CMSC 330, Practice Problems 2

1. Regular expressions and languages
   a. From the perspective of formal language theory, what is a language?
   b. Given the language \(A = \{\text{“aa”}, \text{“c”}\}\) and \(B = \{\text{“b”}\}\), what is the language \(AB\)?
   c. Given the language \(A = \{\text{“aa”}, \text{“c”}\}\), what is the language \(A^0\)?
   d. Given the language \(A = \{\text{“aa”}, \text{“c”}\}\), what is the language \(A^2\)?
   e. Given the language \(A = \{\text{“aa”}, \text{“c”}\}\), what is the language \(A^*\)?
   f. Give a regular expression for all binary numbers including the substring “101”.
   g. Give a regular expression for all binary numbers with an even number of 1’s.
   h. Give a regular expression for all binary numbers that don’t include “000”.

2. Finite automata
   a. When does a NFA accept a string?
   b. How long could it take to reduce a NFA with \(n\) states and \(t\) transitions to a DFA?
   c. Give a NFA that only accepts binary numbers including the substring “101”.
   d. Give a NFA that only accepts binary numbers that include either “00” or “11”.
   e. Give a NFA that only accepts binary numbers that include both “00” and “11”.
   f. What language (or set of strings) is accepted by the following NFA?
   
   ![NFA Diagram]
   
   g. Compute the \(\varepsilon\)-closure of the start state for each of the NFA above.
   h. Give a DFA that only accepts binary number with an odd number of 1’s.
   i. Give a DFA that only accepts binary numbers that include “000”.
   j. Give a DFA that only accepts binary numbers that don’t include “000”.
   k. What language (or set of strings) is accepted by the following DFA?
1. For each regular expression: $1^*, (01)^*0$
   i. Reduce the RE to an NFA using the algorithm described in class.
   ii. Reduce the resulting NFA to an DFA using the subset algorithm.
   iii. Show whether the DFA accepts / rejects the strings “1”, “11”, “101”
   iv. Minimize the resulting DFA using Hopcroft reduction
   v. Are any 2 of the minimized DFA identical?