FLAT TUTORIAL 2

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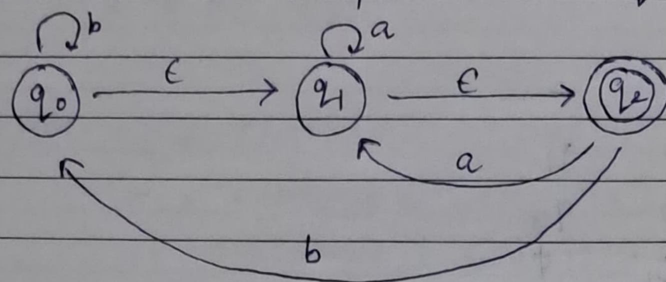
A2

Q1. Convert NFA with Epsilon to equivalent DFA



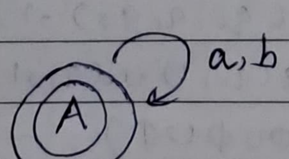
x	y - ε closure(x)	δ(y, a)	δ(y, b)
A {q0}	{q0, q1, q2}	{q1}	{q0}
B {q1}	{q1, q2}	{q1}	{q0}

Q\Σ	a	b
A*	B	A
B*	B	A

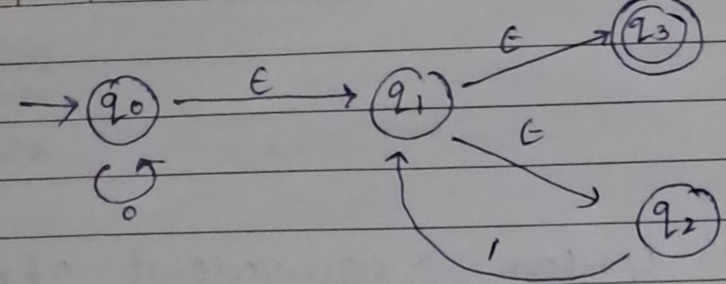
As the transition of A & B is same and as both of them are final states ∴ A & B can be merged.

Q\Σ	a	b
A*	A	A

∴ DFA transition digram



Q2)



Q\ε	0	1	ε
q_0	q_0	ϕ	q_1
q_1	q_2	ϕ	q_3
q_2	ϕ	q_1	ϕ
q_3	q_3	ϕ	ϕ

Hence,

ϵ - closure(q_0) = $\{q_0, q_1, q_3\}$

ϵ - closure (q_1) = $\{q_1, q_3\}$

ϵ - closure (q_2) = $\{q_2\}$

ϵ - closure (q_3) = $\{q_3\}$

$\delta(q_0, 0)$ = ϵ-closure$(\delta(\hat{\delta}(q_0, \epsilon), 0))$

= ϵ-closure $(\delta(q_0, q_1, q_3), 0))$

= ϵ-clos $(\delta(q_0, 0) \cup \delta(q_1, 0) \cup \delta(q_3, 0))$

= ϵ closure $(q_0 \cup q_2 \cup q_3)$

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

$\delta(q_0, 1)$ = ϵ - closure $(\delta(\hat{\delta}(q_0, \epsilon), 1))$

= ϵ - closure $(\delta(q_0, q_1 q_3), 1)$

= ϵ - closure $(\delta(q_0, 1) \cup \delta(q_1, 1) \cup (q_3, 1))$

= ϵ - closure $(\phi \cup \phi \cup \phi)$

= $\{\phi\}$

$$\delta(q_1, 0) = \epsilon\text{-closure}(\hat{\delta}(\delta(q_1, \epsilon); 0))$$
$$= \epsilon\text{ closure}(\delta(q_1, q_3), 0)$$
$$= \epsilon\text{-closure}(\delta(q_1, 0) \cup \delta(q_3, 0))$$
$$= \epsilon\text{-closure}(q_2 \cup q_3)$$
$$= \{q_2, q_3\}$$

