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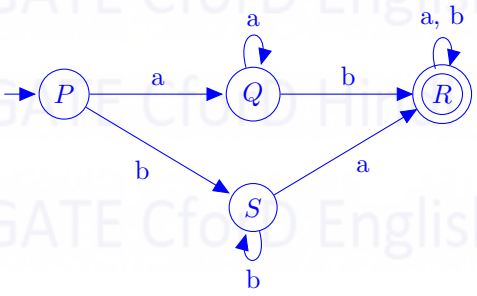
List of Examples of Minimal DFAs.

Contents

1 Very Basic examples

1.1 At least one a and at least one b.

$\sum = \{a,\ b\}$
$L = \{w \mid w$ contains at least one a and contains at least one $b\}$



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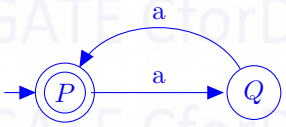
1.2 String length is even.

$\sum = \{a,\ b\}$
$L = \{\ w\ \mid\ |w|$ is even.$\}$



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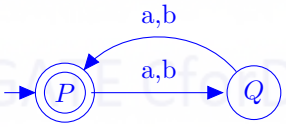
1.3 String length is even different alphabet

$\sum = \{a, b\}$ Here Alphabet contains 2 symbols.
$L = \{\ w\ \mid\ |w|$ is even.$\}$



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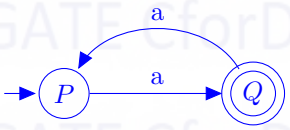
1.4 String length is odd.

$\sum = \{a,\ b\}$
$L = \{\ w\ \mid\ |w|$ is odd.$\}$
We simply change final state for 1.2.



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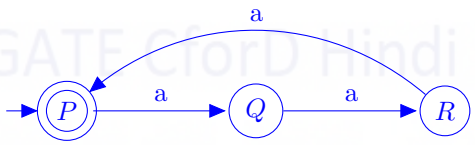
1.5 String length divisible by 3

$\sum = \{a\}$
$L = \{ w \mid |w| \text{ is divisible by 3.}\}$



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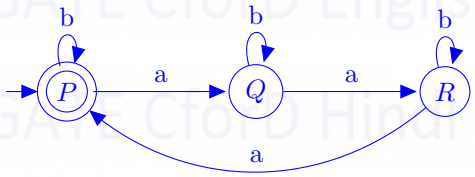
1.6 Number of a's in w is divisible by 3

$\sum = \{a, b\}$
$L = \{ w \mid \#_a(w) \text{ is divisible by 3.}\}$ $\#_a(w)$ is number of a's in w.



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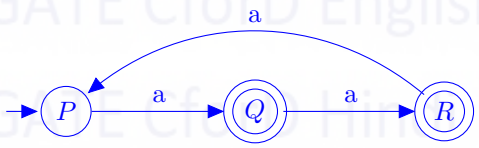
1.7 String length NOT divisible by 3

$\sum = \{a\}$
$L = \{ w \mid |w| \text{ is NOT divisible by 3.}\}$



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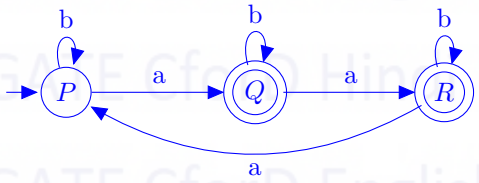
1.8 Number of a's in w NOT divisible by 3

$\sum = \{a, b\}$
$L = \{ w \mid \#_a(w) \text{ is NOT divisible by 3.}\}$ $\#_a(w)$ is number of a's in w.



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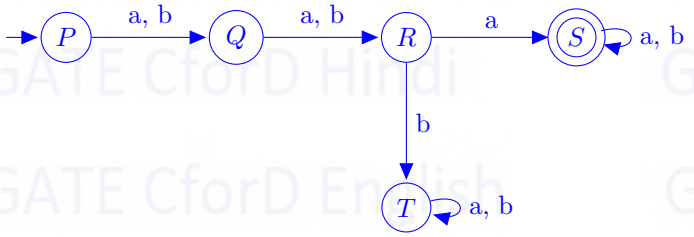
1.9 n^{th} symbol from left is a

$\sum = \{a, b\}$
$L = \{ w \mid 3^{rd}$ symbol from left in w is $a.\}$



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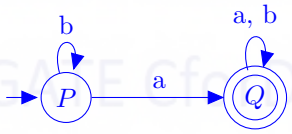
1.10 w contains At least n a's.

1.10.1 w contains At least 1 a.

$\sum = \{a, b\}$
$L = \{w \mid w$ contains at least 1 $a.\}$



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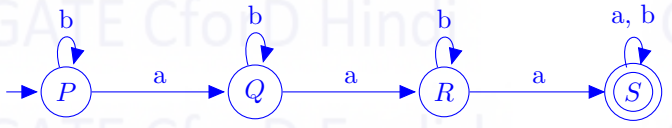
1.10.2 w contains At least 3 a's.

$\sum = \{a, b\}$
$L = \{w \mid w$ contains at least 3 a's.$\}$



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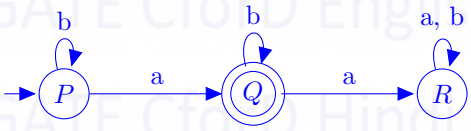
1.11 w contains exactly n a's.

1.11.1 w contains exactly 1 a.

$\sum = \{a, b\}$
$L = \{w \mid w \text{ contains exactly 1 } a.\}$



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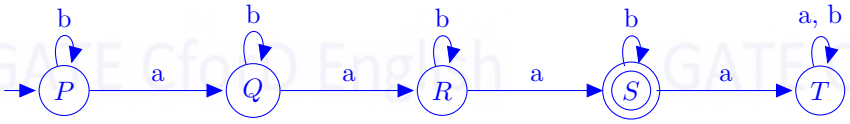
1.11.2 w contains exactly 3 a's.

$\sum = \{a, b\}$
$L = \{w \mid w \text{ contains exactly 3 } a\text{'s.}\}$



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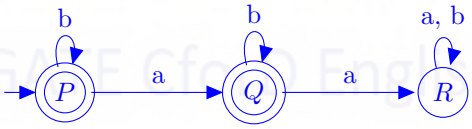
1.12 w contains At most n a's.

1.12.1 w contains At most 1 a.

$\sum = \{a, b\}$
$L = \{w \mid w \text{ contains at most 1 } a.\}$



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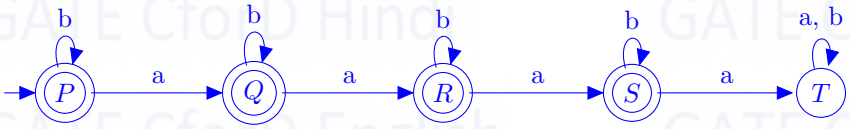
1.12.2 w contains At most 3 a's.

