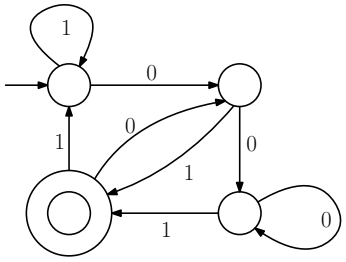
Midterm COMP 3803

February 28, 2019

- All questions must be answered on the scantron sheet.
- Each question is worth 1 mark.

1. Which of these four strings is accepted by the following DFA?

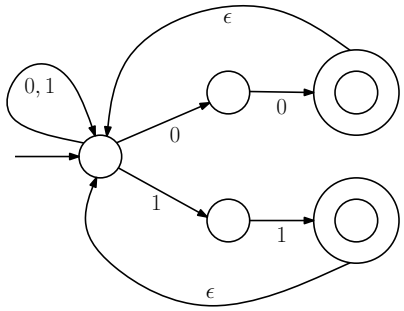


   (a) ϵ
   (b) 001110
   (c) 001011
   (d) 110101

2. Consider the DFA in the previous question. What is the language of this DFA?

   (a) $\{w \in \{0,1\}^* : \text{ the length of } w \text{ is even}\}$
   (b) $\{w \in \{0,1\}^* : \ w \text{ contains } 01\}$
   (c) $\{w \in \{0,1\}^* : \text{ the last two bits in } w \text{ are } 01\}$
   (d) $\{w \in \{0,1\}^* : \text{ the last two bits in } w \text{ are } 10\}$

3. Which of these four strings is accepted by the following NFA?



   (a) 1001001

   (b) 1001011

   (c) 1001010

   (d) ϵ

4. Consider the NFA in the previous question. Which regular expression describes the language that is accepted by this NFA?

   (a) $((0 \cup 1)^*(00 \cup 11))^*$

   (b) $(0 \cup 1)^*(00 \cup 11)((0 \cup 1)^*(00 \cup 11))^*$

   (c) $((0 \cup 1)(00 \cup 11))^*$

   (d) $(0 \cup 1)(00 \cup 11)((0 \cup 1)(00 \cup 11))^*$

5. Let M be an NFA with alphabet $\{0, 1\}$ that accepts the string 0. (In other words, $0 \in L(M)$.) Which of the following is true?

   (a) The start state of M must be an accept state.

   (b) There must be an accept state that can be reached from the start state by making one transition.

   (c) There is an NFA that accepts the same language as M and that has an accept state that can be reached from the start state by making 77 transitions.

   (d) None of the above.

6. Which of the following is true?

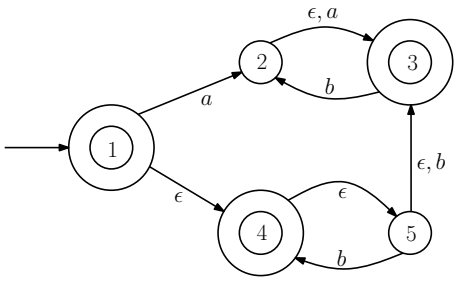
   (a) Let L be the language of the NFA M. If we turn every accept state into a non-accept state, and turn every non-accept state into an accept state, then we obtain an NFA whose language is the complement $\overline{L}$ of L.

   (b) NFA's with ϵ-transitions can accept languages that cannot be accepted by any NFA without ϵ-transitions.

   (c) For every non-empty regular language L, there exists an NFA whose language is L and that has exactly one accept state.

   (d) There exists a language L consisting of a finite number of strings, such that L is not regular.

7. Consider the following NFA:



Assume we convert this NFA to an equivalent DFA (without removing unnecessary states). Consider the following statements:

P : the start state of the DFA is $\{1, 3, 4, 5\}$.
Q : the DFA accepts the string bba.
R : when the DFA is in state $\{5\}$ and reads b, it switches to the state $\{2, 3, 4, 5\}$.

