

# Theory of Computation

Grammar

Lecture 18

Gaurav Raj

## Grammar

1) Unrestricted grammar  $\rightarrow (VUT)^+ \rightarrow (VUT)^*$  } TM

2) CSG  $\left[ \begin{matrix} + \\ X \rightarrow Y \end{matrix} \right]$ , where  $|X| \leq |Y|$  } LBA

3) CFG  $\left[ \begin{matrix} + \\ X \rightarrow Y, \quad X \in V \end{matrix} \right]$  PDA

4) Regular Grammar  $\left[ \begin{matrix} + \\ \cdot \\ \cup \\ LLG \\ RLG \end{matrix} \right]$

Diagram: A state labeled  $V$  has a transition to a state labeled  $VT^*$ . From  $VT^*$ , there is a transition to a state labeled  $\overline{OR}T^*$ , which then has a transition to a state labeled  $T^*V$ . There is also a transition from  $VT^*$  directly to  $T^*$ .

} FA

$$1) S \rightarrow \epsilon \quad L = \{\epsilon\}$$

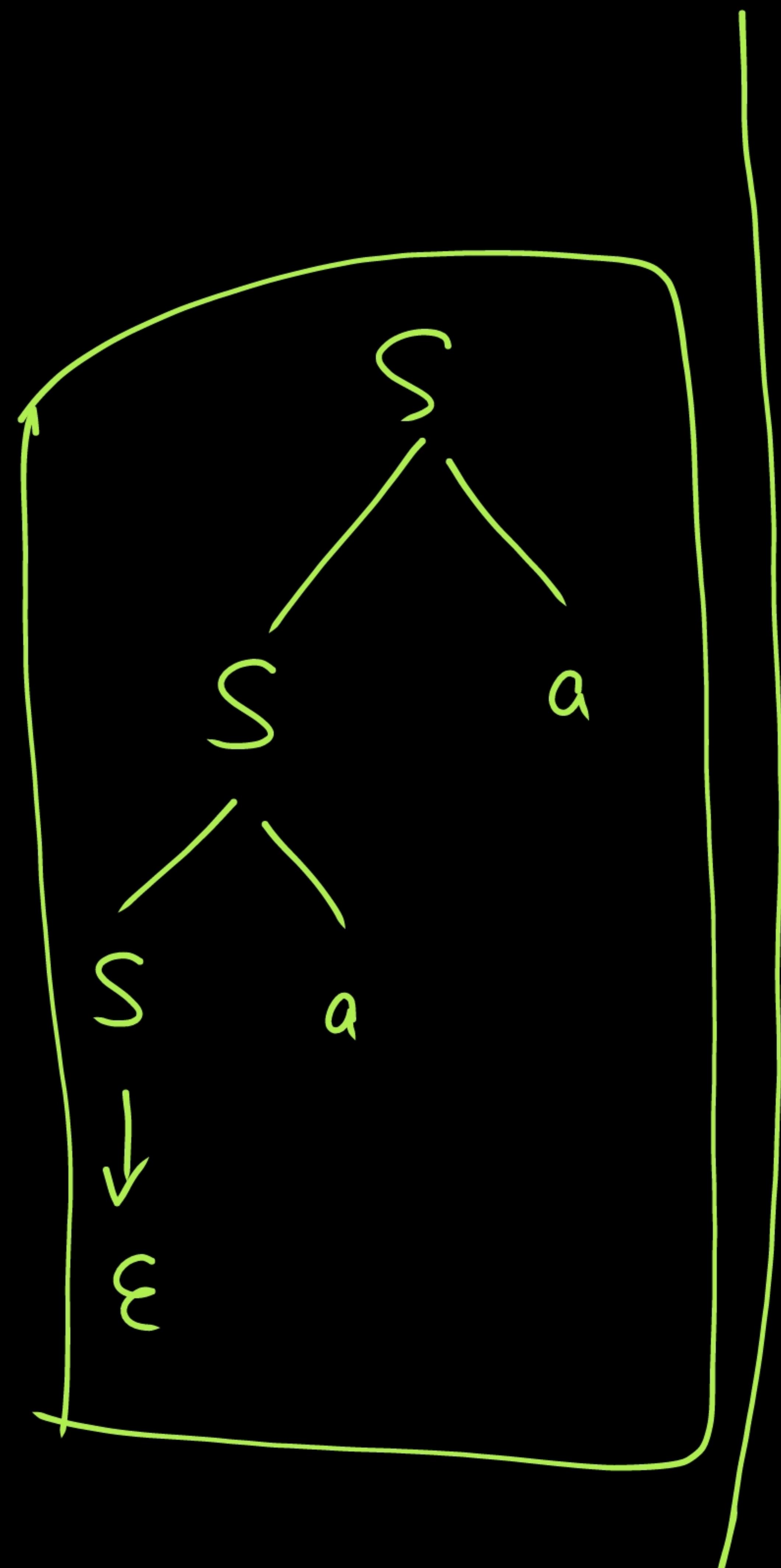