$\sum = \{a, b\}$
$L = \{w \mid w \text{ contains at most 3 } a\text{'s.}\}$



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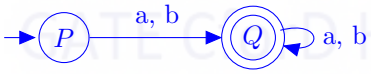
1.13 $\sum^*$, ϕ, $\sum^+$, $\{\epsilon\}$

$\sum = \{a, b\}$
$L = \sum^*$.

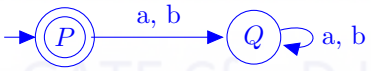
$L = \phi$.

Final States: {},
No final state in DFA.

$L = \sum^+$.



$L = \{\epsilon\}$.



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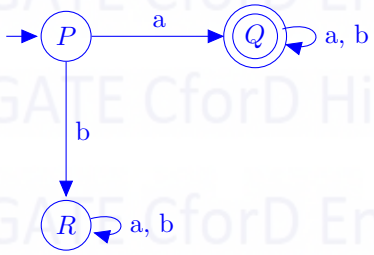
2 w starting with:

2.1 w starting with a

$\sum = \{a, b\}$
$L = \{ w \mid |w| \text{ starts with } a.\}$



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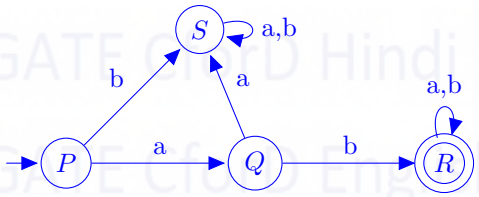
2.2 w starting with ab

$\sum = \{a, b\}$
$L = \{w \mid w \text{ starts with } ab\}$



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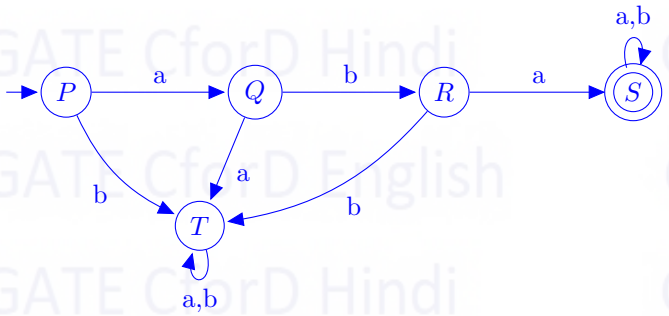
2.3 w starting with aba

$\sum = \{a, b\}$
$L = \{w \mid w \text{ starts with } aba\}$



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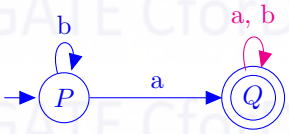
3 w contains substring:

3.1 w contains substring a

$\sum = \{a, b\}$
$L = \{w \mid w \text{ contains substring } a\}$



For DFA of "w contains substring", final state has self-loop for all the symbols.
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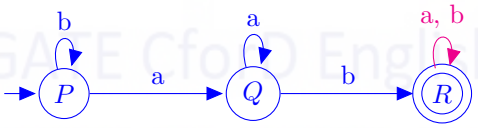
3.2 w contains substring ab

$\sum = \{a, b\}$
$L = \{w \mid w \text{ contains substring } ab\}$



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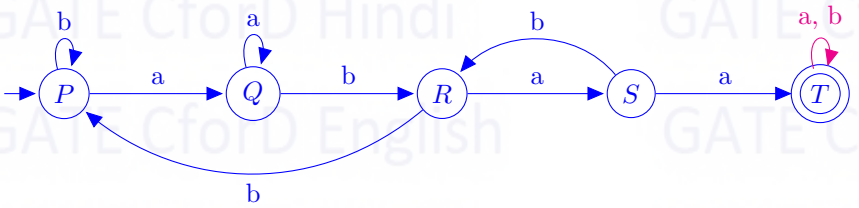
3.3 w contains substring $abaa$

$\sum = \{a, b\}$
$L = \{w \mid w \text{ contains substring } abaa\}$



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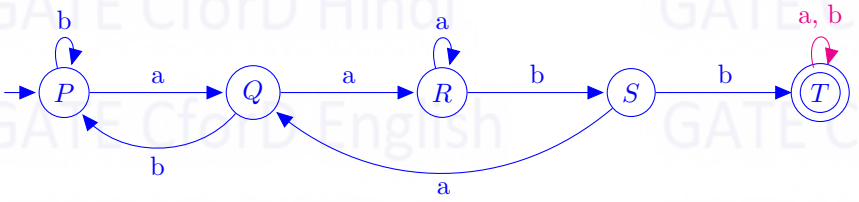
3.4 w contains substring $aabb$

$\sum = \{a, b\}$
$L = \{w \mid w \text{ contains substring } aabb\}$



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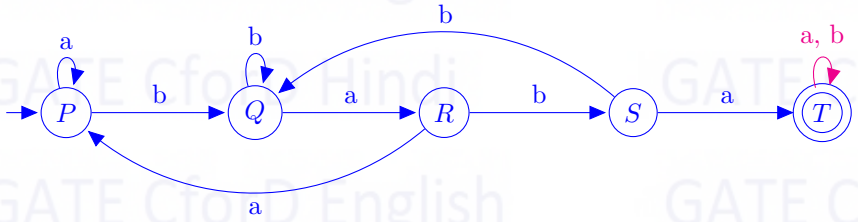
3.5 w contains substring $baba$

$\sum = \{a, b\}$
$L = \{w \mid w \text{ contains substring } baba\}$



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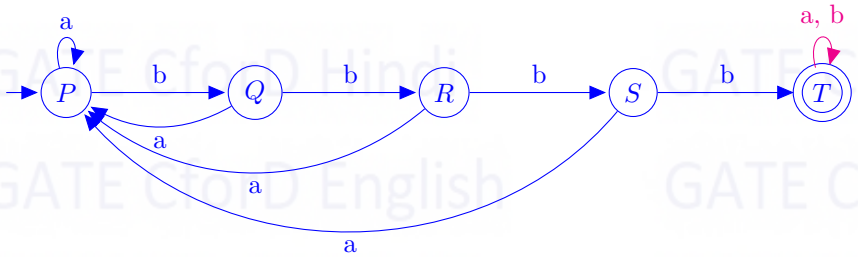
3.6 w contains substring $bbbb$

$\sum = \{a, b\}$
$L = \{w \mid w \text{ contains substring } bbbb\}$



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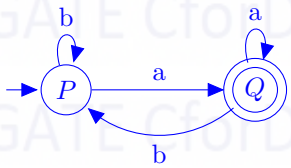
4 w ends with:

