Homework Assignment 5
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Due on Oct. 30, 2002 by 1pm

1 Exercise 1

Take $M_1$, a diagram for a deterministic FSA.

![Diagram of a deterministic FSA]

Give the formal description of $M_1$, where $M_1 = < Q, \Sigma, \delta, q_0, F >$, where

1. $Q =$
2. $\Sigma =$
3. $\delta$ is defined as

<table>
<thead>
<tr>
<th></th>
<th>0</th>
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<tbody>
<tr>
<td>$q_0$</td>
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<td>$q_1$</td>
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<td>$q_2$</td>
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<td>$q_3$</td>
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<td>$q_4$</td>
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4. The start state is
5. $F =$

Which of the following strings does $M_1$ accept?

- a. 101
- b. $\epsilon$
- c. 111111
- d. 000
- e. 0101
- f. 000011
- g. 10000
- h. 01111
- i. 10101
- j. 00001
2 Exercise 2

i Let $M_A$ have the following state diagram:

![State Diagram](image)

Describe as simply as possible the crucial characteristic of the language recognized by this automaton.

ii Let $M_B$ have the following state diagram:

![State Diagram](image)

Describe as simply as possible the crucial characteristic of the language recognized by this automaton.

iii Construct $M'$ that recognizes $L(M_A) \cap L(M_B)$ following the instructions on page 13 of the Deterministic FSA lecture notes. Spell out the formal description of $M'$, draw its diagram, and describe as simply as possible the characteristic of the language recognized by this automaton.

$M_1 = \langle Q, \Sigma, \delta, \epsilon, F \rangle$, where

1. $Q =$
2. $\Sigma =$
3. $\delta$ is defined as

<table>
<thead>
<tr>
<th>$&lt;q0,q3&gt;$</th>
<th>$&lt;q0,q4&gt;$</th>
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4. The start state is
5. $F =$. 

2
3 Exercise 3

Show that the following languages are regular. That is, construct state diagrams for (deterministic) FSA that recognize the following languages. For each language, assume that $\Sigma = \{0, 1\}$ and use as few states as possible.

i) $\{11, 111, 1111\}$

ii) $\{w : w \neq \epsilon \text{ and every position that is a multiple of 3 has a 1} \}$

iii) $\{w : w \text{ contains the sub-string 10 at least three times} \}$

iv) $\{w : w \text{ contains the sub-string 001 no more than twice} \}$

v) $\{w : w \neq \epsilon \text{ and } w \text{ starts and ends with the same symbol of the alphabet} \}$

vi) $\{w : w \text{ is any string except for } 11 \text{ and } 111 \}$

4 Exercise 4

Give a state diagram for the deterministic FSA that recognizes the following language:

$L = \{w : w \text{ contains the substring } ab, \text{ or it contains exactly two } a \text{ as (or both)} \}$

Check that the prediction for the following strings is correct:

a. $\emptyset$ Not accepted
b. $aaa$ Not accepted
c. $ab$ Accepted
d. $aba$ Accepted
e. $aabab$ Accepted
f. $bbbaa$ Accepted
g. $bbaaaa$ Not accepted
h. $aaabaa$ Accepted
i. $aa$ Accepted