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Description automatically generated

**My Solution 1(a)**

NFA N = (Q, Σ, δ, q0, F) is defined by ({Q0,Q1,Q2,Q3,Q4,Q5},{a,b},δ, Q0, {Q0,Q1,Q5}) where δ can be expressed in a transition table as

|  |  |  |  |
| --- | --- | --- | --- |
| States | a | b | ε |
| Q0 | {Q0, Q1} | Q1 | ∅ |
| Q1 | Q1 | Q2 | ∅ |
| Q2 | Q4 | Q3 | ∅ |
| Q3 | Q4 | ∅ | ∅ |
| Q4 | Q5 | ∅ | ∅ |
| Q5 | ∅ | ∅ | {Q1, Q3} |

A diagram of a diagram

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**My Solution 1(b)**

A close-up of a math problem

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**My Solution 2: [** (a ∪ b)\* (abb) (a ∪ b)\* ]

Example(s): a(abb)a, aab(abb)ba, aaaabbbb(abb)bbbbaaaa

A diagram of a diagram

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**My Solution 3:**

NFA N = (QN, Σ, δN, qN, FN) is defined by ({Q0,Q1,Q2,Q3}{a,b},δ, Q0, {Q3}) where δ can be expressed as in a transition table as

|  |  |  |  |
| --- | --- | --- | --- |
| States | a | b | ε |
| Q0 | Q2 | Q1 | Q3 |
| Q1 | {Q1,Q3} | Q1 | ∅ |
| Q2 | ∅ | Q2 | Q3 |
| Q3 | ∅ | ∅ | ∅ |

Now NFA **N** can be expressed as DFA **D** and can be defined by ({Q1, {Q0,Q3},{Q1,Q3},{Q2,Q3},∅},{a,b},δ, Q0,{Q0,Q3},{Q1,Q3},{Q2,Q3}) where δ can be expressed as in a transition table as:

|  |  |  |
| --- | --- | --- |
| States | a | b |
| Q1 | {Q1,Q3} | Q1 |
| {Q0,Q3} | {Q2,Q3} | {Q1,Q3} |
| {Q1,Q3} | {Q1,Q3} | Q1 |
| {Q2,Q3} | ∅ | {Q2,Q3} |
| ∅ | ∅ | ∅ |

The state diagram along with the final states in red as:

A diagram of a diagram

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A math equations on a white background

