Automata

1. **Specifying finite automata.** Specify finite automata that accept the following languages. You don’t have to give a formal definition; the state diagram is enough. Assume the alphabet \( \Sigma \) to be \( \{a, b\} \) in all cases. For each automaton, say whether it is deterministic or not.

   (a) \( \{w \mid w \text{ has the same number of occurrences of substring } ab \text{ as of substring } ba\} \)
   (b) \( \{w \mid w \text{ starts with an } a \text{ and has odd length or starts with } b \text{ and has even length}\} \)
   (c) \( \Sigma^* \setminus \{\epsilon\} \), i.e., all strings of the alphabet except the empty string
   (d) \( \{w \mid w \text{ contains an } a \text{ three places from the right hand end}\} \) (For example, \( abbbabbb \) is a member of this language and so is \( aaaa \), but \( abb \) is not.)
   (e) \( \{a^n \mid n \text{ is a multiple of } 3\} \)

2. **Finite state transducers.** Do exercises 1.24 and 1.25 on page 87 of Sipser [1].

3. **Properties of regular languages.** Do exercise 1.31 on page 88 of Sipser [1].

4. **An automaton with complex symbols.** Do exercise 1.32 on page 88 of Sipser [1].

References