Which of the following are correct?

(a) P is true, Q is true, R is false.

(b) P is false, Q is false, R is true.

(c) P is true, Q is true, R is true.

(d) P is false, Q is true, R is false.

8. Which of the following strings is in the language that is described by the regular expression $(a \cup b)(a^*bc^* \cup a)^* b$.

(a) $baabbc$

(b) $bcccabb$

(c) $acccabb$

(d) $abccabb$

9. Let A be the language

$$A = \{w \in \{a, b\}^* : \text{ every } b \text{ in } w \text{ is followed by at least two } a\text{'s}\}.$$

Which of the following regular expressions describes the language A?

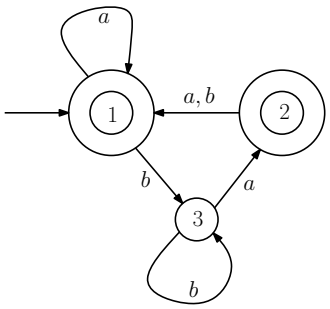
(a) $a^*(baaa^*)^*$

(b) $(baaa^*)^*$

(c) $a^*baaa^*(baaa^*)^*$

(d) $baaa^*(baaa^*)^*$

10. Consider the following DFA:



For each $i = 1, 2, 3$, let L_i be the language of this DFA if we make i the start state. Consider the following statements:

$$\begin{array}{lcl} P & : & L_1 = aL_1 \cup bL_3 \\ Q & : & L_2 = (a \cup b)a^*bL_3 \\ R & : & L_3 = b^*aL_2 \end{array}$$

Which of the following are correct?

(a) P is true, Q is true, R is true.

(b) P is false, Q is false, R is true.

(c) P is false, Q is true, R is true.

(d) P is false, Q is true, R is false.

11. True or false: There exists a regular expression that describes the language $\{a^n b^n c^n : n \geq 12\}$.

(a) True

(b) False

12. True or false: Let L be the language described by the regular expression a^*b^*, and let L' be the language described by the regular expression b^*a^*. Then the regular expression $a^* \cup b^*$ describes the language $L \cap L'$.

(a) True

(b) False

13. Let $A = \{a^{m+1}b^n : n > m \geq 0\}$. Assume we use the Pumping Lemma to prove that A is not a regular language. Which of the following string can be used to obtain a contradiction? (p denotes the pumping length.)

(a) $a^{m+1}b^n$

(b) $a^{p-1}b^p$

(c) $a^{p+1}b^p$

(d) $a^p b^p$.

14. Let A and B be languages such that $A \subseteq B$; thus, A is a subset of B. Assume that the language A is regular. Which of the following is true?

    (a) B must be regular.

    (b) B cannot be regular.

    (c) B may be regular.

    (d) Since the Pumping Lemma applies to A, and since $A \subseteq B$, the Pumping Lemma applies to B as well.

15. Let L be a language consisting of a finite number of binary strings. Which of the following is true?

    (a) The Pumping Lemma applies to L.

    (b) The Pumping Lemma does not apply to L.

16. Define the language $L = \{a^n b^n : n \geq 1\}$, let $\overline{L}$ denote the complement of L, and define $L' = L\overline{L}$, i.e., L' is the concatenation of L and $\overline{L}$. Which of the following is true?

    (a) The language L' is regular.

    (b) The language L' is not regular.

17. Let A, B, and C be languages such that $A \cup B = C$. Which of the following is true?

    (a) If C is regular, then both A and B are regular.

    (b) If C is regular, then at least one of A and B is regular.

    (c) If A is not regular, then C is not regular.

    (d) None of the above.

18. Which proof technique did we use to prove the Pumping Lemma?

    (a) We used a proof by contradiction.

    (b) We used induction on the number of states of the DFA that accepts the language.

    (c) We used the Pigeonhole Principle.

    (d) We used the conversion of DFA's to regular expressions.