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MODULE IV

CHOMSKY HIERARCHY LAGUAGES

The Chomsky hierarchy is a system for classifying formal grammars and languages in computer science and linguistics. It consists of four levels, which describe increasingly complex types of languages that can be generated by formal grammars. These levels are

Type 0 (unrestricted)

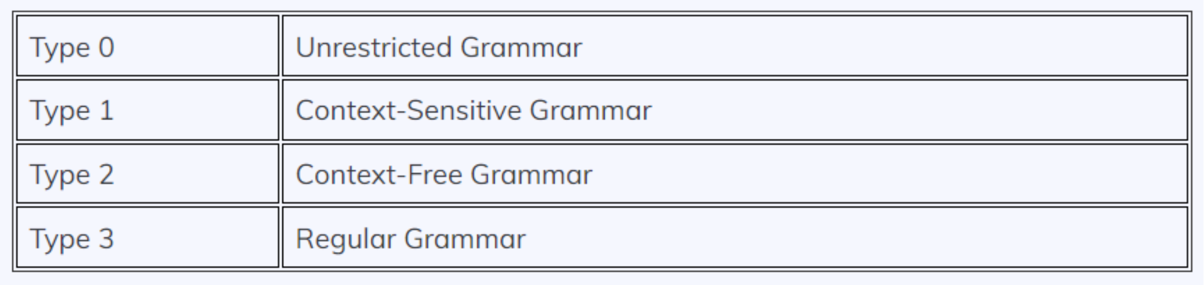
Type 1 (context-sensitive)

Type 2 (context-free)

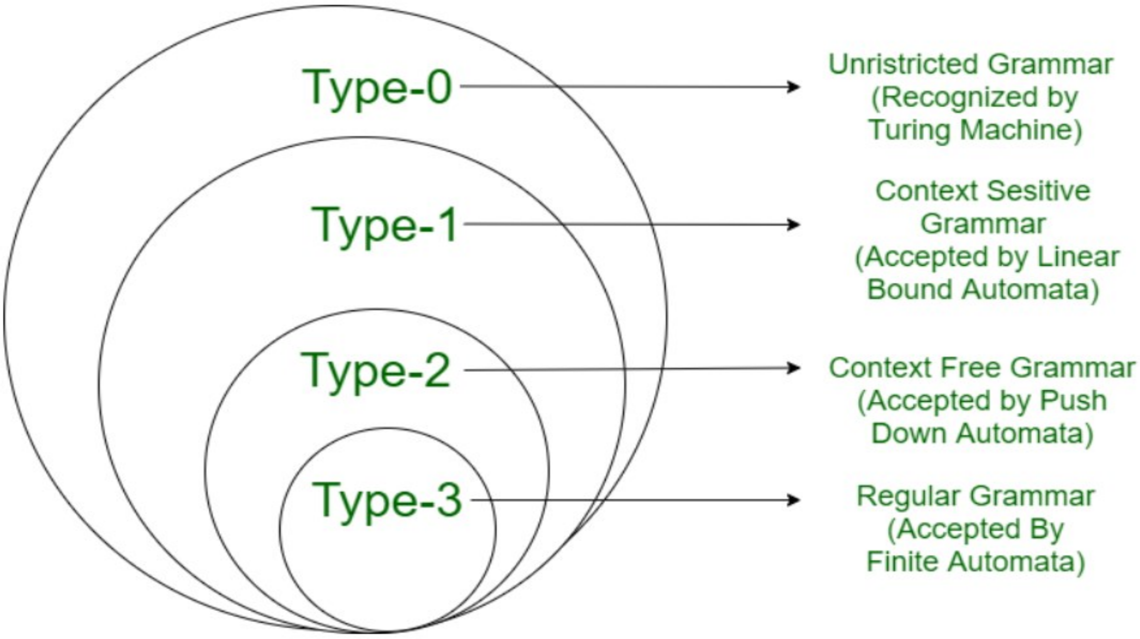
Type 3 (regular)

