Theoretical Computer Science II

Dr. M. Helmert, Dr. A. Karwath
G. Röger
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University of Freiburg
Department of Computer Science

Exercise Sheet 8

Due: December 16, 2009

Exercise 8.1 (Regular Expressions, 1 + 2 marks)

(a) Give regular expressions generating the following languages. In all cases the alphabet is $\Sigma = \{0, 1\}$.

- $L = \{w \mid w$ has length at least 3 and its 3rd symbol is a $0\}$
- $L = \{w \mid w$ starts with 0 and has odd length, or starts with 1 and has even length$\}$

(b) Give a regular expression for the language $L(A)$, recognized by the DFA $A = (Q, \Sigma, \delta, q_0, F)$, where $Q = \{q_0, q_1, q_2\}$, $F = \{q_2\}$, $\Sigma = \{0, 1\}$, and δ given by the following transition table:

δ	0	1
q_0	q_0	q_1
q_1	q_2	q_1
q_2	q_0	q_0

Exercise 8.2 (Pumping Lemma, 1 + 1 + 1 + 2 marks)

Are the following languages regular? If yes, prove it by giving a regular expression or a finite automaton that recognizes the language. If not, prove it using the pumping lemma.

(a) $L = \{a^n b^{3n} \mid n \geq 0\}$, $\Sigma = \{a, b\}$

(b) $L = \{a^n b c^r \mid n, r \geq 0\}$, $\Sigma = \{a, b, c\}$

(c) $L = \{a^n b^{n+s} c^s \mid n, s \geq 0\}$, $\Sigma = \{a, b, c\}$

(d) $L = \{a^3 b^n c^{n-3} \mid n \geq 1\}$, $\Sigma = \{a, b, c\}$

Exercise 8.3 (Context-free Grammars, 2 marks)

Give the formal definition for a context-free grammar defining the following language: $L = \{w a^n b^n w^R \mid w \in \Sigma^*, n \geq 1\}$, with $\Sigma = \{a, b\}$, where w^R denotes the reversal of string w (for example, for $w = aabb$, $w^R = bbaa$).