CS 4510 Automata and Complexity

Exam 2: Practice

- Name: ____ GTID: ____
- Any topic covered in lecture notes 7-12 and homeworks 4-5 are fair game for the exam. (Additionally, although the exam is not cumulative, you are expected to still be familiar with earlier topics.) Absence of a topic from this practice exam does NOT imply an absence of that topic from the exam. Similarly, the actual exam may differ in length, format, and difficulty from this practice exam.
- We will go over this practice exam in class on Wednesday, March 9. In the meantime, you are encouraged to discuss this exam on Piazza and in office hours!
- Calculators are NOT permitted.
- You may use any of the theorems/facts/lemmas from the lecture notes, homeworks, or textbook without re-proving them unless explicitly stated otherwise.
- Good luck!

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1. **True or False**

   Circle one. No explanation necessary.

   (a) TRUE FALSE Let L be a context-free language. Then L must satisfy the context-free pumping lemma.

   (b) TRUE FALSE Let L be a context-free language, let G be an ambiguous grammar for L, and let $x \in L$. Then G must have at least two distinct derivation trees for x.

   (c) TRUE FALSE Let N be an NFA with p states. Then there is a PDA P with p states which has the same language as N.

   (d) TRUE FALSE Let G be a context-free grammar in Chomsky normal form whose only non-terminal is the start non-terminal S. Then $L(G)$ must be finite.

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2. **Context-Free Grammars**
   Give a context-free grammar for each of the following languages:

   (a) $L_1 = \{a^i b^j c^k \mid i + k < j \text{ and } i, j, k \in \mathbb{Z}^{\geq 0}\}$

   (b) $L_2 = \{w \mid w \text{ is a binary palindrome containing at least one } 1\}$

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3. **Pushdown Automata**

4. Give a PDA for L_1 as defined in question 2.

5. Give a PDA for L_2 as defined in question 2.

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6. **Pumping Lemma**
   Prove that the following language is not context-free using the Pumping Lemma:

$$L = \{0^n 1^{n^2} \mid n \in \mathbb{Z}^{\geq 0}\}$$