4.1 w ends with a

$\sum = \{a, b\}$
$L = \{w \mid w \text{ ends with } a\}$



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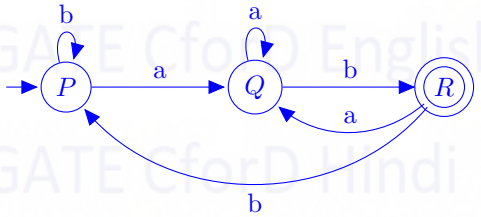
4.2 w ends with ab

$\sum = \{a, b\}$
$L = \{w \mid w \text{ ends with } ab\}$



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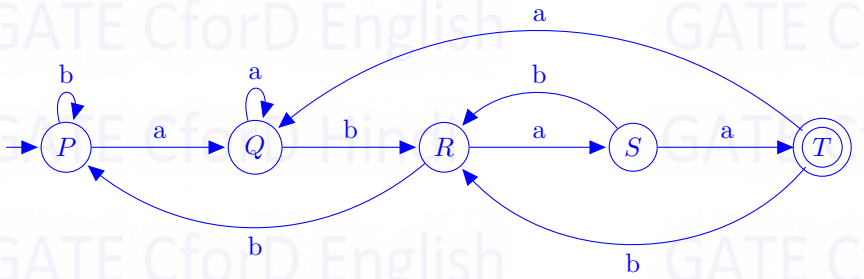
4.3 w ends with $abaa$

$\sum = \{a, b\}$
$L = \{w \mid w \text{ ends with } abaa\}$



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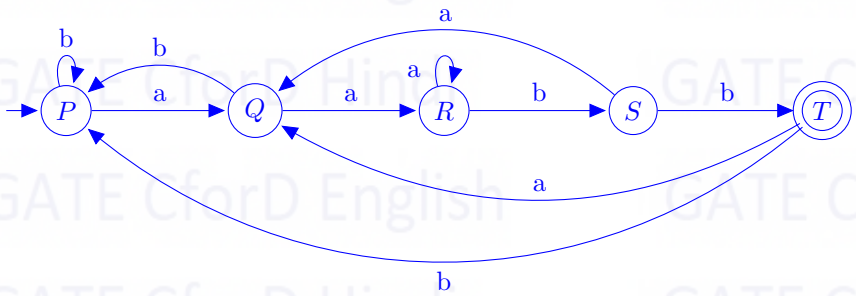
4.4 w ends with $aabb$

$\sum = \{a, b\}$
$L = \{w \mid w \text{ ends with } aabb\}$



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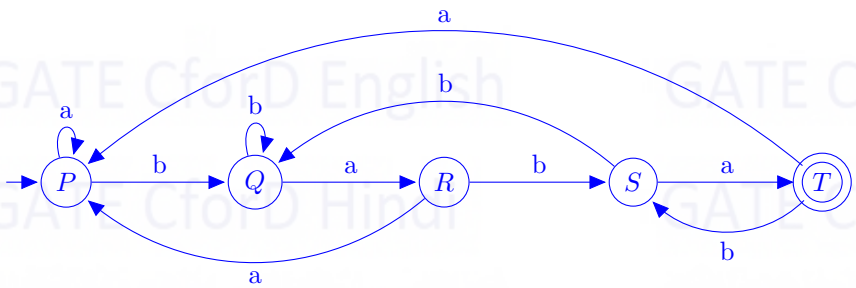
4.5 w ends with $baba$

$\sum = \{a, b\}$
$L = \{w \mid w \text{ ends with } baba\}$



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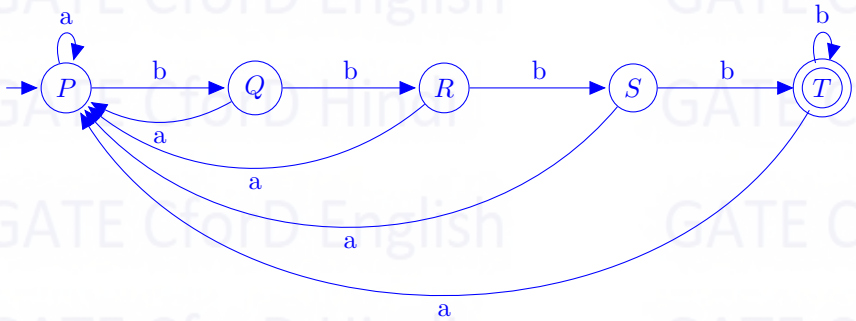
4.6 w ends with $bbbb$

$\sum = \{a, b\}$
$L = \{w \mid w \text{ ends with } bbbb\}$



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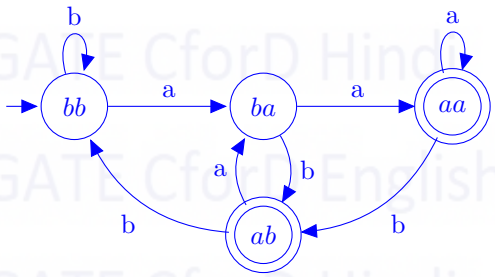
5 n^{th} symbol from right is a

5.1 2^{nd} symbol from right is a

5.1.1 2^{nd} symbol from right is a, alphabet contains 2 symbols

$\sum = \{a, b\}$
$L = \{w \mid$ Second symbol from right in w is $a\}$



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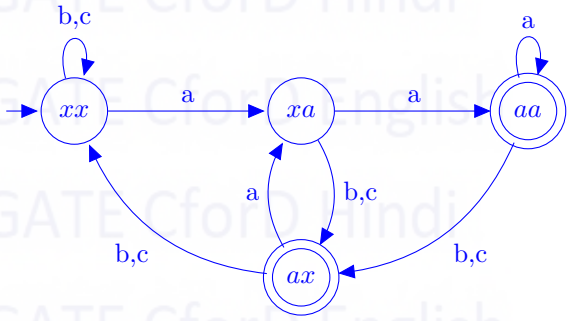
5.1.2 2^{nd} symbol from right is a, alphabet contains 3 symbols