$$2) S \rightarrow a \quad L = \{a\}$$

$$3) S \rightarrow ab \quad L = \{ab\}$$

$$4) S \rightarrow a \mid ab \mid \epsilon \quad L = \{\epsilon, a, ab\}$$

$$5) S \rightarrow Sa \mid \epsilon \quad L = a^*$$

$\subseteq a^*$



$V \rightarrow$  Set of variables

$S \rightarrow$  Starting Variable

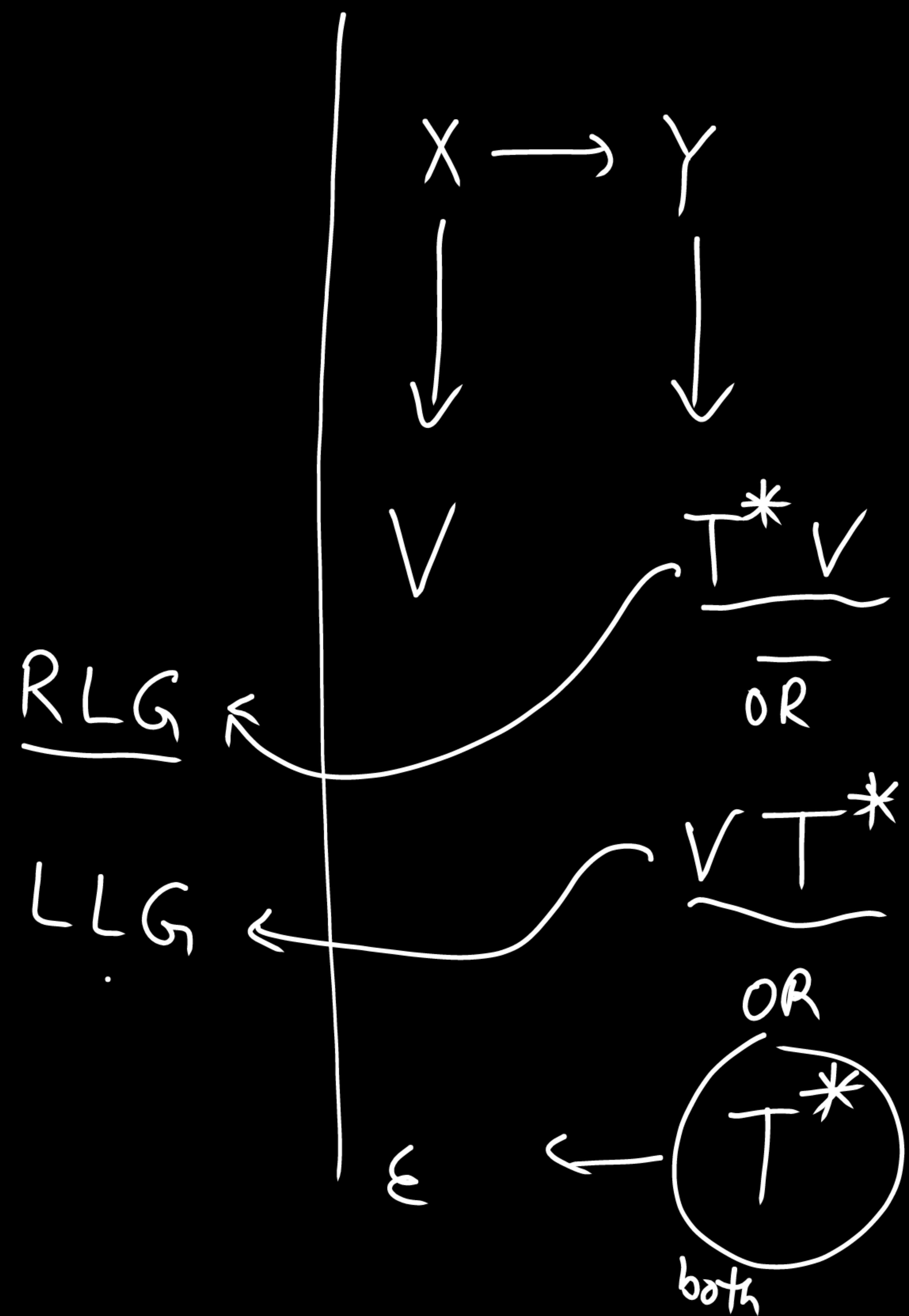
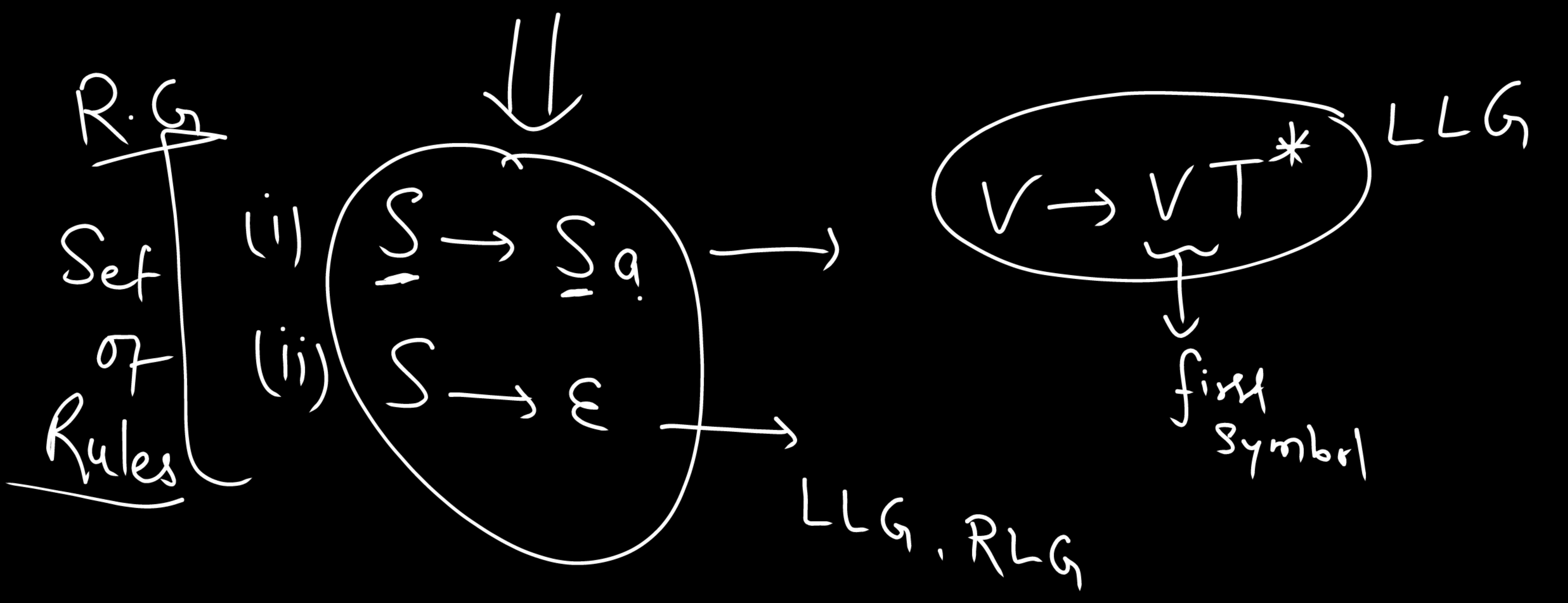
$T \rightarrow$  Set of terminals

