CS & IT ENGINEERING

Theory of Computation

Regular Languages

Lecture No.- 19

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Recap of Previous Lecture

Topic Model-I (Easy: Phi, Sigma*, only epsilon, Sigma$^+$)

Topic Construction of DFA Model II (Length)

Topic Construction of DFA Model III (No. of symbols)

Topic Construction of DFA Model IV (Over 1 symbol)

Topic Construction of DFA Model V (Sequence based)

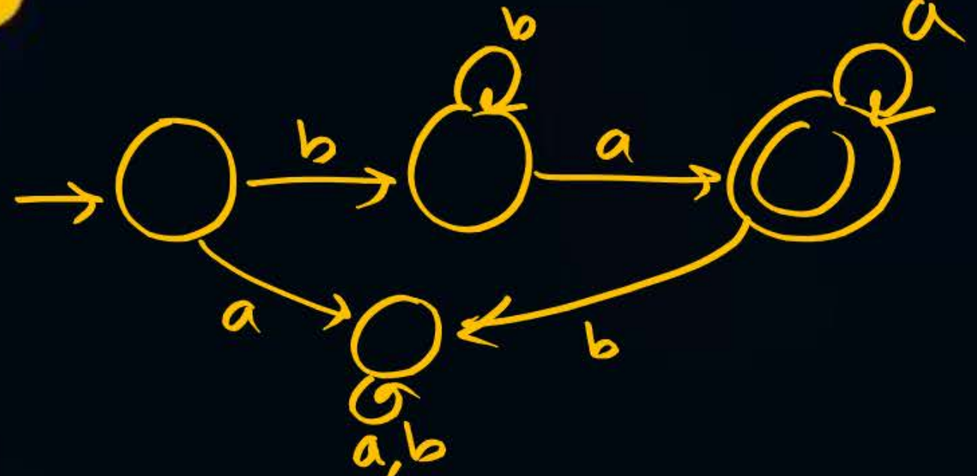
Topics to be Covered

Topic Construction of DFA Model VI (Length & Remainder)

Topic Construction of DFA Model VII (Symbols & Remainder)