$\sum = \{a, b, c\}$
$L = \{w \mid$ Second symbol from right in w is $a\}$



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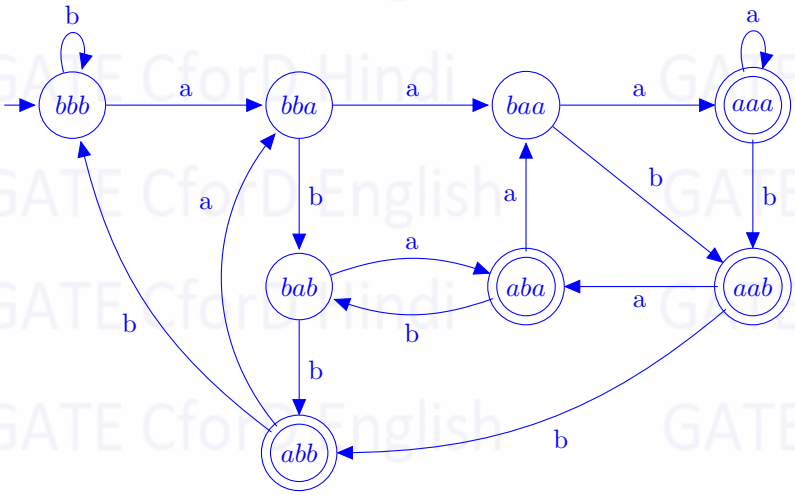
5.2 3^{rd} symbol from right is a

5.2.1 3^{rd} symbol from right is a, alphabet contains 2 symbols

$\sum = \{a, b\}$
$L = \{w \mid$ Third symbol from right in w is $a\}$



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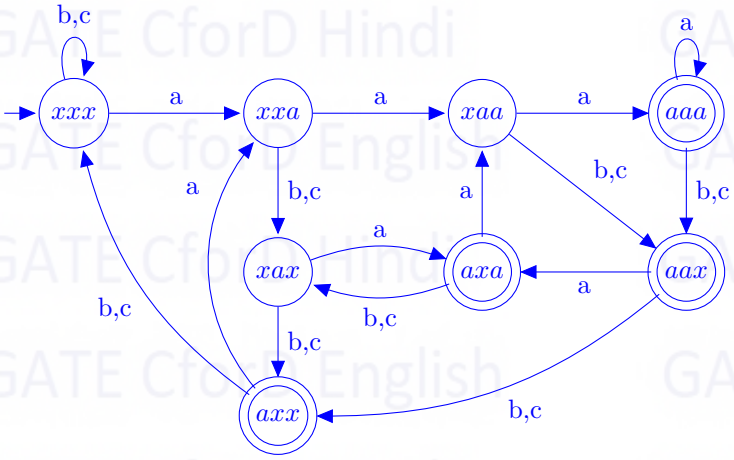
5.2.2 3^{rd} symbol from right is a, alphabet contains 3 symbols

$\sum = \{a,\ b,\ c\}$
$L = \{w \mid$ Third symbol from right in w is $a\}$



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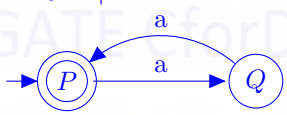
6 For same symbol, divisible by m, AND / NOT / OR divisible by n

6.1 n is multiple of m

6.1.1 w_a divisible by 2 OR divisible by 4.

$\sum = \{a\}$
$L = \{ w \mid w_a \text{ is divisible by 2 OR divisible by 4.}\}$



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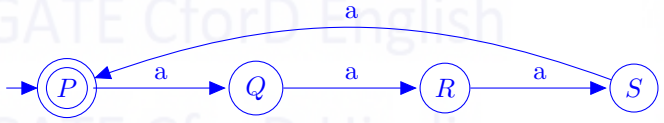
6.1.2 w_a divisible by 2 AND divisible by 4.

$\sum = \{a\}$
$L = \{ w \mid w_a \text{ is divisible by 2 AND divisible by 4.}\}$



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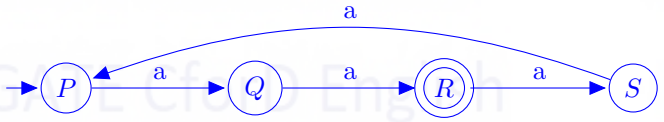
6.1.3 w_a divisible by 2 but not divisible by 4.

$\sum = \{a\}$
$L = \{ w \mid w_a \text{ is divisible by 2 but not divisible by 4.}\}$



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6.1.4 w_a divisible by 4 but not divisible by 2.

$\sum = \{a\}$
$L = \{ w \mid w_a \text{ is divisible by 4 but not divisible by 2.}\}$

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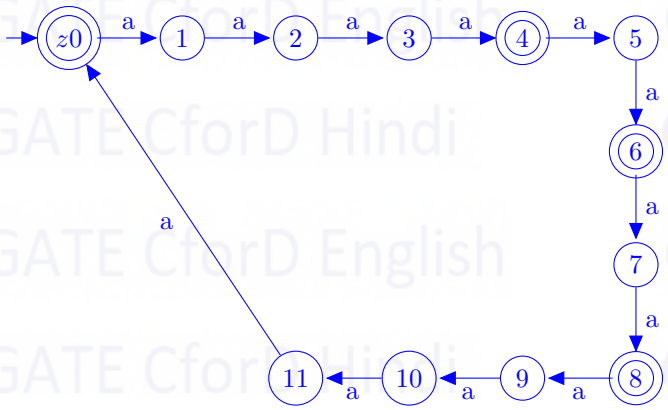
6.2 n is NOT multiple of m

6.2.1 w_a is divisible by 4 OR divisible by 6.

$\sum = \{a\}$
$L = \{ w \mid w_a \text{ is divisible by 4 OR divisible by 6.}\}$



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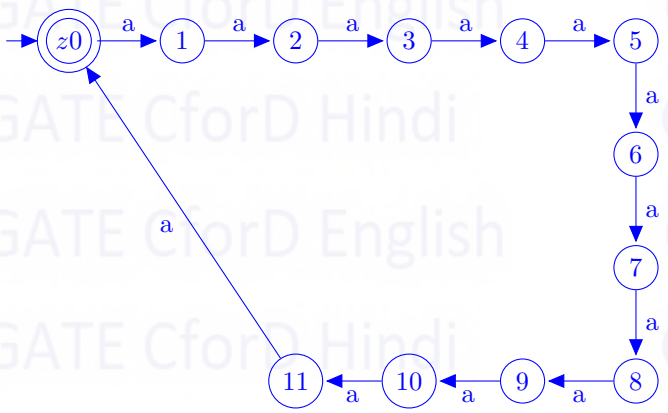
6.2.2 w_a is divisible by 4 AND divisible by 6.

