LIACS — Leiden University

Examination Fundamentele Informatica 2

11 January 2010, 14:00 - 17:00

Question 1: **[2,0 points]**

a) Find a regular expression for $L = \{w \in \{0,1\}^* \mid w$ has *exactly* one pair of consecutive 0's$\}$.

b) Prove that $r_1^*(r_1+r_2)^*$ and $(r_1+r_2)^*$ denote the same language for all regular expressions r_1 and r_2.

c) Let w^R be the reverse of a string w and $L^R = \{w^R \mid w \in L\}$. Give a general method by which any regular expression r can be transformed into another regular expression $\check{r}$ such that $L(\check{r}) = L(r)^R$.

Question 2: **[1,5 points]**

Design a non-deterministic finite automaton with no more than four states for each of the following languages over the alphabet $\Sigma = \{ 0, 1 \}$:

a) $(010+0101)^*$

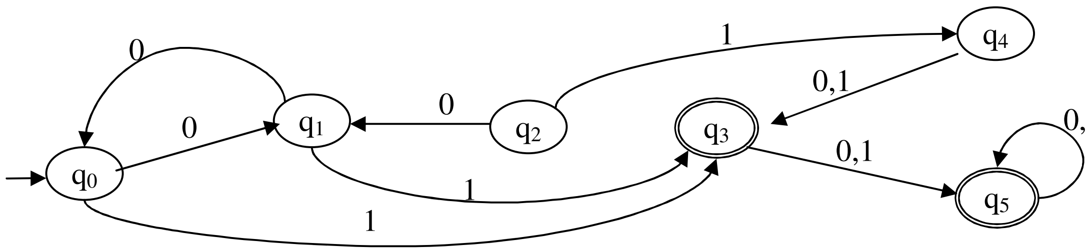
b) $101^* + 10^*$

c) $1^* + 1^*0$.

Question 3: **[2,5 points]**

a) The *nor* of two languages is defined by $nor(L_1,L_2) = \{w \mid w \notin L_1 \text{ and } w \notin L_2\}$. Are regular languages closed under the *nor* operation? Justify jour answer.

b) Minimize the states of the deterministic finite automaton depicted below:



Question 4: **[1,5 points]**

a) Show that the grammar G with production $S \rightarrow aSb \mid SS \mid \Lambda$ is ambiguous.

b) Give a grammar for the language $\{a^n b^n c^m \mid n,m \geq 0\} \cup \{a^n b^m c^m \mid n,m \geq 0\}$? Is it ambiguous?

Question 5: **[2,5 points]**

a) Give a context free grammar for the language $\{ww^R \mid w \in \{a,b\}^*\}$.

b) Give a context free grammar for the language $\{a^n b^m \mid 2n \leq m \leq 3n\}$.

c) Let $L = \{a^n b^n \mid 0 \leq n\}$. Show that L^* is a context-free language.

The final score is given by the sum of the points obtained.