1. (20%) Give state diagrams of DFAs recognizing the following languages. In both parts, the alphabet is \{0, 1\}.
   (a) \{w \mid w \text{ does not contain the substring } 110\}
   (b) \{w \mid w \text{ is any string except } 11 \text{ and } 111\}

2. (15%)
   (a) Show that, if \(M\) is a DFA that recognizes language \(B\), swapping the accept and nonaccept states in \(M\) yields a new DFA that recognizes the complement of \(B\). Conclude that the class of regular languages is closed under complement.
   (b) Show by giving an example that, if \(M\) is an NFA that recognizes language \(C\), swapping the accept and nonaccept states in \(M\) does not necessarily yield a new NFA that recognizes the complement of \(C\). Is the class of languages closed under complement? Explain your answer.

3. (15%)
   (a) Give a formal description of the following NFA:

   (b) Use the construction given in Notes 4 (pages 13–14) to convert the above NFA to an equivalent DFA.

4. (10%) Show that the language \(A = \{www \mid w \in \{a, b\}^*\}\) is not regular.

5. (20%) Prove that the following languages are not regular. You may use the pumping lemma and the closure of the class of regular languages under union, intersection, and complement.
   (a) \(\{w \mid w \in \{0, 1\}^* \text{ is not a palindrome}\}\)
   (b) \(\{wtw \mid w, t \in \{0, 1\}^+\}\)

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\(^1\) A palindrome is a string such that it reads the same forward and backward. E.g., dad, level, racecar.
6. (20%) Let $A/B = \{ w | wx \in A \text{ for some } x \in B \}$.

(a) Suppose that $A$ is a language recognized by the following DFA:

![DFA Diagram](image1)

Also, suppose that $B = \{ 0^n1^n \mid n \geq 1 \}$. Show that the language $A/B$ is recognized by the following DFA:

![DFA Diagram](image2)

(b) In general, show that if $A$ is regular and $B$ is any language, $A/B$ is regular.

7. (Further studies: No marks) Use the procedure described in Notes 6 (pages 5–8) to convert the regular expression $(a \cup b^+)(ab)^*$ to an equivalent NFA.

8. (Further studies: No marks) Use the procedure described in Notes 6 (pages 15–18) to convert the DFA of Question 6(a) to an equivalent regular expression.

9. (Further studies: No marks) Study last year’s Homework 1, which is indeed quite difficult 😞.