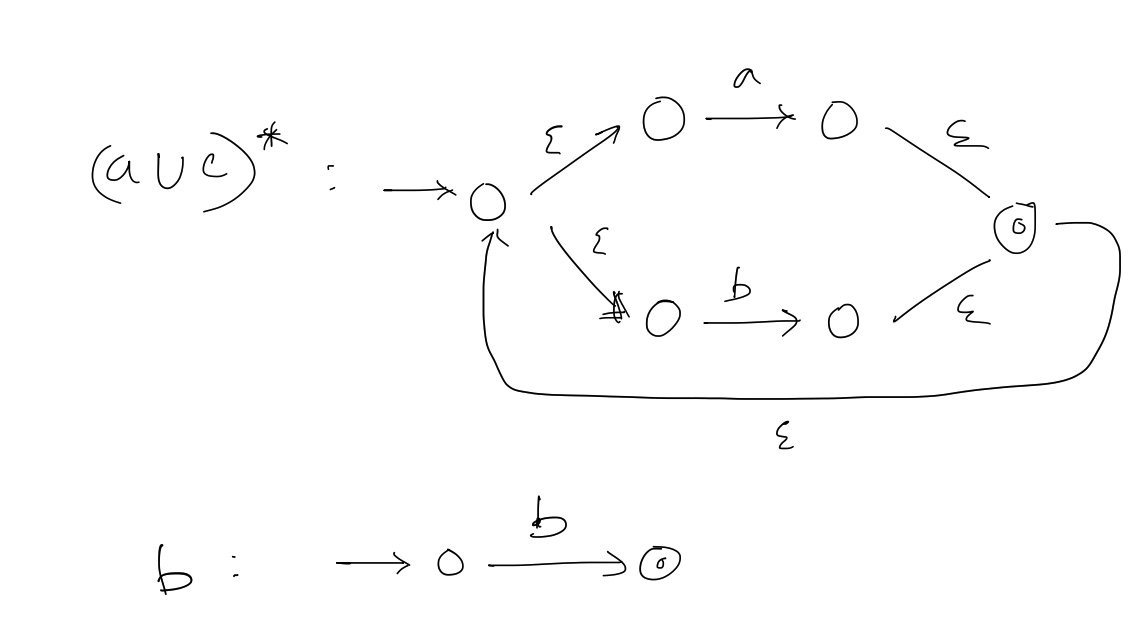
Description automatically generated

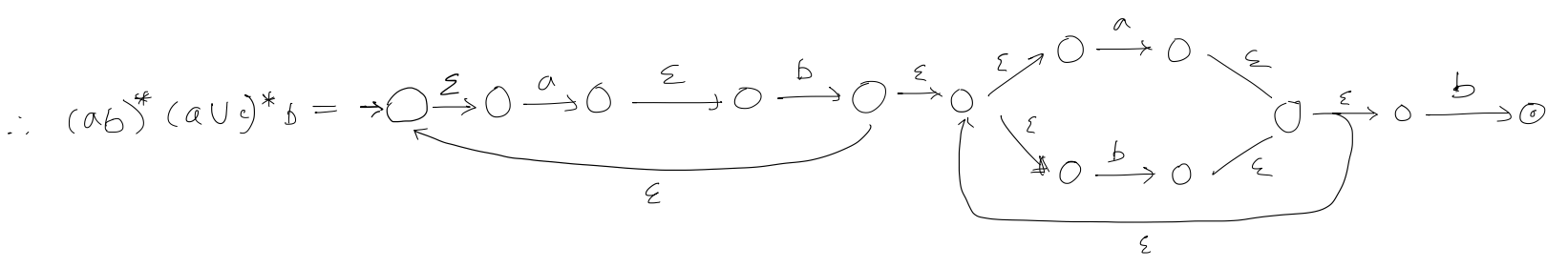
**My Solution 4:**

A diagram of a mathematical equation

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I followed the state diagrams figures and replicated them in my solution.

A diagram of a diagram

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A diagram of a triangle with circles and a line

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**My Solution 5:**

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**A white paper with black writing on it

Description automatically generated**

**A white paper with writing on it

Description automatically generated**

A diagram of a network

Description automatically generated

**My Solution 6:**

We can write the transition state for the DFA ***D*** in the following way:

|  |  |  |
| --- | --- | --- |
| States | 1 | 0 |
| Q0 | Q1 | Q2 |
| Q1 | Q3 | Q4 |
| Q2 | Q4 | Q0 |
| Q3 | Q1 | Q2 |
| Q4 | Q4 | Q4 |

**0 Equivalence** through separating the normal and the final states = {Q1, Q2, Q4} {Q0, Q3}

**1 Equivalence** through separating the normal states associated = {Q1} {Q2} {Q0, Q3} {Q4}

**2 Equivalence** through separating the normal states associated = {Q1} {Q2} {Q0, Q3} {Q4}

… **2 Equivalence** through separating the normal states associated = {Q1} {Q2} {Q0, Q3} {Q4}

|  |  |  |
| --- | --- | --- |
| States | 1 | 0 |
| Q0Q3 | Q1 | Q2 |
| Q1 | Q0Q3 | Q4 |
| Q2 | Q4 | Q0Q3 |
| Q4 | Q4 | Q4 |

And here’s the minimized DFA for the given **D**:

A diagram of a diagram

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**My Solution 7:**

Assuming L is regular and letting p be the pumping length by the pumping lemma we choose a string ap(abb). Since |s| >= p, the pumping lemma says that s can be split into 3 parts xyz where   
  
|xy| <= p  
|y| >0  
xyiz is in L for all *i >=0*

The analysis considers all possible substrings 'y' within the language 'L' defined by the condition of containing the substring 'abb'. If 'y' contains only 'a's, pumping it will violate the condition by introducing more 'a's than 'b's. Similarly, if 'y' consists solely of 'b's, pumping it will disrupt the 'abb' substring. Even if 'y' contains 'ab', pumping will alter the balance of 'a's and 'b's, violating the condition. Thus, for every case, pumping 'y' results in strings outside of 'L', indicating that 'L' is non-regular.