Tutorial - 1

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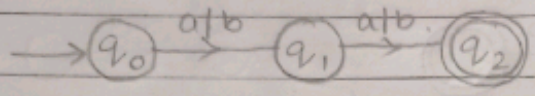
For the problem find RE & convert it to NFA and DFA

1 Obtain a regular expression representing strings of a's and b's having length 2.

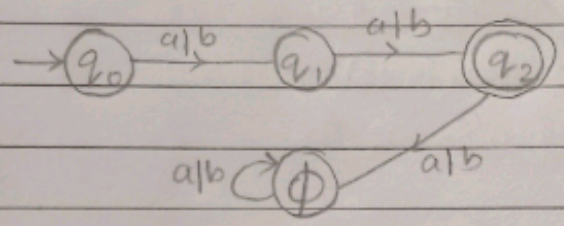
→ Strings of a's and b's having length 2.

Regular Expression = $(a|b)^2$.

NFA of regular expression is,



DFA of above NFA is,

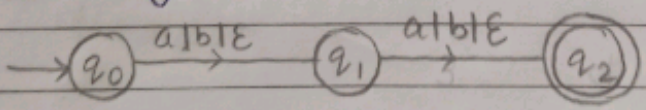


2. Obtain regular expression to accept strings of a's and b's of length ≤ 2.

→ Strings of a's and b's of length ≤ 2

Regular expression = $(a|b)|\varepsilon|(a|b)^2 = (a|b|\varepsilon)^2$

NFA of regular expression is,



DFA of above NFA is.

ε-closure$(q_0) = \{q_0, q_1, q_2\} = A$

ε-closure$(q_1) = \{q_1, q_2\} = B$

ε-closure$(q_2) = \{q_2\} = C$

$\delta(q_0 q_1 q_2, a) = \varepsilon$-closure$(\delta(q_0 q_1 q_2, a)) = \varepsilon$-closure$(q_1, q_2)$

$\delta(A, a) = B$

$\delta(A, b) = B$

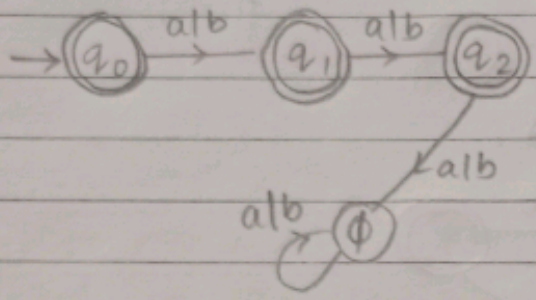
$\delta(q_1 q_2, a) = \varepsilon$-closure$(q_2) = C$

$\delta(B, b) = C$.

$\delta(q_2, a) = \text{Reducible}(q_2) \cdot \phi$

$\delta(q_2, b) = \phi$

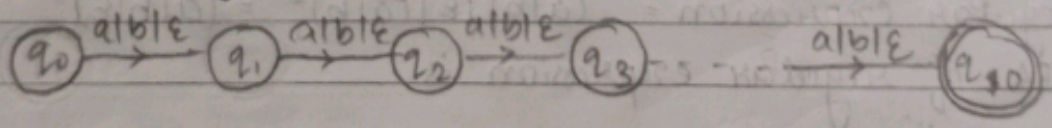
δ	a	b
→ *A	B	B
*B	C	C
*C	ϕ	ϕ
ϕ	ϕ	ϕ



3. Obtain a regular expression to accept strings of a's and b's of length ≤ 10

→ Regular expression = $(a|b|\varepsilon)^{10}$

NFA of regular expression is,



States	a	b	ε
→ q_0	q_1	q_1	q_1
q_1	q_2	q_2	q_2
q_2	q_3	q_3	q_3
q_3	q_4	q_4	q_4
q_4	q_5	q_5	q_5
q_5	q_6	q_6	q_6
q_6	q_7	q_7	q_7
q_7	q_8	q_8	q_8
q_8	q_9	q_9	q_9
q_9	q_{10}	q_{10}	q_{10}
*q_{10}	-	-	-

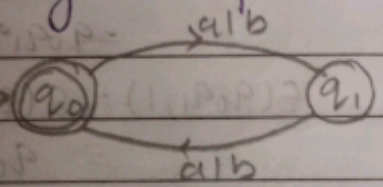
DFA of above NFA is,

States	a	b
$\rightarrow *q_0$	q_1	q_1
$*q_1$	q_2	q_2
$*q_2$	q_3	q_3
$*q_3$	q_4	q_4
$*q_4$	q_5	q_5
$*q_5$	q_6	q_6
$*q_6$	q_7	q_7
$*q_7$	q_8	q_8
$*q_8$	q_9	q_9
$*q_9$	q_{10}	q_{10}
$*q_{10}$	ϕ	ϕ
ϕ	ϕ	ϕ

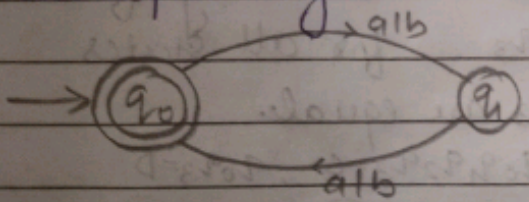
4. Obtain a regular expression representing strings of a's and b's having even length.

