CFG and PDA - V

Complete Course on Theory of Computation

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Concatenation

$\phi \cdot a = \phi$

① $a^* \cdot b^* \neq b^* \cdot a^*$

② $\phi \cdot L_1 = \phi$

$L_1 \cdot \phi = \phi$

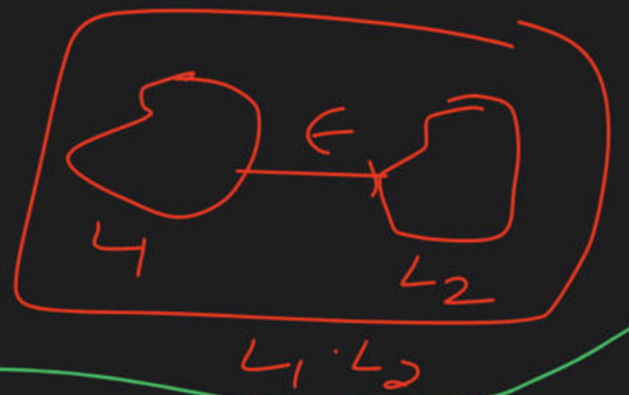
③ $\in \cdot L_1 = L_1$

$L_1 \cdot \in = L_1$

④ $\boxed{\underline{\Sigma^* \cdot a = (a+b)^* \cdot a} \neq (a+b)^*}$

$a \cdot \Sigma^* = a(a+b)^*$

⑤ $\boxed{(a+b)^* \cdot a^* = (a+b)^* = a^*(a+b)^*}$



⑥ $(a+b)^* \cdot a^+ = (a+b)^* \cdot a$

⑦ If L_1 is reg & L_2 also regular then $L_1 \cdot L_2$ is always regular

(8) $L_1 = \text{regular} = \underline{a^n} \mid n \geq 1 = a^+$

$L_2 = \text{regular} = \underline{b^n} \mid n \geq 1 = b^+$

$L_1 \cdot L_2 = \cancel{a^n \cdot b^n}$

$a^m \cdot b^n \mid m, n \geq 1 \Longrightarrow a^+ b^+ \Longrightarrow$ regular

(9.1) $\underbrace{a^n b^n \mid n \geq 1}_{L_1} \cdot \underbrace{\phi}_{L_2} = \phi$ Regular

(9.2) $\underbrace{a^n b^n}_{L_1} \cdot \underbrace{b}_{L_2} \Longrightarrow a^n b^{n+1}$

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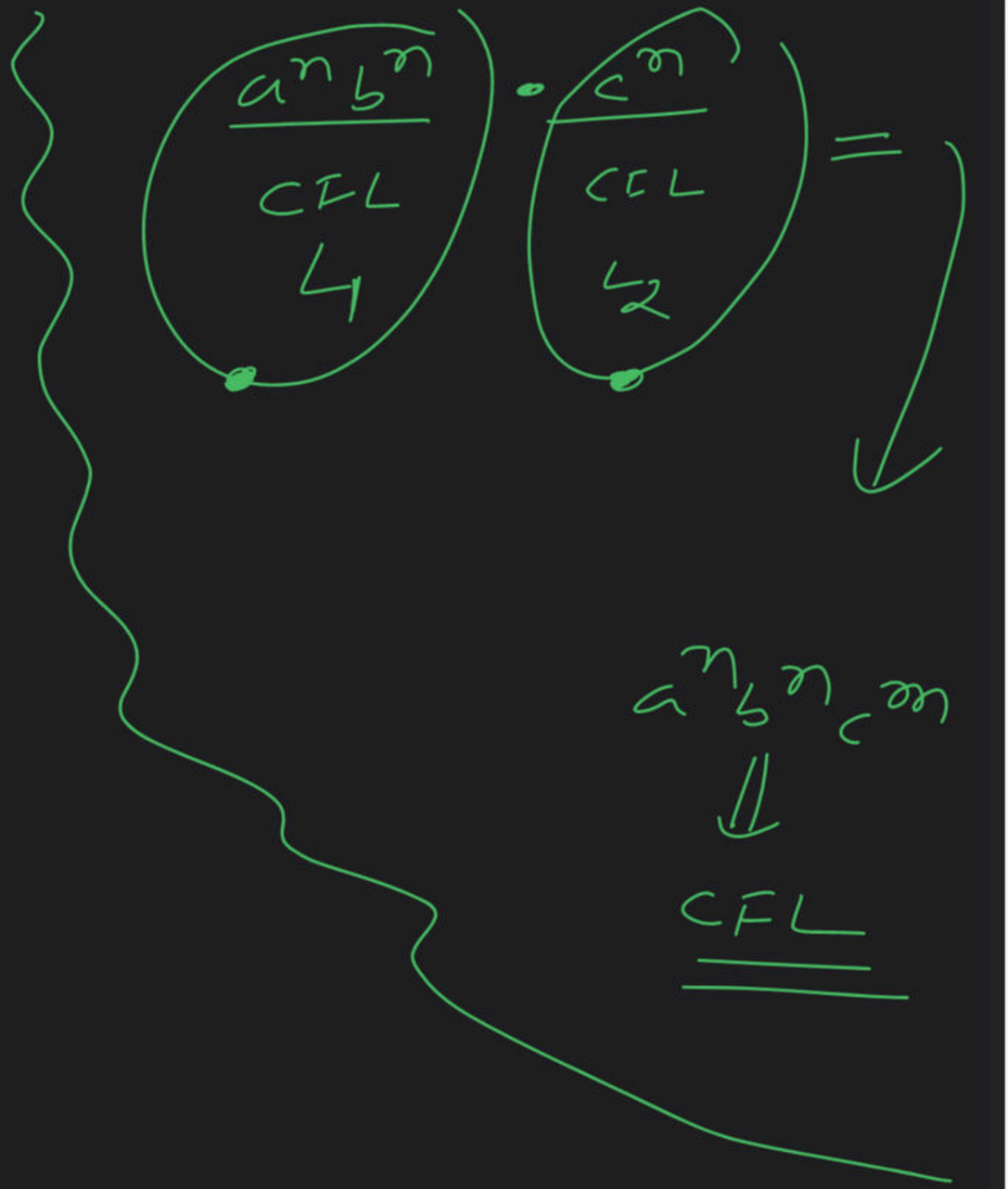
$a^n b^n \cdot b^n$