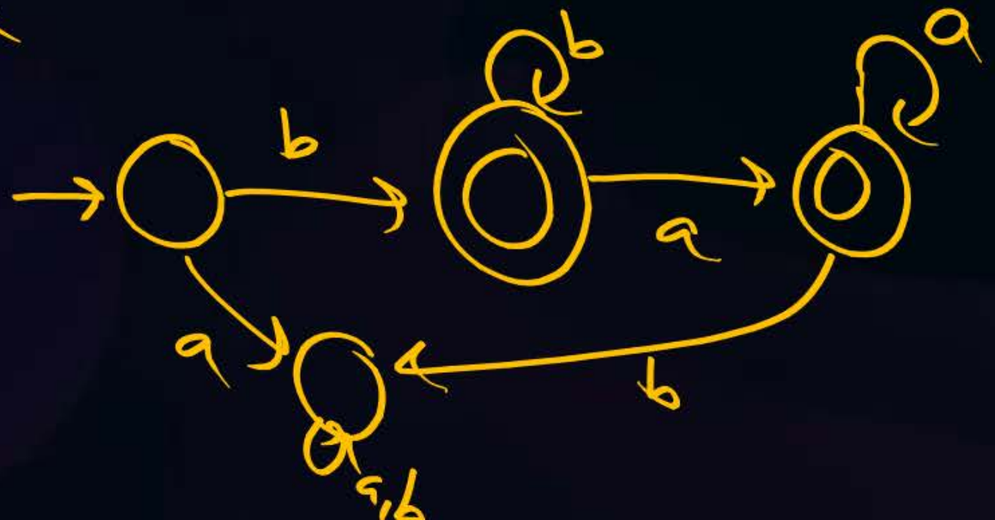
Construction of DFA

(38) b^+a^+



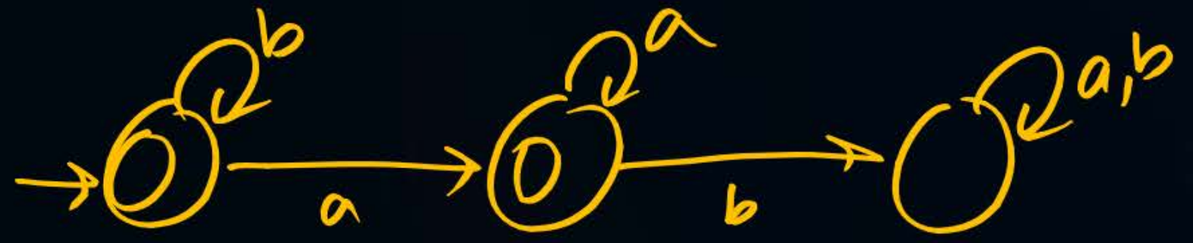
(39) b^*a^+

(40) b^+a^*

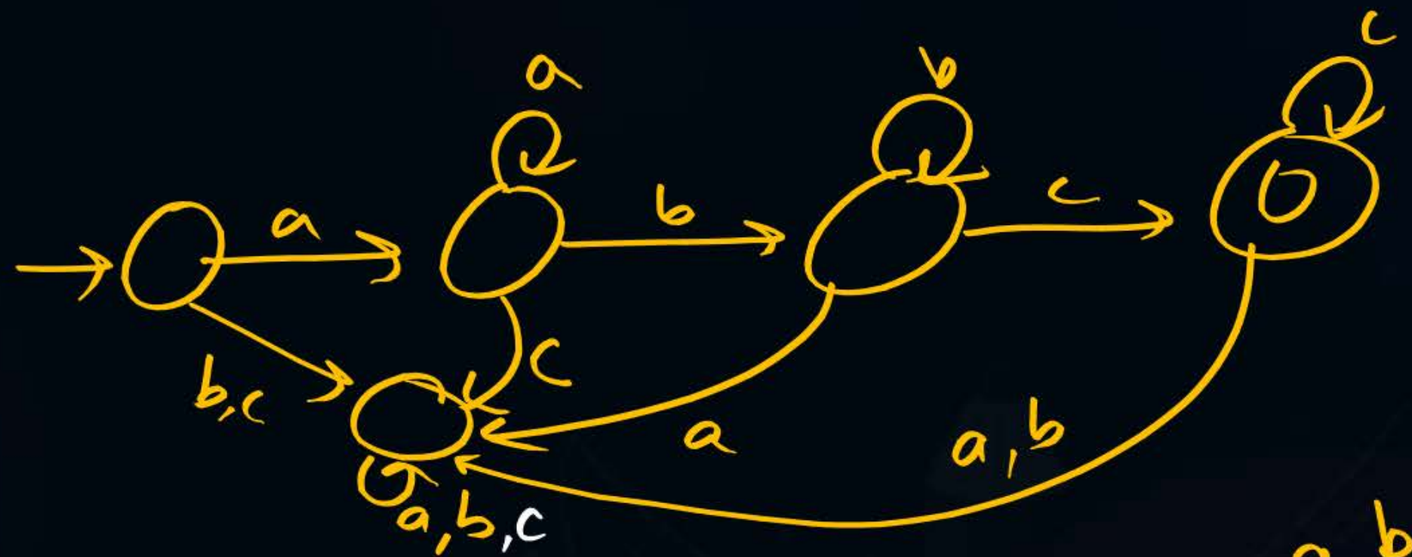


Construction of DFA

(41) $b^* a^*$



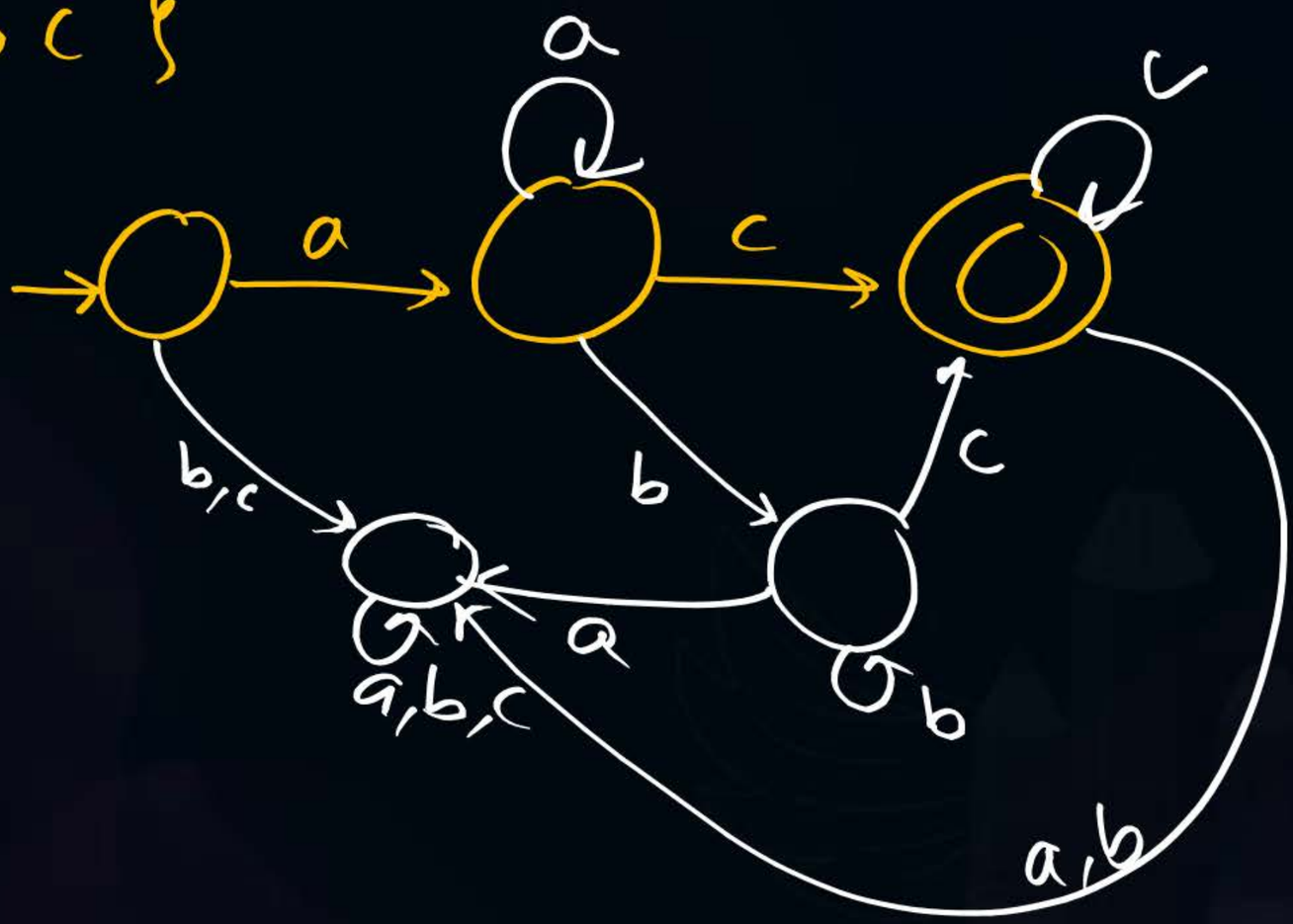
(42) $a^+ b^+ c^+$



(43) $a^* b^* c^*$

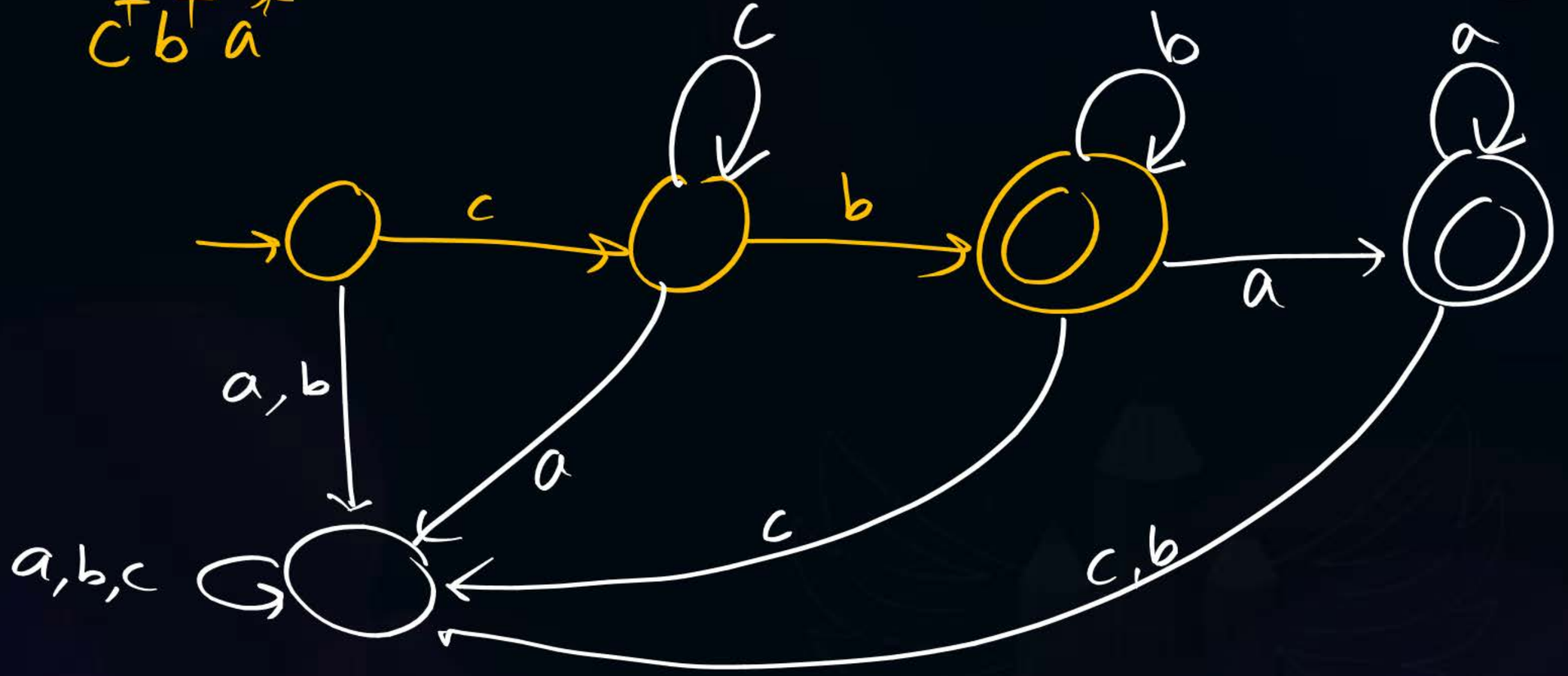
