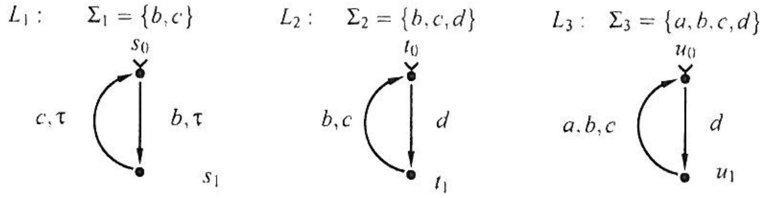
Aalto University, Department of Information and Computer Science KH

T-79.4302 Parallel and Distributed Systems

Examination, May 23, 2011

Assignment 1 Consider the following three labelled transition systems (LTSs):



(a) Compute the parallel composition $L = L_1 || L_2 || L_3$. (3p)

(b) Does L contain any deadlocks? If it does, please give a list of global states of L which are deadlocks. (1p)

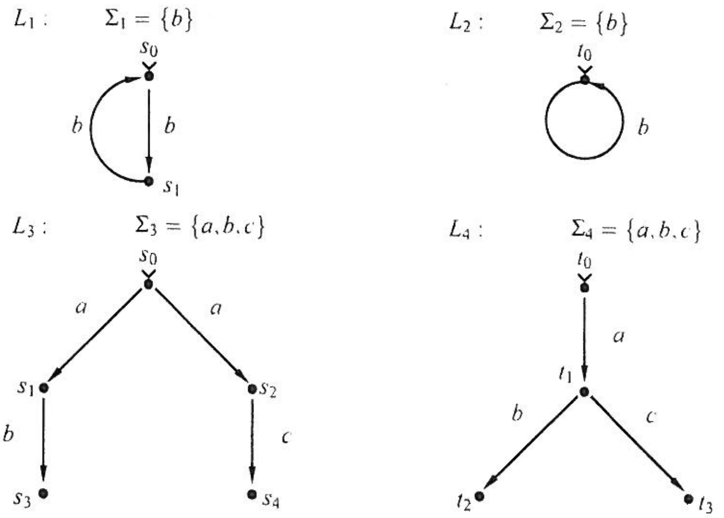
(c) Does L contain any livelocks? If it does, please give a list of global states of L in which a livelock exists. (1p)

(d) Does L contain a pair of independent transitions? If it does, give one example of two global transitions which are independent. (1p)

(e) Give a deterministic finite automaton A_e accepting the language $\Sigma^* \setminus traces(L)$, where Σ is the alphabet of L. (1p)

(f) Answer the question: Is $traces(L_2) \subseteq traces(L)$? Please use the automaton A_e constructed in the previous step. If the answer is no, give a word in $traces(L_2) \setminus traces(L)$. (1p)

Assignment 2 Consider the following LTSs L_1 to L_4.



a) Is it the case that $L_1 \sim L_2$? (2p)

b) Is it the case that $L_3 \sim L_4$? (2p)

In each case, either find a bisimulation relation to show that the two LTSs are bisimilar, or show that no such bisimulation relation exists.

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.

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.) (1p)

(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. (1p)

(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. (1p)

(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. (1p)

(e) Define formally the notion: Safety property. (1p)

(f) Define formally the notion from the theory of LTSs: Conflict. (1p)

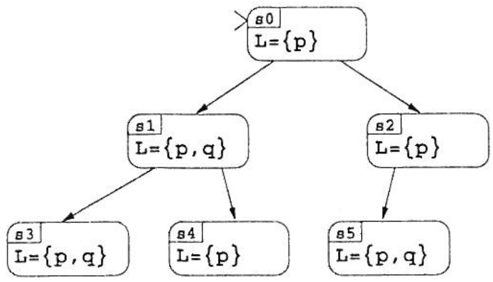
Assignment 4 Consider the Kripke structure M below. For each of the formulas below check whether the formula holds in M or not. If the formula holds, give a short explanation (max 5 lines of text) why the formula holds. If the formula does not hold, give a counterexample path through the Kripke structure. (A simple yes/no answer is **not** sufficient to obtain full points in this assignment.)

(a) Does $M \models \mathbf{G}(p \vee q)$ hold? (1p)

(b) Does $M \models \mathbf{G}(\mathbf{Y}\, p)$ hold? (1p)

(c) Does $M \models \mathbf{G}(q \Rightarrow (\mathbf{Y}\, \neg q))$ hold? (1p)

(d) Does $M \models \mathbf{G}((p \wedge q) \Rightarrow (\mathbf{Y}((\neg q) \vee \mathbf{Y}(\neg q))))$ hold? (1p)



Assignment 5 Describe briefly (using half a page maximum) how constructions from the automata theory can be used to check whether $L \leq_{tr} L'$ holds. (2p)