Homework 2
CptS 317, Spring 2020
Due Date: February 5, 2020, In Class.

For all questions that ask you to build an NFA, please make sure there is non-determinism somewhere in the machine. In other words, dont provide a DFA as an answer.

There will be five problems, each of which is equally weighted.

1. Build NFAs for the following two languages.

   a) The set of strings over the alphabet \{a, b, c\} such that the last symbol in the string has appeared before.

   b) The set of strings over the alphabet \{a, b, c\} such that the last symbol in the string has not appeared before.

   You can assume that neither of these two languages contain \epsilon in them.

2. Convert the following NFAs to equivalent DFAs
3. Show that if $M$ is a DFA that recognizes language $B$, swapping the accept and nonaccept states in $M$ yields a new DFA recognizing the complement of $B$.

4. Give regular expressions generating the following languages. In all cases, the alphabet is $\{0, 1\}$.
   a) $\{w | w \text{ contains at least three } 1\text{s}\}$
   b) $\{w | w \text{ starts with } 0 \text{ and has odd length, or starts with } 1 \text{ and has even length}\}$
   c) $\{w | \text{ the length of } w \text{ is at most } 5\}$
   d) $\{w | w \text{ is any string except } 11 \text{ and } 111\}$

5. Consider the following description of a simple programming language for evaluating arithmetic expressions:
   - An operator is one of the characters $+ - * /$
   - A number is any sequence of one or more of the digits $0-9$ (example: 42)
• A list expression is defined as an open parenthesis “(”, followed by an operator, followed by a space, followed by one or more expressions (each separated by spaces) and terminated by a close parenthesis “)”.

• An expression is defined as either a number or a list expression.

• A single list expression defines a valid program. An example might look like either of the following:

\[
(+ (* 5 3) (/ 8 4))\\
(\text{-} 25 (+ 4 2))
\]

Is this language regular? Why or why not? If the language is regular, provide a regular expression for valid programs.