Construction of DFA

(44) $\{a^+ b^* c^+\}$



Construction of DFA

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



Construction of DFA

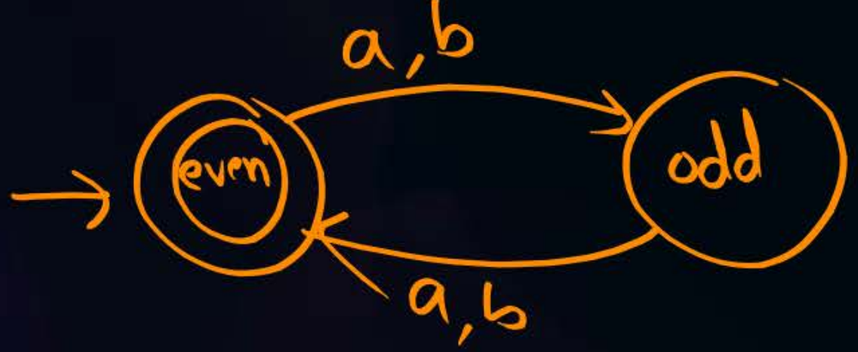
Model- VI [Length & remainder]:

(46) $\{w \mid w \in \{a,b\}^*, |w| \text{ is divisible by } 2\}$?

Remainder: 0, 1

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

