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Unrestricted Grammar:-

⇒ A grammar $G = (V, T, P, S)$ is called Unrestricted if all the productions are of the form

$$u \longrightarrow v$$

where u is in $(VUT)^+$ and
v is in $(VUT)^*$.

⇒ In unrestricted grammar, no conditions are imposed on the productions.

⇒ Any no. of variables and terminals can be on the left or right, and these can occur in any order.

⇒ There is only one restriction. ϵ is not allowed as the left side of production.

eg:-
$$S \longrightarrow S_1 B$$
$$S_1 \longrightarrow a S_1 B$$
$$bB \longrightarrow bbbB$$
$$aS_1 B \longrightarrow aa$$
$$B \longrightarrow \epsilon$$

Content Sensitive grammar:-

⇒ A grammar $G = (V, T, P, S)$ is said to be content sensitive if all productions are of the form

$$x \longrightarrow y$$

where $x, y \in (VUT)^+$ and $|x| \leq |y|$

Form
$\alpha \longrightarrow \beta$
$\alpha, \beta \in (V+T)^*$
$x\alpha y \longrightarrow x\beta y$

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eg:- $xAy \longrightarrow xVy$ is equivalent to

$A \longrightarrow V$

can be applied in the situation where A occurs in a context of the string x on the left & the string y on the right.

Chomsky hierarchy :-

=) Noam chomsky, a founder of formal language theory, provided an initial classification into 4 language types. type 0, type 1, type 2, type 3.

Ty:- (UG) more powerful, less restricted.

$\alpha \longrightarrow \beta$

$\alpha \in (V+T)^+$

$\beta \in (V+T)^*$

eg:-

$aAb \longrightarrow bB$

$aA \longrightarrow G$ → only restriction.

T1:- (CSG) for LBA

$\alpha \longrightarrow \beta$

$|\alpha| \leq |\beta|$

$\alpha, \beta \in (V+T)^+$

$b \in (V+T)^*$

eg:- $aAb \longrightarrow bbb$

$aA \longrightarrow bbb$

bVT

$aAb \longrightarrow bb$

length 3 length 2

not allowed

T2:-

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T2:- CFG. PDA.

$A \to \alpha$.

$\alpha \in (V+T)^*$

eg:- $A \to \epsilon$

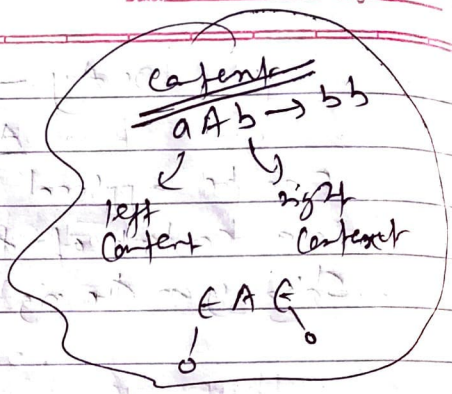
$A \to BCD$

Can have any variables (T, V) on RHS.

$V \to (V+T)^*$

↓ no content ∴ content free

↳ can have content



T3:- (RG) :- most restricted, less powerful (FA).

(RG)

Right linear

eg $A \to xB/x$

left linear.

$A \to Bx/x$

↳ repetition on left

⇒ production containing atmost one nonterminal on the right hand side of its production.

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$A, B \in V$

$x \in T^*$

eg:-

$S \rightarrow aS \mid b$ } RL

$S \rightarrow aS \mid \epsilon$ } RL

$S \rightarrow Sa \mid b$ } LL

$A \rightarrow \epsilon$

Linear grammar:-

There exist exactly one variable on L.H.S and at most one variable on R.H.S. is Linear grammar.

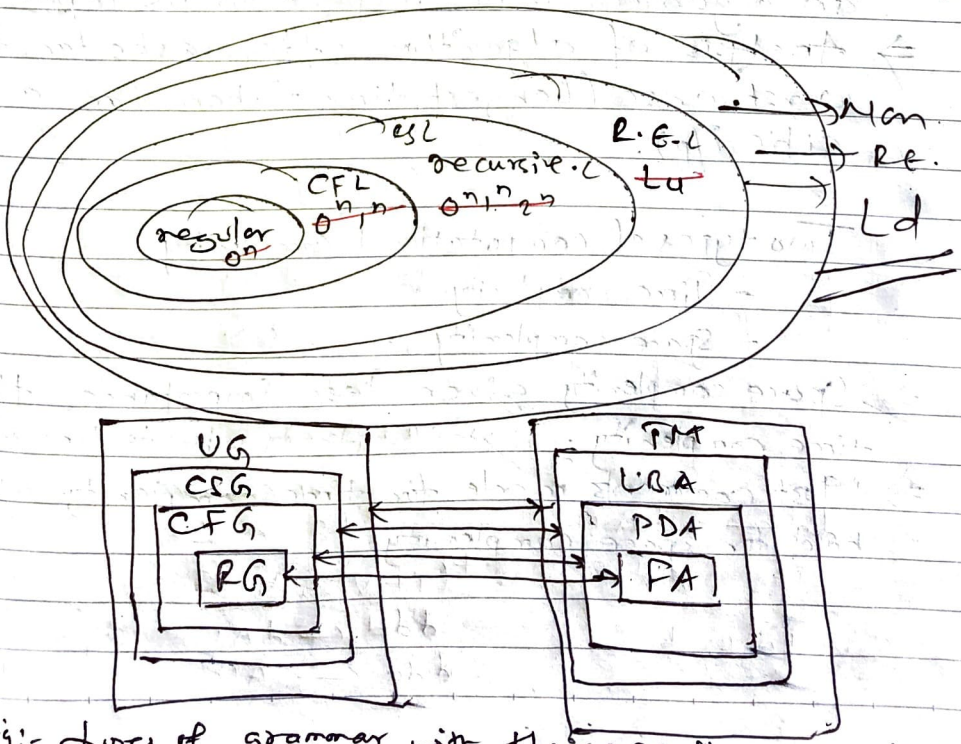

fig:- Types of grammar with their respective mathematical model.