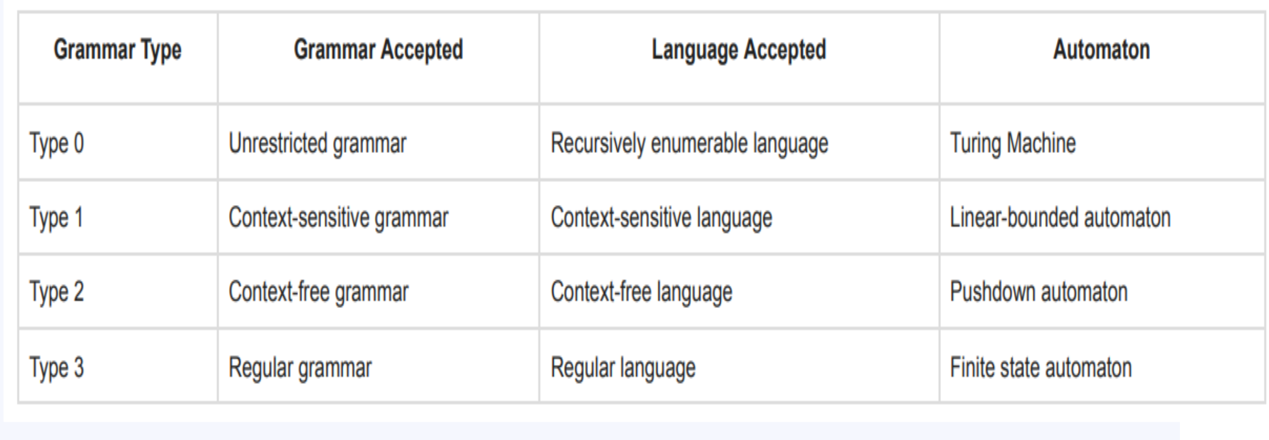
The hierarchy is named after Noam Chomsky, who proposed it as a way of characterizing the expressive power of different types of formal languages and grammars. It is a fundamental concept in the study of formal languages and is used in the development of parsing algorithms and other tools for working with formal languages.

According to the given hierarchy, Grammar is divided into four types



Type 0	Unrestricted Grammar
Type 1	Context-Sensitive Grammar
Type 2	Context-Free Grammar
Type 3	Regular Grammar


Type-0
Type-1
Type-2
Type-3
Unristricted Grammar (Recognized by Turing Machine)
Context Sesitive Grammar (Accepted by Linear Bound Automata)
Context Free Grammar (Accepted by Push Down Automata)
Regular Grammar (Accepted By Finite Automata)



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

1. Type 0: Unrestricted Grammar

Language recognized by **Turing Machine** is known as Type 0 Grammar. They are also known as Recursively Enumerable Languages.

Grammar Production for Type 0 is given by

α —> β

For Example

Sba —> a

S —> B

Where S and B are Variables.

And a and b are Terminals.

In type 0 there must be at least one variable on the **Left side of production.**

2. Type 1: Context-Sensitive Grammar

Languages recognized by **Linear Bound Automata** are known as Type 1 Grammar. Context-sensitive grammar represents context-sensitive languages.

For grammar to be context-sensitive, it must be unrestricted. Grammar Production for Type 1 is given by

α —> β (ensuring count symbol in LHS must be less than or equal to RHS)

For Example,

S —> BA

BA —> bca

B —> b

3. Type 2: Context-Free Grammar

Languages recognized by **Pushdown Automata** are known as Type 2 Grammar. Context-free grammar represents context-free languages.

For grammar to be context-free, it must be context-sensitive. Grammar Production for Type 2 is given by

A —> α

Where A is a single non-terminal.

For Example,

A —> aB

B —> b

In Type 2:

- First of all, it should be Type 1.
- The left-hand side of production can have only one variable and there is no restriction on β.

4. Type 3: Regular Grammar

Languages recognized by **Finite Automata** are known as Type 3 Grammar. Regular grammar represents regular languages.

For grammar to be regular, it must be context-free. Grammar Production for Type 3 is given by

V → T*V / T*

For Example,

A —> ab