L_1 L_2

$n \geq 1$ b^+

$a^m b^n \mid m, n \geq 1$, $m \leq n$ { Non regular


$a^n b^n$
CFL
L_1
c^n
CFL
L_2
=
$a^n b^n c^m$
CFL

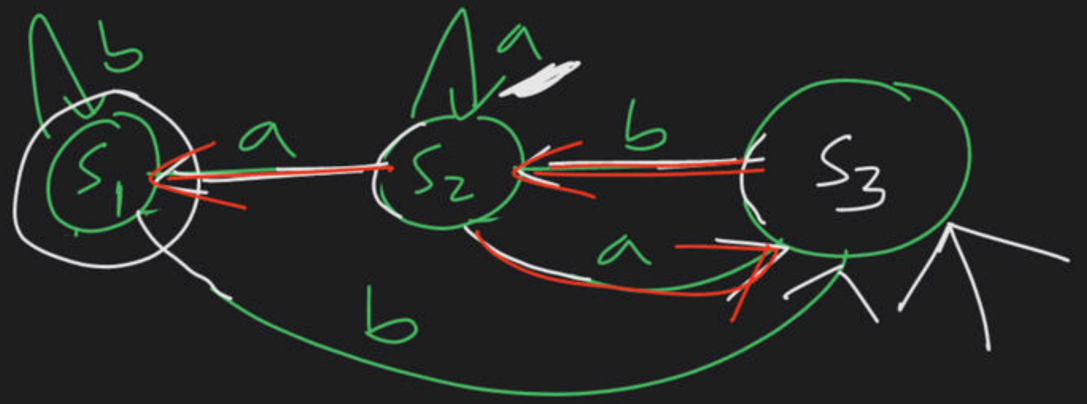
Reversal operator

$L = (a+b)^* ab$

$L^R = ba(a+b)^*$

baaaaaa

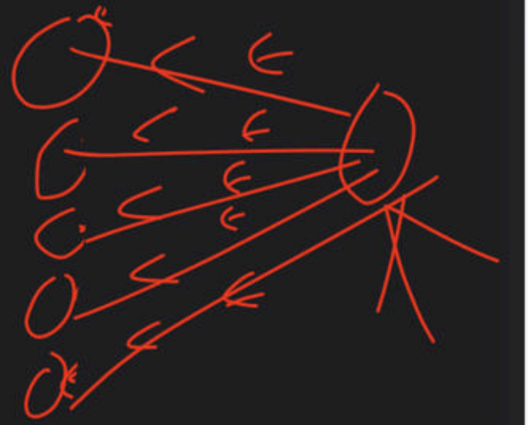
DFA



① reverse edge direction

② Interchange Initial & Final

③ DFA Reverse DFA | NFA | ∈-NFA



④ After reversal if more than 1 initial then make it as single initial with the help of ∈-transitions.

Note: If L is regular then L^R also regular

(2) $L = \Sigma^*$ then $L^R = \Sigma^*$

(3) $L = a^* \Rightarrow L^R = a^*$

(4) $L = \phi \Rightarrow L^R = \phi$

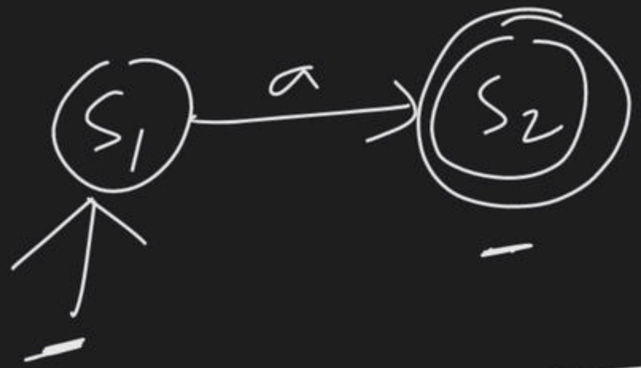
(5) $a(a+b)^* \xrightarrow{R} (a+b)^* a$