$V \rightarrow \{S\}$

$T \rightarrow \{a\}$

R.G  
1.)  $S \rightarrow \epsilon$

2.)  $S \rightarrow S_a | \epsilon$



$R^G$  4)  $S \rightarrow aS | bS | c$

~~$S \rightarrow aS$~~   
 ~~$S \rightarrow bS$~~   
 ~~$S \rightarrow c$~~

~~5.)~~  $S \rightarrow aS | cS | S_d | \epsilon$

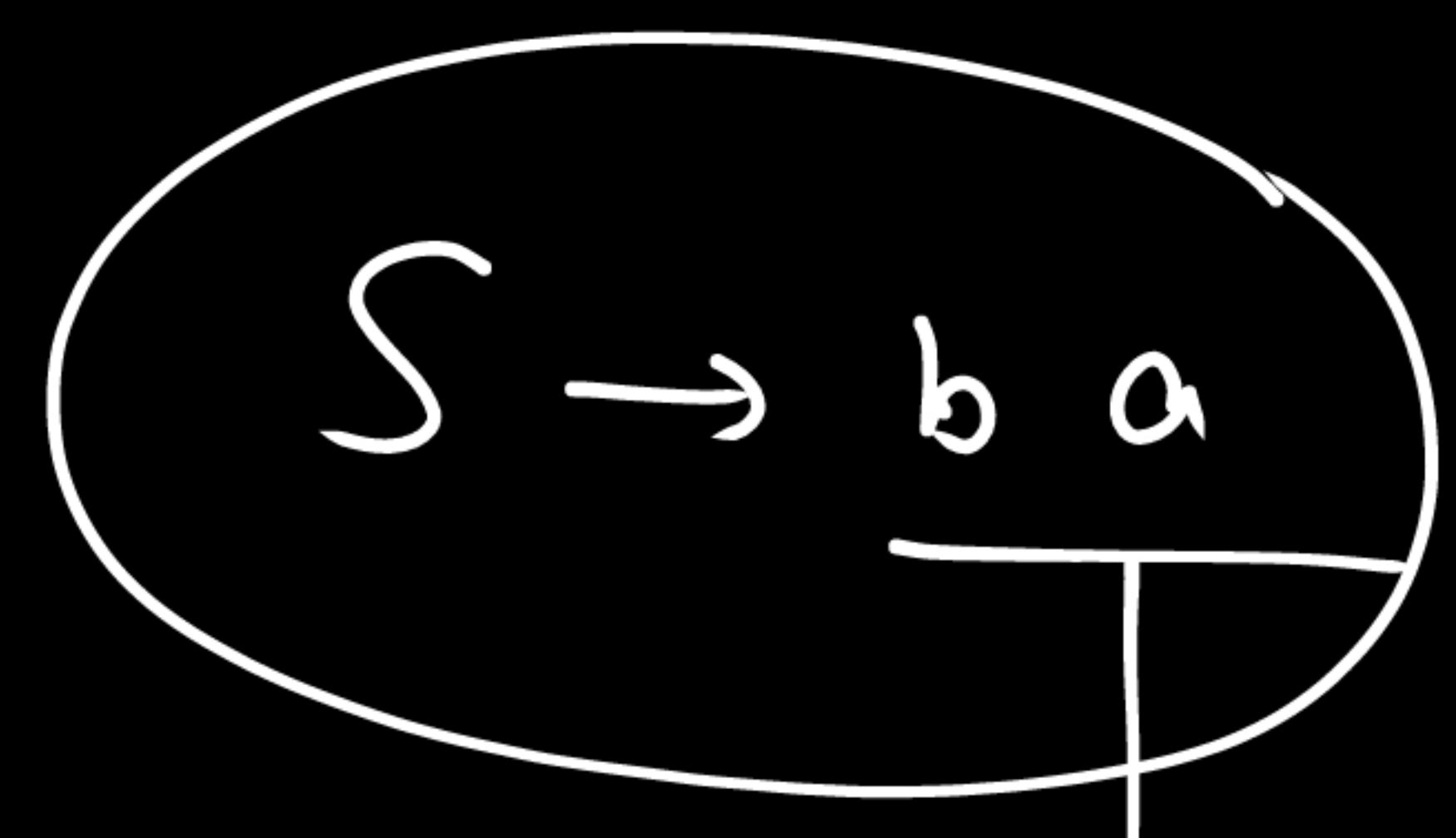
$S \rightarrow aS$   
 $S \rightarrow cS$   
 $S \rightarrow S_d$   
 $S \rightarrow \epsilon$

