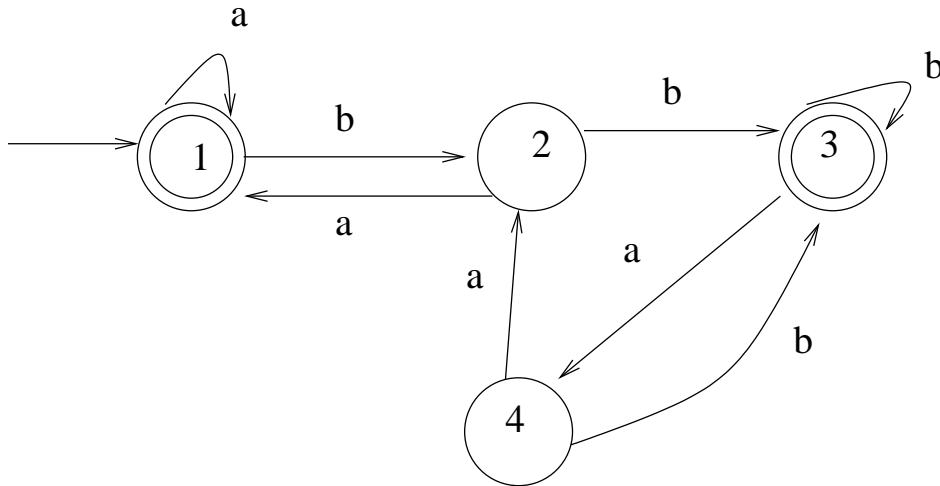


CS341 Automata Theory

Midterm Practice Problems

1. Define a deterministic finite automaton for the following languages:
 - (a) $L = \{w \in \{0, 1, \dots, 9\}^* \mid w \text{ represents an odd natural number with no leading 0s}\}$
 - (b) $L = \{w \in \{0, 1, 2\}^* \mid w \text{ does not end in } 12\}$
 - (c) $L = \{w \in \{a, b\}^* \mid w \text{ contains the string } aba \text{ or } w \text{ does not contain } aa\}$
2. Define an NFA that recognizes the following languages:
 - (a) $L = \{w \in \{a, b\}^* \mid w \text{ contains at least one instance of } abaa, abbb, \text{ or } baab\}$
 - (b) $L = \{a^n b a^m \mid n, m \geq 0, n \equiv_3 m\}$
 - (c) $L = \{w \in \{a, b, c\}^* \mid w \text{ contains substring } abb \text{ and substring } bbc\}$
3. Describe concisely the language described by the regular expression.
 - (a) $(a^*a)b \cup b$
 - (b) $(a^*b^*)^*ab \cup (a^*b^*)^*ba(b \cup a)^*$
4. Write a regular expression that represents the following languages.
 - (a) $L = \{w \in \{a, b\}^* \mid \#_a(w) \leq 5\}$
 - (b) $L = \{w \in \{a, b\}^* \mid \#_a(w) \equiv_3 0\}$
 - (c) $L = \{w \in \{a, b\}^* \mid w \text{ contains exactly one occurrence of string } aa\}$
5. Use the algorithm presented in class to convert the regular expression $(0 \cup 1)^* 000(0 \cup 1)^*$ to an NFA.
6. Convert the following finite automaton to a regular expression using the algorithm given in class.



7. 1.29 in Sipser

8. 1.30 in Sipser

9. True or False:

- (a) The union of an infinite number of regular languages is regular.
- (b) The intersection of an infinite number of regular languages is regular.
- (c) Every subset of a regular language is regular.

10. For each of the following languages L , state whether L is regular or not. Prove your answer.

- (a) $L = \{xy \mid x, y \in \{0, 1\}^*, \text{ and } \#_0(x) = \#_0(y)\}$
- (b) $L = \{xy \mid x, y \in \{0, 1\}^*, \text{ and } \#_0(x) = \#_1(y)\}$
- (c) $L = \{x2y \mid x, y \in \{0, 1\}^*, \text{ and } \#_0(x) = \#_1(y)\}$
- (d) $L = \{a^i b^j c^k \mid i + j = k\}$
- (e) $L = \{a^i b^j c^k \mid (i = 1) \rightarrow (j = k)\}$
- (f) $L = \{a^p \mid p \text{ is prime}\}$
- (g) $L = \{w \in \{0, 1\}^* \mid \#_0(w) \neq \#_1(w)\}$