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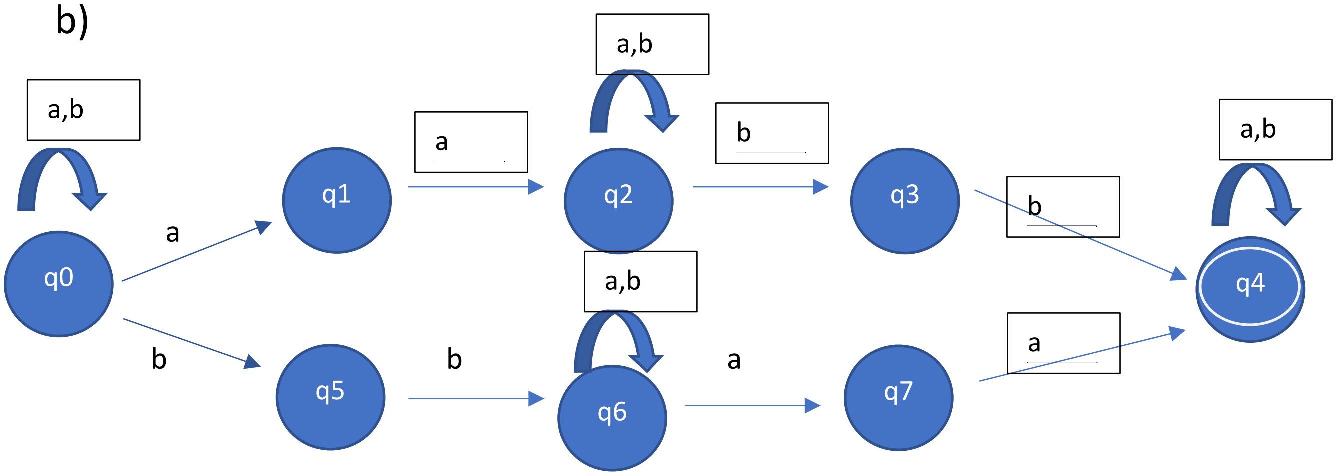
ANSWER 1)

a)

(a* b*) * (aa) (a* b*) (bb) (a* b*) * ∪ (a* b*) * (bb) (a* b*) (aa) (a* b*) *

b)



c) Let M = (K, Σ, Δ, s, F) be a nondeterministic finite automaton. We

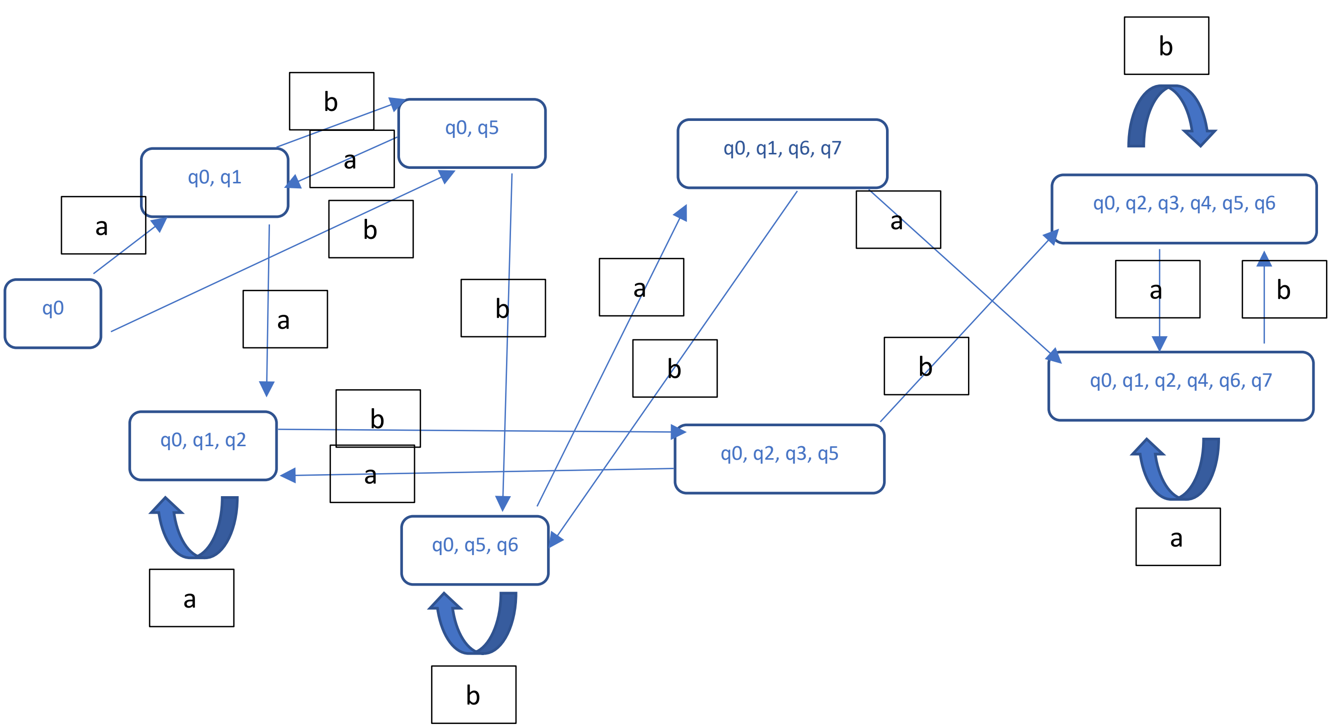
shall construct a deterministic finite automaton M' = (K', Σ, δ' , s', F') equivalent to M.