$= \{\varepsilon, aa, ab, ba, bb, (a+b)^4, (a+b)^6, \ldots\}$



$|w| \% 2 = 0$

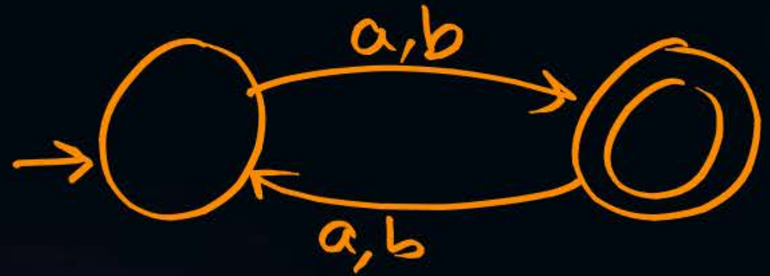
$|w|$ = even

$|w| = 2n$, $n \geq 0$

$|w| = 0 \bmod 2$

Construction of DFA

(47) $\{w \mid w \in \{a,b\}^*, |w| = \text{odd}\}$ $= \left((a+b)^2\right)^*(a+b)$



$$L = \{w \mid w \in \{a,b\}^*,\ |w| = \text{even}\}$$

even
0, 2, 4, 6, 8, . . .

