



# Theoretical Computer Science - Bridging Course

## Exercise Sheet 2

Due: Tuesday, 30th of April 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.  $L_1 = \{w \mid w \text{ has an odd number of } a\text{'s and ends with } b\}$ .
2.  $L_2 = \{w \mid w \text{ is any string except } bb \text{ and } bbb\}$ .
3.  $L_3 = \{w \mid w \text{ is any string where at least one of the symbols } a \text{ or } b \text{ occurs an even number of times}\}$ .

### 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.

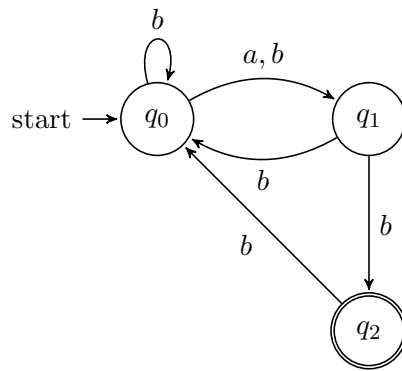
3. Show that  $L_1 \cap L_2$  is regular by constructing its corresponding DFA.
4. Deduce from parts 1 and 3 that regular languages are closed under the symmetric difference i.e.  $L_1 \Delta L_2$  is also regular.

*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.*