

Discrete Event Systems

Exercise Sheet 3

1 Pumping Lemma [Exam]

Is the following language regular? Prove your claims!

$$L = \{0^a 1^b 0^c 1^d \mid a, b, c, d \geq 0 \text{ and } a = 1, b = 2 \text{ and } c = d\}$$

2 Deterministic Finite Automata [Exam]

Transform the NFA A in Figure 1 into an equivalent DFA using the powerset construction presented in the lecture, while assuming $\Sigma = \{0, 1\}$. (*Hint*: Only construct states which are necessary!)

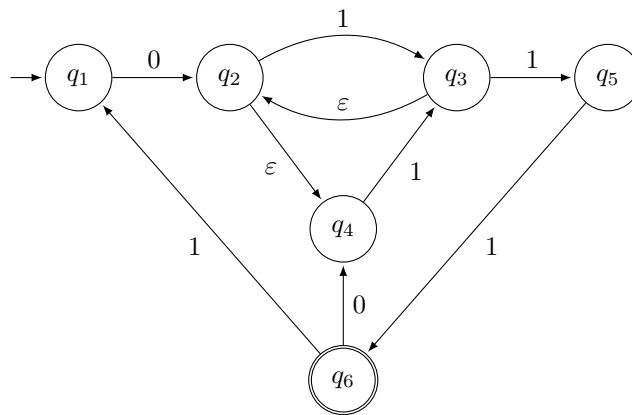


Figure 1: NFA A .

3 Transforming Automata [Exam]

Consider the DFA B in Figure 2 over the alphabet $\Sigma = \{0, 1\}$. Give a regular expression for the language L accepted by the automaton B . If you like, you can do this by ripping out states as presented in the lecture.

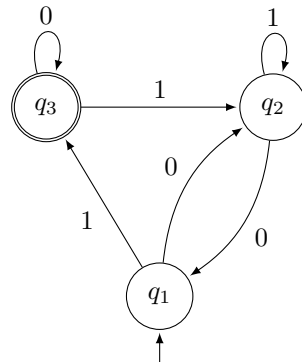


Figure 2: DFA B .

4 Regular and Context-Free Languages

- Consider the context-free grammar G with the production $S \rightarrow SS \mid 1S2 \mid 0$. Describe the language $L(G)$ in words, and prove that $L(G)$ is not regular.
- The regular languages are a subset of the context-free languages. Give the context-free grammar for an arbitrary language L that is regular.

5 Context-Free Grammars

Give context-free grammars for the following languages over the alphabet $\Sigma = \{0, 1\}$:

- $L_1 = \{w \mid \text{the length of } w \text{ is odd}\}$
- $L_2 = \{w \mid \text{contains more 1s than 0s}\}$

6 Ambiguity

Consider the following context-free grammar G with non-terminals S and A , start symbol S , and terminals “(”, “)”, and “0”:

$$\begin{aligned} S &\rightarrow SA \mid \varepsilon \\ A &\rightarrow AA \mid (S) \mid 0 \end{aligned}$$

- What are the eight shortest words produced by G ?
- Context-free grammars can be ambiguous. Prove or disprove that G is unambiguous.