CS116-Automata Theory and Formal Languages
Problem Set on Regular Languages
1st semester 2025-2026

I. Build a DFA for each of the following languages:

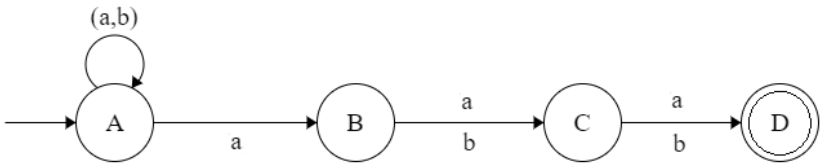
1. L={ w | w ϵ{0,1}* and begins in 001 }
2. L={ w | w ϵ{0,1}* and has a 0 in its 2nd last position, if such a position exists}
3. L={ w | w ϵ{0,1,2}* and the sum of the symbols in w is a multiple of 3}. For example, 021201 is part of the language because the sum of all its symbols equals 6 (6 mod 3 = 0); whereas, 010012 is not in the language because it sums up to 4 (4 mod 3 = 1).

II. Build an NFA for each of the following languages(You can assume that neither of these two languages contain λ-transition in them.)

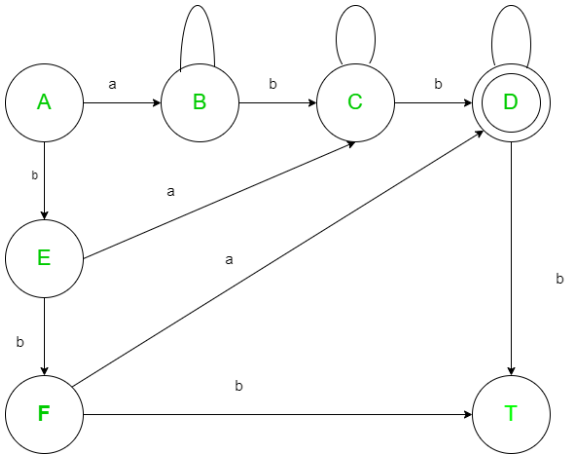
1. The set of strings over alphabet {a, b, c} such that the last symbol in the string has appeared before.
2. The set of strings over alphabet {a, b, c} such that the last symbol in the string has not appeared before.

III. Determine the language accepted by the following DFAs or NFAs

1.

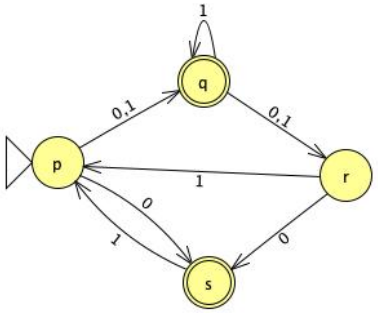


2.

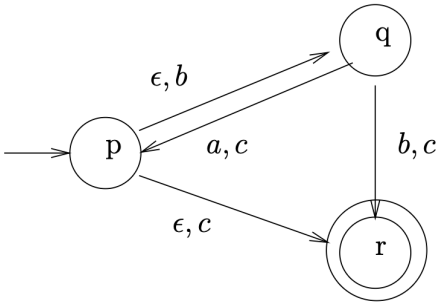


IV. Convert the following NFA to DFA

1.



2.



V. Give a regular expression for each of the following languages.

1. The set of binary strings, i.e. Σ={0,1}, not containing consecutive 1's.
2. The set of binary strings containing exactly one instance of 11 somewhere inside.
3. The set of binary strings with at most one pair of consecutive 1's — i.e, if 11 is present, it can occur exactly once.

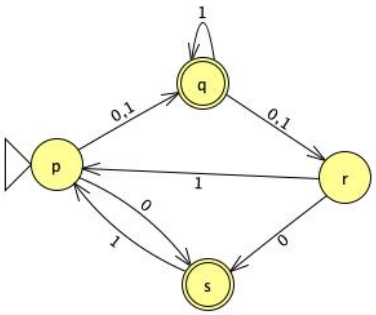
VI. Give a simple English description of each language represented by the regular expressions. Your answers should describe the language clearly (e.g., "all binary strings that start with 0"), rather than restating the exact conditions of the expression. Aim for concise, easy-to-understand descriptions without losing precision.

1. $(0 + 1)^*1(0 + 1) + (0 + 1)^*1(0 + 1)(0 + 1)$
2. $(a+ b+ c)^*b(a+ b+ c)^*c(a+ b+ c)^* + (a+ b+ c)^*c(a+ b+ c)^*b(a+ b+ c)^*$

VII. Convert the following regular expressions to ϵ−NFAs. Use the modular building approach discussed in class.

1. $(0 + 1)01$
2. $00(0 + 1)^*$

VIII. Convert the NFA to its equivalent regular expression



IX. Prove that the following languages are not regular using the pumping lemma.

1. $L=\{w \in \{a,b\}^* \mid w \text{ is a palindrome}\}$
2. $L=\{a^i b^j \mid i \neq j\}$ (strings with a different number of a's and b's)