$\neg A \wedge \neg B$   
 $\neg(A \cup B)$

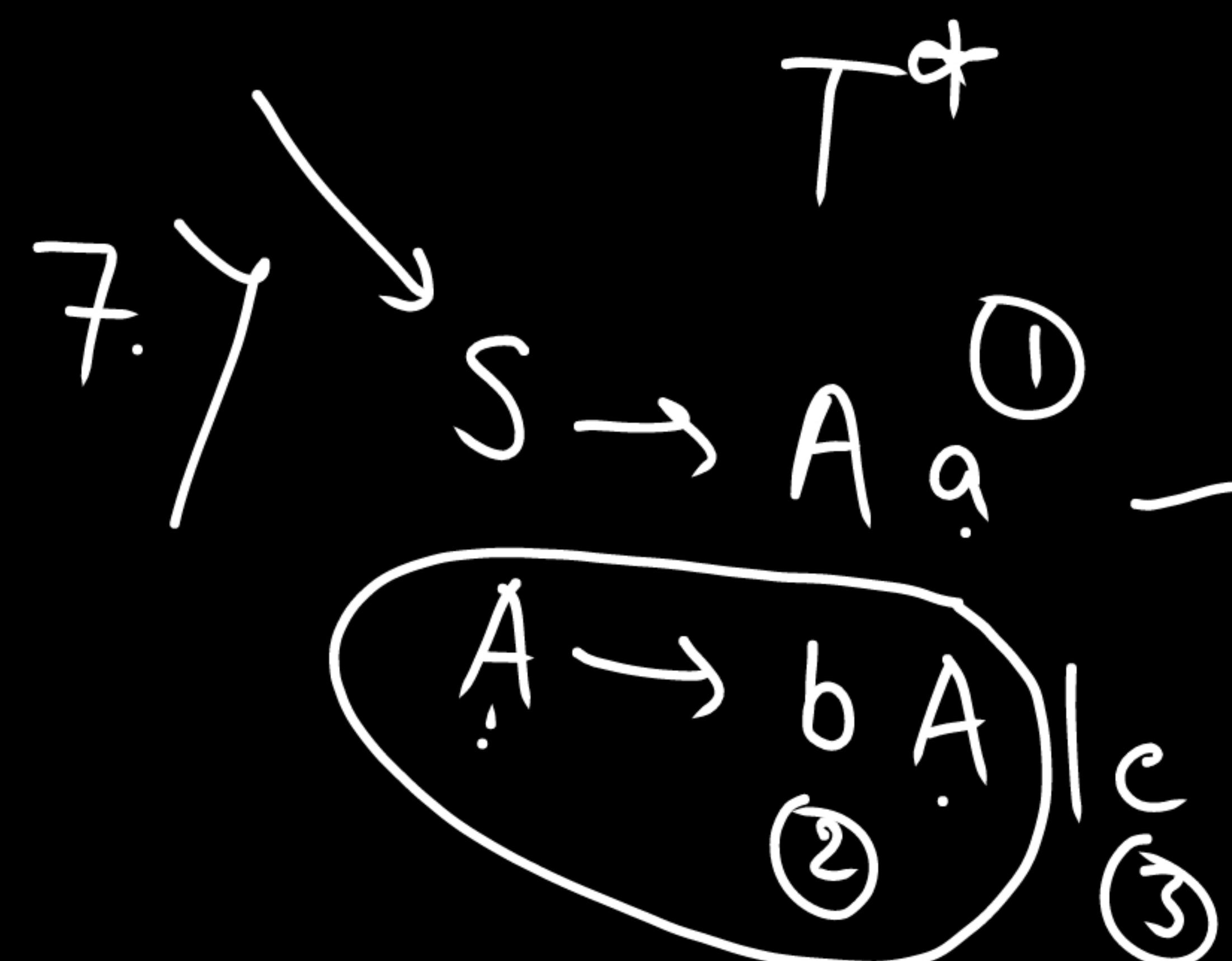
R.G  
6.)

