Date ....

THEORY OF COMPUTATION

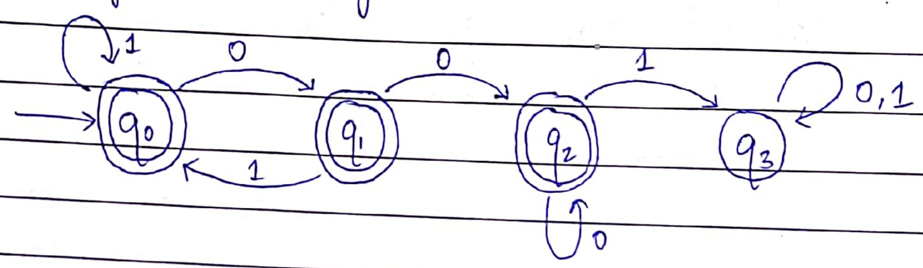
MC-304

ASSIGNMENT-1

SUBMITTED BY: AIMAN SIDDIQUA

2K18/MC/008

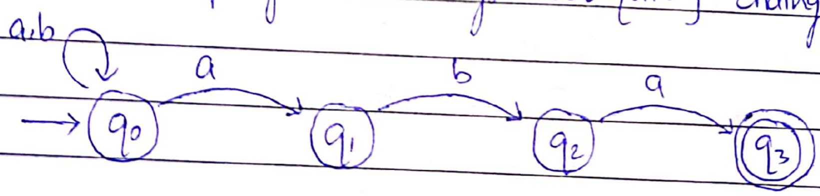
① DFA that accepts all strings over $\{0,1\}$ except those containing the substring 001 :



State Table:

	0	1
$\rightarrow q_0$	q_1	q_0
q_1	q_2	q_0
q_2	q_2	q_3
q_3	q_3	q_3

② NDFA accepting the strings over $\{a,b\}$ ending in aba



$M = (\{q_0, q_1, q_2, q_3\}, \{a,b\}, \delta, q_0, \{q_3\})$

Let $Q = \{q_0, q_1, q_2, q_3\}$

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A DFA accepting the same set of strings is:

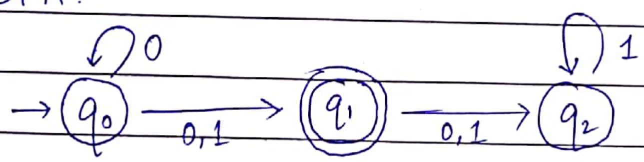
$M' = (2^Q, \{a,b\}, \delta', [q_0], F)$

where $F = ([q_3], [q_3, q_0], [q_3, q_1], [q_3, q_2], [q_3, q_0, q_1], [q_3, q_0, q_2], [q_3, q_1, q_2], [q_3, q_0, q_1, q_2])$

State Table:

State / Σ	a	b
$\rightarrow [q_0]$	$[q_0\ q_1]$	$[q_0]$
$[q_0\ q_1]$	$[q_0\ q_1]$	$[q_0\ q_2]$
$[q_0, q_2]$	$[q_0, q_1, q_3]$	$[q_0]$
$[q_0, q_1, q_3]$	$[q_0, q_1]$	$[q_0, q_2]$

(3.) NDFA:



$M = (Q, \{0,1\}, \delta, q_0, \{q_1\})$

where $Q = \{q_0, q_1, q_2\}$

State Table

State / Σ	0	1
$\rightarrow q_0$	q_0, q_1	q_1
q_1	q_2	q_2
q_2		q_2

Corresponding DFA:

$M' = (2^Q, \{0,1\}, \delta', [q_0], F)$

where $F = (\{q_1\}, [q_1, q_0], [q_1, q_2], [q_1, q_0, q_2])$

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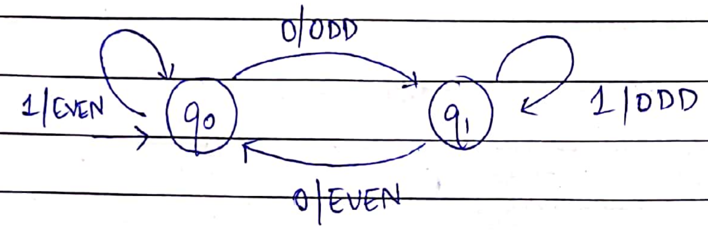
and δ' is defined by state table:

State / Σ	0	1
$\rightarrow [q_0]$	$[q_0, q_1]$	$[q_1]$
$[q_0\ q_1]$	$[q_0, q_1, q_2]$	$[q_1, q_2]$
$[q_1]$	$[q_2]$	$[q_2]$
$[q_0, q_1, q_2]$	$[q_0, q_1, q_2]$	$[q_1, q_2]$
$[q_1, q_2]$	$[q_2]$	$[q_2]$
$[q_2]$	ϕ	$[q_2]$

(4.)



