

Exercise for the Lecture  
**Theoretical Computer Science**  
Summer 2024  
Sheet 1

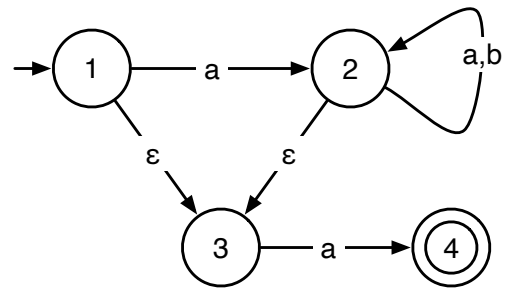
Please upload exactly one PDF file to ILIAS, other submissions will be ignored. Write all names and matriculation numbers of the group participants on the submission.

**Exercise 1: DFA or NFA**

(2 Points)

Consider this automaton:

- Is this a DFA or an NFA? Justify your answer.
- Provide a formal description of the automaton.
- Which language does this automaton accept? Prove your statement!
- Is the language closed under the Kleene star operator? That is, is  $L^* = L$ ? Justify!



**Exercise 2: Complement and Difference**

(3 Points)

- Prove that regular languages are closed under complement. That is, if  $L \subseteq \Sigma^*$  is a regular language, then  $\bar{L} = \Sigma^* \setminus L$  is also a regular language.
- Prove that regular languages are closed under difference. That is, if  $A, B \subseteq \Sigma^*$  are regular languages, then  $C = A \setminus B = A \cap \bar{B}$  is also a regular language.

Note: The construction of an automaton for the resulting language alone is not a proof.

**Exercise 3: Construction of Automata**

(5 Points)

Construct a DFA or an NFA (whatever you feel better suited) for the languages  $A, B, C, D$ , and  $E$ .

- $A$  contains all words  $w \in \{a, b\}^*$  that contain at least two letters  $a$ .
- $B$  contains all words  $w \in \{a, b\}^*$  where the number of occurrences of the character  $b$  is a multiple of 3.
- $C$  contains all words  $w \in \{a, b\}^*$  that contain the subword  $abbab$ .
- $D$  contains all words  $w \in \{a, b\}^*$  that end with  $bbb$ .
- $E$  contains all words  $w \in \{a, b\}^*$  where the fourth-last letter is  $b$ .