Model Checking WS 2015: Assignment 3

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Due 19.11.2015

Exercise 13

Let $L := (S, I, \Sigma, T)$ be an LTS with states S. Let $\Psi : \mathbb{P}(S \times S) \to \mathbb{P}(S \times S)$ be the operator defined on slide 38, i.e. $\Psi(\lesssim) := \{(r,t) \in (S \times S) \mid r \lesssim t \text{ or } \exists s \in S : [r \lesssim s \text{ and } s \lesssim t]\}$ for relation $\lesssim \subseteq S \times S$.

a) Prove that if $\lesssim$ is a simulation then $\Psi(\lesssim)$ is also a simulation.

b) Given a relation $\lesssim \subseteq S \times S$, is $\Psi(\lesssim)$ always a transitive relation? Justify your answer.

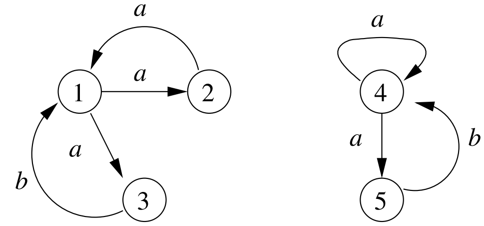
Exercise 14

Let A_1 and A_2 be two LTS. Prove the theorem from slide 40: If $A_1 \lesssim A_2$ then $L(A_1) \subseteq L(A_2)$.

Hint: let $L := (S, I, \Sigma, T)$ be an LTS. Let $w := a_1 a_2 \ldots a_{n-1} a_n$ be a trace of L for $s_0 \xrightarrow{a_1} s_1 \xrightarrow{a_2} \ldots \xrightarrow{a_{n-1}} s_{n-1} \xrightarrow{a_n} s_n$ where $s_0 \in I$ and length $|w| = n$ for $n \geq 0$. Note that w can not only be interpreted as a sequence $a_1 \ldots a_n$ of symbols a_i in Σ but also as a sequence $s_0 \ldots s_n$ of states s_i in S.

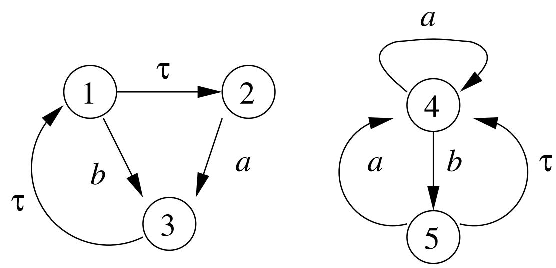
Exercise 15

Compute the maximal simulation $\lesssim$ over the following LTS using the fixpoint algorithm:



Exercise 16

Compute the *maximal weak simulation* $\lesssim$ over the LTS shown on the right.



Exercise 17

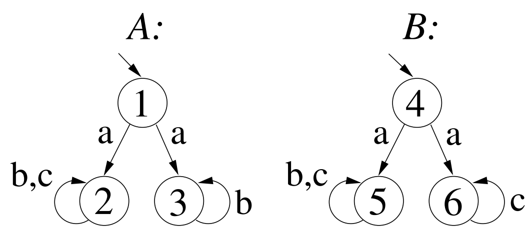
Given LTS A and B as shown on the right,...

a) ...compute the *maximal strong simulation* $\lesssim$ over $A \dot{\cup} B$.

b) ...compute the *maximal strong bisimulation* $\approx$ over $A \dot{\cup} B$.

c) Check whether $1 \lesssim 4$, $4 \lesssim 1$ and $1 \approx 4$.

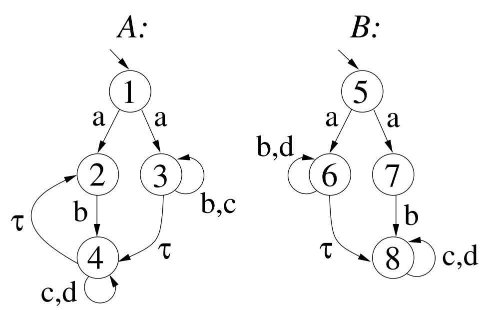
d) Is $L(A) = L(B)$?



Exercise 18

Given LTS A and B as shown on the right, and relation $\approx := \{(1,5),(2,7),(3,6),(4,8),(3,8),(4,6)\}$.[a] Assume that we want to find out whether relation $\approx$ is a *weak* bisimulation over $A \cup B$ by checking pairs in $\approx$.

[a] Assume this is symmetric by definition, i.e. $(5,1),(7,2),\ldots \in \approx$



a) Does the check succeed for pair $(3,6)$? Justify your answer.

b) Does the check succeed for pair $(4,6)$? Justify your answer.

c) Does the check succeed for pair $(4,8)$? Justify your answer.