$$\delta(q_1, 1) = \epsilon\text{-closure}(\hat{\delta}(\delta(q_1, \epsilon), \phi))$$
$$= \epsilon\text{ closure}(\delta(q_1, q_3), 1)$$
$$= \epsilon\text{-closure}(\delta(q_1, 1) \cup \delta(q_3, 1))$$
$$= \epsilon\text{-closure}(\phi \cup \phi)$$
$$= \{\phi\}$$

$$\delta(q_2, 0) = \epsilon\text{-closure}(\hat{\delta}(\delta(q_2, \epsilon); \phi))$$
$$= \epsilon\text{-closure}(\delta((q_2), 0))$$
$$= \epsilon\text{-closure}\ \{\phi\}$$

$$\delta(q_2, 1) = \epsilon\text{-closure}(\hat{\delta}(\delta(q_2, \epsilon), 1))$$
$$= \epsilon\text{-closure}(\delta(q_2), 1)$$
$$= \epsilon\text{-closure}(q_1)$$
$$= \{q_1, q_3\}$$

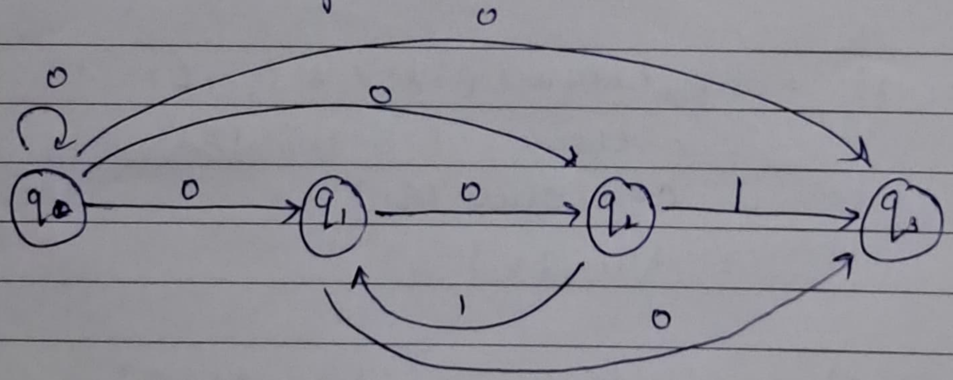
$$\delta(q_3, 0) = \epsilon\text{-closure}(\delta(\delta(q_3, \epsilon)), 0)$$
$$= \epsilon\text{-closure}(\delta(q_3), 0)$$
$$= \epsilon\text{-closure}(\delta(q_3, 0))$$
$$= \epsilon\text{-closure}(q_3)$$
$$= \{q_3\}$$

$\delta(q_3, 1) = \epsilon\text{-closure}(\delta(q_3, \epsilon), 1)$
$= \epsilon\text{-closure}(q_3, 1))$
$= \epsilon\text{-closure}(\phi)$
$= \{\phi\}$

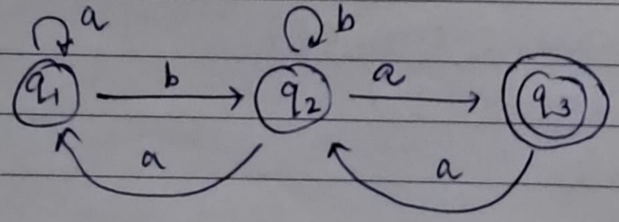
state transition diagram

$Q \backslash \Sigma$	0	1
q_0	$\{q_0, q_1, q_2, q_3\}$	ϕ
q_1	q_2, q_3	ϕ
q_2	ϕ	$\{q_1, q_3\}$
q_3	q_3	ϕ

transition diagram



Q3)



state transition equation is given as

$q_1 = \epsilon + q_1 . a + q_2 . a$ ... (1)

$q_2 = q_1 . b + q_2 . b + q_3 . a$ ... (2)

$q_3 = q_2 . a$ ... (3)

substituting (3) in (2)