$\sum = \{a\}$
$L = \{ w \mid w_a \text{ is divisible by 4 AND divisible by 6.}\}$



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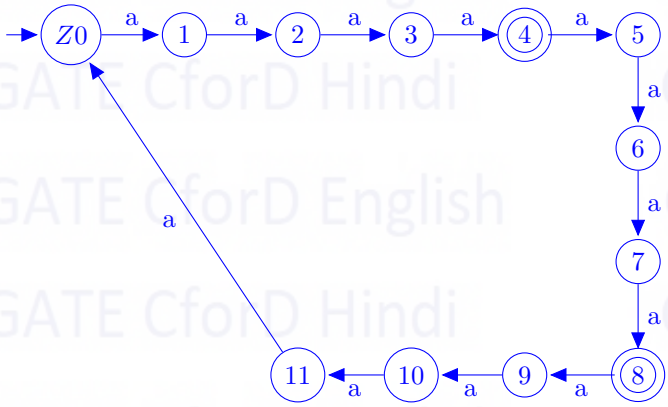
6.2.3 w_a is divisible by 4 but not divisible by 6.

$\sum = \{a\}$
$L = \{ w \mid w_a \text{ is divisible by 4 but not divisible by 6.}\}$



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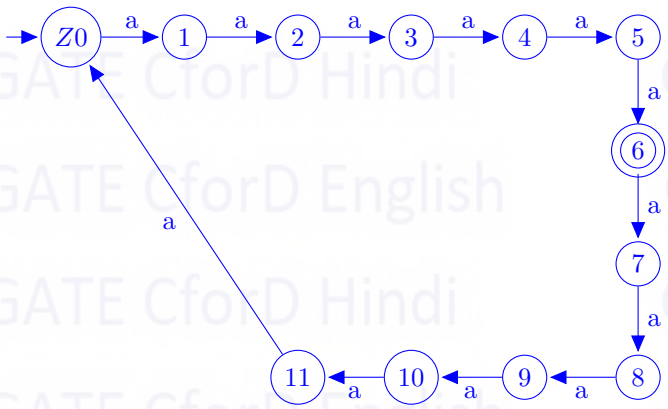
6.2.4 w_a is divisible by 6 but not divisible by 4.

$\sum = \{a\}$
$L = \{ w \mid w_a \text{ is divisible by 6 but not divisible by 4.}\}$



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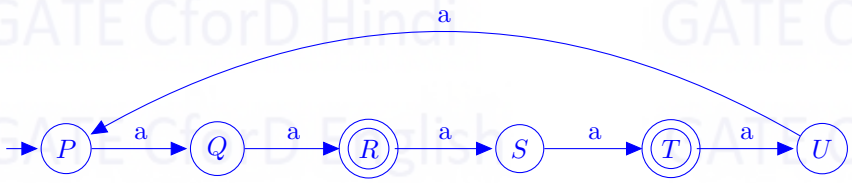
6.3 Some more variations and examples.

6.3.1 w_a divisible by 2, but not divisible by 6.

$\sum = \{a\}$
$L = \{ w \mid w_a \text{ is divisible by 2 but not divisible by 6.}\}$



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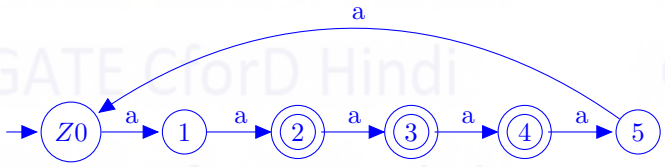
6.3.2 w_a is divisible by 2 OR 3, but not divisible by 6.

$\sum = \{a\}$
$L = \{ w \mid w_a$ is divisible by 2 or 3 but not divisible by 6.$\}$



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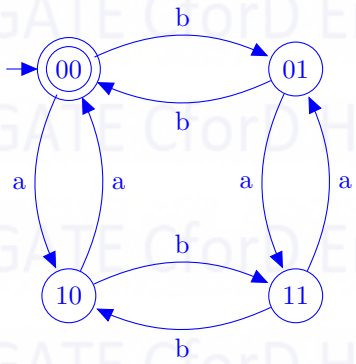
7 Divisible by conditions for different symbols

7.1 w_a is divisible by 2 and w_b is divisible by 2.

$\sum = \{a, b\}$
$L = \{w \mid w_a$ is divisible by 2 and w_b is divisible by 2$\}$



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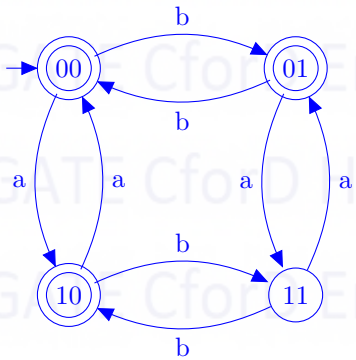
7.2 w_a is divisible by 2 OR w_b is divisible by 2.

$\sum = \{a, b\}$
$L = \{w \mid w_a$ is divisible by 2 OR w_b is divisible by 2$\}$



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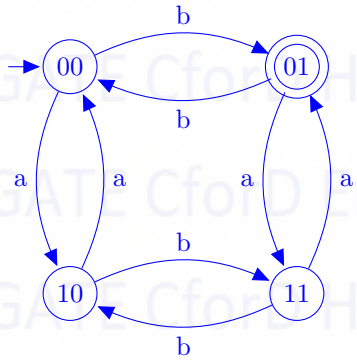
7.3 w_a is divisible by 2 and w_b is NOT divisible by 2.

$\sum = \{a, b\}$
$L = \{w \mid w_a$ is divisible by 2 and w_b is NOT divisible by 2$\}$



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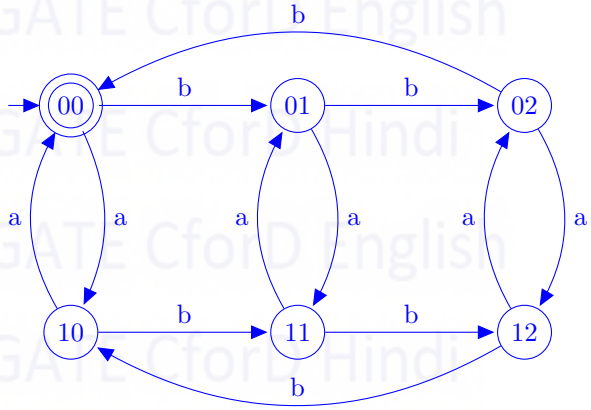
7.4 w_a is divisible by 2 and w_b is divisible by 3.

$\sum = \{a, b\}$
$L = \{w \mid (w)_a$ is divisible by 2 and $(w)_b$ is divisible by 3$\}$



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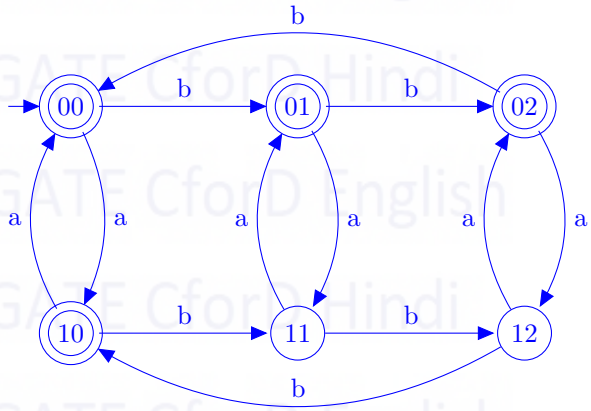
7.5 w_a is divisible by 2 OR w_b is divisible by 3.

