

## Theoretical Computer Science II

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### Exercise Sheet 7

Due: December 12, 2011

**Exercise 7.1** (Regular expressions,  $0.5 + 0.5 + 0.5 + 0.5$  marks)

Consider the following regular expressions. What language do they recognize? Give two strings that are members of the the corresponding language and two strings which are not members – a total of four strings for each part. Assume the alphabet  $\Sigma = \{a, b, c\}$  in all parts.

- (a)  $a^*b^*c^*$
- (b)  $\Sigma^*aba\Sigma^*$
- (c)  $((a \cup c)^*b(a \cup c)^*b(a \cup c)^*b(a \cup c)^*)^*$
- (d)  $b \cup b\Sigma^*b$

**Exercise 7.2** (Regular Expressions,  $0.5 + 0.5 + 1 + 1 + 1$  marks)

Construct regular expressions for the following languages over the alphabet  $\Sigma = \{0, 1\}$

- (a)  $L_1 = \{w \in \Sigma^* \mid \text{every } 0 \text{ in } w \text{ is immediately followed by a } 1\}$
- (b)  $L_2 = \{w \in \Sigma^* \mid \text{the second or the third position from the end is a } 1\}$
- (c)  $L_3 = \{w \in \Sigma^* \mid w \text{ consists of alternating } 0 \text{ and } 1\}$
- (d)  $L_4 = \{w \in \Sigma^* \mid w \text{ does not contain } 11\}$
- (e)  $L_5 = \{w \in \Sigma^* \mid w \text{ ends in even number of } 0s\}$

**Exercise 7.3** (NFAs and Regular Expressions,  $2.5 + 1.5$  marks)

Consider the regular expression  $(30 \cup 75 \cup 45)^* \circ 10$  (over the alphabet  $\Sigma = \{0, 1, 2, 3, 4, 5, 6, 7, 8, 9\}$ ).

- (a) Give the NFA that recognizes  $L((30 \cup 75 \cup 45)^* \circ 10)$  as it would be constructed according to the proof of Lemma 1.29 from the lecture.
- (b) Give another NFA with at most 5 states that recognizes the same language (you do not have to justify your answer).