

COMP 335 Worksheet

Normal Forms for Context-Free Grammars

1. Convert the following grammar to Chomsky Normal Form:

$$\begin{aligned} S &\rightarrow ABAC \mid BaA \\ A &\rightarrow Aa \mid BAbC \mid \lambda \\ B &\rightarrow bB \mid aBaC \mid \lambda \\ C &\rightarrow a \mid b \end{aligned}$$

2. A variable A is called useless if either (a) it does not generate any string of terminals, or if (b) it is not possible to generate a string containing A from the start variable S . Does it matter in which order we remove such useless variables?
3. If we first remove unit productions, and then λ -productions, is the resulting grammar guaranteed to have neither unit nor λ -productions?
4. If we first remove useless productions, then unit productions, is the resulting grammar guaranteed to have neither useless nor unit productions?
5. A production is called *left recursive* if it is of the form $A \rightarrow Ax$ for some $x \in (V \cup T)^*$. Consider the grammar $S \rightarrow Sa \mid b$. Show how to rewrite the grammar so that it contains no left-recursive rules.
6. Convert the following grammar to Greibach Normal Form:
$$\begin{aligned} S &\rightarrow AA \mid a \\ A &\rightarrow BB \mid b \end{aligned}$$
7. Suppose G is a grammar in CNF, and let $w \in L(G)$ with $|w| = n$. What is the length of a derivation of w in G ?
8. Suppose G is a grammar in GNF, and let $w \in L(G)$ with $|w| = n$. What is the length of a derivation of w in G ?