RADBOUD UNIVERSITY NIJMEGEN

Test **Formal Languages, Grammars and Automata, NWI-MOL090**

May 31, 2013, 14.40 – 15.30, HG 00.304

This test consists of **4 exercises** + **1 bonus exercise**. The maximum number of points per question is given in the margin. (The grade is obtained by **dividing the number of points by** 5, rounding down to 10 if necessary.)

In this test, $\Sigma = \{a, b\}$.

(10) 1. Give a regular expression e such that $L(e) = L_1$, where

$$L_1 = \{w \in \Sigma^* \mid w \text{ contains } aba \text{ and } abba\}$$

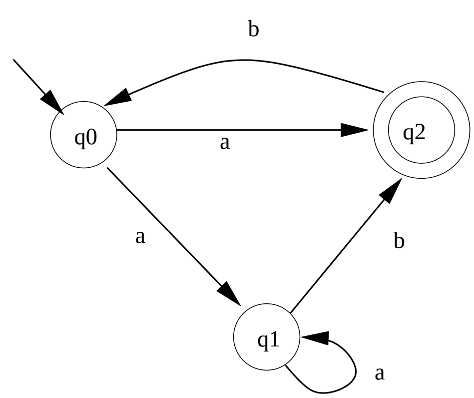
NB. Note that aba and $abba$ can overlap.

(10) 2. Give a DFA (deterministic finite automaton) that accepts the language L_2 where

$$L_2 = \{w \in \{a, b, c, d\}^* \mid \text{ all characters in } w \text{ appear in alphabetic order}\}.$$

So, $abbcd \in L_2$ and $bc \in L_2$, but $abad \notin L_2$ and $db \notin L_2$.

3. Consider the following NFA (non-deteministic finite automaton) M



(6) (a) Indicate for each of the following words whether they are accepted by M: $abba$, $ababa$, $abab$.

(7) (b) Is it true that $L(ab(ab)^*) \subseteq L(M)$? Explain your answer. (So, the question is to verify whether all words in $L(ab(ab)^*)$ are also in $L(M)$.)

(7) (c) Construct a DFA M' that accepts the same language as M. (Use the "powerset construction" that was used in the lecture.)

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(10) 4. Prove that the following language L_4 is not regular.

$$L_4 = \{ww \mid w \in \Sigma^*\}$$

So, a word is in L_4 if it consists of two copies of the same word. For example, $aabaab \in L_4, babaababaa \in L_4$, but $abaa \notin L_4, aaaaa \notin L_4$.

(10) 5. [**Bonus**] We define the function $\mathsf{F} : \{a, b\}^* \to \{a, b, c\}^*$ that puts a c behind every b in a word. For example, $\mathsf{F}(abab) = abcabc$, $\mathsf{F}(abba) = abcbca$ and $\mathsf{F}(aaa) = aaa$. The function F extends to languages in the obvious way: if $L \subseteq \{a, b\}^*$, then $\mathsf{F}(L) = \{\mathsf{F}(w) \mid w \in L\}$

Show that the following holds.

If L is regular, then $\mathsf{F}(L)$ is regular.

END