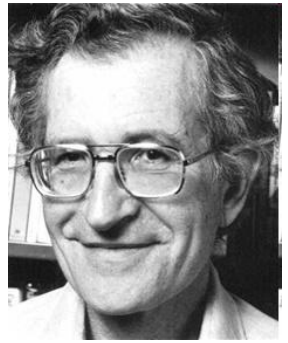
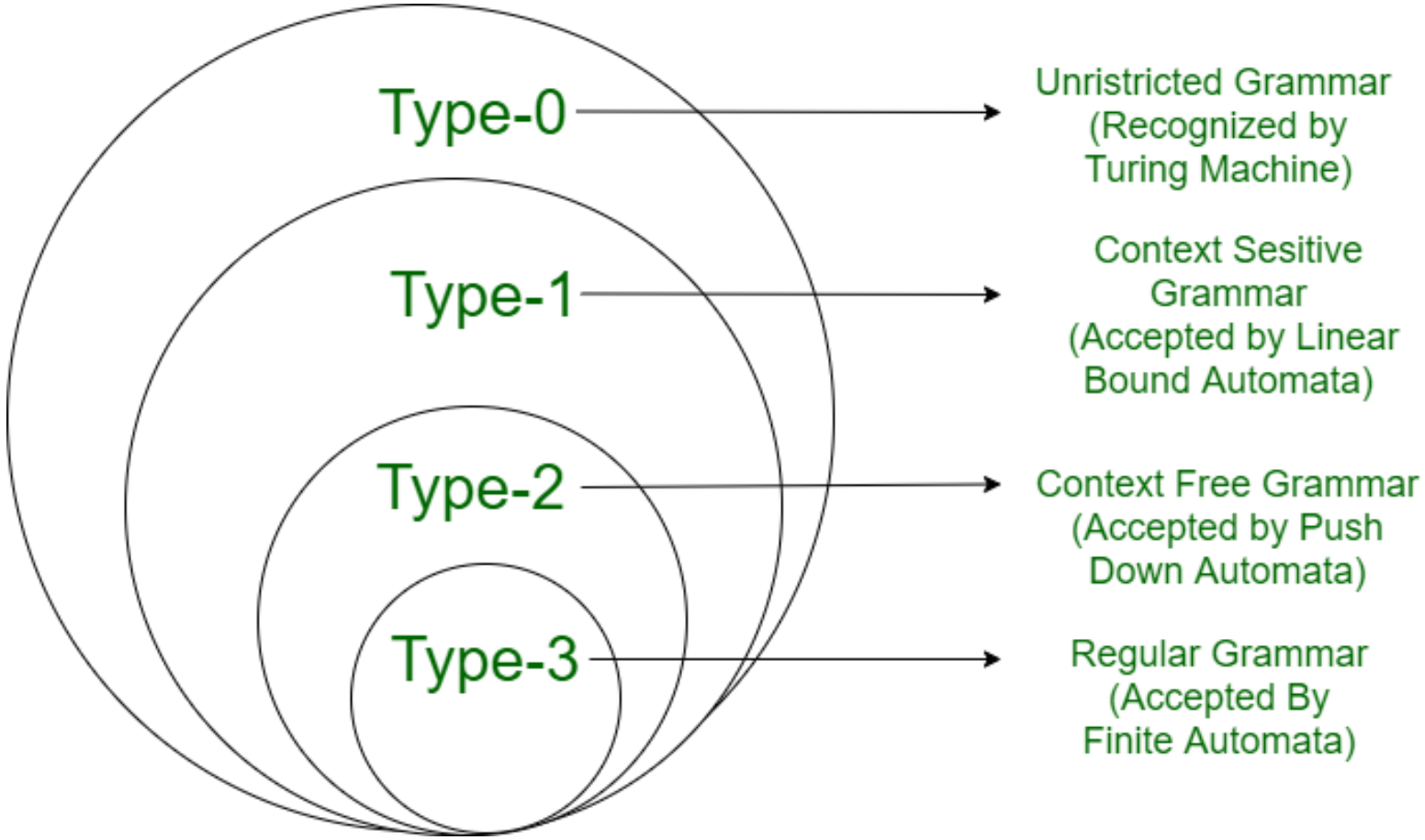
Chomsky Hierarchy

