Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Networked Systems Group (NSG)

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based on Prof. R. Wattenhoffer's material

# 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!)

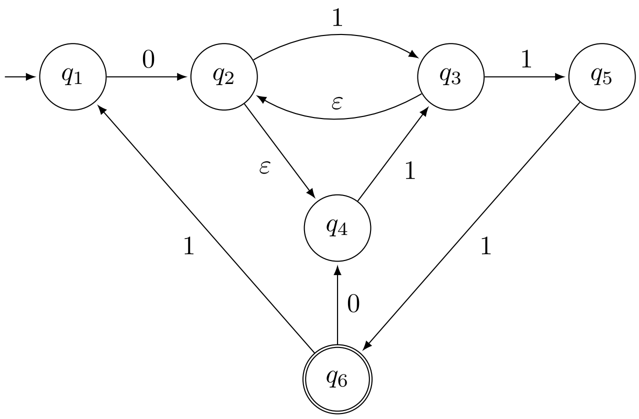


Figure 1: NFA $A$.

## 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.

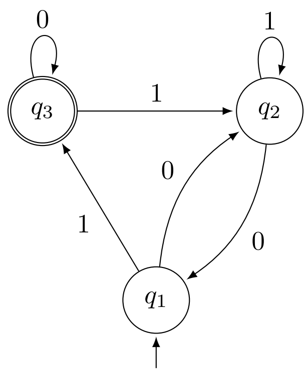


Figure 2: DFA $B$.

## 4 Regular and Context-Free Languages

**a)** Consider the context-free grammar $G$ with the production $S \to SS \mid 1S2 \mid 0$. Describe the language $L(G)$ in words, and prove that $L(G)$ is not regular.

**b)** 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 $\Sigma = \{0, 1\}$:

**a)** $L_1 = \{w \mid \text{the length of } w \text{ is odd}\}$

**b)** $L_2 = \{w \mid \text{contains more 1s than 0s}\}$

## 6 Ambiguity

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

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

**a)** What are the eight shortest words produced by $G$?

**b)** Context-free grammars can be ambiguous. Prove or disprove that $G$ is unambiguous.