(6) $a^* b^* \xrightarrow{R} b^* a^*$

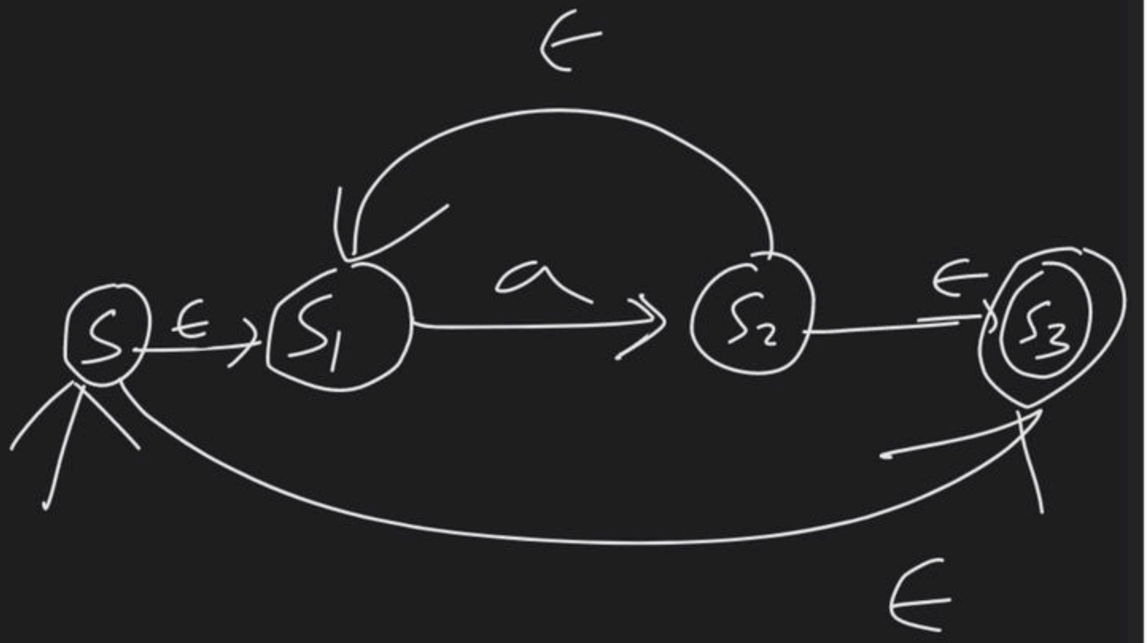
(7) $(a+b)^* ab(a+b)^* \xrightarrow{R} (a+b)^* ba(a+b)^*$

Kleen closure

1. $L = a$



L^*



Note: If L is regular then L^* also regular

② $L = \phi$ then $\underline{L^* = \epsilon}$

③ $L = a^* b^*$ then L^*

$\Rightarrow (a^* b^*)^* = (a+b)^*$

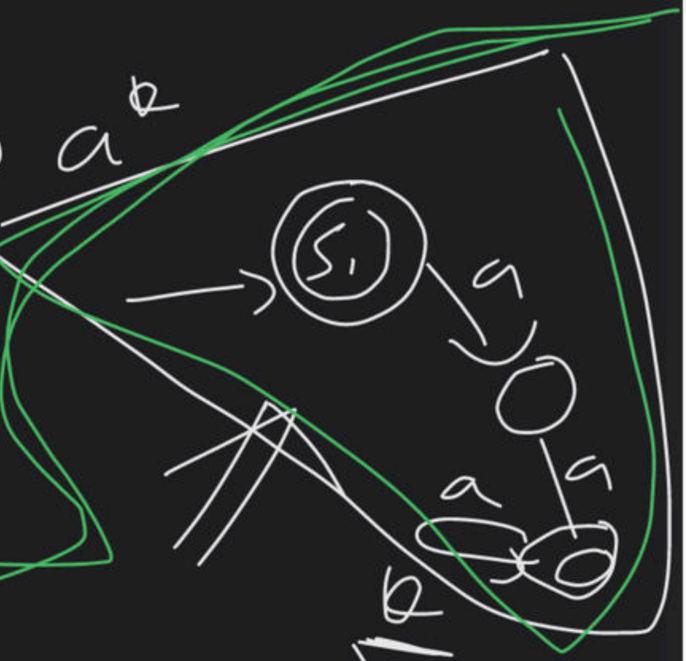
L

$\Downarrow$

④ $\epsilon + a^+ \Rightarrow a^*$ $\Longrightarrow$ $L^* = (a^*)^* \Rightarrow a^*$

⑤ $(L^*)^* = L^*$

⑥ $\epsilon^* = \epsilon$



$L = \{a^p \mid p \text{ is prime}\}$

Reg ✗ CFL ✗

CSL ✓

$L^* = (a^p \mid p \text{ is prime})^*$

$= \epsilon, a^2, a^4, \underline{a^6}, a^8, a^{10}$

$a^3, a^9, \ldots \Rightarrow$ Regular

(6) If L is non regular then L^* may be reg
(or)
may not be reg

Thank you

Dedicate Hat