CS 2200 Spring 2019 HW 06

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Due Tuesday, April 16, 2019, 11:59PM

Submit your HW as a SINGLE PDF file that includes your answers, your programs, and their output. Also include any data files if you used them. Please make sure that your PDF is well-organized so we can quickly find all the pieces of each problem that belong together.

PROBLEMS

1. (15 points) Answer each part for the following context-free grammar G.

$$R \rightarrow XRX|S \quad (1)$$
$$S \rightarrow aTb|bTa \quad (2)$$
$$T \rightarrow XTX|X|\epsilon \quad (3)$$
$$X \rightarrow a|b \quad (4)$$

   (a) (1 point) What are the variables of G?
   (b) (1 point) What are the terminals of G?
   (c) (1 point) Which is the start variable of G?
   (d) (1 point) Give three strings in L(G).
   (e) (1 point) Give three strings not in L(G).
   (f) (1 point) True or False: T $\rightarrow^*$ aba.
   (g) (1 point) True or False: T$\rightarrow^*$ aba.
   (h) (1 point) True or False: T $\rightarrow^*$ T.
   (i) (1 point) True or False: T$\rightarrow^*$ T .
   (j) (1 point) True or False: XXX $\rightarrow^*$ aba.
   (k) (1 point) True or False: X $\rightarrow^*$ aba.
   (l) (1 point) True or False: T$\rightarrow^*$ XX.
   (m) (1 point) True or False: T $\rightarrow^*$ XXX.

(n) (1 point) True or False: S$\rightarrow^*$ ϵ.

(o) (1 point) Give a description in English of L(G).

2. (20 points) Give context-free grammars that generate the following languages. In all parts, the alphabet A is {0,1}.

   (a) (4 points) {w | w contains at least three 1s}

   (b) (3 points) {w | w starts and ends with the same symbol}

   (c) (3 points) {w | the length of w is odd}

   (d) (4 points) {w | the length of w is odd and its middle symbol is a 0}

   (e) (4 points) {w | w = wR, that is, w is a palindrome}

   (f) (2 points) The empty set

3. (30 points) Using your finite state automaton simulator as a model, create a simulator for Pushdown Automata. Document carefully the file structure that you use to specify the machine and the problem. Please use your simulator to test the PDA in Problem 5.

4. (15 points) Let L_1 be the language { w@y | y is a substring of w, where w, y $\in$ {c,d}* }.

   (a) (5 points) Using the Strong Pumping Lemma for regular languages, show that L_1 is not regular.

   (b) (10 points) Using the Pumping Lemma for context-free languages, show that L_1 is not context-free.

5. (20 points) Let G_2 be the grammar =
({ E, F, T}, { $x, \times, +, (,)$ }, {$E \rightarrow E + T|T, T \rightarrow T \times F|F, F \rightarrow (E)|x$ }, E)

   (a) (8 points) Give parse trees and derivations for each of the following strings: x, x+x, (x×x)+x, ((x)).

   (b) (12 points) Define a PDA, P_2, that recognizes exactly the strings produced by G_2. Test this PDA on the strings in the previous part of this problem.