$$\frac{S \rightarrow Aa}{A \rightarrow b} \xrightarrow{\text{L(G)}}$$

$A \rightarrow b \rightarrow \text{both}$

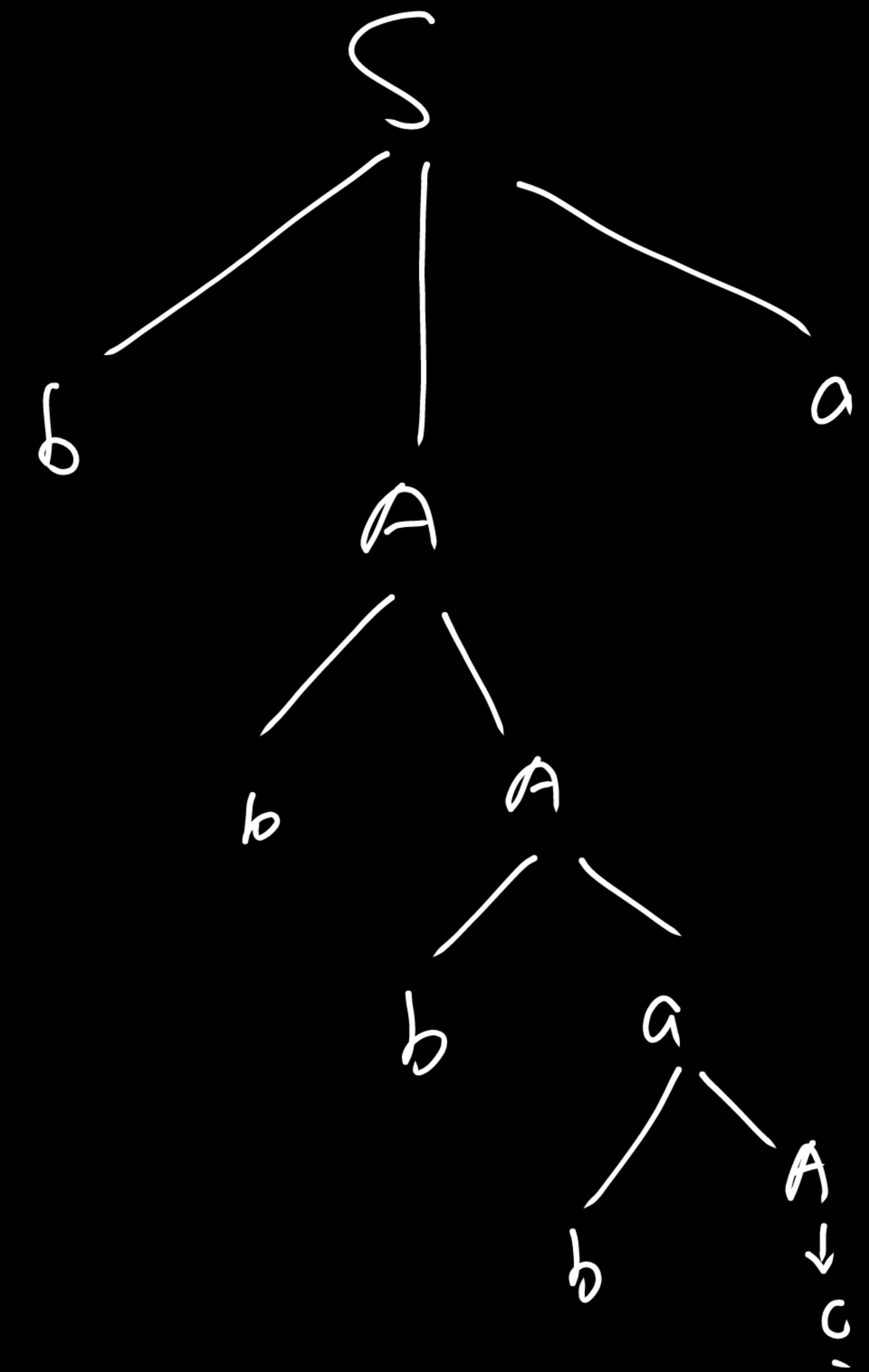


$$L = \{ba\}$$



$$\begin{array}{c} T^* \subseteq a \\ \times \quad b^+ \subseteq a \end{array}$$

$$S \rightarrow b \underline{A} a \quad \{T^*\}$$



$$7.) S \rightarrow AB$$

