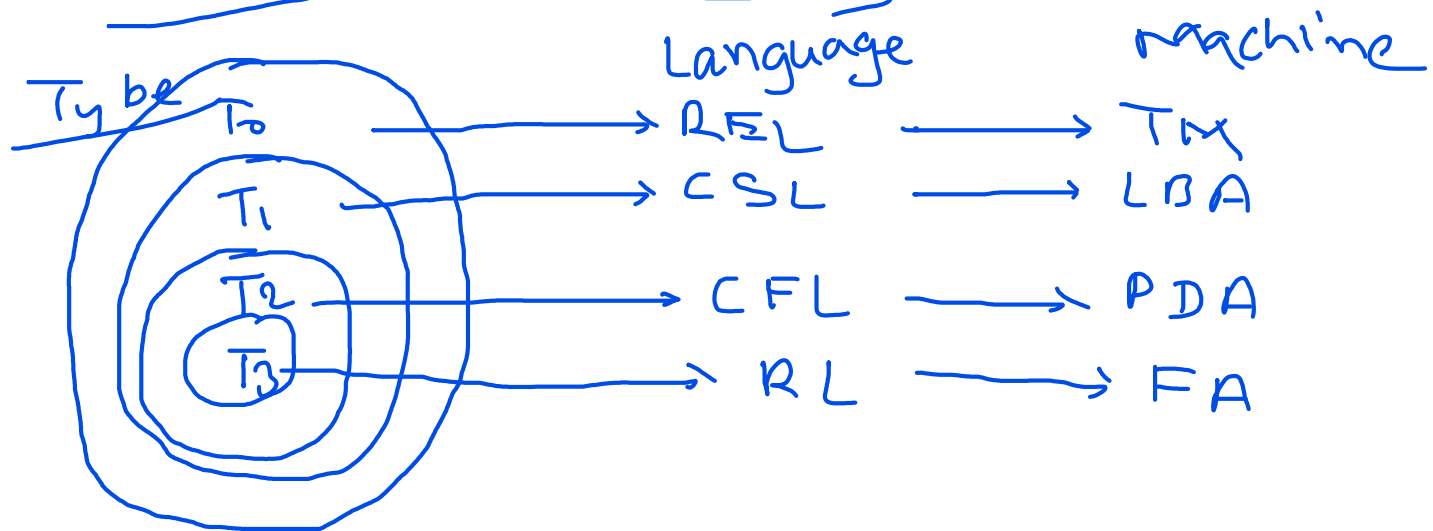


# Chomsky hierarchy



Type 0  $\rightarrow$  REG  $\rightarrow$  REL  $\rightarrow$  TM

$$G = (V_n, \Sigma, P, S)$$

Production Rule

$$\alpha \rightarrow \beta$$

$$\alpha \in (\Sigma \cup V_n)^* V_n (\Sigma \cup V_n)^*$$

$$\beta \in (\Sigma \cup V_n)^*$$

Type 1 —

CSG — CSL — LBA

$$\alpha \rightarrow \beta \quad |\alpha| \leq |\beta|$$

$$\alpha \in (\Sigma \cup V_n)^* V_n (\Sigma \cup V_n)^*$$

$$\beta \in (\Sigma \cup V_n)^+$$

$$\alpha A \beta \rightarrow \alpha \delta \beta$$

$$\alpha, \beta \in (\Sigma \cup V_n)^*$$

$$A \in V_n$$

$$\delta \in (\Sigma \cup V_n)^+$$

$\epsilon$  and Null not used in type 1

Type 2 -  $CFG \rightarrow CFL \rightarrow PDA$

$$\alpha \rightarrow \beta \quad \alpha \in V_n, \quad \beta \in (\Sigma \cup V_n)^*$$

$$|\alpha| = 1$$

Type 3 -  $RLG \rightarrow RL \rightarrow FA$

Left linear grammar

$$A \rightarrow a | Ba$$

$$A, B \in V_n$$

$$|A| = |B| = 1$$

$$a \in \Sigma^*$$

Right Linear grammar

$$A \rightarrow a | aB$$

$$A, B \in V_n$$

$$|A| = |B| = 1$$

$$a \in \Sigma^*$$

## Closure Properties — $(U, \cap, L^c, \cdot, *, +)$

- 1- Reg, CSL, REL  $\rightarrow \gamma$  (accept all properties)
- 2- RE  $\rightarrow$  All but  $L^c$
- 3- CFL  $\rightarrow$  All but  $\cap$  and  $L^c$
- 4- DCFE  $\rightarrow$  no All but  $L^c$

## Power of machine —

— NFA = DFA  $\therefore$  Accept only Reg. Lang

—  $\begin{array}{c} \text{PDA} \\ \swarrow \quad \searrow \\ \text{DPDA} \quad \text{NPDA} \end{array}$  PDA have memory so accept more lang than FA  
so PDA > FA

NPDA > DPDA

— n-Stack PDA > NPDA > DPDA

— TM can be programmed so accept very large class of Language —

$\left[ \text{TM} > \text{n-Stack PDA} > \text{NPDA} > \text{DPDA} > \text{FA} \right]$   
 $\qquad \qquad \qquad > \text{NFA} = \text{DFA}$