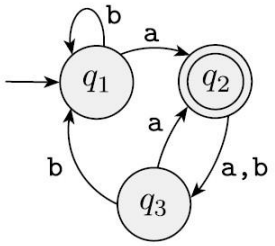
CS333 Theory of Automata

Assignment 1

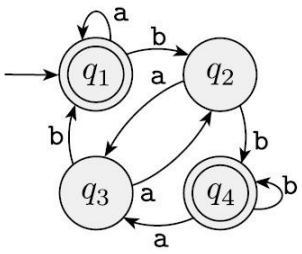
Topics Covered: **Deterministic Finite State Automata**

Deadline: Monday, March 18, 2024 Total Points: 120

A**1.1** The following are the state diagrams of two DFAs, M_1 and M_2. Answer the following questions about each of these machines. [5x2=10 pts.]



M_1



M_2

a. What is the start state?

b. What is the set of accept states?

c. What sequence of states does the machine go through on input `aabb`?

d. Does the machine accept the string `aabb`?

e. Does the machine accept the string ε? [2x2=4 pts.]

A**1.2** Give the formal description of the machines M_1 and M_2 pictured in Exercise 1.1.

1.3 The formal description of a DFA M is $(\{q_1, q_2, q_3, q_4, q_5\}, \{\mathtt{u}, \mathtt{d}\}, \delta, q_3, \{q_3\})$, where δ is given by the following table. Give the state diagram of this machine. [3 pts.]

	u	d
q_1	q_1	q_2
q_2	q_1	q_3
q_3	q_2	q_4
q_4	q_3	q_5
q_5	q_4	q_5

1.4 Each of the following languages is the intersection of two simpler languages. In each part, construct DFAs for the simpler languages, then combine them using the construction discussed in footnote 3 (page 46) to give the state diagram of a DFA for the language given. In all parts, $\Sigma = \{\mathtt{a}, \mathtt{b}\}$.

[7x5=35 pts.]
1+1 pts for each simple DFA + 3 pts. for the intersection i.e., final DFA

a. $\{w \mid w$ has at least three a's and at least two b's$\}$

A**b.** $\{w \mid w$ has exactly two a's and at least two b's$\}$

c. $\{w \mid w$ has an even number of a's and one or two b's$\}$

A**d.** $\{w \mid w$ has an even number of a's and each a is followed by at least one b$\}$

e. $\{w \mid w$ starts with an a and has at most one b$\}$

f. $\{w \mid w$ has an odd number of a's and ends with a b$\}$

g. $\{w \mid w$ has even length and an odd number of a's$\}$

1.5 Each of the following languages is the complement of a simpler language. In each part, construct a DFA for the simpler language, then use it to give the state diagram of a DFA for the language given. In all parts, $\Sigma = \{\mathtt{a}, \mathtt{b}\}$.

[8x5=40 pts.]
3 pts for each simple DFA + 2 pts. for final DFA

- **a.** $\{w \mid w$ does not contain the substring $\mathtt{ab}\}$
- **b.** $\{w \mid w$ does not contain the substring $\mathtt{baba}\}$
- **c.** $\{w \mid w$ contains neither the substrings $\mathtt{ab}$ nor $\mathtt{ba}\}$
- **d.** $\{w \mid w$ is any string not in $\mathtt{a}^*\mathtt{b}^*\}$
- **e.** $\{w \mid w$ is any string not in $(\mathtt{ab}^+)^*\}$
- **f.** $\{w \mid w$ is any string not in $\mathtt{a}^* \cup \mathtt{b}^*\}$
- **g.** $\{w \mid w$ is any string that doesn't contain exactly two $\mathtt{a}$'s$\}$
- **h.** $\{w \mid w$ is any string except $\mathtt{a}$ and $\mathtt{b}\}$

1.6 Give state diagrams of DFAs recognizing the following languages. In all parts, the alphabet is $\{0,1\}$.

[14x2=28 pts.]

- **a.** $\{w \mid w$ begins with a 1 and ends with a $0\}$
- **b.** $\{w \mid w$ contains at least three 1s$\}$
- **c.** $\{w \mid w$ contains the substring 0101 (i.e., $w = x0101y$ for some x and y)$\}$
- **d.** $\{w \mid w$ has length at least 3 and its third symbol is a $0\}$
- **e.** $\{w \mid w$ starts with 0 and has odd length, or starts with 1 and has even length$\}$
- **f.** $\{w \mid w$ doesn't contain the substring $110\}$
- **g.** $\{w \mid$ the length of w is at most $5\}$
- **h.** $\{w \mid w$ is any string except 11 and $111\}$
- **i.** $\{w \mid$ every odd position of w is a $1\}$
- **j.** $\{w \mid w$ contains at least two 0s and at most one $1\}$
- **k.** $\{\varepsilon, 0\}$
- **l.** $\{w \mid w$ contains an even number of 0s, or contains exactly two 1s$\}$
- **m.** The empty set
- **n.** All strings except the empty string

Reference: Exercises 1.1 to 1.6 from the textbook (Introduction to the Theory of Computation, 3ed. by Michael Sipser)

Important Instructions:

- For full credit, show your working clearly and state any assumptions that you have made.
- JFLAP use: You are encouraged to use JFLAP tool for drawing the DFAs.
