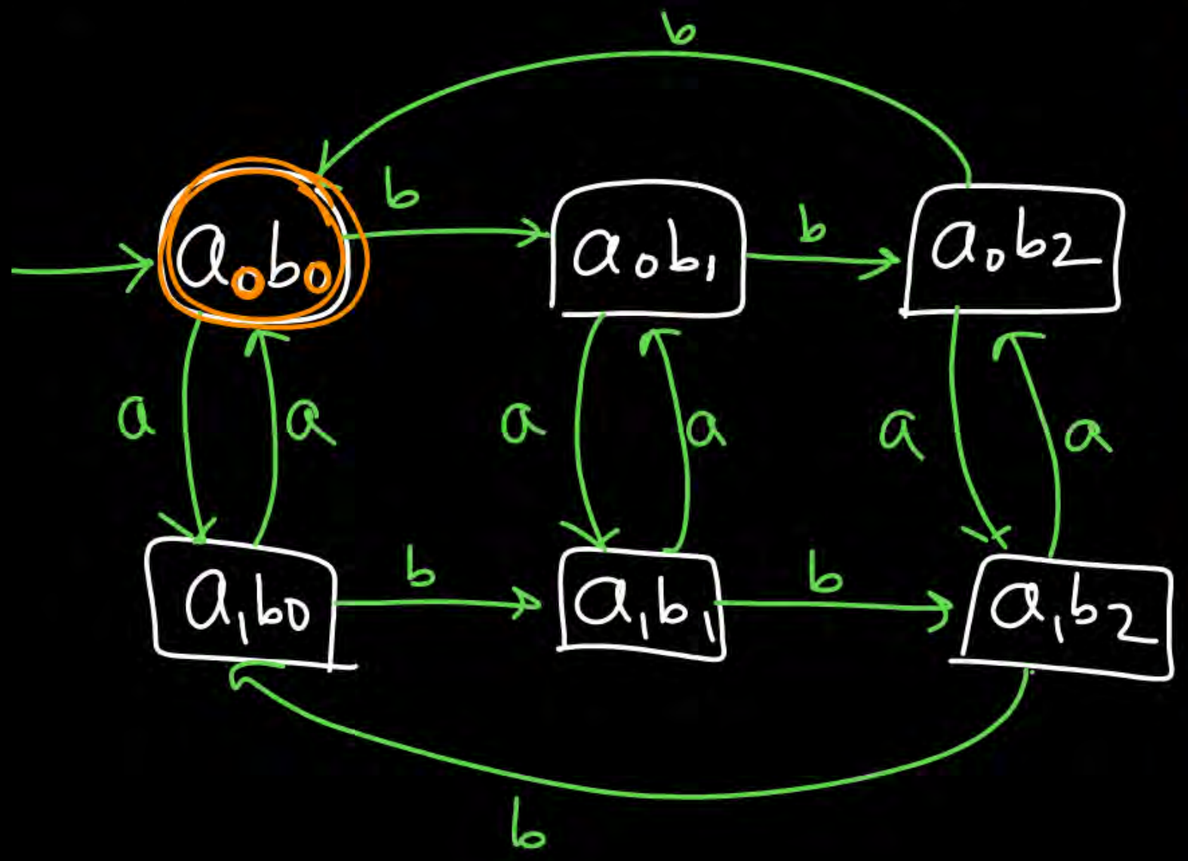
$\{w \mid w \in \{a,b\}^*$, $n_a(w)$ is divisible by 2, $n_b(w)$ is divible by 3$\}$