State Table:

Present State	Next State			
	Input a=0		Input a=1	
	state	Output	state	Output
$\rightarrow q_0$	q_1	ODD	q_0	EVEN
q_1	q_0	EVEN	q_1	ODD

(5.) Since q_2 and q_3 are associated with different outputs, we split them into q_{20}, q_{21} and q_{30}, q_{31} respectively. The table can be reconstructed as:

Present / Next	a=0		a=1	
$\rightarrow q_1$	q_1	1	q_{20}	0
q_{20}	q_4	1	q_4	1
q_{21}	q_4	1	q_4	1
q_{30}	q_{21}	1	q_{31}	1
q_{31}	q_{21}	1	q_{31}	1
q_4	q_{30}	0	q_1	1

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Corresponding Moore Machine:

Present State	Next State a=0	Next State a=1	Output
→ q_1	q_1	q_{20}	1
q_{20}	q_4	q_4	0
q_{21}	q_4	q_4	1
q_{30}	q_{21}	q_{31}	0
q_{31}	q_{21}	q_{31}	1
q_4	q_{30}	q_1	1

6. Mealy Machine:

Present State	Next State a=0 State	a=0 Output	a=1 State	a=1 Output
→ q_0	q_1	0	q_2	1
q_1	q_3	1	q_2	1
q_2	q_2	1	q_1	0
q_3	q_0	1	q_3	1

7.

State	Input a	b
→ q_0	q_0	q_3
q_1	q_2	q_5
q_2	q_3	q_4
q_3	q_0	q_5
q_4	q_0	q_6
q_5	q_1	q_4
q_6	q_1	q_3

$\pi_0 = \{\{q_6\}, \{q_0, q_1, q_2, q_3, q_4, q_5\}\}$

Spiral

$\pi_1 = \{ \{q_6\}, \{q_0, q_1, q_2, q_3, q_5\}, \{q_4\} \}$

$\pi_2 = \{ \{q_6\}, \{q_0, q_1, q_3\}, \{q_2, q_5\}, \{q_4\} \}$

$\pi_3 = \{ \{q_6\}, \{q_0\}, \{q_1\}, \{q_3\}, \{q_2, q_5\}, \{q_4\} \}$

$\pi_4 = \{ \{q_6\}, \{q_0\}, \{q_1\}, \{q_3\}, \{q_2\}, \{q_5\}, \{q_4\} \}$

Hence the minimum state automaton is same as the given automata.

8. Transition table for the given automata:

State	Input 0	1
$\rightarrow q_0$	q_1	q_3
q_1	q_0	q_3
q_2	q_1	q_4
q_3	q_5	q_5
q_4	q_3	q_3
q_5	q_5	q_5

$\pi_0 = \{ \{q_3, q_5\}, \{q_0, q_1, q_2, q_4\} \}$

$\pi_1 = \{ \{q_3, q_5\}, \{q_0, q_1\}, \{q_2\}, \{q_4\} \}$

$\pi_2 = \{ \{q_3, q_5\}, \{q_0, q_1\}, \{q_2\} \{q_4\} \}$

As $\pi_1 = \pi_2$, π_1 gives us the equivalence classes

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Minimum State Automata:

$$M' = (Q', \{0,1\}, \delta', q_0', F')$$

where

$Q' = \{[q_3, q_5], [q_0, q_1], [q_2], [q_4]\}$

$q_0' = [q_0, q_1]$

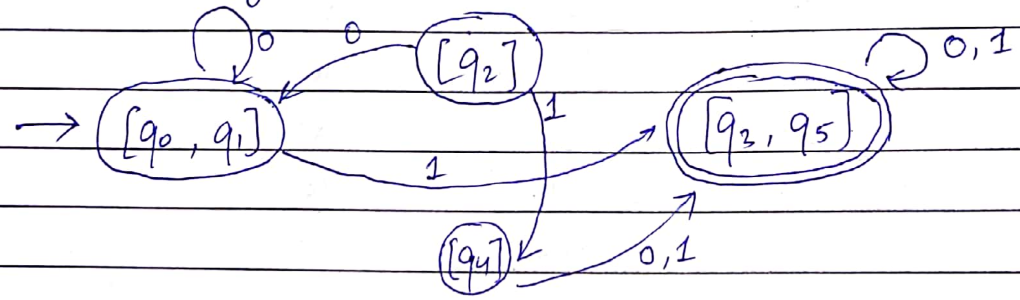
$F' = [q_3, q_5]$

and

δ' is defined by the following table:

State / Σ	0	1
→ $[q_0\ q_1]$	$[q_0, q_1]$	$[q_3, q_5]$
$[q_2]$	$[q_0, q_1]$	$[q_4]$
$[q_3\ q_5]$	$[q_3, q_5]$	$[q_3, q_5]$
$[q_4]$	$[q_3, q_5]$	$[q_3, q_5]$

Transition diagram:



(10) DFAs can be used for Artificial Intelligence Language. State machines are certainly not the most sophisticated means of implementing artificially intelligent agents in games, but many games include characters with simple, state-based behaviours that are easily and effectively modeled using state machines.

For example, the classic game of Pac-Man.

The ghosts in Pac-Man have four behaviours and their transitions are dictated by the situation in the game. Hence its an application of DFA.

Another application of DFA is Markov Chain which is widely used in probability and statistics. Rather than fixed transition rules, we have probablistic rules.

9. Let M be the finite Automata

$M = (Q, \Sigma, \delta, q_0, F)$

where Q = q_0 ≡ Nothing is done
q_a ≡ Stove is lit
q_b ≡ Water is boiled
q_c ≡ filter has water
q_d ≡ filter holder has the filter
q_e ≡ ground coffee is in filter
q_f ≡ filter holder over cup
q_g ≡ Coffee is prepared
q_h ≡ Mess is made

$\Sigma \equiv \{a, b, c, d, e, f, g\}$

$F \equiv \{q_g\}$

Transition diagram: