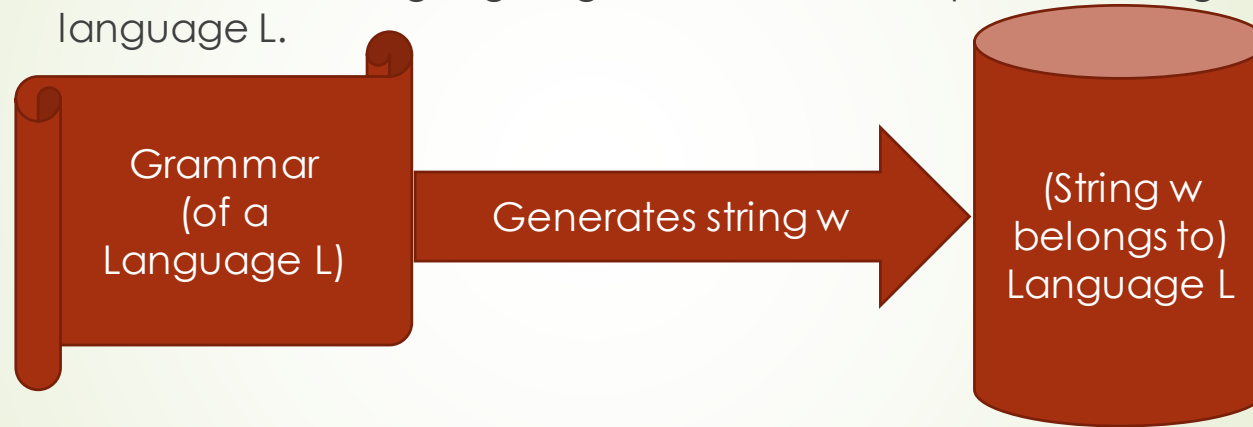


# Grammar

## Language Generating Device

- Grammar of a language  $L$  generates set of all possible strings  $w$  in the language  $L$ .





# Grammar

## Language Generating Device

- In 1956 Noam Chomsky defined mathematical model of a Grammar.
- To understand Parsing of Natural Language.
- Example of Parsing - checking whether a sentence is correct or not.
- The boy ate an apple.
- The – Article, boy – Noun, ate – Verb, an – Article, apple – Noun
- **Grammar Rules**
- $\langle S \rangle \rightarrow \langle NP \rangle \langle VP \rangle$
- $\langle NP \rangle \rightarrow \langle ART \rangle \langle N \rangle$
- $\langle ART \rangle \rightarrow \text{the} \mid \text{an}$
- $\langle N \rangle \rightarrow \text{boy} \mid \text{apple}$
- $\langle VP \rangle \rightarrow \langle V \rangle \langle NP \rangle$
- $\langle V \rangle \rightarrow \text{ate}$

# Grammar

## Language Generating Device

### Grammar Rules ( $\rightarrow$ )

1.  $\langle S \rangle \rightarrow \langle NP \rangle \langle VP \rangle$
2.  $\langle NP \rangle \rightarrow \langle ART \rangle \langle N \rangle$
3.  $\langle ART \rangle \rightarrow \text{the} \mid \text{an}$
4.  $\langle N \rangle \rightarrow \text{boy} \mid \text{apple}$
5.  $\langle VP \rangle \rightarrow \langle V \rangle \langle NP \rangle$
6.  $\langle V \rangle \rightarrow \text{ate}$

### Derivation ( $\Rightarrow$ )

1.  $\langle S \rangle \Rightarrow \langle NP \rangle \langle VP \rangle$
2.  $\Rightarrow \langle ART \rangle \langle N \rangle \langle VP \rangle$
3.  $\Rightarrow \text{The} \langle N \rangle \langle VP \rangle$
4.  $\Rightarrow \text{The boy} \langle VP \rangle$
5.  $\Rightarrow \text{The boy} \langle V \rangle \langle NP \rangle$
6.  $\Rightarrow \text{The boy ate} \langle NP \rangle$
7.  $\Rightarrow \text{The boy ate} \langle ART \rangle \langle N \rangle$
8.  $\Rightarrow \text{The boy ate an} \langle N \rangle$
9.  $\Rightarrow \text{The boy ate an apple}$



# Grammar Formal Definition

## Grammar Rules ( $\rightarrow$ )

1.  $\langle S \rangle \rightarrow \langle NP \rangle \langle VP \rangle$
2.  $\langle NP \rangle \rightarrow \langle ART \rangle \langle N \rangle$
3.  $\langle ART \rangle \rightarrow \text{the} \mid \text{an}$
4.  $\langle N \rangle \rightarrow \text{boy} \mid \text{apple}$
5.  $\langle VP \rangle \rightarrow \langle V \rangle \langle NP \rangle$
6.  $\langle V \rangle \rightarrow \text{ate}$

## Components of Grammar

1. Non Terminal Symbols – S, VP, NP, N, V, ART
2. Terminal Symbols – the, an, ate, apple, boy
3. Rules -  $\langle S \rangle \rightarrow \langle NP \rangle \langle VP \rangle$
4. Special Non Terminal Symbol – S (Start Symbol)

# Grammar

## Formal Definition

- A Grammar  $G$  is a 4-tuple  $G=(N,T,P,S)$  which generates sentences ( strings consisting of terminal symbols only) in the language  $L$ .
- $N$ - finite set non terminal symbols
- $T$ - finite set of terminal symbols
- $P$ - set of production rules of the form  $\alpha \rightarrow \beta$
- $S$  – Start symbol  $S \in N$
- Note –
- $N \cap T = \emptyset$
- $\rightarrow$  : Rewrite rule (  $S \rightarrow w$  means  $S$  can be rewritten as  $w$ )
- $\Rightarrow$  : Directly derives (  $S \Rightarrow v$  means  $S$  derives in one step / directly derives  $v$ )



# Grammar

## Chomsky Classification of Grammar

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