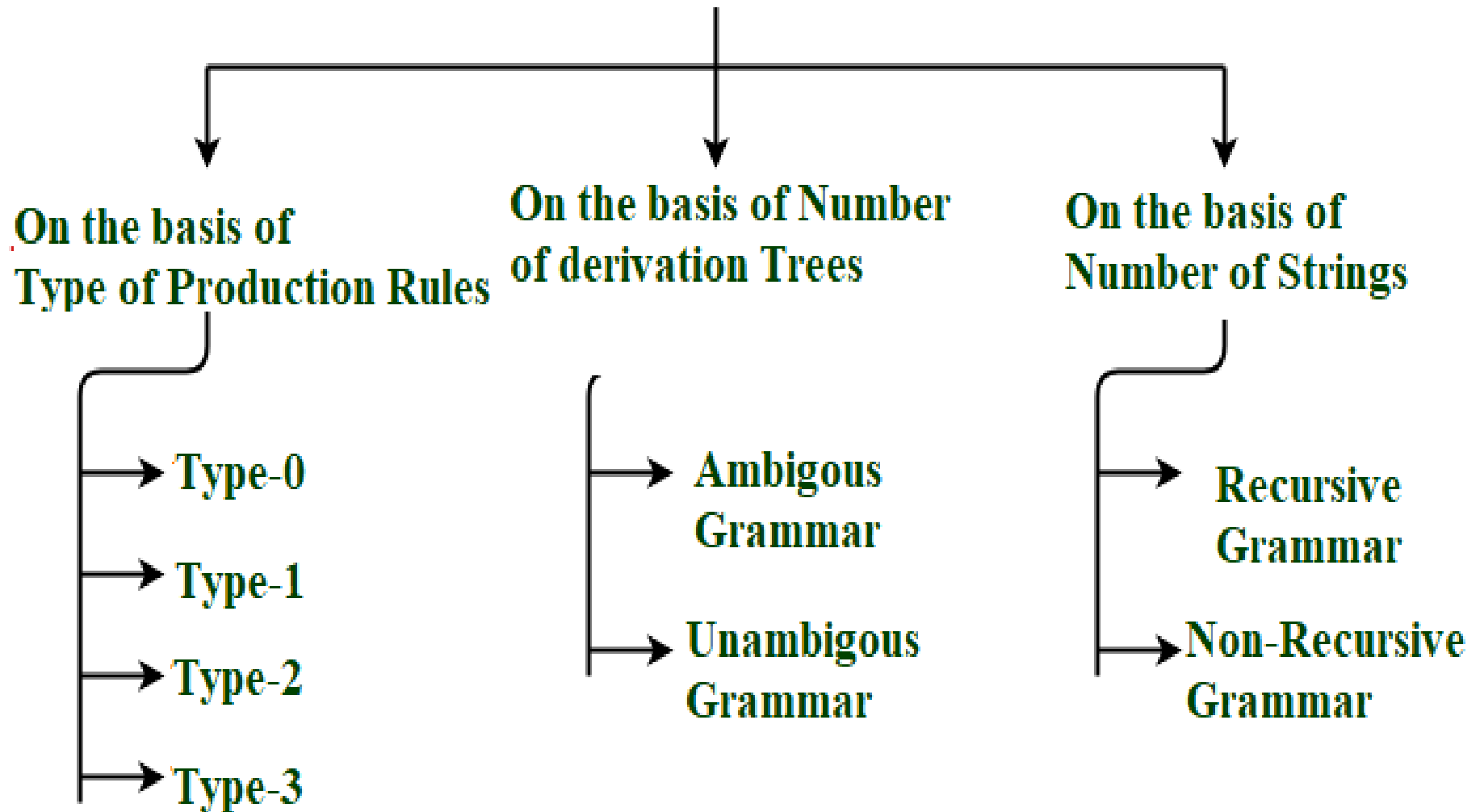


Introduction to Grammar & Derivation

Introduction to Grammar

- **Chomsky Hierarchy represents the class of languages that are accepted by the different machine. The category of language in Chomsky's Hierarchy is as given below:**
 - 1.Type 0 known as Unrestricted Grammar.**
 - 2.Type 1 known as Context Sensitive Grammar.**
 - 3.Type 2 known as Context Free Grammar.**
 - 4.Type 3 Regular Grammar.**

Types of Grammar



Type 0 Grammar

- Type 0 grammar is known as Unrestricted grammar. There is no restriction on the grammar rules of these types of languages.

$bAa \rightarrow aa$

$S \rightarrow s$

Type 1 Grammar:

- Type 1 grammar is known as Context Sensitive Grammar. The context sensitive grammar is used to represent context sensitive language. It follows the following rules:

- **The context sensitive grammar may have more than one symbol on the left hand side of their production rules.**
- **The number of symbols on the left-hand side must not exceed the number of symbols on the right-hand side.**
- **The rule of the form $A \rightarrow \varepsilon$ is not allowed unless A is a start symbol.**
- **The Type 1 grammar should be Type 0. In type 1, Production is in the form of $V \rightarrow T$**

Where the count of symbol in V is less than or equal to T .

