CSCI 311/500 Models of Computation
Homework 4

Due: Thursday, October 11th at the beginning of class

Please follow the guidelines for writing up homework.

1. (a) Right-linear grammar to NFA
   
i. Given the following RL-grammar, draw an NFA for the language.
   
   \[
   \begin{align*}
   S &\rightarrow aA \mid bB \\
   A &\rightarrow bS \\
   B &\rightarrow bD \\
   C &\rightarrow bD \\
   D &\rightarrow aC \mid \lambda
   \end{align*}
   \]

   ii. Give a regular expression or set notation for this language.

   (b) Set-notation to NFA to RL-grammar.
   Consider the language \( L = \{a^ib^j : i + j \text{ is even}\} \).
   
i. Draw an NFA for the language.
   
   ii. Write a right-linear grammar for the language.

2. Properties of Languages
   
   (a) Exhibit an algorithm that given any three regular languages, \( L, L_1, L_2 \), determines whether or not \( L = L_1L_2 \).
   
   (b) Find an algorithm for determining whether language \( L \) contains an infinite number of even-length strings.

   Graduate students do both of the next two problems. Undergraduates do one or the other.

3. Use the pumping lemma to show the language \( L = \{a^n b^l : n \leq l \leq 2n\} \) is not regular.

4. Use the pumping lemma to show the language \( L = \{ww : w \in \{a, b\}^*\} \) is not regular.