CSE 331: Automata & Computability
Spring 2024
Prepared By: KKP
Assignment 01 (DFA & NFA)
Total Mark: 94

[Or means you may solve any One question]
[Problems having multiple Or, mention the problem no properly. For example: 2a) 3b)]

Submission Deadline:

- Part A (Question 1-9): Feb 8, 2024
- Part A (Question 10-18): Feb 12, 2024
- Part B (Question 01-04): Feb 17, 2024

Submission Link: https://forms.gle/7SgURw2ThbZntfVW6

Penalty:

- For every one day delay you will receive a 5 marks penalty.
- If you plagiarize , then each member of the group will receive (number of question plagiarized * 3 * number of group members) points penalty.

Additional Resources

Please go through the video lectures of Mursalin Sir [**The first three video lectures on DFA**]
Link: https://drive.google.com/drive/folders/179OApcX9k_8GBFM3Suea1_SEwTpyReRW

Part A: Deterministic Finite Automata (DFA) [Each question contains 3 marks]

1. a) Draw a DFA for the set of strings that have three consecutive 0s. $\sum = \{0,1\}$

   Or, b) Draw a DFA for the set of strings that doesn't contain 0s. $\sum = \{0,1\}$

2. a) Construct a DFA that accept the language, L = { w ∈ {a,b}*: w starts and ends with different symbols.}

   Or, b) Construct a DFA that accept the language, L = { w ∈ {a,b}*: w starts and ends with the same symbol.}

3. a) Draw a DFA of strings that ends with "0101". $\sum = \{0,1\}$

   Or, b) Design a DFA that accepts the language L = {w | w ends with the substring "yxxy"} over the alphabet {*x*,*y*}

4. Construct a DFA defined as L = { w ∈ {0,1}*: the length of w is one more than multiple of 3}

5. Construct a DFA defined as L = { w ∈ {0,1}*: w, when **interpreted** as **a binary number,** is divisible by 5.}

6. L = {w ∈ {0, 1, #}* : w does not contain # and the number of 0s in w is not a multiple of 3}

7. Construct a DFA of the language *L* over the alphabet $\sum = \{a,b,c\}$ defined as follows-
   L = { w|w does not contain "ba" and ends with "cb"}

8. Draw a DFA of strings that contains at least three 0s or exactly two 1s. $\sum = \{0,1\}$

9. a) Draw a DFA of strings where the 2nd last symbol is a. $\sum = \{a,b\}$

   Or, b) Draw a DFA of strings where the 3rd last symbol is 1. $\sum = \{0,1\}$ [You may draw the NFA for this problem if you find it difficult to solve using DFA]

10. a) Draw a DFA of strings that have 1 as every 3rd symbol. $\sum = \{0,1\}$

Or, b) The set of binary numbers has 0 in all even positions. ∑={0,1}.

11. a) Draw a DFA which accepts exactly one “ab”. ∑ = {a,b}

    Or, b) Draw a DFA which accepts exactly two “ab”. ∑ = {a,b}

12. Draw a DFA which accepts at least two “00” as a substring. ∑ = {0,1}

13. a) Draw a DFA which accepts exactly two “00” as a substring. ∑ = {0,1}

    Or, b) Draw a DFA which accepts at most two “00” as a substring. ∑ = {0,1}

14. Construct a DFA defined as L = {An even number of 0s follow the last 1 in w} ∑ = {0,1}

15. Construct a DFA defined as L = {w| each “b” is followed by at least one “a”} ∑ = {a,b}
    For example: baaa

16. Construct a DFA where the set of binary strings where numbers of 0s between two successive 1s will be even. ∑ = {0,1}.

17. a) Construct a DFA of the Language, L = { w ∈ {0,1}* : w contains 01^{m}0 as a substring where m is divisible by 3 }

    Or, b) Construct a DFA of the Language, L = { w ∈ {0,1}* : w contains 01^{m}0 as a substring where m leaves a remainder of 2 when divided by 3}

Hints:

$$\text{We denote by } 1^m \text{ the string } \underbrace{111\ldots111}_{m \text{ times}}.$$

18. a) Construct a DFA of the Language, L = { w ∈ {0,1}* : w = 0^{m}1^n where m and n are both odd.}

    Or, b) Construct a DFA of the Language, L = { w ∈ {0,1}* : w = 0^{m}1^n where m and n are both even.}

    Or, c) The problem can also be designed as:

    L1 = {w : w = 0^m, where m is even}
    L2 = {w : w = 1^n, where n is even}
    L = L1 . L2

    Prove L is a regular language by giving a state diagram for DFA.

Part B: Mursalin Sir’s [MHB] Quiz Question from Previous semesters [Each question contains 10 marks.]

Question 1.

Let ∑ = {0, 1}
L1 = {w : w = 1^m where m is odd}
L2 = {w : w does not contain any y ∈ L1 as a substring}

(a) Write down a length 6 string that is in L2. (1 point) .
(b) Give the state diagram for a DFA that recognizes L1. (5 points)
(c) Give the state diagram for a DFA that recognizes L2. (3 points)
(d) Give the state diagram for a DFA that recognizes L1 ∩ L2. You can use the construction shown in class but there is a much simpler DFA. (2 points)

Question 2.

The symmetric difference of the languages L1 and L2, denoted by L1△L2, is defined in the following way.

L1△L2 = {w : w is in exactly one of L1 and L2}

Let ∑ = {0, 1}. Consider the following languages over ∑.

A = {w : the length of w is greater than or equal to 3 but less than or equal to 5}
B = {w : the length of w is greater than or equal to 2 but less than or equal to 4}
C = {w : the length of w is odd}

(a) Give the state diagram for a DFA that recognizes A. (2 points)
(b) Give the state diagram for a DFA that recognizes B. (2 points)
(c) Give the state diagram for a DFA that recognizes A△B. (2 points)
(d) If you use the construction from class to get a DFA for the language (A△B)∪ C, how many states will it have? (1 point)
(e) Give a 5-state DFA that recognizes (A△B) ∪ C. (3 points)

Question 3.

Let ∑ = {0, 1}. Consider the following languages over ∑.

L1 = {w : every second letter of w is 0}
L2 = {w : every third letter of w is 1}

(a) Write down a length 5 string that is in L1 ∩ L2. (1 point) .
(b) Give the state diagram for a DFA that recognizes L1. (3 points)
(c) Give the state diagram for a DFA that recognizes L2. (3 points)
(d) Give the state diagram for a DFA that recognizes L1 ∩ L2. (3 points)

Question 4.

Let ∑ = {0, 1}. Consider the following languages over ∑.

L1 = {0, 10}
$L2 = L_1^*$
L3 = {w : the length of w is four}

(a) Write down all the strings in L2 ∩ L3. (2.5 points)
(b) Give the state diagram for a DFA that recognizes L1. (4.5 points)
(c) Give the state diagram for a DFA that recognizes L2. (3 points)

For Practice: [Don't have to submit]

Non-Deterministic finite automata (NFA)

1. Construct a NFA which recognize the language L = { w ∈ $\{0,1\}^*$: w contains both "000" and "111" as a substring}

2. Construct a NFA which recognize the language L = { w ∈ $\{0,1\}^*$: w contains at least two 0s or exactly two 1s}

3. Construct a NFAs for for the languages L = {w ∈ ∑: w does not start with a Punctuation or contains only Alphabets} where ∑ = D U A U P

   Digit, D = {0,1,2,3,4,5,6,7,8,9}
   Alphabet, A = {a, b, c,....., x, y, z}
   Punctuation, P = {*,#}

   You can use the sets above to label the transitions of your NFA.