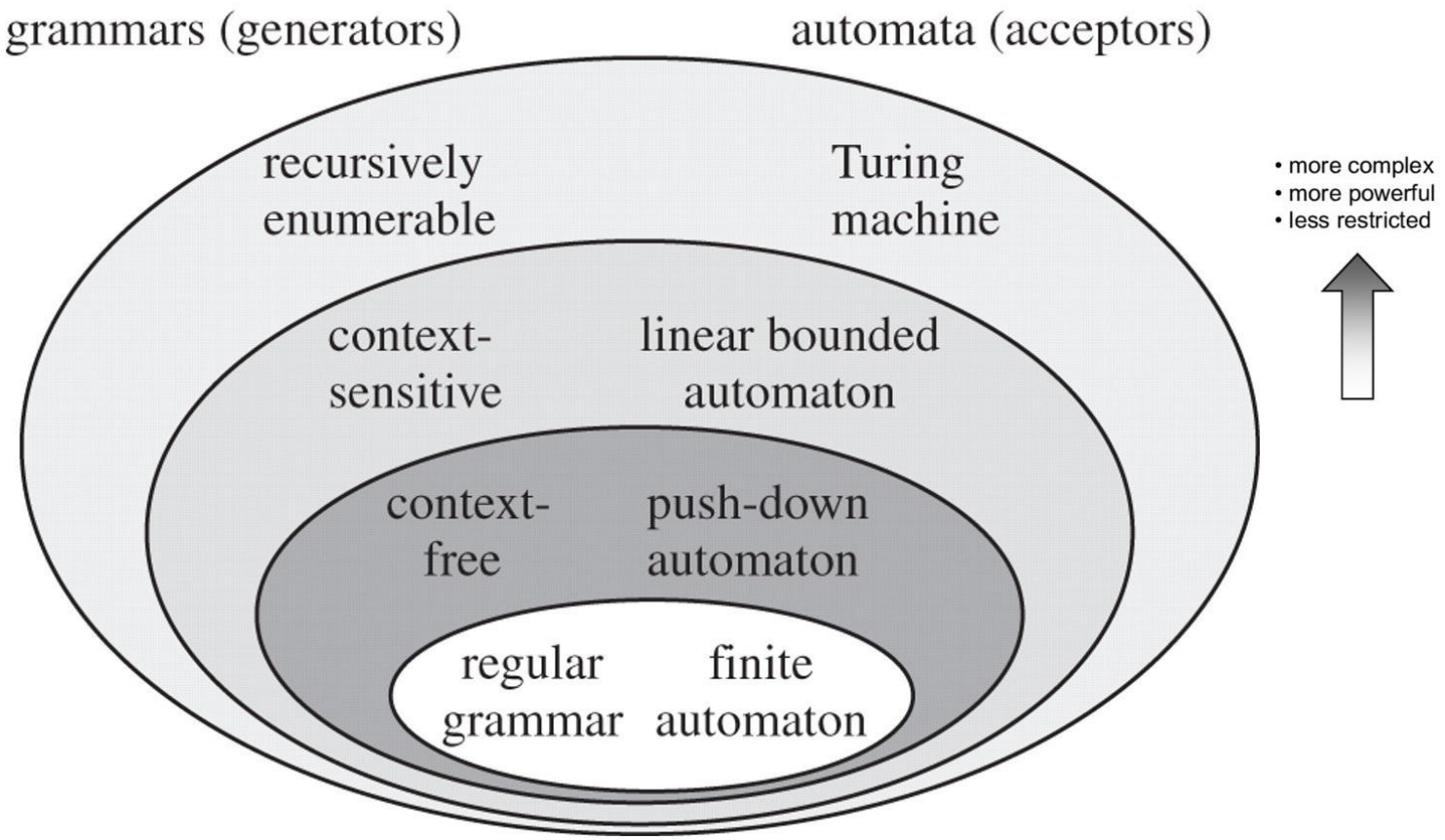
- What is the expressive power of these grammars?
- Restricting the types of rules, allows one to describe different aspects of natural languages
- These grammars form a hierarchy

