
GRAMMAR

Types of Grammar

- ***Grammar in Automata***
  - **G = (V, T, P, S)**
  - V – Non-Terminals / Variables /Auxillary Symbols (A,B,C,….)
    - Takes part in generation of sentence (Not a part of sentence)
  - T – Terminals (small-case letters a,b,c,….)
  - P – Production Rules
  - S – Start Symbol

Example1

V = {S}

T = {a, b}

P = {S→aSbS, S→bSaS, S→ ∈**}**

S = {S}

Example2

V = {S,A,B}

T = {a,b}

P = {S→ABA,

A→BB,

B→ab,

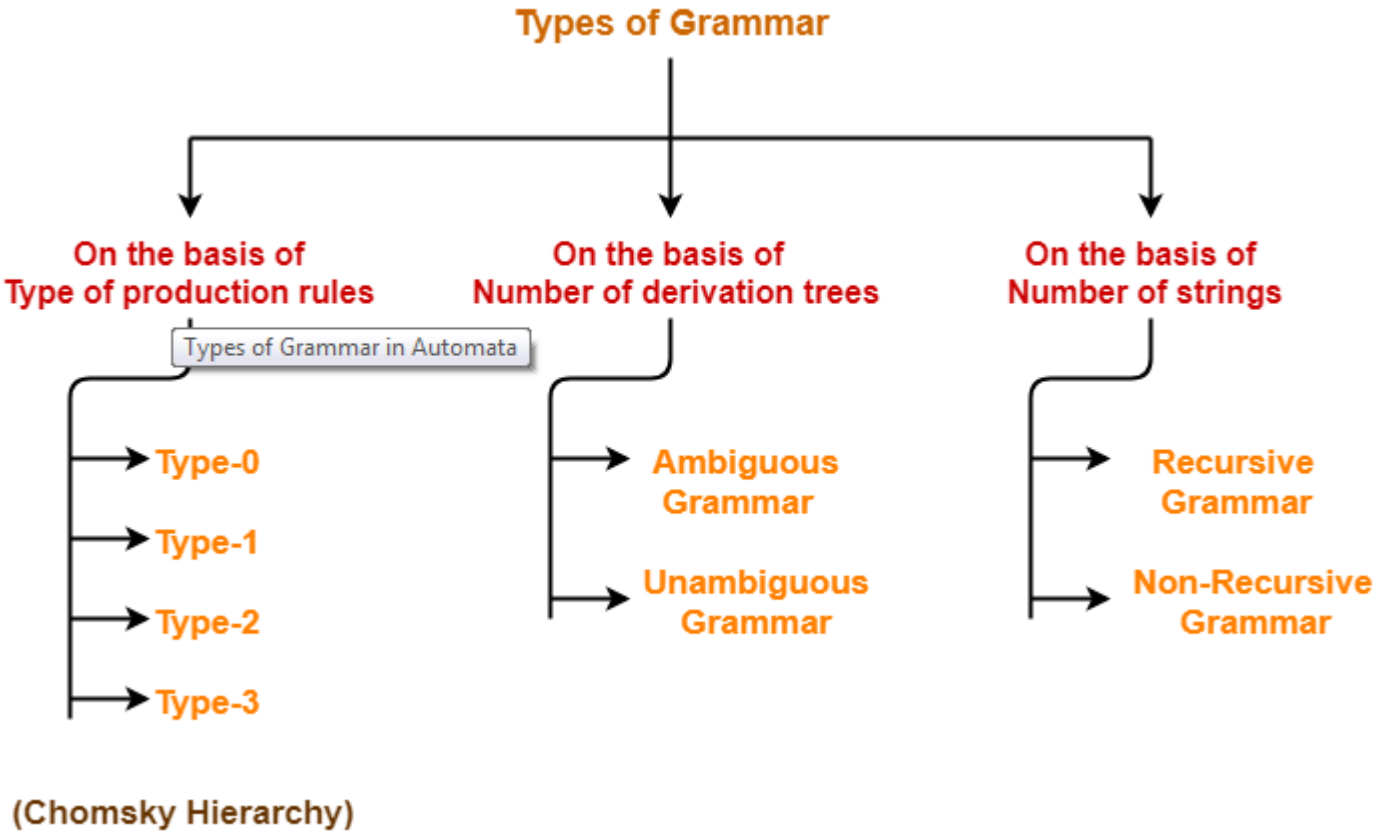
AA→b}

S = {S}

Grammar in Automata

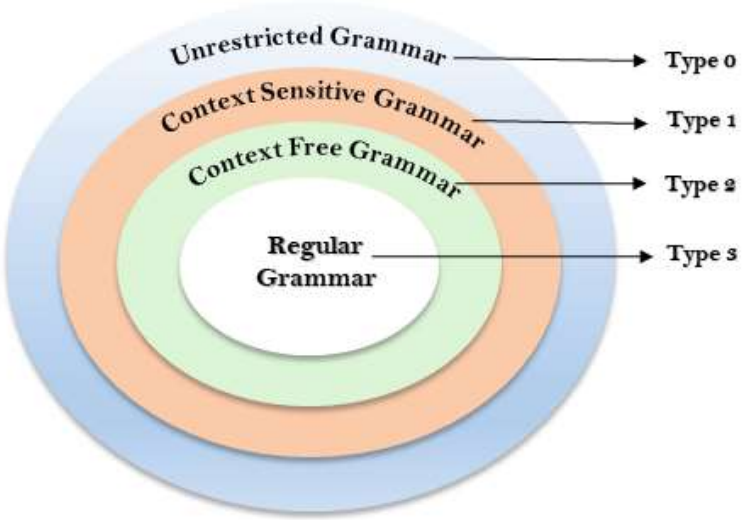
- ***Example (Equivalent Grammar)***
- G1
  - **S→aSb/**
    - S→aSb→ ∈→ab
    - S→a**S**b →a**aSb**b→aabb
    - S→a**S**b →a**aSb**b→aaabbb
    - S→{ab,aabb,aaabbb,aaaabbbb,….}
- G2
  - **S→aAb/**
  - **A→aAb/**
    - S→aaabbb
    - S→{ab,aabb,aaabbb,….}

Types of Grammar



Chomsky Hierarchy

Grammar Type	Grammar Accepted	Language Accepted	Automaton
Type 0	Unrestricted grammar	Recursively enumerable language	Turing Machine
Type 1	Context-sensitive grammar	Context-sensitive language	Linear-bounded automaton
Type 2	Context-free grammar	Context-free language	Pushdown automaton
Type 3	Regular grammar	Regular language	Finite state automaton



Type 3 ⊆ Type2, Type 1, Type 0
Type 2 ⊆ Type 1, Type 0
Type 1 ⊆ Type 0

Chomsky Hierarchy

- Type 0 (Unrestricted)
  - $\alpha \rightarrow \beta$
  - $\alpha \in (V+T)^+$ ← excluding $\in$
  - $\beta \in (V+T)^*$ ← including $\in$
