

Discrete Event Systems

Exercise Sheet 2

1 Nondeterministic Finite Automata

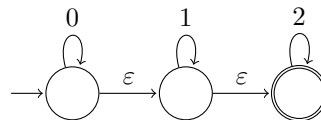
- Consider the alphabet $\{a, b\}$. Construct an NFA that accepts all strings containing the substring $abba$ at least twice. (This means that words containing $abbaabba$ as a substring should also be accepted!)
- Construct an NFA which accepts the following regular expression: $(00 \cup (0(0 \cup 1)^*))^*$.
- Construct an NFA accepting $1^*0^*1^+$ with as few states as possible. (cf. Exercise 1.1.a)
- Consider an automaton $M := (Q, \Sigma, \delta, q_0, Q)$. What can you say about the strings being accepted by M ? Does it make a difference whether M is deterministic or not?

2 Exam question [2018]

Assume that the alphabet Σ is $\{0, 1\}$ and consider the language $L = \{w \mid \text{there exist two zeros in } w \text{ that are separated by a string whose length is } 4i \text{ for some } i \geq 0\}$. For example, the strings 1001 and 10110101 belong to L , whereas the strings 101 and 010101 do not. Design an NFA that recognizes L with 6 states or less.

3 De-Randomization

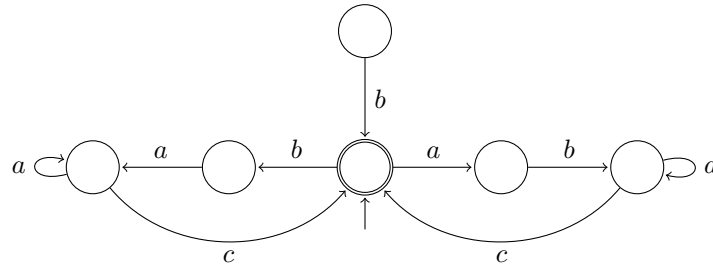
- Give a regular expression for the following NFA and construct an equivalent NFA *without* ε -transitions.



- Finally, transform the machine into a deterministic automaton.

4 States Minimization

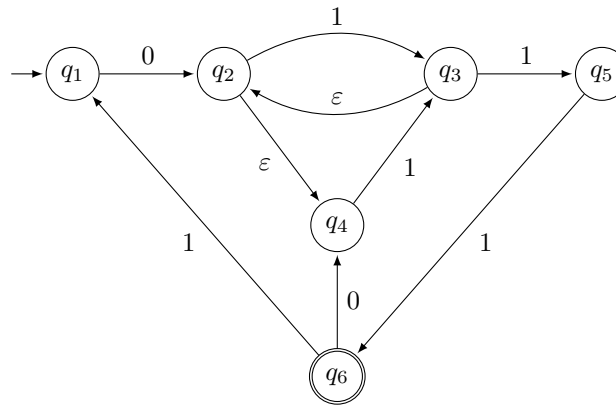
Simplify the following automaton. Explain why your changes are allowed. Finally, give the corresponding regular expression.



5 Derandomizing a large NFA [Exam HS14]

Transform the given NFA into an equivalent DFA, while assuming $\Sigma = \{0, 1\}$.

*Hint: Only construct states which are necessary!*¹



6 “Regular” Operations in UNIX

In this exercise you are asked to provide a full UNIX command using **egrep** to output all lines in a file "top-secret.md" ending with "password" or "passwort", followed by an unknown number (potentially zero) of vowels. To check your answer use a terminal on your computer or a website like regex101.com.²

¹For more derandomization, we recommend solving exercise 2 of Exam HS24.

²The symbol \$ signifies end of line. Consider lower and upper case letters.