$$\overline{L} = \{w \mid w \in \{a,b\}^*,\ |w| = \underbrace{\text{not even}}_{\text{odd}}\}$$

odd
1, 3, 5, 7, . . .

$$L \cup \bar{L} = \Sigma^*$$

$$L \cap \bar{L} = \phi$$

Note: I) If L is Regular language and min DFA has K states

then $\bar{L}$ is Regular language

$\bar{L}$ has K states in min DFA

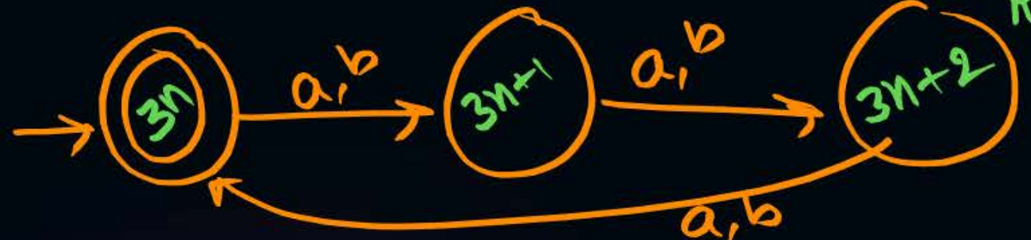
II) If L has min DFA with x finals and y nonfinals