For M, K = {q_0, q_1, q_2, q_3, q_4, q_5, q_6, q_7} and Σ = {a, b} and F = {q_4} and s = {q_0}.

State	a	b
->q_0	q_0, q_1	q_0, q_5
q_1	q_2	---
q_2	q_2	q_2, q_3
q_3	---	q_4
*q_4	q_4	q_4
q_5	---	q_6
q_6	q_6, q_7	q_6
q_7	q_4	---

For M’ transition (δ') I will construct a table below.

State	a	b
q_0	q_0, q_1	q_0, q_5
q_0, q_1	q_0, q_1, q_2	q_0, q_5
q_0, q_5	q_0, q_1	q_0, q_5, q_6
q_0, q_1, q_2	q_0, q_1, q_2	q_0, q_2, q_3, q_5
q_0, q_5, q_6	q_0, q_1, q_6, q_7	q_0, q_5, q_6
q_0, q_2, q_3, q_5	q_0, q_1, q_2	q_0, q_2, q_3, q_4, q_5, q_6
q_0, q_1, q_6, q_7	q_0, q_1, q_2, q_4, q_6, q_7	q_0, q_5, q_6
q_0, q_2, q_3, q_4, q_5, q_6	q_0, q_1, q_2, q_4, q_6, q_7	q_0, q_2, q_3, q_4, q_5, q_6
q_0, q_1, q_2, q_4, q_6, q_7	q_0, q_1, q_2, q_4, q_6, q_7	q_0, q_2, q_3, q_4, q_5, q_6



For M’ K = $\{q_0, q_1, q_2, q_3, q_4, q_5, q_6, q_7\}$ and $\Sigma = \{a, b\}$ and F = $\{q_4\}$ and s = $\{q_0\}$.

d)

$$\begin{aligned} (q_0, bbabb) &\vdash_M (q_5, babb) \\ &\vdash_M (q_6, abb) \\ &\vdash_M (q_6, bb) \\ &\vdash_M (q_6, b) \\ &\vdash_M (q_6, e) \end{aligned}$$

$$\begin{aligned} (q_0, bbabb) &\vdash_M (q_0, babb) \\ &\vdash_M (q_0, abb) \\ &\vdash_M (q_0, bb) \\ &\vdash_M (q_0, b) \\ &\vdash_M (q_0, e) \end{aligned}$$

$$\begin{aligned} (q_0, bbabb) &\vdash_M (q_0, babb) \\ &\vdash_M (q_0, abb) \\ &\vdash_M (q_0, bb) \\ &\vdash_M (q_5, b) \\ &\vdash_M (q_6, e) \end{aligned}$$

$$\begin{aligned} (q_0, bbabb) &\vdash_M (q_5, babb) \\ &\vdash_M (q_6, abb) \\ &\vdash_M (q_6, bb) \\ &\vdash_M (q_6, b) \\ &\vdash_M (q_6, e) \end{aligned}$$

$$\begin{aligned} (q_0, bbabb) &\vdash_M (q_0, babb) \\ &\vdash_M (q_0, abb) \\ &\vdash_M (q_1, bb) \end{aligned}$$

$$\begin{aligned} (q_0, bbabb) &\vdash_M (q_5, babb) \\ &\vdash_M (q_6, abb) \\ &\vdash_M (q_7, bb) \end{aligned}$$

ANSWER 2)

a)

L_1 is given in the question. Assume that w ∈ L_1 and w is regular. w = $a^{n+3}b^n$ where |w| > n. From pumping lemma we need w = xyz split. x = a^{n-3} y = a^n z = a^3b^n. Again from the pumping lemma xy^iz must be in the L_1. But in our case when i = 0, it becomes a^nb^n. In the language's condition it says a's count must be greater than the b's count. Therefore, L_1 is not regular.

Assume that L_2 is regular. From the book's Finite Automata and Regular Expression part, we get the complement part. It says if L_2 is regular, $\overline{L_2}$ must be regular. But in our case $L_1 = \overline{L_2}$ and we know that L_1 is not regular. Therefore, L_2 is not regular.

b)

$L4$= {a_nb_n| n∈ℕ+}, $L5$= {a_mb_n |m,n ∈ℕ} and $L6$= $b*a(ab*a)*$

We need to prove whether $L4 \cup L5 \cup L6$ is regular or not.

L6 is a regular expression. Therefore, it is a regular language.

L4 is a language where it has equal number of consecutive a's and b's. and this language is not regular.

L5 is a language where it has consecutive a's and b's. Then, we see that L4 is a subset of L5. Although L4 is not a regular language, L5 is a regular language, and it contains L4. So L4 ∪ L5 = L5.

Union of two regular languages is regular. And in our case L5 and L6 is regular. Therefore, $L4 \cup L5 \cup L6$ is regular.