→ Regular expression = $(a|b)^2)^*$

NFA of regular expression is,



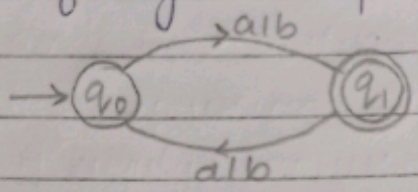
DFA corresponding to above NFA is,



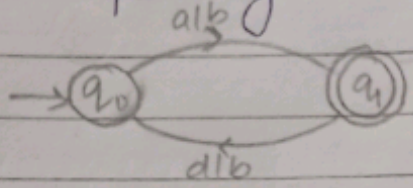
5. Obtain regular expression representing strings of a's and b's having odd length.

→ Regular expression = $(a|b)((a|b)^2)^*$

NFA of regular expression is,



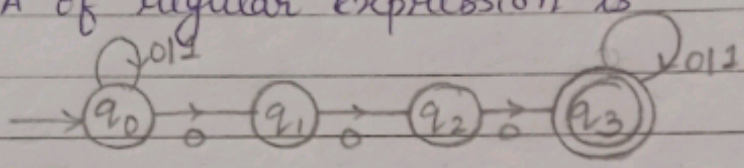
DFA corresponding to above NFA is



6. Obtain a regular expression such that
$L(R) = \{w | w \in \{0,1\}^* \}$ with at least three consecutive 0's}

→ Regular expression = $(0|1)^*000(0|1)^*$

NFA of regular expression is

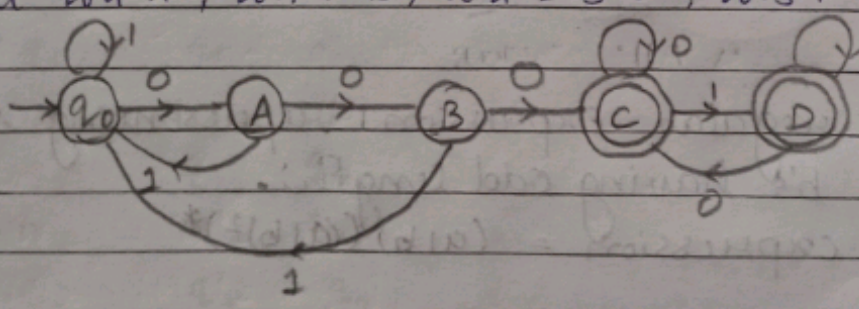


DFA corresponding to above NFA is,

	States	a 0	1	
→	q_0	q_0q_1	q_0	$\delta(q_0q_1,0) = \delta(q_0,0) \cup \delta(q_1,0)$
	q_0q_1	$q_0q_1q_2$	q_0	$= q_0q_1q_2$
	$q_0q_1q_2$	$q_0q_1q_2q_3$	q_0	$\delta(q_0q_1,1) = \delta(q_0,1) \cup \delta(q_1,1)$
*	$q_0q_1q_2q_3$	$q_0q_1q_2q_3$	q_0q_3	$= q_0$
*	q_0q_3	$q_0q_1q_3$	q_0q_3	Similarly find transitions
*	$q_0q_1q_3$	$q_0q_1q_2q_3$	q_0q_3	for all states

States $q_0q_1q_2q_3$ & $q_0q_1q_3$ are equal.

Let $q_0q_1 = A$, $q_0q_1q_2 = B$, $q_0q_1q_2q_3 = C$, $q_0q_3 = D$



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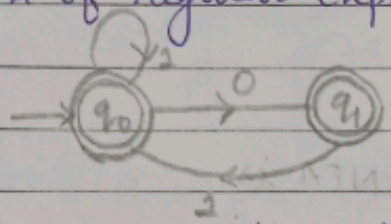
7b. Obtain a regular expression to accept strings of 0's and 1's having ~~two~~ no two consecutive 0's

→ Regular expression = ~~1*10(0+10)*+0(0+10)*~~ $(1^*01)^*$.

= ~~(0+E)(0+10)*~~

NFA of regular expression is,



DFA corresponding to above NFA is.

ε-closure(q_0) = $\{q_0\}$

ε-closure(q_1) = $\{q_1\}$

ε-closure(q_2) = $\{q_2\}$

$\delta(q_0q_1, 0)$ = ε-closure(q_1, q_2) = q_1q_2

$\delta(q_0q_1, 1)$ = ε-closure(q_1) = q_1

$\delta(q_1, 0) = q_2$, $\delta(q_1, 1) = q_1$

$\delta(q_2, 0) = \phi$, $\delta(q_2, 1) = q_1$

$\delta(\phi, 0) = \phi$, $\delta(\phi, 1) = \phi$.

