

ChatGPT 3.5 ▾



You

Describe the Chomsky Hierarchy of languages with their rules to define the language. Take suitable example of each class of language.



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The Chomsky Hierarchy is a classification of formal languages, named after the linguist and cognitive scientist Noam Chomsky. It categorizes languages into four levels or classes, each with its own set of rules and characteristics. These classes are:

1. **Type 3: Regular Languages (Regular Grammars):**
 - **Rules:**
 - Production rules of the form $A \rightarrow \alpha B$ or $A \rightarrow \alpha$, where A and B are non-terminal symbols, and α is a string of terminal symbols or ϵ (empty string).
 - Regular expressions are another formalism to describe regular languages.
 - **Example:**
 - Language: $L = \{0^n 1^n | n \geq 0\}$
 - Regular expression: $0^* 1^*$
2. **Type 2: Context-Free Languages (Context-Free Grammars):**
 - **Rules:**
 - Production rules of the form $A \rightarrow \beta$, where A is a non-terminal symbol, and β is a string of terminal and/or non-terminal symbols.
 - **Example:**
 - Language: $L = \{0^n 1^n | n \geq 0\}$
 - Context-free grammar:
 - $S \rightarrow 0S1 | \epsilon$
3. **Type 1: Context-Sensitive Languages (Context-Sensitive Grammars):**
 - **Rules:**
 - Production rules of the form $\alpha \rightarrow \beta$, where α and β are strings of terminal and/or non-terminal symbols, and the length of α is less than or equal to the length of β .
 - **Example:**
 - Language: $L = \{0^n 1^n 2^n | n \geq 0\}$
 - Context-sensitive grammar:
 - $S \rightarrow 0AB$
 - $A1 \rightarrow 1A$
 - $B2 \rightarrow 2B$
 - $A \rightarrow \epsilon$
 - $B \rightarrow \epsilon$
4. **Type 0: Recursively Enumerable Languages (Turing Machines):**
 - **Rules:**
 - No restrictions on production rules.
 - **Example:**
 - Language: $L = \{0^n 1^n 2^n | n \geq 0\}$
 - Recognized by a non-deterministic Turing machine.

These language classes form a hierarchy in terms of generative power, with each class being a proper superset of the class below it. As you move up the hierarchy, the languages become more complex and expressive, but the corresponding grammars become more powerful and flexible.



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