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Theoretical Computer Science - Bridging Course
Exercise Sheet 2

Due: Tuesday, 29th of October 2024, 12:00 pm

Exercise 1: Constructing DFAs, NFAs *(2+2+2 Points)*

Construct DFAs that recognize the first two languages and an NFA that recognizes the last language. The alphabet set is $\Sigma = \{a, b\}$.

1. $L_1 = \{w \mid w$ has an odd number of a's and ends with $b\}$.
2. $L_2 = \{w \mid w$ is any string except bb and $bbb\}$.
3. $L_3 = \{w \mid w$ is any string where at least one of the symbols a or b occurs an even number of times$\}$.

Exercise 2: Closure of Regular Languages *(2+3+2+2 Points)*

1. Show that if M is a DFA that recognizes language L, you can construct a new DFA M' that recognizes the complement of L i.e. $\bar{L} := \Sigma^* \setminus L$. Conclude that the class of regular languages is closed under complementation.
2. Show by giving an example that if M is an NFA (instead of a DFA) that recognizes language L, then the same approach you used to construct the new DFA M' above doesn't necessarily yield a new NFA that recognizes the complement of L. Is the class of languages recognized by NFAs closed under complementation? Explain your answer.

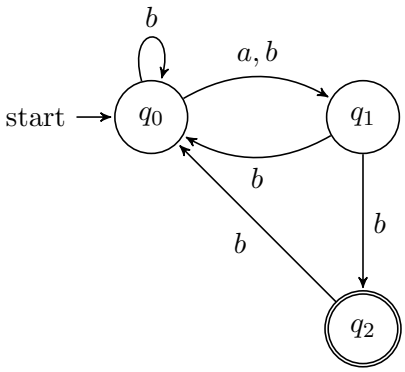
   Let L_1 and L_2 be regular languages.

3. Show that $L_1 \cap L_2$ is regular by constructing its corresponding DFA.
4. Deduce from parts 1 and 3 that regular languages are closed under the symmetric difference i.e. $L_1 \Delta L_2$ is also regular.

Remark: For parts 1 and 3 there's no need for drawing state diagrams. Show how a DFA for the language in the question can be constructed presuming the existence of DFAs for L, L_1, and L_2.

Exercise 3: NFA to DFA *(2+3 Points)*

Consider the following NFA.



1. Give a formal description of the NFA by giving the alphabet, state set, transition function, start state and the set of accept states.

2. Construct a DFA which is equivalent to the above NFA by drawing the corresponding state diagram.

   Bonus question: Explain which language the automaton accepts.