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COMP 4200

Homework 5

Problem 1

Total: 30 points (15 points each)

Exercise 2.6. Give context-free grammars (CFGs) generating the following languages.

1. The set of strings over the alphabet $\Sigma = \{a, b\}$ with more a's than b's

$S \rightarrow aSbS \mid aSb \mid a$

2. The complement of the language $\{a^n b^n \mid n \geq 0\}$

$S \rightarrow X \mid Y$

$X \rightarrow aXb \mid aYb \mid A \mid B \mid \epsilon$

$Y \rightarrow aY \mid Yb \mid A \mid B \mid \epsilon$

$A \rightarrow aA \mid \epsilon$

$B \rightarrow bB \mid \epsilon$

Problem 2

Total: 15 points

Exercise 2.9. Give CFG generating the following language:

$A = \{a^i b^j c^k \mid i = j \text{ or } j = k \text{ where } i, j, k \geq 0\}$

$S \rightarrow aS \mid bS \mid cS \mid \epsilon$

Is your grammar ambiguous? Why or why not? If yes, please provide an example of two different leftmost derivations that generate the same string.

This grammar is inherently ambiguous. Since for the string abc , we can draw two different paths.

Problem 3

Total: 15 points

Exercise 2.14. Convert the following CFG into an equivalent CFG in Chomsky normal form using the procedure given in Theorem 2.9.

Please provide all intermediate steps with comments on how you transform from the grammar from one version to another (these steps are critical for your work to be graded).

$$\begin{aligned} A &\rightarrow BAB \mid B \mid \epsilon \\ B &\rightarrow 00 \mid \epsilon \end{aligned}$$

Step 1: Eliminate start symbol

$S \rightarrow A$, so

G1: $S \rightarrow A$

$A \rightarrow BAB \mid B \mid \epsilon$

$B \rightarrow 00 \mid \epsilon$

Step 2: Remove the null

$S \rightarrow A$

$A \rightarrow BB \mid B \mid BAB$

$B \rightarrow \mid 00 \mid \epsilon$