$q_2 = q_1 . b + q_2 . b + q_2 . a . a$

$R = Q + RP$ {Arden's theorem}

$\therefore q_2 = q_1 b (b + aa)^*$ ... (4)

sub. eq (4) in (1)

$q_1 = \epsilon + q_1 . a + q_1 . b (b + aa)^* a$

$q_1 = \epsilon + (a + b (b + aa)^* a) q_1$

$R = Q + RP$

$\therefore q_1 = (a + b (b + aa)^* . a)^*$ (5) {Arden's theorem}

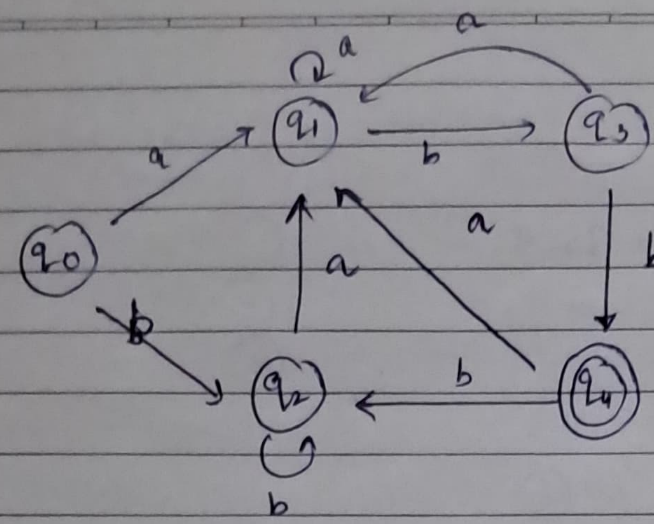
sub (5) in (4)

$q_2 = (a + b (b + aa)^* . a)^* b (b + aa)^*$ ... (6)

sub (6) in (3)

$q_3 = (a + b (b + aa)^* . a)^* b (b + aa)^* . a$

Q4)



Q\Σ	a	b
q_0	q_1	q_2
q_1	q_1	q_3
q_2	q_1	q_2
q_3	q_1	q_4
q_4*	q_1	q_2

q_1	3			
q_2	X	3		
q_3	2	2	2	
q_4	1	1	1	1
	q_0	q_1	q_2	q_3

for (q_0, q_1)

check

$\left.\begin{array}{l}\delta(q_0, a) = q_1 \\ \delta(q_1, a) = q_1\end{array}\right] \times$ $\quad$ $\begin{array}{l}\delta(q_1, b) = q_3 \\ \delta(q_1, a) = q_2\end{array}$

$\because (q_2, q_3)$ is not marked, $(q_2, q_3) \Longrightarrow (q_0, q_1)$

for (q_0, q_2)

$\left.\begin{array}{l}\delta(q_0, a) = q_1 \\ \delta(q_2, a) = q_1\end{array}\right] \times$ $\quad$ $\left.\begin{array}{l}\delta(q_0, b) = q_2 \\ \delta(q_2, b) = q_2\end{array}\right] \times$

$\therefore$ cannot be marked.

→ for (q_1, q_2)

$\delta(q_1, a) = q_1$] × $\quad \delta(q_1, b) = q_3$

$\delta(q_2, a) = q_1$ $\quad \delta(q_2, b) = q_2$

∴ (q_2, q_3) ain't marked $(q_2, q_3) \Rightarrow (q_1, q_2)$

→ for (q_0, q_3)

$\delta(q_0, a) = q_1$] × $\quad \delta(q_0, b) = q_2$

$\delta(q_3, a) = q_1$ $\quad \delta(q_3, b) = q_4$

Now (q_2, q_4) is marked as 1

∴ $(q_0, q_3) \rightarrow 2$

→ for (q_1, q_3)

$\delta(q_1, a) = q_1$] × $\quad \delta(q_1, b) = q_2$

$\delta(q_3, a) = q_1$ $\quad \delta(q_3, b) = q_4$

∵ (q_2, q_4) is marked.

