Homework 3

Cpt S 317, Spring 2017

Due Date: February 17, 2017

Total points: 49

- For all questions that require you to construct a regular expression, do a direct construction. Please do not build a finite automaton and then convert it. That is an indirect solution and won't get points.
- When building regular expressions, try to use a modular approach wherever possible to simplify the design process.
- In your answers involving pumping lemma, use 'N' as your pumping lemma constant, to differentiate it from the lower case n used in problems.

Also, please look at the PDF for "Rubrics" that describes performance indicators pertinent to this homework.

A digital version of this homework in PDF and the Rubrics in PDF are available at `http://www.eecs.wsu.edu/~ananth/CptS317`.

Any reference to problems from the textbook corresponds to the text specified in the course webpage. If you are one of those students who have the wrong text book or the wrong edition, then you need to get the correct question either from me or from others who have the right text. Points won't be awarded for solving the wrong question.

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1. (6 points)

   Give English descriptions of the languages represented by the following regular expressions. The descriptions should be simple, similar to how we have been defining languages in class (e.g., "languages of binary strings containing 0 in even positions..."). Note: While describing your language, you don't want to simply spell out the conditions in your regular expressions. E.g., if the regular expression is $0(0+1)^*$, an answer of the sort "language of all binary strings that start with a 0" will receive A grade, but an answer of the sort "language of all binary strings where the first symbol is a 0 and it is followed by an arbitrary number of 0s and 1s" will receive a B grade. Note that both are technically correct, but the former one is easier to comprehend. Basically, try to simply the description (without losing precision) to the extent possible.

   a) $(0+1)^*1(0+1) + (0+1)^*1(0+1)(0+1)$

   b) $(a+b+c)^*b(a+b+c)^*c(a+b+c)^* + (a+b+c)^*c(a+b+c)^*b(a+b+c)^*$

2. (3 points)

   Give a regular expression for the language of binary strings containing at least two zeros somewhere.

3. (10 points)

   Give a regular expression for each of the following languages.

   a) The set of binary strings *not* containing consecutive 1's.

   b) The set of binary strings containing *exactly one* instance of 11 somewhere inside.

   c) The set of binary strings with *at most* one pair of consecutive 1's — i.e, if 11 is present, it can occur exactly once.

4. (6 points)

   Convert the following regular expressions to $\epsilon-$NFAs. Use the modular building approach discussed in class.

a) $(0+1)01$

b) $00(0+1)^*$

5. (9 points)

   Let R, S and T be any three regular expressions. State True or False for the following. If your answer is false, show a counterexample.

   a) $(\epsilon + R)^*S = R^*S$

   b) $(R+S)^*S^* = (R^*S)^*$

   c) $S(RS+R)^* = (SR+R)^*R$

6. (15 points)

   Prove that the following languages are not regular using the pumping lemma.

   a) Exercise 4.1.1e.

   b) Exercise 4.1.2c.

   c) Exercise 4.1.2f.