1. In a spell checker, it is useful to check whether the given word is one symbol away from a word in the dictionary. For a language \( L \), define \( L' \) to the set of all strings obtainable by altering at most one symbol in a string of \( L \). For example, if \( L \) is \{\textsc{cat}, \textsc{dog}\}, then \( L' \) is \{\textsc{aat}, \textsc{bat}, \textsc{cat}, \ldots, \textsc{zat}, \ldots, \textsc{aog}, \ldots, \textsc{doz}\}. Show how to convert an FA for \( L \) into one for \( L' \).

2. Let \( M \) be the language of all binary strings that contain the substring 11 and whose number of 0's is even. (For example, 0101100 is in \( M \).)
   (a) Give a largest possible set of strings that are pairwise distinguishable with respect to \( M \).
   (b) Give a largest possible set of strings that are pairwise indistinguishable with respect to \( M \).
   (c) Give a largest possible set of strings that are pairwise distinguishable with respect to the complement of \( M \).
   (d) Give a largest possible set of strings that are pairwise indistinguishable with respect to the complement of \( M \).

3. For each of the following CFGs: (1) determine which of the strings \( \varepsilon \), \textsc{abba}, \textsc{aaaaa} and \textsc{b} is generated, and (2) give an English description of the language.
   (a) \( S \rightarrow aS \mid bS \mid a \mid b \mid \varepsilon \)
   (b) \( S \rightarrow XaaaX \)
       \( X \rightarrow aX \mid bX \mid \varepsilon \)
   (c) \( S \rightarrow aaS \mid aaaS \mid a \)
   (d) \( S \rightarrow aX \mid bS \mid a \mid b \\
       X \rightarrow aX \mid a \)

4. Give CFGs for the following languages with alphabet \{a, b\}:
   (a) all strings of the form \( a^m b^n \) with \( m \leq n \leq 2m \).
   (b) all strings such that the middle symbol is \( a \).

Due: Tuesday February 15