

CSci 3501 Lab 10
31 points (See canvas for due date)
Work in pairs

- All lab submissions should be done by canvas. Please be sure to include your group members.
- When working on the lab, please comment your work so that it is clear what the contributions from each person are.
- At the end of the lab each group should submit the results of their in-class work. Please indicate if this is your final submission. Don't forget to answer all the questions below.
- If your submission at the end of the lab time was not final, please submit a final copy before the due time.

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Lab overview and goals

The goal of the lab is to get practice with context-free grammars, push-down automata, and the pumping lemma for context-free languages.

Problem 1: Context-free grammars and pushdown automata (21 points)

Please refer to the corresponding sections of the [JFLAP tutorial](#), namely [Entering grammars](#) (just pressing "enter" in RHS enters an empty string), [Brute Force Parser](#) for constructing parse trees, and [Constructing a push-down automaton](#).

Your tasks are as follows:

1. A context free grammar for the language of strings $a^n b^m$, where $n \geq m$.
2. A context free grammar for the language of strings a^k followed by any number of b followed by c^k .

3. A context-free grammar for odd-length strings of alternating zeros and ones. It can start with either zero or one.
4. A context-free grammar of strings of **a,b** that has more occurrences of **a** than occurrences of **b**. The order of letters is arbitrary. Test your automaton on strings **baaba** and **aaab** and export the corresponding parse trees as jpg files.
5. A pushdown automaton for the language of strings \mathbf{a}^k followed by any number of **b** followed by \mathbf{c}^k (do not convert your grammar from the previous question into an automaton or vice versa)
6. A pushdown automaton for the language of strings $\mathbf{a}^n \mathbf{b}^m$ where $n \leq m$.
7. A pushdown automaton for strings $w_1 w_2$ where w_2 contains a reversed w_1 as a substring and w_1 has at least one symbol. The alphabet is $\{0, 1\}$.

Problem 2: Convert context-free grammars to pushdown automata (3 points) Use the option **Convert CFG to PDA (LL)** for this problem. In a plain-text file explain what rules were added to the PDA and why.

- Convert the grammar for the language of palindromes to a PDA. The alphabet is 0,1. Submit the resulting PDA.

Problem 3: Play the context-free “pumping lemma game” (7 points) Use the **tutorial for the pumping lemma**. Play the “pumping lemma game” for the following examples. For each example state whether the language is context-free; justify it based on which side has a winning strategy in the pumping lemma game. Clearly describe the strategy. (submit your answers as a .txt)

1. the third language $\{\mathbf{a}^n \mathbf{b}^j \mathbf{a}^n \mathbf{b}^j | n \geq 0, j \geq 0\}$ – computer goes first
2. the eighth language $\{\mathbf{a}^k \mathbf{b}^n \mathbf{c}^n \mathbf{d}^j | j \neq k\}$ – you go first

What to submit:

Submit your JFLAP files via canvas. Make sure to submit your automata

files (as .jff), your input data (as .txt), and your parse trees (as .jpeg). Make sure to follow the naming requirements! Make it clear which data refers to which automaton.