$\sum = \{a, b\}$
$L = \{w \mid w_a$ is divisible by 2 OR w_b is divisible by 3$\}$



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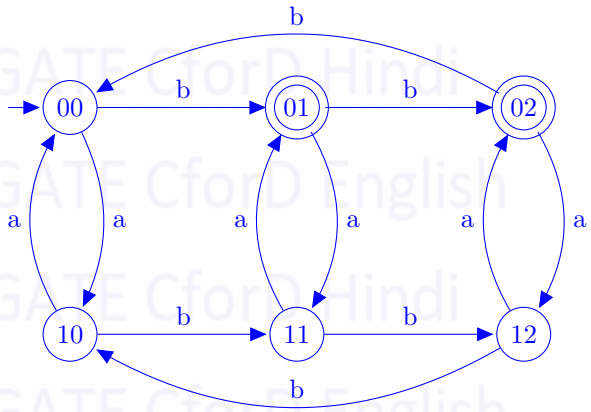
7.6 w_a is divisible by 2 and w_b is NOT divisible by 3.

$\sum = \{a, b\}$
$L = \{w \mid w_a$ is divisible by 2 and w_b is Not divisible by 3$\}$



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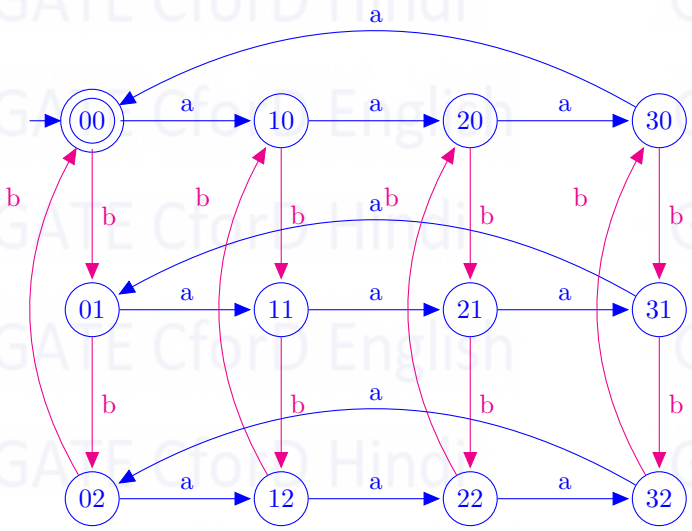
7.7 w_a is divisible by 4 and w_b is divisible by 3.

$\sum = \{a, b\}$ $L = \{w \mid w_a \text{ is divisible by 4 and } w_b \text{ is divisible by 3}\}$



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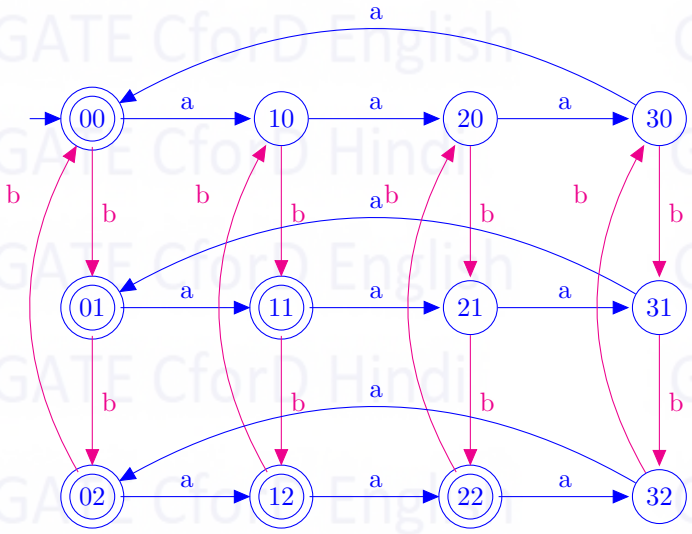
7.8 $w_a \ mod \ 4 \leqslant w_b \ mod \ 3$.

$L = \{w \mid (w)_a \ mod \ 4 \leqslant (w)_b \ mod \ 3\}$



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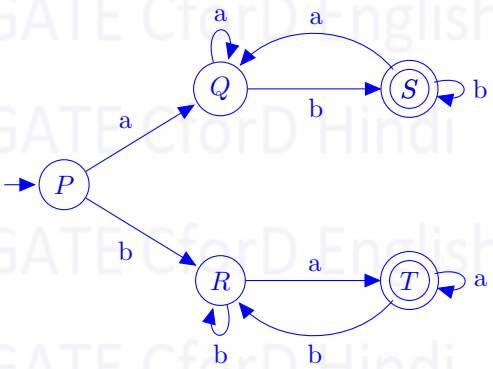
8 Miscellaneous Examples:

8.1 w starts and ends with different symbols.

$\sum = \{a, b\}$
$L = \{w \mid w$ starts and ends with different symbols.$\}$



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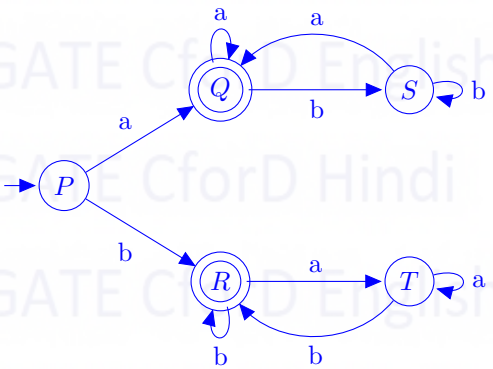
8.2 w starts and ends with same symbol.

$\sum = \{a, b\}$
$L = \{w \mid w$ starts and ends with same symbol.$\}$



Note: $\epsilon \notin L, \quad a \in L, \quad b \in L.$
ϵ starts with ϵ and ends with ϵ, but ϵ is not a symbol.

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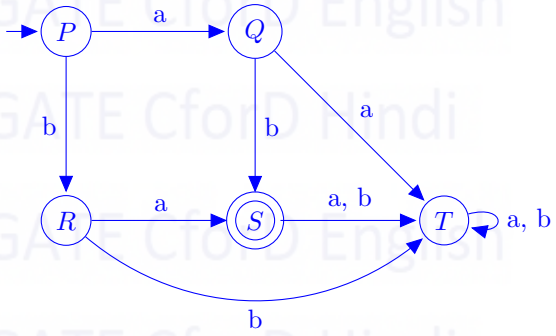
9 At least, At most, Exactly condition on different symbols.

