LIACS
Leiden University

Examination Fundamentele Informatica 2
15 January 2009, 10:00 - 13:00

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

Write a regular expression for each of the following sets of strings over { 0, 1 }:

a) Any strings excepts 11,
b) Any strings for which any odd occurrence symbol is 1,
c) Any strings of odd length.

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

a) For each of the following languages give a deterministic finite automaton recognizing it and having as fewer states as possible
   i. {0}
   ii. {1,00}
   iii. $\{1^n \mid n \geq 2\}$.
b) For each of the above languages give a non-deterministic finite automaton recognizing it having fewer states than the deterministic automaton you found in the previous exercise.

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

a) Give an algorithm to determine if a *regular* language L is infinite.
b) Give an algorithm to determine if two *regular* languages L_1 and L_2 are identical.
c) Give an algorithm to determine for a *context-free* language L if $w \in L$.

Question 4: **[2,0 points]**

a) Consider the grammar $G = (\{S,X\},\{a,b\}, S, \{S \rightarrow \Lambda, S \rightarrow aX, X \rightarrow Sb\})$. Is the language generated by the above grammar a regular language? If yes give a finite automaton accepting the same language, otherwise use the pumping lemma to prove it is not a regular language.
b) Consider the grammar $G = (\{S\},\{a,b\}, S, \{ S \rightarrow \Lambda, S \rightarrow aSb, S \rightarrow bSa, S \rightarrow SS\})$ generating all strings having an equal number of a's and b's. Show that this grammar is ambiguous.

Question 5: **[2,0 points]**

a) Turn the non-deterministic finite automata of question 2 into regular grammars.
b) Give a context free grammar generating all the strings of the form $a^k b^m c^n$ with $n = k + m$, $k \geq 1$and $m \geq 0$.
c) Transform the grammar you found in 5.b into Chomsky normal form.

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