

CS5371 THEORY OF COMPUTATION

Homework 1

Due: 2:10 pm, October 16, 2007 (before class)

1. (20%) Give state diagrams of DFAs recognizing the following languages. In both parts, the alphabet is $\{0, 1\}$.

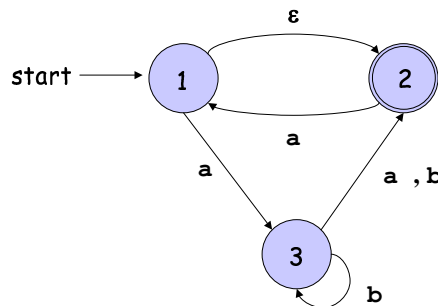
- (a) $\{w \mid w \text{ does not contain the substring } 110\}$
- (b) $\{w \mid w \text{ is any string except } 11 \text{ and } 111\}$

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:

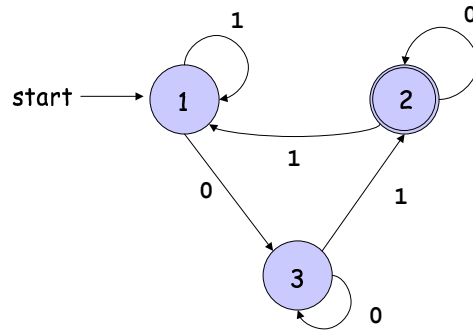


- (b) Use the construction given in Notes 4 (pages 13–14) to convert the above NFA to an equivalent DFA.
4. (10%) Show that the language $A = \{www \mid w \in \{a, b\}^*\}$ is not regular.
5. (20%) Prove that the following languages are not regular. You may use the pumping lemma and the closure of the class of regular languages under union, intersection, and complement.
- (a) $\{w \mid w \in \{0, 1\}^* \text{ is not a palindrome}\}^1$
 - (b) $\{wtw \mid w, t \in \{0, 1\}^+\}$

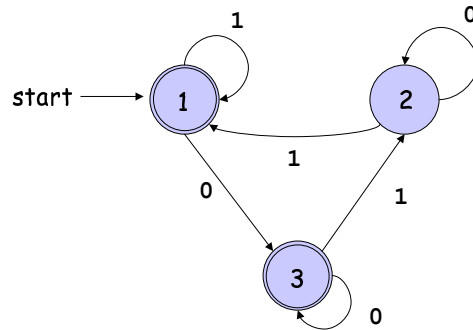
¹A palindrome is a string such that it reads the same forward and backward. E.g., dad, level, racecar.

6. (20%) Let $A/B = \{w \mid wx \in A \text{ for some } x \in B\}$.

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



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



(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 ^_~;.