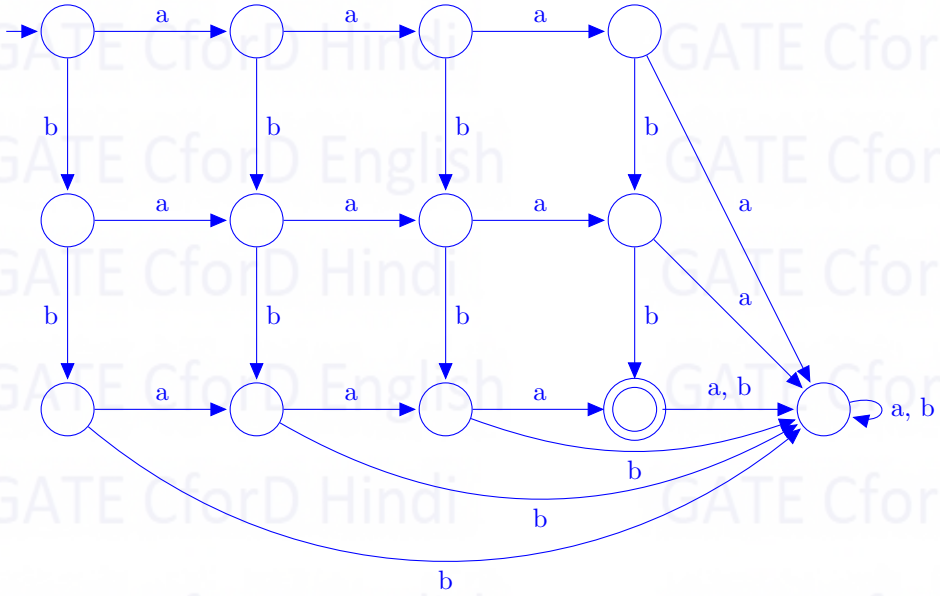
9.1 Exactly 1 a and exactly 1 b

$\sum = \{a, b\}$
$L = \{w \mid w$ contains exactly 1 a and exactly 1 $b.\}$



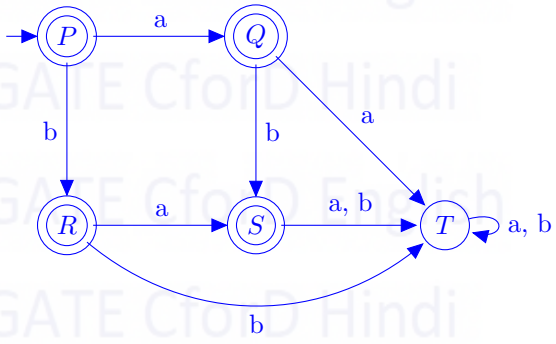
9.2 Exactly 3 a's and exactly 2 b's

$\sum = \{a, b\}$
$L = \{w \mid w$ contains exactly 3 a's and exactly 2 b's.$\}$



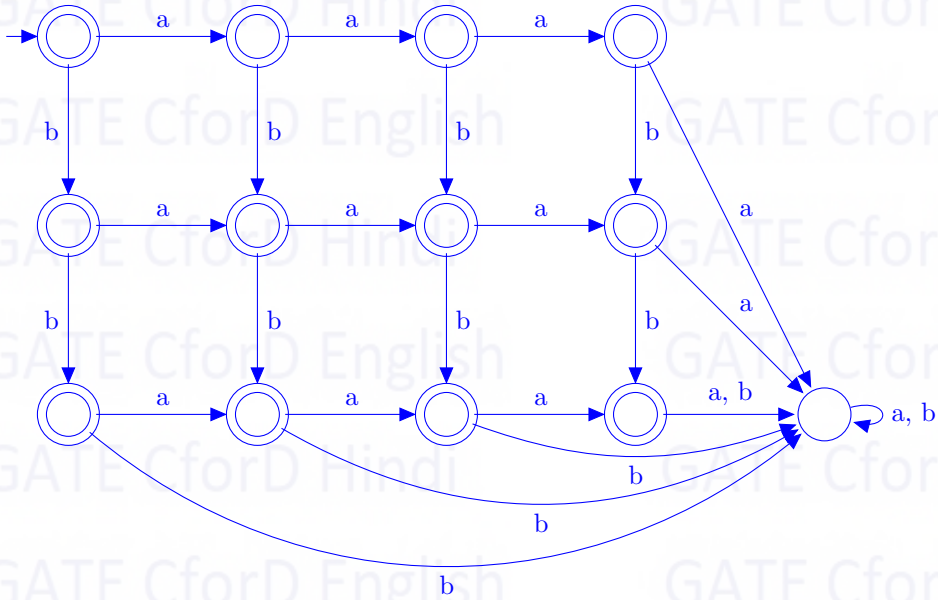
9.3 At most 1 a and at most 1 b

$\sum = \{a, b\}$
$L = \{w \mid w$ contains at most 1 a and at most 1 $b.\}$



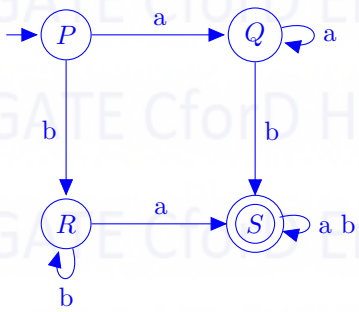
9.4 At most 3 a's and at most 2 b's

$\sum = \{a, b\}$
$L = \{w \mid w$ contains at most 3 a's and at most 2 b's.$\}$



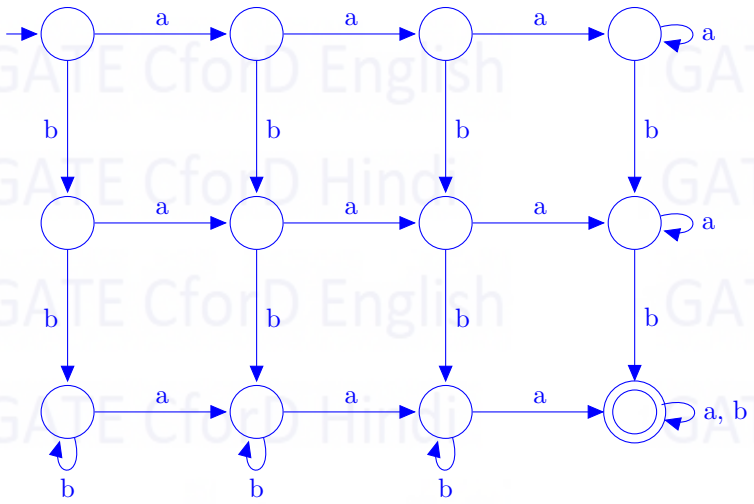
9.5 At least 1 a and at least 1 b

$\sum = \{a, b\}$
$L = \{w \mid w$ contains at least 1 a and at least 1 b.$\}$



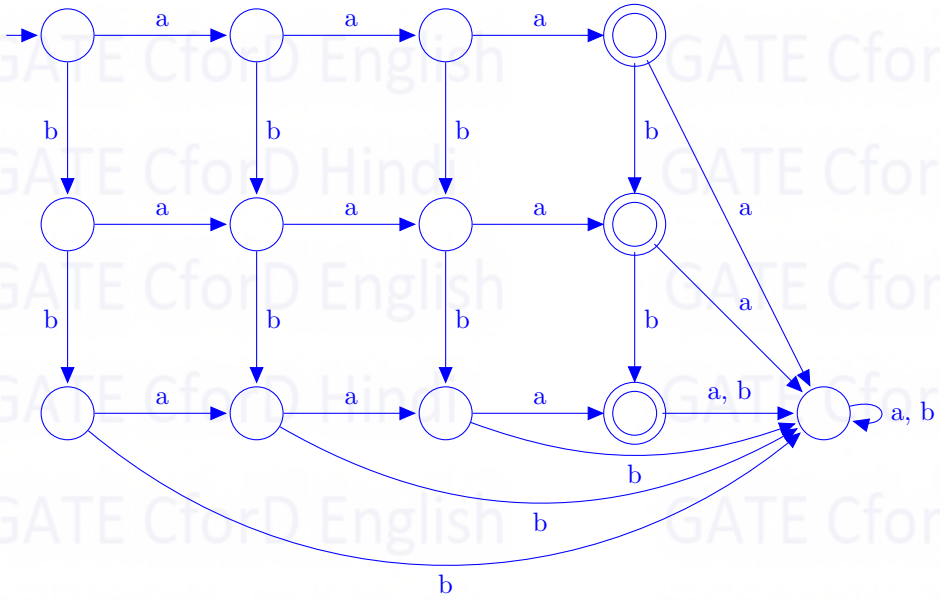
