CS 383: Theory of Computation **Fall 2023**

Homework 5

Instructions

For each of the languages below, construct a context free grammar (CFG) in JFLAP that generates the given language.

In addition, for each language, create two text files, one that contains 5 strings (one string per line) that are in the language and one that contains 5 strings (one string per line) that are *not* in the language. Name the files according to the problem number: `1.jff` for the JFLAP file, `1-in.txt` for the list of 5 strings in the language, and `1-out.txt` for the list of 5 strings not in the language and similarly for the other problems, `2.jff`, `2-in.txt`, `2-out.txt`, etc.

In order to test if strings are in the language or not, first convert the CFG to Chomsky normal form (CNF) by selecting "Transform Grammar" from the "Convert" menu and selecting "Do all" and then "Proceed" until the CFG is in CNF and then click "Export." You can test the resulting CFG by selecting "Multiple CYK Parse" from the "Input" menu. **If you do not first convert to CNF, the CYK algorithm will fail and JFLAP will give you incorrect results.** The grammars you turn in should *not* be the ones you converted to CNF.

Problem 1 [10 points] $A = \{w \mid w \in \{\mathtt{a}, \mathtt{b}\}^* \text{ has more } \mathtt{a}\text{s than } \mathtt{b}\text{s}\}$.

Problem 2 [10 points] $B = \{w\#x \mid w, x \in \{\mathtt{a}, \mathtt{b}\}^* \text{ and } w^{\mathcal{R}} \text{ is a substring of } x\}$. Remember, $w^{\mathcal{R}}$ is a substring of x if there are strings $y, z \in \{\mathtt{a}, \mathtt{b}\}^*$ such that $x = yw^{\mathcal{R}}z$.

Problem 3 [10 points] $C = \{\mathtt{a}^m\mathtt{b}^n\mathtt{c}^k \mid m, n > 0 \text{ and } k = m + n\}$.

Problem 4 [20 points]

$$D = \{x_1\#x_2\#\cdots\#x_k \mid k \geqslant 1, \text{ each } x_i \in \{\mathtt{a}, \mathtt{b}\}^*, \text{ and for some } i \text{ and } j,\ x_i = x_j^{\mathcal{R}}\}.$$

[*Hint: There are two cases you need to handle, $i = j$ and $i < j$ (make sure you understand why $i > j$ is no different from $i < j$). For the $i = j$ case, $x_i = x_i^{\mathcal{R}}$ and the other x values are arbitrary. For the $i < j$ case, you have $x_i = x_j^{\mathcal{R}}$ and any other x values are arbitrary.*]