then $\bar{L}$ has min DFA with y finals and x nonfinals

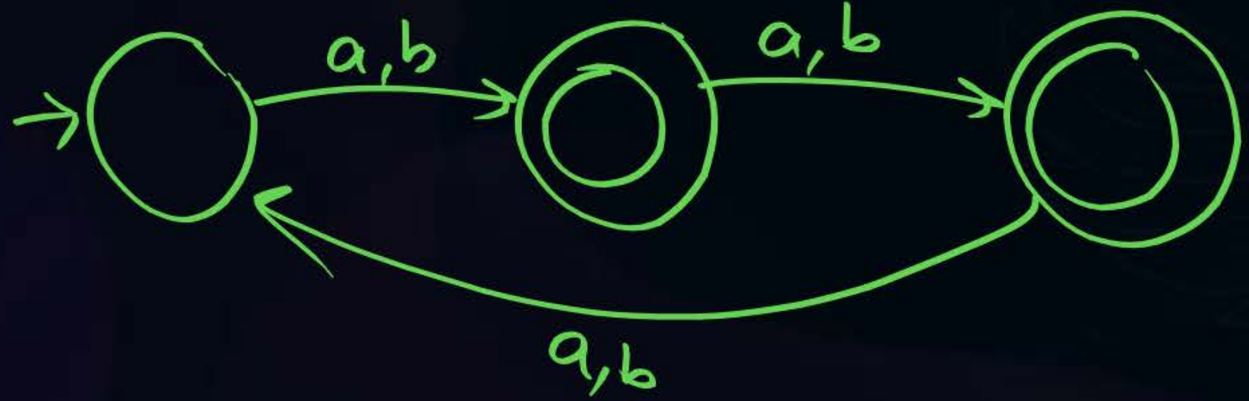
Construction of DFA

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

Remainders: 0 ✓, 1 ✗, 2 ✗

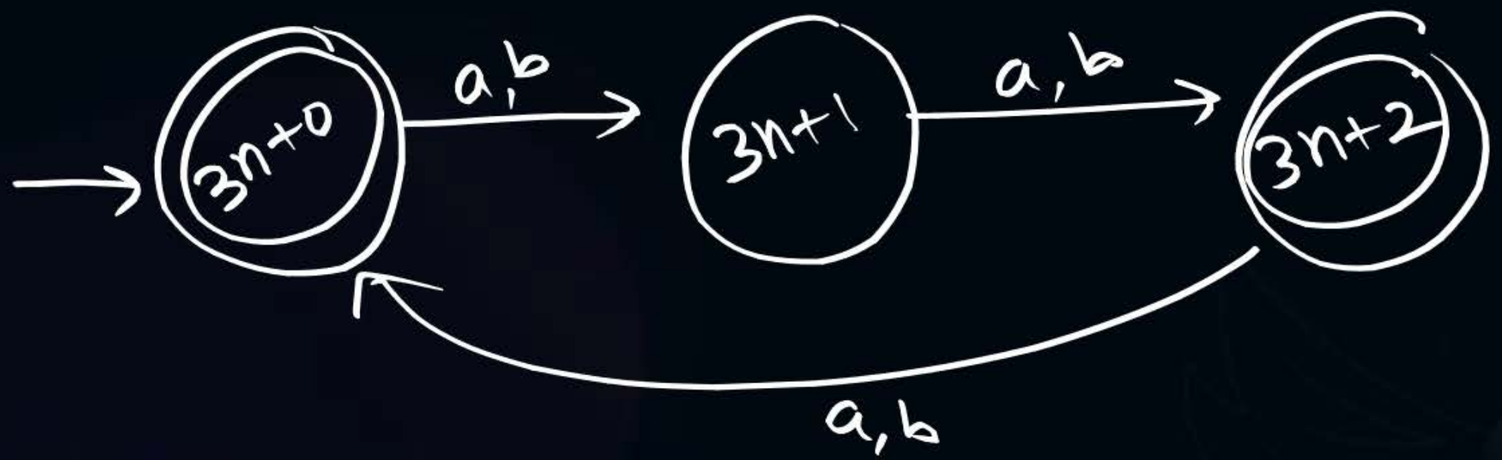


(49) $\{w \mid w \in \{a,b\}^*, |w| \text{ is not divisible by } 3\}$



Construction of DFA

(50) $\{w \mid w \in \{a,b\}^*, \ |w| \neq 1 \bmod 3\}$



$|w| \neq 1 \bmod 3$

$|w| \% 3 \neq 1$

$|w| \% 3 = 0$ or 2

Note: $\{w \mid w \in \{a,b\}^*, |w| \text{ is divisible by } n\}$

↳ n states in min DFA.

Construction of DFA

Model-VIII [Symbols & Remainder] :

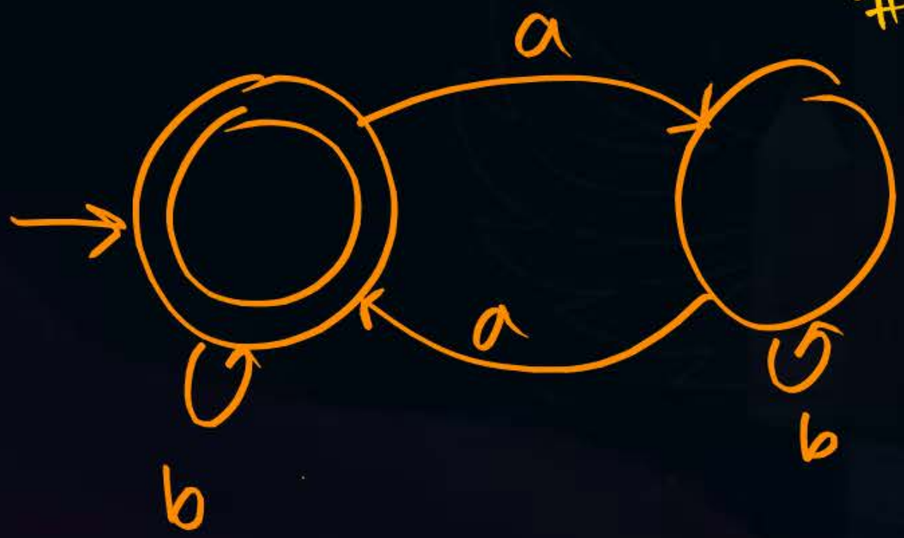
(S1) $\{w \mid w \in \{a,b\}^*, \#_a(w) \text{ is } \overbrace{\text{divisible by 2}}^{\text{even}}\}$

$= \{\underbrace{\varepsilon, b, bb, \ldots}_{\text{zero a's}}, \underbrace{aa, aba, baa, aab, \ldots}_{\text{2 a's}}, \ldots\}$

$\#a's = 0, 2, 4, 6, 8, \ldots$

$\#b's = \text{any}$

$$b^*(b^*ab^*ab^*)^*b^*$$

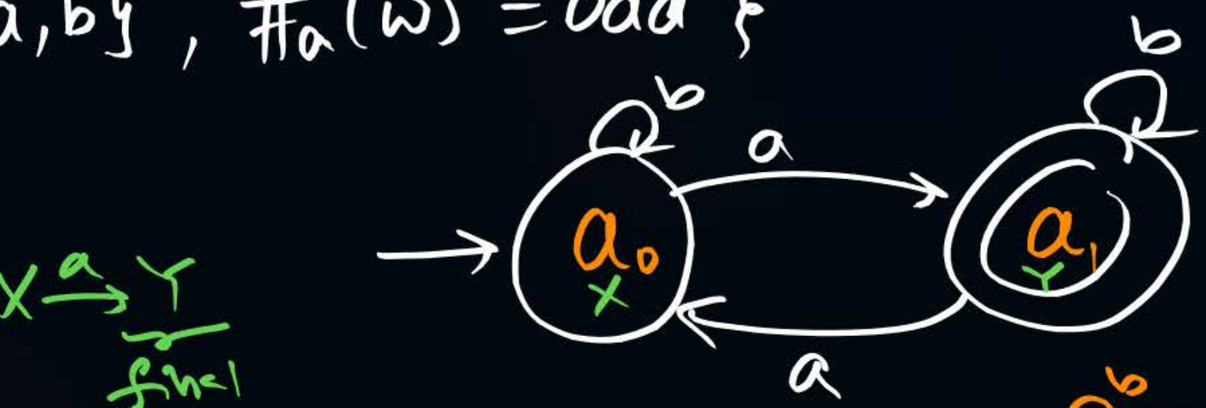


Construction of DFA

(S2) $\{w \mid w \in \{a,b\}^*, \#_a(w) = \text{odd}\}$

baaa ✓

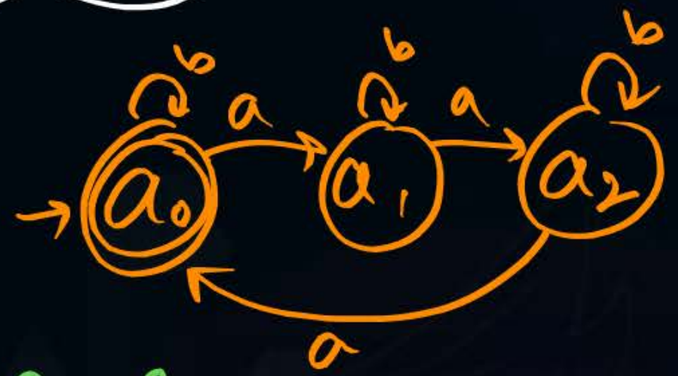
X —b→ X —a→ Y —a→ X —a→ Y (final)



H.W.:

3 states

(S3) $\{w \mid w \in \{a,b\}^*, \#_a(w) \text{ is divisible by } 3\}$



(S4) $\{w \mid$ " , $\#_a(w) = 3n+2, n \geq 0\}$ ⇒ a_2 final

(S5) $\{w \mid$ " , $\#_a(w) \neq 3n+1, n \geq 0\}$ a_0 and a_2 final

Construction of DFA

Model-VIII [Multiple conditions on symbols]

(56) $\{w \mid w \in \{a,b\}^*,\ n_a(w)=1,\ n_b(w)=2\}$

(57) $\{w \mid$ " $,\ n_a(w) \geq 1,\ n_b(w) \geq 2\}$

(58) $\{w \mid$ " $,\ n_a(w) \leq 1,\ n_b(w) \leq 2\}$

(59) $\{w \mid$ " $,\ n_a(w)=1,\ n_b(w) \leq 2\}$

(60) $\{w \mid$ " $,\ n_a(w) \leq 1,\ n_b(w)=2\}$

(61) $\{w \mid$ " $,\ n_a(w) \leq 1,\ n_b(w) \geq 2\}$

Construction of DFA

(56) $\{w \mid w \in \{a,b\}^*,\ n_a(w) = 1,\ n_b(w) = 2\}$

$= \{\underbrace{abb}_{\substack{1a \\ 2bs}}, \underbrace{bab}_{\substack{1a \\ 2bs}}, \underbrace{bba}_{\substack{1a \\ 2bs}}\}$

2 mins Summary

Topic Construction of DFA Model VI (Length & Remainder) ✓

Topic Construction of DFA Model VII (Symbols & Remainder) ✓

THANK - YOU