2 X 3 ⇨ 6 states

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

2 X 2 ⇨ 4 states

(65) #a's/2 and #b's/3



(67) #a's/2 but not #b's/3

↳ a_0b_1, a_0b_2 } finals

(68) #b's/3 but not #a's/2

↳ a_1b_0 is final

(69) #a's % 2 = 1
#b's % 3 = 2
} a_1b_2 final

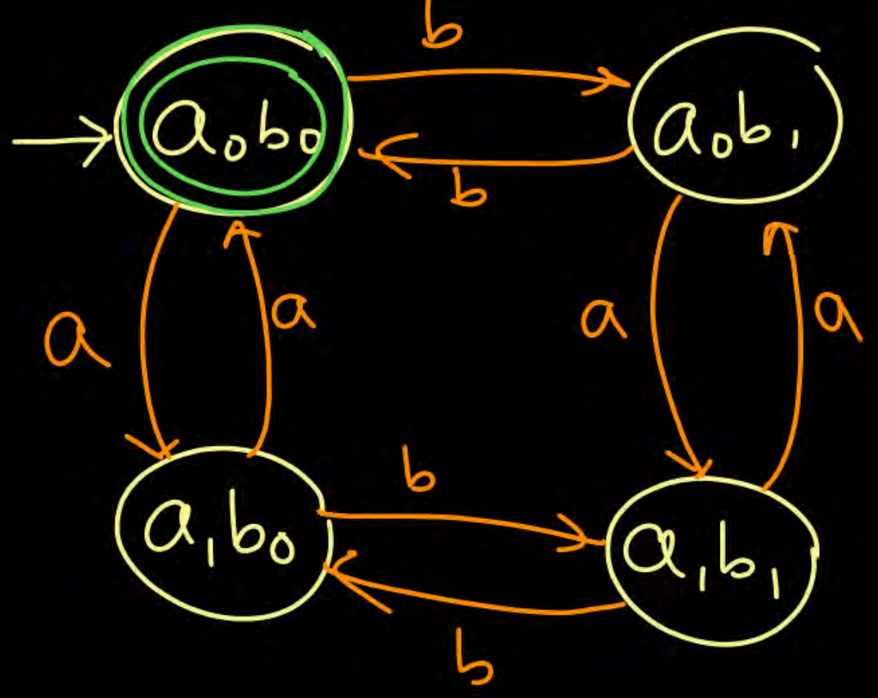
(66) #a's/2 and #b's/2

#a's = even

#b's = even

a_0
a_1

b_0
b_1



$a_0 = a_2 = a_4$

$a_1 = a_3 = a_5$

(70) #a's = odd, #b's = odd
↳ a_1b_1 is final

(71) #a's = even, #b's = odd
↳ a_0b_1 is final

(72) #a's = odd, #b's = even
↳ a_1b_0 is final

Model - X [Many things but simple thing]

(73) $\{w \mid w \in \{a,b\}^*$, $|w|$ is div by 2 OR $|w|$ is div by 4 $\}$

(74) $\{w \mid$ "", $|w|$ is div by 2 AND $|w|$ is div by 4 $\}$

(75) $\{w \mid$ "", w starts with 'a' OR starts with 'b' $\}$

(76) $\{w \mid$ "", w ends with 'a' OR ends with 'b' $\}$

1 state $\Leftarrow L = \phi$

(77) $\{w \mid$ "", w starts with 'a' AND w starts with 'b' $\}$

(78) $\{w \mid$ "", w ends with 'a' AND w ends with 'b' $\}$

Model-XI [multiple conditions → sequence]

H.W:

(79) $\{w \mid w \in \{a,b\}^*$, w starts with 'a', w contains 'b'$\}$

(80) $\{w \mid$ " , w starts with 'a', w ends with 'b'$\}$

(81) $\{w \mid$ " , w ends with 'a', w contains 'b'$\}$

(82) $\{w \mid$ " , w starts and ends with different symbols$\}$

(83) $\{w \mid$ " , w starts and ends with same i/p symbol$\}$

---

(84) $(a+b)^*(aa+bb)$

(85) $(aa+bb)(a+b)^*$

(86) $(a+b)^*(aa+bb)(a+b)^*$

Summary

Sequence based

Position based

Compound based

Multiple conditions
- Simple
- Sequence

Thank you