The Chomsky Hierarchy

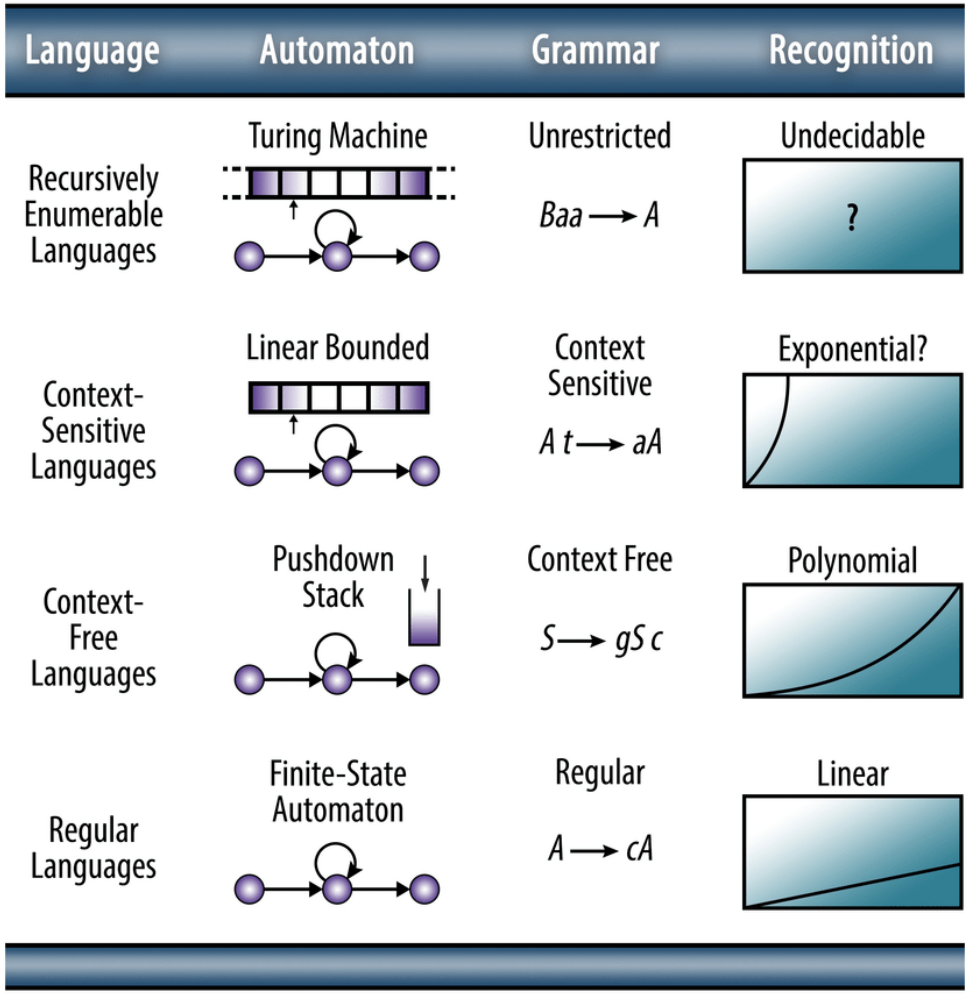




Chomsky Hierarchy Languages and Automata



Chomsky Hierarchy Languages



Chomsky Hierarchy Summary

Type	Name	Allowable Productions	Example Language	Example Grammar	Example Use	Recognizing Automaton	Storage Required	Parsing Complexity
0	Type 0	Unrestricted				Turing Machine	Infinite Tape	Undecidable
1	Context Sensitive	$\alpha \rightarrow \beta$ where $\lvert\alpha\rvert \leq \lvert\beta\rvert$ $\alpha \in V^*NV^*$ $\beta \in V^+$	$a^n b^n c^n$	$S \rightarrow aSBC$ $S \rightarrow aBC$ $CB \rightarrow BC$ $aB \rightarrow ab$ $bB \rightarrow bb$ $bC \rightarrow bc$ $cC \rightarrow cc$		Linear Bounded Automaton	Tape a linear multiple of input length	NP Complete
2	Context Free	$A \rightarrow \alpha$ $A \in N$ $\alpha \in V^*$	$a^n b^n$	$S \rightarrow aSb$ $S \rightarrow ab$	Arithmetic Expression $x = a + b * c$	Pushdown Automaton	Pushdown Stack	$O(n^3)$
3	Regular Right Linear Finite Automaton Recognizable	$A \rightarrow xB$ $A \rightarrow x$ $A, B \in N$ $x \in T^*$	$a^n b$	$S \rightarrow ab$ $S \rightarrow aS$	Identifier VECTOR7	Finite Automaton	Finite Storage	$O(n)$