COMS W3261 CS Theory: Problem Assignment 1  
Assigned September 26, 2016; due on Courseworks October 4, 2016

Instructions

• Problems 1-5 are each worth 20 points.

• Submit your solutions in pdf format on Courseworks/COMSW3261/Assignments by noon October 4, 2016.

• You can discuss these problems with others but your answers must be in your own words.

• You may choose to skip this assignment since only the four best assignments will be chosen for 15% of the final grade. Late assignments will not be accepted.

Problems

1. If $R$ and $S$ are regular languages, is $R - S$ always a regular language? (− is the set difference operator.) Prove your answer.

2. Let $L$ be the language consisting of all strings of $a$’s and $b$’s with an equal number of occurrences of $aa$ and $bb$ as substrings. (The substring $aabbbaa$ has two occurrences of each of the substrings $aa$ and $bb$.) Is $L$ a regular language? Prove your answer.

3. Let $L$ be the language consisting of all strings of $a$’s and $b$’s with an equal number of occurrences of $ab$ and $ba$ as substrings. (The substring $aabbbaa$ has one occurrence of each of the substrings $ab$ and $ba$.) Is $L$ a regular language? Prove your answer.

4. Construct your own nonregular language that satisfies the pumping lemma for regular languages.

   (a) Prove that your language is not regular.

   (b) Show how your language satisfies the pumping lemma for regular languages.

5. Consider the regular expression $a(ba)^*$.  

   (a) For this regular expression construct an $\epsilon$-NFA using the McNaughton-Yamada-Thompson algorithm. (Specify the five components of your NFA using a transition diagram for the transition function.)

   (b) Show all possible state transition sequences your $\epsilon$-NFA can make on the input $aba$.

   (c) Using the subset construction convert your $\epsilon$-NFA into an equivalent DFA.
(d) Show the sequence of state transitions your DFA makes on the input $aba$. What is the relationship between this sequence of deterministic state transitions to the possible state transition sequences of the $\epsilon$-NFA in part (b) above?

(e) Minimize the number of states in your DFA and draw the transition diagram for your minimum-state DFA.

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