LIACS
Leiden University

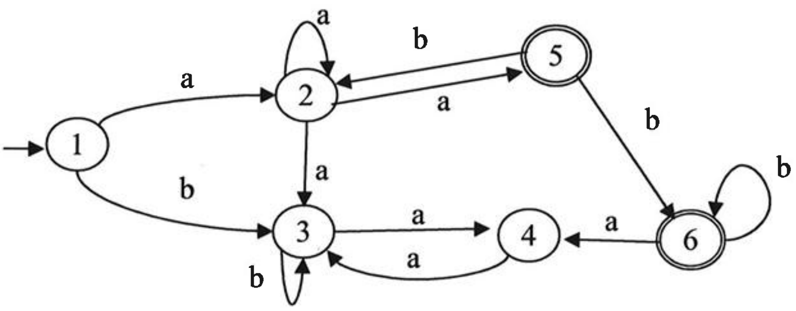
Examination Fundamentele Informatica 2
13 January 2016, 10:00 - 13:00

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

a) Give a *deterministic* finite automaton recognizing the language $L_1 = \{ x \in \{a,b\}^* \mid bb$ is a substring of $x \}$.
b) Give a *deterministic* finite automaton recognizing the language $L_2 = \{ x \in \{a,b\}^* \mid ba$ is not a substring of $x\}$.
c) Use the *product construction* to give a *deterministic* finite automaton recognizing the language $L_1 \setminus L_2$.

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

Construct a *minimal* deterministic finite automaton equivalent to the following one:



Question 3: **[2 points]**

Find a regular expression corresponding to each of the following subsets of $\{a,b\}^*$:

a) The language of all strings containing exactly two b's
b) The language of all strings containing an even number of b's
c) The language of all strings not containing the substring bb
d) The language of all strings in which every b is followed immediately by aa.

Question 4: **[2 points]**

a) Use the *pumping lemma* to show that the language $L = \{ w_1cw_2 \mid w \in \{a,b\}^*$ and $|w_1| = |w_2| \}$ over the alphabet { a, b, c } is not regular.
b) Give a *pushdown automaton* accepting by *empty stack* recognizing the above language L. Use only *one single stack symbol* X, which must necessarily be the initial stack symbol.

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

a) Give a *regular grammar* generating the language $L = \{ x \in \{a,b\}^* \mid x$ ends with bb $\}$.
b) Construct a non-deterministic finite automata corresponding to your regular grammar above.
c) Give an example of an *ambiguous* context free grammar and show why it is so.

Question 6: **[1,5 points]**

Give context free grammars generating the following languages over the alphabet { a, b, c }:

a) $L_1 = \{a^nb^m c^k \mid 0 < n \leq m \text{ and } k \geq 0\}$
b) $L_2 = \{a^nb^mc^k \mid 0 < n+2m \leq k\}$
c) $L_3 = L_1 \cup L_2$

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