- **For example:**

$$\mathbf{S \rightarrow AT}$$

$$\mathbf{T \rightarrow xy}$$

$$\mathbf{A \rightarrow a}$$

Type 2 Grammar:

- **Type 2 Grammar is known as Context Free Grammar. Context free languages are the languages which can be represented by the context free grammar (CFG).**
- **The Grammar has four tuples: (V, T, P, S)**

- **V- set of variables or non terminals symbols**
- **T- set of terminal symbols.**
- **P- set of production rules that consist of both terminal and non-terminal symbols.**
- **S- Start Symbol.**

A grammar is said to be context-free grammar if every production is of the form

$$G \rightarrow (V \cup T)^*$$

- **LHS will be always a variable or non terminal symbols**
- **RHS can be a variable or terminal or a combination of both.**

Example

$A \rightarrow aBb$, $S \rightarrow A$, $S \rightarrow a$

Type 3 Grammar:

- Type 3 Grammar is known as Regular Grammar. Regular languages are those languages which can be described using regular expressions. These languages can be modeled by NFA or DFA.
- Type 3 is most restricted form of grammar. The Type 3 grammar should be Type 2 and Type 1. Type 3 should be in the form of $V \rightarrow T^*V / T^*$

Example: $A \rightarrow a$, $B \rightarrow aB$, $B \rightarrow \epsilon$

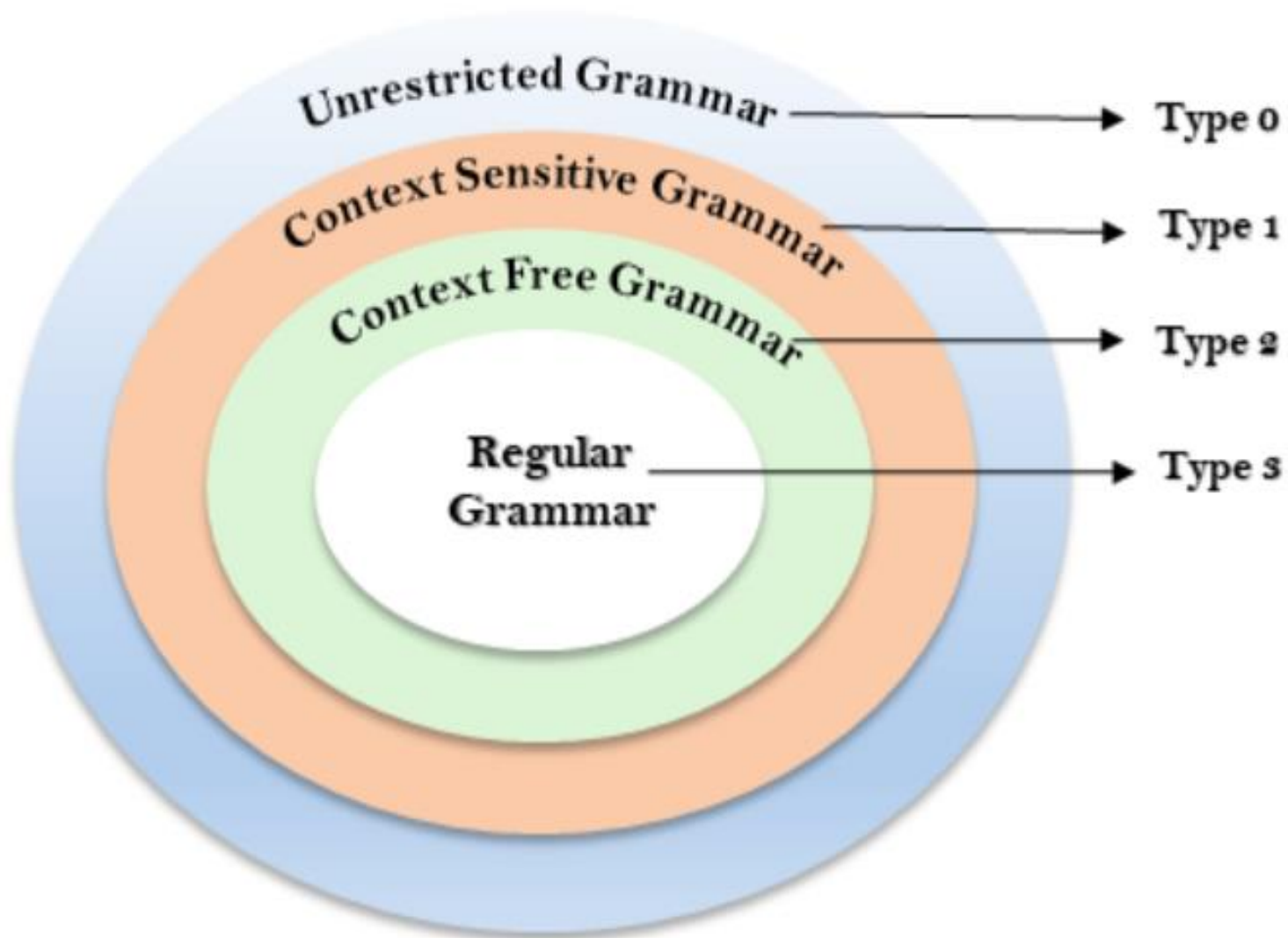


Fig: Chomsky Hierarchy

Derivation

- It is a sequence of production rules. It is used to get the input string through these production rules.
- During parsing we have to take two decisions.
 - Identify the non-terminal which is to be replaced.
 - Identify the production rule by which the non-terminal will be replaced.

Types of Derivation:

- **Left most derivation**
 - **Right most derivation**
- **In the left most derivation, the input is scanned and replaced with the production rule from left to right.**
- **In the right most derivation, the input is scanned and replaced with the production rule from right to left.**