Grammar

- Every grammar has 5 tuples :- G(V, T, P, S)
  - V: set of variables (capitals) (can further be derived)
  - T: set of terminals (small) (can't be derived further)
  - P: no. of Products
  - S: starting symbol of the grammar

* → Type-3 (Regular grammar) :- $A \to Bx \mid xB \mid x$; $A, B \in V$ & $x \in T^*$
  - Bx: left linear grammar
  - xB: right linear grammar

Type-2 (Context free grammar) :- $A \to \alpha$; $\alpha \in (V+T)^*$, $A \in V$
(A: single variable)

Type-1 (Context sensitive grammar) :- $\alpha \to \beta$; where $|\alpha| \leq |\beta|$; $\alpha \in (V+T)^*$, $\beta \in (V+T)^*$

Type-0 (Recursive Enurable grammar) :- $\alpha \to \beta$; $\alpha \in (V+T)^*$, $\beta \in (V+T)^*$

* Identify Language from grammar :-

→ $S \to aS \mid bS \mid \epsilon \Rightarrow (a+b)^*$ | $S \to aS \mid bS \mid a \mid b \Rightarrow (a+b)^+$

→ $S \to aSbS \mid bSaS \mid \epsilon \Rightarrow n_a(n) = n_b(n)$ [no. of a's = no. of b]

→ $S \to aSa \mid bSb \mid \epsilon \Rightarrow WW^R$ [W^R = reverse of W]

→ $S \to aSa \mid bSb \mid c \Rightarrow WcW^R$

→ $S \to 0S11 \mid 011 \Rightarrow L = \{0^n 1^{2n} / n \geq 1\}$

→ $S \to aS \mid \epsilon \Rightarrow a^*$ | → $S \to bS \mid \epsilon \Rightarrow b^*$

→ $S \to aS \mid a \Rightarrow a^+$ | → $S \to bS \mid b \Rightarrow b^+$

* Context free Grammar :-

Ambiguous CFG
- for one string more than one LMD/RMD/parse tree

Unambiguous CFG
- for one string one LMD & RMD & LMD parse tree = RMD parse tree.

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* Examples of CFG:-

(1) a=b+c; a=b+c*d; a=b ⇒ unambiguous CFG
(2) S → SS | a ⇒ ambiguous CFG
(3) S → aSbS | bSaS | ∈ ⇒ ambiguous CFG
(4) E → E+T | T ; T → T*F | F ; F → id ⇒ unambiguous CFG
(5) E → E+E | E*E | id ⇒ ambiguous CFG

* Simplification of CFG:-

(1) Useless production elimination :- Production which doesn't terminate or not used in other productions
(2) Unit " :- eliminate mediator productions & directly assign values
(3) null " :- if there's an ∈, try to put 'ϵ' in every non-terminal possible step-by-step & then take them as productions

Sequence of simplifying CFG:-

null production elimination → unit production elimination → useless production elimination

* Normal Form → CNF [Chomsky] → in decision problem of CFG
→ GNF [Greibach] → in construction of PDA

☆ CNF :- A → BC or A → a
☆ GNF :- A → aα ; α ∈ V*