  - $\alpha \neq \in$
- Type 1 (Context Sensitive Grammar)
  - $\alpha \rightarrow \beta$
  - $|\alpha| <= |\beta|$
  - Example: (aSb→ ab) ← production
- Type 2 (Context Free Grammar)
  - $\alpha \rightarrow \beta$
  - $\alpha \in V$
  - $\beta \in (V+T)^*$
- Type 3 (Restricted)
  - V→VT*/T* (Right Regular Language) OR T*V/T* (Left Regular language)
  - Example: A→aB, A→ a

Chomsky Hierarchy

Rules

Type 0 → α ≠ ∈
Type 1 → | α|<= | β|
Type 2 → α ∈ V, β ∈ (V+T)*
Type 3 → V→VT*/T* (or)
V→T*V/T*

- Example 1
- (TYPE 1)
  - S→ACaB
  - Bc→acB
  - CB→DB
  - aD→Db
- Example 2
- (TYPE 2)
  - S→Xa
  - X→a
  - X→aX
  - X→abc
  - X→ ∈

- Example 3
- (TYPE 2)
  - S→AC|CB
  - C→aCb|a|b
  - A→aA| ∈
  - B→Bb| ∈
- Example 4
- (TYPE 2)
  - S→AC|CB
  - C→aCb| ∈
  - A→aA| ∈
  - B→Bb| ∈

Chomsky Hierarchy

Rules

Type 0 → α ≠ ∈
Type 1 → | α|<= | β|
Type 2 → α ∈ V, β ∈ (V+T)*
Type 3 → V→VT*/T* (or)
V→T*V/T*

- **Example 5:**
- Type 3
  - A → ε
  - A → a
  - A → abc
  - A → B
  - A → abcB

- **Example 6:**
- Type 1
  - AB → CDB
  - AB → CdEB
  - ABcd → abCDBcd
  - B → b

- **Example 7:**
- Type 0
  - bAa → aa
  - S → s


Thank You

- Type 0 (Unrestricted)
  - $\alpha \rightarrow \beta$
  - $\alpha \in (V+T)^+$ ← excluding $\in$
  - $\beta \in (V+T)^*$ ← including $\in$

  $-\alpha \neq$?
- Variables →S,A,B,AS,AB,
- Terminals→a,b,c,d,…ab,acd,
- Variables&terminals →Sa,aaAB,ABacd
- S→Aa
- a--> $\in$
- Sa→abc
- aSa→ABC
- SaA→ABCab