9.6 At least 3 a's and at least 2 b's

$\sum = \{a, b\}$
$L = \{w \mid w$ contains at least 3 a's and at least 2 b's.$\}$



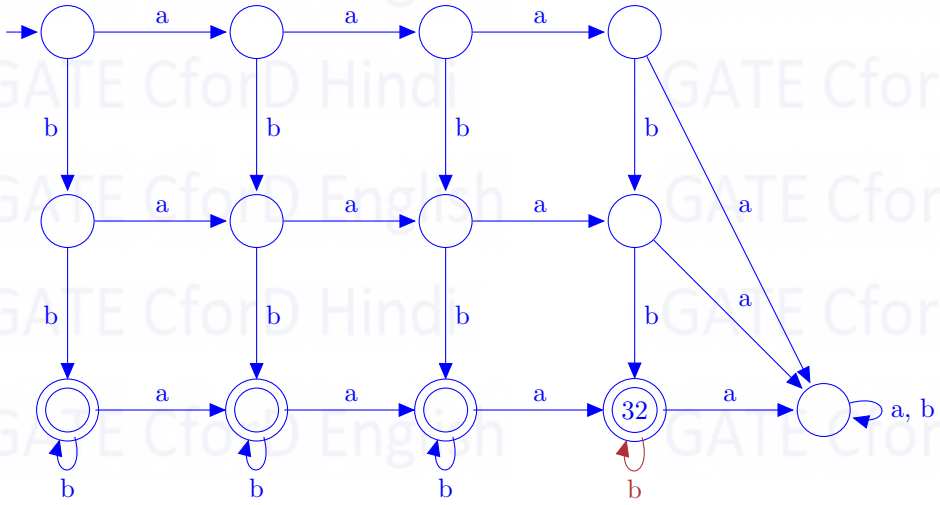
9.7 Exactly 3 a's and at most 2 b's

$\sum = \{a, b\}$
$L = \{w \mid w$ contains exactly 3 a's and at most 2 b's.$\}$



9.8 At most 3 a's and at least 2 b's

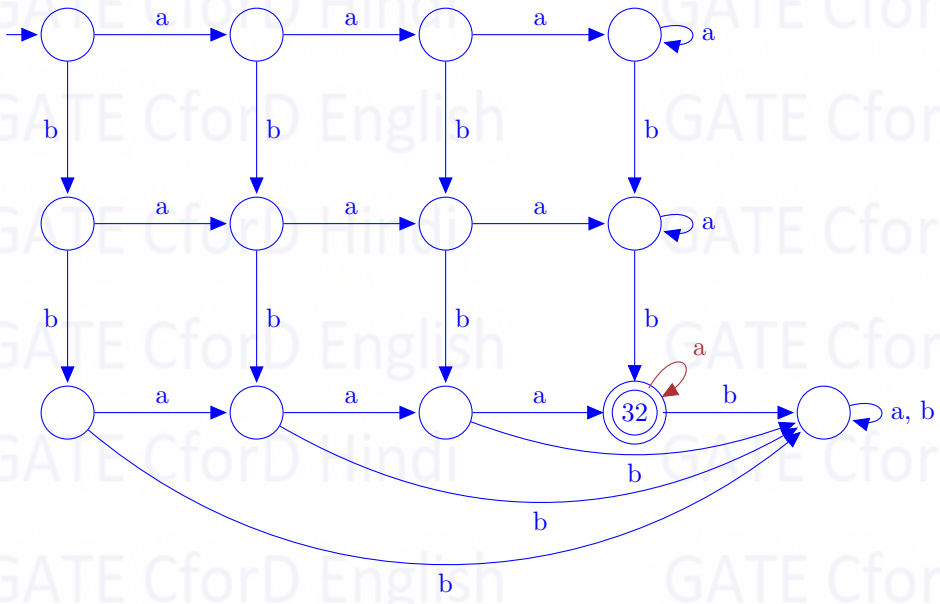
$\sum = \{a, b\}$
$L = \{w \mid w$ contains At most 3 a's and at least 2 b's.$\}$



Note: For state (32), self loop for b, and transition to trap state on a.
By mistake for $\delta(32, b)$, do not transition to trap state.

9.9 At least 3 a's and exactly 2 b's

$\sum = \{a,\ b\}$
$L = \{w \mid w$ contains at least 3 a's and exactly 2 b's.$\}$



Note: For state (32), self loop for a, and transition to trap state on b.
By mistake for $\delta(32, b)$, do not add transition to trap state.
