This homework is due in class on Monday, December 1. An answer sheet will be available at that time. Note that there is a test on Wednesday, December 3. This homework covers Sections 3.7, 4.1, and 4.3. You can work with other people in the class, but you should write up your solutions in your own words to turn in.

1. Use the pumping lemma to show that the language $L_o = \{a^{n!} \mid n \in \mathbb{N}\}$ is not regular.

2. Use the pumping lemma to show that the language $L_1 = \{w \in \{a, b\}^* \mid w^R = w\}$ is not regular.

3. Use the pumping lemma to show that the language $L_2 = \{a^n b^m c^k \mid k = n + m\}$ is not regular.

4. Show that the language $L_1 = \{w \in \{a, b\}^* \mid w^R = w\}$ is context free by finding a context-free grammar that generates the language. Explain briefly how your grammar works. L_1 is the language that consists of all *palindromes* over the alphabet $\{a, b\}$.

5. Show that the language $L_2 = \{a^n b^m c^k \mid k = n + m\}$ is context free by finding a context-free grammar that generates the language. Explain briefly how your grammar works.

6. Show that the language $L_3 = \{w \in \{a, b\}^* \mid n_a(w) \geq n_b(w) + 3\}$ is context free by finding a context-free grammar that generates the language. Explain briefly how your grammar works.

7. Suppose that G is a context-free grammar, and let $L = L(G)$. Explain how to construct from G a new context-free grammar for the language L^*. You do not need to prove that your answer is correct. (See Theorem 4.3.)

8. Consider the following context-free grammar:

$$
\begin{aligned}
S &\longrightarrow BSC \\
S &\longrightarrow a \\
B &\longrightarrow Ba \\
B &\longrightarrow b \\
C &\longrightarrow aC \\
C &\longrightarrow c
\end{aligned}
$$

a) Give two different parse trees for the string *babaaacc* according to this grammar.

b) For each parse tree from part **a)**, give the corresponding left derivation of the string.