CSE396, Spring 2019 Problem Set 7 Due Thu. 4/11, 11:59pm

Reading. Next week will cover Turing machines from chapter 3. Please read the whole chapter in one gulp. Tuesday's lecture may blend the definitions of multi-tape and nondeterministic Turing machines with the basic one-tape DTM definition in one shot.

Again, Prelim II is now fixed for **Thursday, April 25**. The homework is back to being due on Thursdays.

Homework—part online and all *individual work*—due **Thu.** 4/11, 11:59pm.

(1) Using *TopHat*, the "Worksheet" titled **Spr'19 HW7.1**. There are 10 questions, each worth 2 points, for 20 total. All are unique-answer questions with 1 attempt given.

(2) Over $\Sigma = \{a, b\}$, define $L = \{ww^R : \#a(w) = \#b(w)\}$. Prove using the CFL Pumping Lemma that L is not a CFL. *Hint:* Think of test strings $x \in L$ that have the form $x = a^i b^j a^k$. What must then be true about the numbers i, j, and k? (24 pts.)

(3) Consider the following three languages over the alphabet $\Sigma = \{a, b, c, d\}$, where by default i, j, k, ℓ are non-negative integers (can be 0):

$$\begin{aligned} L_1 &= \{a^i b^j c^k d^\ell : i < j \wedge k < \ell\} \\ L_2 &= \{a^i b^j c^k d^\ell : i < k \wedge j < \ell\} \\ L_3 &= \{a^i b^j c^k d^\ell : i < \ell \wedge j < k\}. \end{aligned}$$

One of these is not a CFL; the other two are CFLs. Give context-free grammars for the two that are CFLs, and a CFL Pumping Lemma proof for the one that is not a CFL. (You need not prove your grammars correct, but their plan should be clear. (6+6+18 = 30 pts., for 74 total on the set)