

Computer Science 423
Fall 2025
Homework 6
My name and section

Due: Friday, 10/24/2025 11:59 p.m.

Points: 50

Answer the following questions and submit typeset solutions by the due date. As stated on the syllabus, any collaborators or outside sources must be listed under the corresponding problem. Further, your final submission must be completely your own work.

1. [3 points each] For each statement below, state whether it is True or False. No explanation necessary.
 - (a) If a language L can be recognized by a NFA, a CFG must exist to generate L .
 - (b) If there are different derivations for the same string in a CFG for a context-free language, the grammar is ambiguous.
 - (c) If language B is a subset of a context-free language A , then B must also be context-free.
 - (d) If A is a context-free language, then A must be non-regular.
 - (e) A context-free language cannot contain ϵ .

Collaborators:

2. [23 points] Use the pumping lemma for CFLs to prove that the following languages are not context-free.
 - (a) [3 points] $L_1 = \{0^n 1^n 0^n 1^n \mid n \geq 0\}$
 - (b) [5 points] $L_2 = \{0^n \mid n \text{ is prime}\}$
 - (c) [7 points] $L_3 = \{a^n b^n c^j \mid n \leq j\}$.
 - (d) [8 points] $L_4 = \{t_1 \# t_2 \# \dots \# t_k \mid k \geq 2, \text{ each } t_i \in \{a, b\}^* \text{ and } t_i = t_j \text{ for some } i \neq j\}$ (Hint: Choose s with one $\#$)

Collaborators:

3. [2 points each] Determine whether or not the following languages are CFLs. Justification of your answers are helpful but not required.
 - (a) $A = \{a^m b^n a^m b^n \mid m, n \geq 0\}$
 - (b) $B = \{a^m b^n a^n b^m \mid m, n \geq 0\}$
 - (c) $C = \{a^i b^j c^k d^l \mid i + j \leq k + l\}$
 - (d) $D = \{a^i b^j c^k d^l \mid i + l \leq j + k\}$
 - (e) $E = \{a^n w w^R b^n \mid n \geq 0, w \in \{a, b\}^*\}$
 - (f) $F = \{w a^n b^n w^R \mid n \geq 0, w \in \{a, b\}^*\}$

Collaborators: