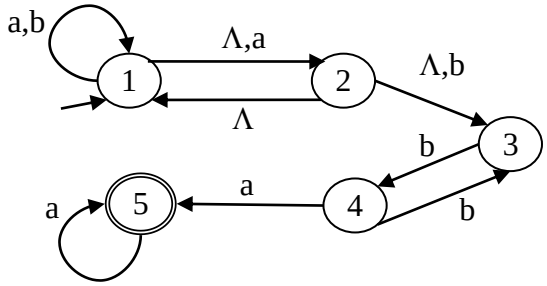
LIACS Examination Fundamentele Informatica 2
Leiden University 15 March 2019, 14:00 - 17:00

Question 1: **[2 points]**

a) Give a regular expression for the L = { w ∈ { a, b }* | w does *not* begin with bb }.
b) Give a *deterministic* finite automaton recognizing the above language L.
c) Give *a minimal deterministic* finite automaton recognizing the language L*.

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

Consider the nondeterministic finite automaton



a) Give the *Λ-closure* of each state.
b) Construct a *deterministic* finite automaton accepting the same language.

Question 3: **[1,5 points]**

Give examples proving the following statements on languages over the alphabet { a,b }:

a) A subset of a regular language can be non-regular.
b) The infinite union of regular languages can be non-regular.
c) If L_1 and L_2 are different regular languages and L_3 is not regular then $L_1L_2L_3$ can be non-regular.

Question 4: **[1 point]**

Give a context-free grammar that generates the language of *all* palindromes over alphabet {a,b} that do *not* contains the substring bb.

Question 5: **[2 points]**

Consider a context-free grammar G with productions:

$S \rightarrow aSa \mid A \qquad A \rightarrow aBa \mid B \qquad B \rightarrow bBb \mid a$

a) Give an example of a string w *not* in L(G) with |w| = 5.
b) Show that G is ambiguous
c) Give another grammar in Chomsky normal form generating the same language of G.

Question 6: **[2 points]**

a) Give a context free grammar generating the language
L = { w ∈ { a, b }* | the first, the last and the middle symbols of w are the same }.
b) Draw a pushdown automaton recognizing the language L.
c) Use the pumping lemma to show that L is *not* regular.

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