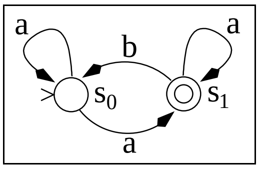
T-79.4301 Parallel and Distributed Systems

Examination, May 8, 2007

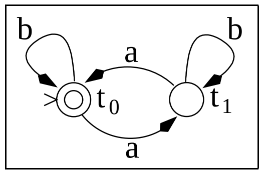
Please note the following: To pass the course you need at least 50% of the home assignment points. Please contact the Lecturer after the exam if you've not completed the home assignments successfully.

Assignment 1 Consider the following finite state automata A_1 and A_2, where $\Sigma_1 = \Sigma_2 = \{a,b\}$.

A_1:



A_2:

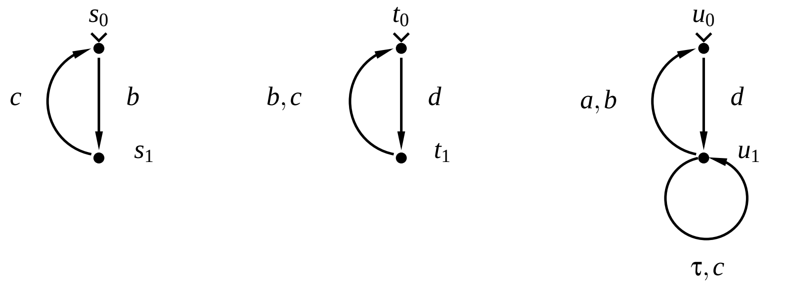


(a) Construct the finite state automaton $A_a = A_1 \cap A_2$.

(b) Construct the finite state automaton A_b that accepts the complement of the language accepted by the automaton A_a.

Assignment 2 Consider the following three labelled transition systems (LTSs) L_1, L_2, and L_3:

$L_1 : \quad \Sigma_1 = \{b,c\}$ $\qquad L_2 : \quad \Sigma_2 = \{b,c,d\}$ $\qquad L_3 : \quad \Sigma_3 = \{a,b,c,d\}$



(a) Compute the parallel composition $L = L_1 || L_2 || L_3$.

(b) Does L contain any conflicts? If it does, please give a list consisting of all the triples (v,t,t'), where: v is a global state of L where a conflict occurs and t,t' are a pair of global transitions of L which are in conflict in v.

(c) Does L contain any deadlocks? If it does, please give a list of global states of L which are deadlocks.

(d) Does L contain any livelocks? If it does, please give a list of global states of L in which a livelock exists.

(e) Does L contain a pair of independent transitions? If it does, give one example of two global transitions which are independent.

(f) Give a deterministic finite automaton A_f accepting the language $\Sigma^* \setminus \mathit{traces}(L)$, where Σ is the alphabet of L.

(g) Answer the question: Is $\mathit{traces}(L_3) \subseteq \mathit{traces}(L)$? Please use the automaton A_f constructed in the previous step. If the answer is no, give a word in $\mathit{traces}(L_3) \setminus \mathit{traces}(L)$.

Note! More assignments on the other side of the paper.

The name of the course, the course code, the date, your name, your student id, and your signature must appear on every sheet of your answers.

Course feedback (deadline 23.5): `http://www.tcs.tkk.fi/Studies/T-79.4301/`

Assignment 3 (a) Give two LTSs L_c and L'_c such that $L_c \leq_{sim} L'_c$ holds but $L'_c \sim L_c$ does not hold.

(b) Give two LTSs L_b and L'_b such that $L_b \leq_{tr} L'_b$ holds but $L'_b \leq_{tr} L_b$ does not hold.

(c) Is the following claim true: If both $L_d \leq_{sim} L_e$ and $L_e \leq_{sim} L_f$ hold, then L_d simulates L_f.

(d) Define formally the notion from LTS theory: Independence.

(e) Shortly describe (in ten sentences in maximum) how the reachability analysis technique “bitstate hashing” works, and what can it be used for.

Assignment 4 Give Kripke models $M_a - M_d$ with $AP = \{p, q\}$ such that:

a) $M_a \models \mathbf{G}\neg q$ and $M_a \models \mathbf{G}\,(p \Rightarrow q)$

b) $M_b \not\models \mathbf{G}\,p$ and $M_b \models \mathbf{G}\,(p \vee \mathbf{Y}\,q)$

c) $M_c \not\models \mathbf{G}\,(p\,\mathbf{S}\,q)$ and $M_c \models \mathbf{G}\,\mathbf{O}\,q$

d) $M_d \not\models \mathbf{G}\neg p$ and $M_d \models \mathbf{G}\,(p \Rightarrow (q\,\mathbf{S}\,\neg p))$

Assignment 5 Translate the parallel composition of LTSs $L = L_1||L_2||L_3$ as given in Assignment 2(a) to a P/T-net N that contains at most 6 places but still has the same reachability graph as L.