$\delta(q_1q_2, 0) = q_2$

$\delta(q_1q_2, 1) = q_1$

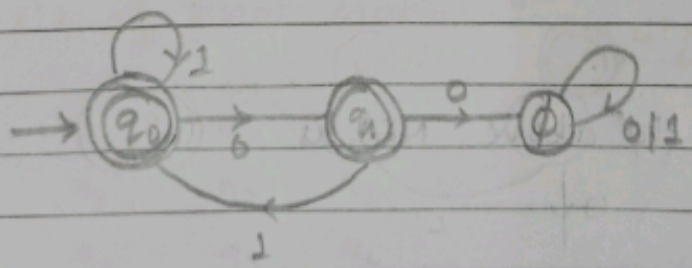
*q_1 & *q_1q_2 are equal states

Transition Table:

State	0	1
→*q_0q_1	q_1	q_1
*q_1	q_2	q_1
*q_2	ϕ	q_1
ϕ	ϕ	ϕ

Transition Table:

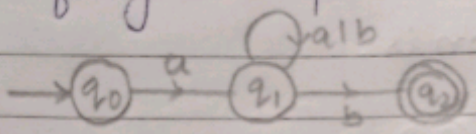
States	0	1
→*q_0	q_1	q_0
*q_1	ϕ	q_0
ϕ	ϕ	ϕ



8. Obtain a regular expression to accept strings of a's and b's starting with 'a' and ending with 'b'

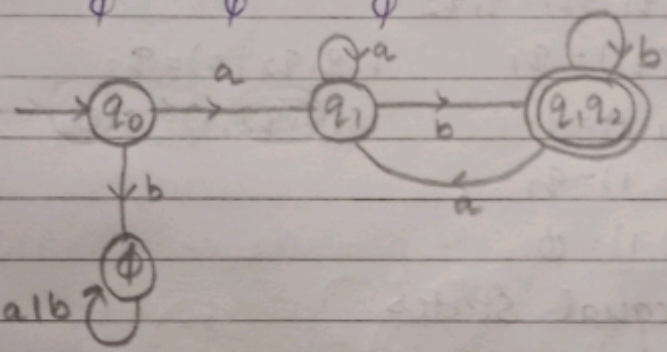
→ Regular expression = a(a|b)*b

NFA of regular expression is



DFA corresponding to above NFA is

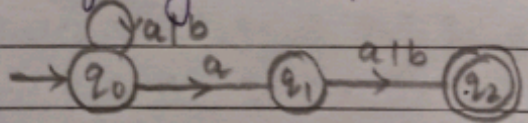
States	a	b
→ q_0	q_1	ϕ
q_1	q_1	q_1q_2
*q_1q_2	q_1	q_1q_2
ϕ	ϕ	ϕ



9. Obtain a regular expression to accept strings of a's and b's whose second symbol from right end is a

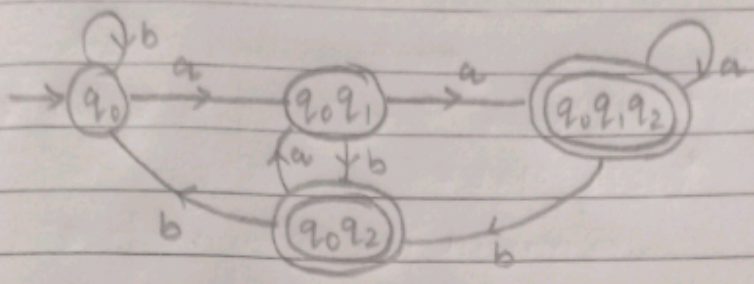
→ Regular expression = (a|b)*a(a|b).

NFA of regular expression is,



DFA corresponding to above NFA is

States	a	b
→ q_0	q_0q_1	q_0
q_0q_1	$q_0q_1q_2$	q_2q_0
*$q_0q_1q_2$	$q_0q_1q_2$	q_0q_2
*q_0q_2	q_0q_1	q_0.



10. Obtain a regular expression representing strings of a's & b's whose 10th symbol from right end is a.

→ Regular expression = $(a|b)^*a(a|b)^9$.

NFA of regular expression is

State	a	b
→ q_0	q_0, q_1	q_0
q_1	q_2	q_2
q_2	q_3	q_3
q_3	q_4	q_4
q_4	q_5	q_5
q_5	q_6	q_6
q_6	q_7	q_7
q_7	q_8	q_8
q_8	q_9	q_9
q_9	$*q_{10}$	$*q_{10}$

- DFA corresponding to above NFA is

No. of states in DFA = $2^{10} = 1024$.

No. of final states = $2^{10-1} = 512$.

Final states are $q_{512}, q_{513} \cdots q_{1024}$

States	a	b
→ q_0	q_1	q_0
q_1	q_3	q_2
q_2	q_5	q_4
q_3	q_7	q_6
⋮	⋮	⋮
q_{1024}	odd states	even states