

Assignment 6
CSCI-661 Foundations of Computer Science Theory
Due Tuesday, April 2, 2024

This assignment is to be completed individually.

1. **(3 points)** Give a CFG that generates the language $\{a^i b^j \mid i, j \geq 0 \text{ and } i \neq j\}$. It suffices to give the rules. Your CFG should not be overly complicated.
2. **(3 points)** Give a CFG that generates the language of all strings over $\{a, b\}$ that are not palindromes. It suffices to give the rules. Your CFG should not be overly complicated.
3. **(4 points)** Give a CFG that generates the language $\{a^i b^j c^k d^l \mid i + k = j + l\}$. It suffices to give the rules. Your CFG should not be overly complicated.
4. **(4 points)** Construct a context free grammar that generates the language:
 $L = \{w \in \{0, 1\}^* \mid n_0(w) = 2n_1(w) \text{ and } |w| \text{ is even}\}$. Your CFG should not be overly complicated.
5. **(4 points)** Convert the following CFG into an equivalent CFG in Chomsky normal form, using the procedure given in Theorem 2.9. (Note: following Sipser's conventions, S is the start variable of this CFG.)

$$\begin{aligned} S &\rightarrow AA \mid a \\ A &\rightarrow Ac \mid bbA \mid \epsilon \end{aligned}$$

Give your answer in a format similar to Example 2.10. Include intermediate steps.

6. **(4 points)** Let $L = \{w \in \{a, b\}^* \mid w \text{ has twice as many } a\text{'s as } b\text{'s}\}$. Draw the state diagram of a PDA that accepts language L . Your PDA should not be overly complicated.

Note: I want you to solve this without referring to the equivalence of CFGs and PDAs. That is, your PDA should not be formed by deriving the CFG for L and then appealing to the construction that shows that every CFG can be converted into a PDA.

7. **(4 points)** Let $L = \{a^i b^j c^k \mid j > i + k\}$. Draw the state diagram of a PDA that accepts language L . Your PDA should not be overly complicated.

Note: I want you to solve this without referring to the equivalence of CFGs and PDAs. That is, your PDA should not be formed by deriving the CFG for L and then appealing to the construction that shows that every CFG can be converted into a PDA.

8. **(5 points)** Solve Exercise 2.11 from your textbook.
9. **(6 points)** Solve Exercise 2.13 and Problem 2.34 from your textbook.