∴ marking (q_3, q_4) as 2

Now again checking for .

→ (q_0, q_1)

$\delta(q_0, a) = q_1$] × $\quad \delta(q_0, b) = q_2$

$\delta(q_1, a) = q_1$ $\quad \delta(q_1, b) = q_3$

∴ marked. we mark (q_0, q_1) as 3

→ for (q_0, q_2)

$\delta(q_0, q_2)$

$\delta(q_0, a) = q_1$] × $\quad \delta(q_0, b) = q_2$] ×

$\delta(q_2, a) = q_1$ $\quad \delta(q_2, b) = q_2$

cannot be marked.

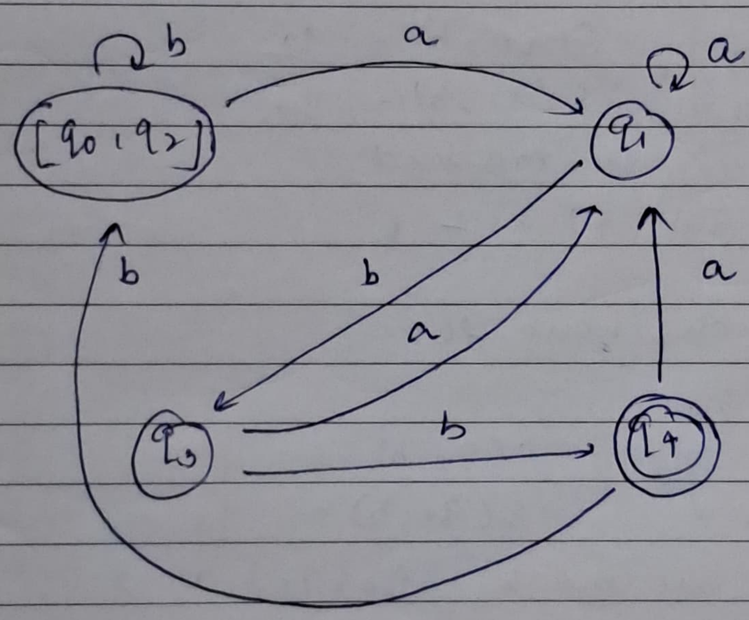
for (q_1, q_2)

$$\left.\begin{array}{l}\delta(q_1, a) = q_1 \\ \delta(q_2, a) = q_1\end{array}\right\} \times \quad \begin{array}{l}\delta(q_1, b) = q_3 \\ \delta(q_2, b) = q_2\end{array}$$

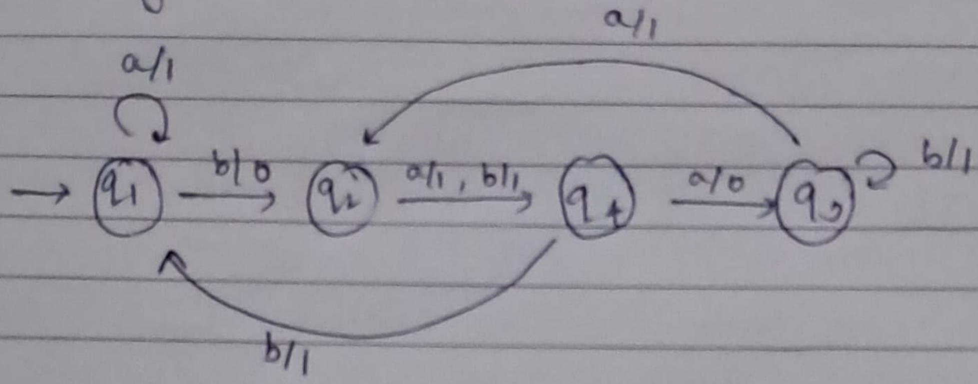
$\because$ (q_2, q_3) is marked
marking (q_1, q_2) as 3

Merging (q_0, q_2)

$\therefore$ minimized DFA



Q5) Mealy to Moore Machine.



Moore Machine.