$$A \rightarrow \epsilon$$

$$L = \{\epsilon\}$$

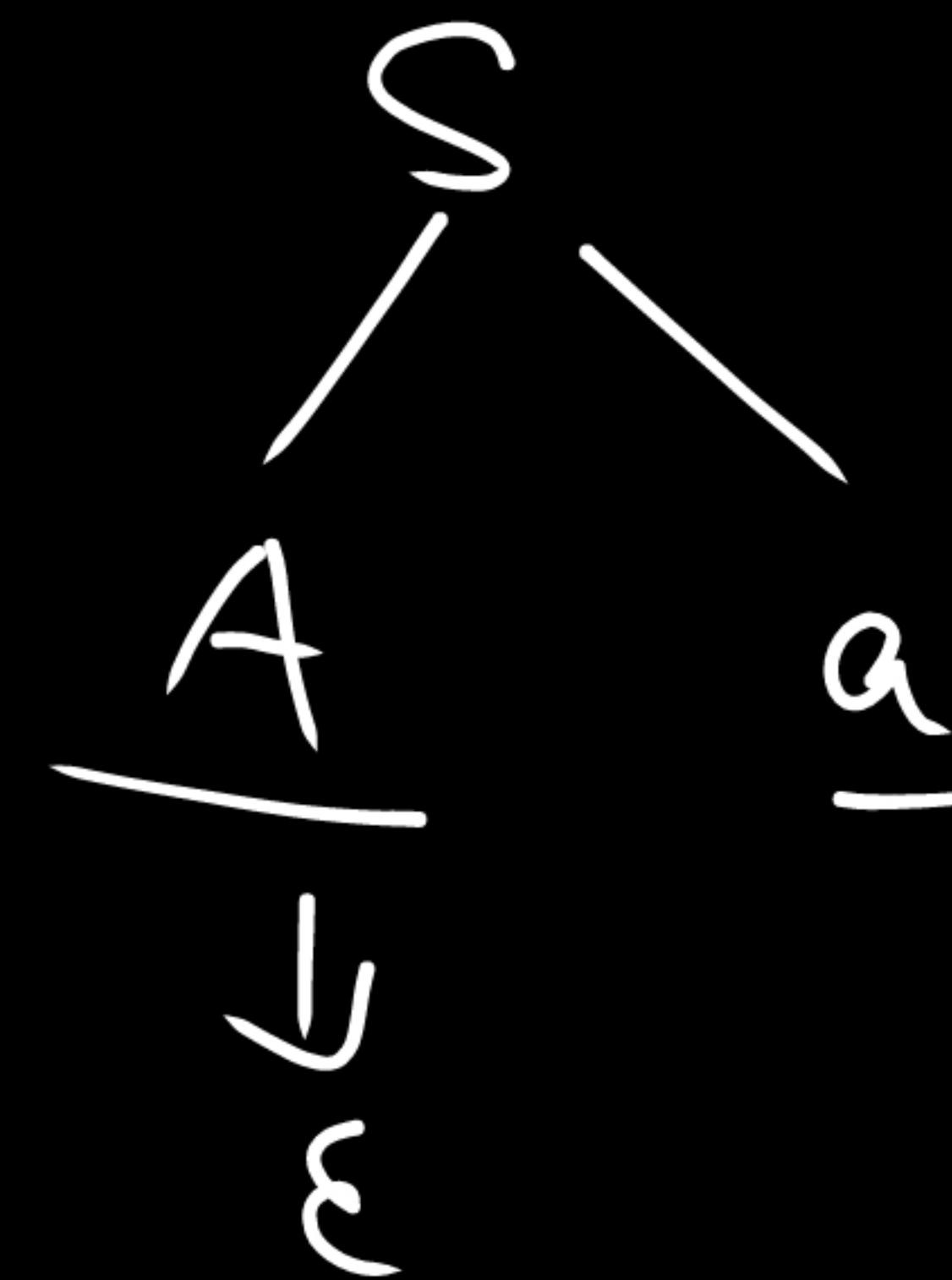
$$B \rightarrow \epsilon$$

$$R.G_8.) S \xrightarrow{①} Aa$$

$$\left. \begin{array}{c} \\ A \xrightarrow{②} a \\ \hline \end{array} \right| \left. \begin{array}{c} \\ \epsilon \xrightarrow{③} \\ \hline \end{array} \right\}$$

$$L = \cancel{a^*} \quad \cancel{aa^*}$$

$$L = \{a, aa\}$$



R.G

⑨

$$\left. \begin{array}{c} both \\ ① \quad A_a \\ \hline both \\ ② \quad B_b \\ \hline \end{array} \right\}$$

$$S \rightarrow A_a \mid B_b$$

$$A \rightarrow \epsilon \quad both$$

$$B \rightarrow \epsilon \quad both$$

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

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

$$R.G = ?$$

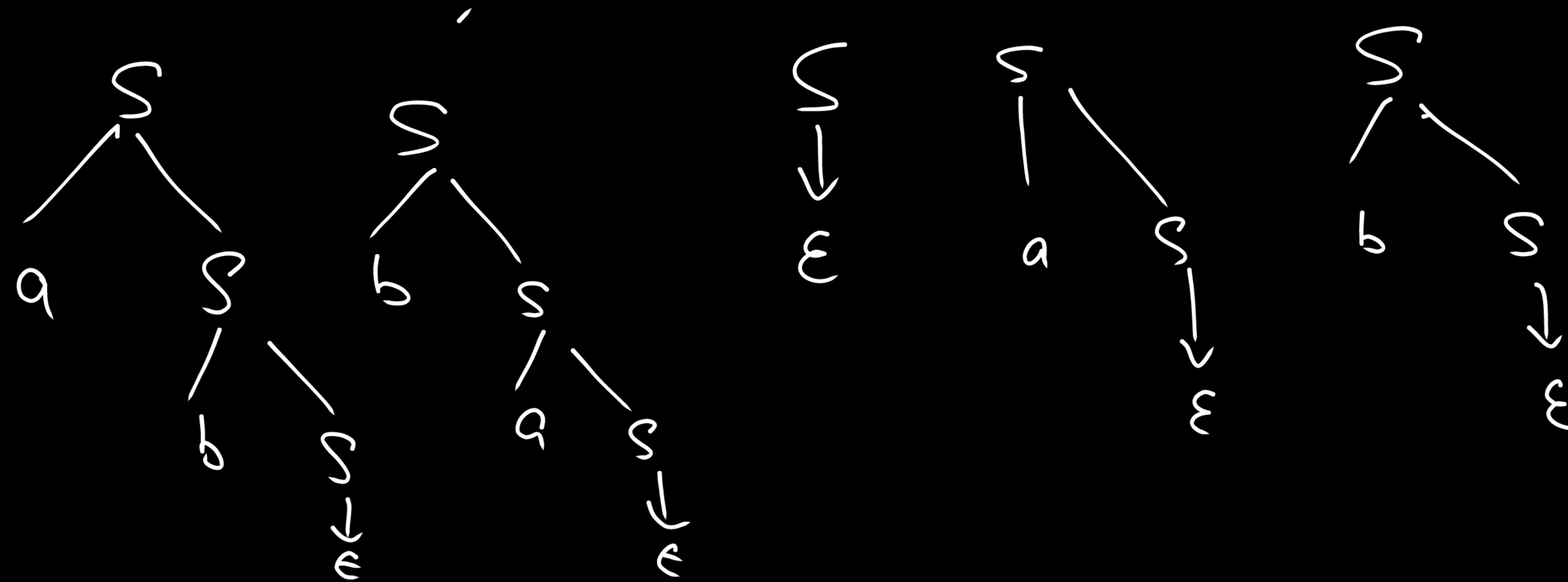
$$S \xrightarrow{①} aA \left| \begin{array}{c} \\ ② \quad bB \\ \hline \end{array} \right.$$

$$A \rightarrow aA \mid \epsilon$$

$$B \rightarrow bB \mid \epsilon$$

$$S \rightarrow aS \mid bS \mid \epsilon$$

---

~~X~~
$$S \rightarrow aS \mid bS \mid \epsilon$$




Thank You

