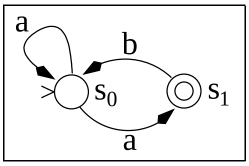
T-79.4301 Parallel and Distributed Systems

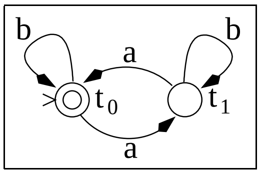
Examination, August 31, 2007

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

A_1:



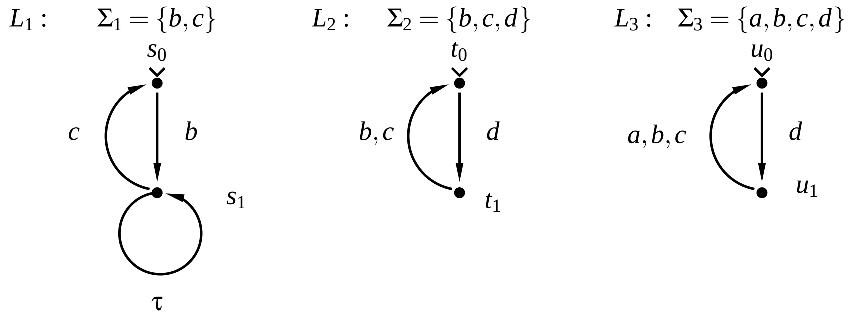
A_2:



(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:



(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 $\Sigma^* \setminus traces(L)$, where Σ is the alphabet of L.

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

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.

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Assignment 3 (a) Let L be a parallel composition of LTSs $L = L_1||L_2||\cdots||L_n$ with n global transitions enabled in the initial state that are all pairwise independent, and in which each transition becomes disabled after its firing. How many states does the reachability graph of L at least have? How many edges does the reachability graph of L at least have? (In both cases give as tight a lower bound as possible as a function of the parameter n.)

(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) 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.

(d) Is the following claim true: If both $L_d \leq_{sim} L'_d$ and $L'_d \leq_{sim} L_d$ hold, then L_d and L'_d are bisimilar. Please explain your answer in a sentence or two.

(e) Define formally the notion: Bisimulation.

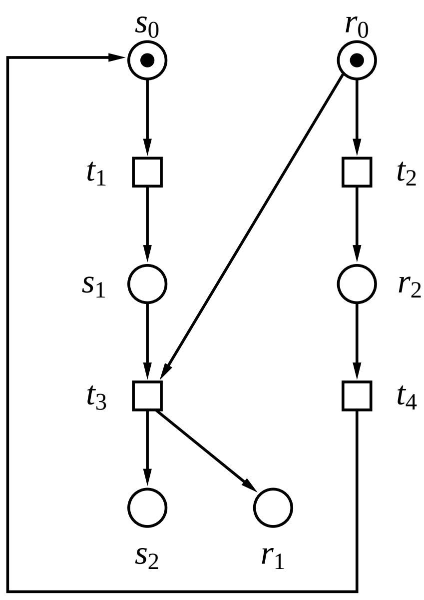
Assignment 4 Give the formalisation of the following properties as past safety formulas:

(a) Processes 0 and 1 are never at the same time in the critical section. Use atomic propositions: cs_0 - process 0 is in the critical section, and cs_1 - process 1 is in the critical section.

(b) If a lock is released, it has been locked in the past. Use atomic propositions: *release* - the lock is being released, and *lock* - the lock is being locked.

(c) If the alarm is on, the system has crashed in the past and has not been reset after crashing. Use atomic propositions: *alarm* - the alarm is on, *crashed* - the system crashed, and *reset* - the system is being reset.

Assignment 5 Create the reachability graph G of the P/T-net N below.



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