

$$\Sigma_{\text{exn}} = 3$$

$$L(G) = \{u \in \{a,b\}^+ / |u|_a > |u|_b\}$$

The shortest word is  $\{a\}$ .

$$1 - G = (N, T, S, P), \quad N = \{S\}, \quad T = \{a, b\}$$

$$P = (S \rightarrow b^{(1)}Sa^{(2)}|a^{(2)}Sb^{(3)}|ba^{(4)}S|ab^{(5)}S|s^{(6)}ab|S^{(7)}ba|Sa^{(8)}|a^{(9)}S|a)$$

$G$  is a Context-free grammar.

2 -  $w = baaba$  check if  $w \in L(G)$ , we try to derive  $w$  from  $S$  using  $G$ .

$$S \xrightarrow{3} baS \xrightarrow{4} baabS \xrightarrow{9} baaba$$

Then  $w \in L(G)$ .

$$\Sigma_{\text{exn}} = 4$$

The type of  $G$  is Type 1 (Context-Sensitive)

because The context rule is respected  $uAv \rightarrow u\beta v$   
 $S \rightarrow \epsilon, (\alpha \rightarrow \beta, |\alpha| \leq |\beta|)$ .

$$2 - S \xrightarrow{(1)} S' \xrightarrow{(4)} ABC \xrightarrow{(11)} aBC \xrightarrow{(12)} abc \xrightarrow{(13)} abc \in L(G)$$

$$S \xrightarrow{(1)} S' \xrightarrow{(4)} ABCS \xrightarrow{(1)} ABCS' \xrightarrow{(4)} ABCABC \xrightarrow{(5)} BACABC$$

$$S \xrightarrow{(1)} S' \xrightarrow{(4)} ABCS \xrightarrow{(1)} ABCS' \xrightarrow{(4)} ABCABC \xrightarrow{(12+11+12+13)} bacabc \in L(G)$$

- Textual specification: Language of words composed from  $a, b, c$  having the same number of occurrences of  $a, b$ , and  $c$  and in any order

- Formally specification:

$$L(G) = \{u \in \{a,b,c\}^* / |u|_a = |u|_b = |u|_c\}$$