COMPSCI 2AC3, Automata and Computability
Assignment 4, Winter 2024

Hassan Ashtiani, McMaster University

Due date: Saturday, April 6, 11:00pm

Notes. Your solutions **MUST be typeset in Latex**. Only upload a pdf file as your solution to Avenue (avoid compressing your file). If you have questions post them on the Students Questions channel on MS teams.

1. Tell whether each of the following sets are CFL. If the set is not CFL, prove your answer (e.g., using pumping lemma or closure properties of CFLs). If the set is a CFL, give a grammar for it (no formal proof is required in this case).

   (a) [**25 points**] $A = \{a^p \mid p \text{ is prime}\}$.

   (b) [**25 points**] $B = L(a^*b^*c^*) - \{a^n b^n c^n \mid n \geq 0\}$

2. [**25 points**] Design an NPDA (which uses the convention of accepting with a final state) for the following language. Also, explain how your NPDA works.

$$\{a, b\}^* - \{ww \mid w \in \{a, b\}^*\}$$

3. Consider the grammar G defined below.

$$S \rightarrow aSb \mid T$$
$$T \rightarrow bTaa \mid SS \mid \varepsilon$$

   (a) [**10 points**] Design a new CNF grammar G' such that $L(G') = L(G) - \{\varepsilon\}$.

   (b) [**15 points**] We want to apply the CKY algorithm to see if *abbaa* can be generated by G'. For this, draw the CKY table for $T_{i,j}$'s. Answer the question based on the table you have drawn. (look at the lecture notes, or at the book page 194 for an example of a table that has been filled out for another example. Note that each $T_{i,j}$ is a set of non-terminals.