Concurrency Theory WS 2013/2014
Chair for Software Modeling and Verification
Rheinisch-Westfälische Technische Hochschule Aachen

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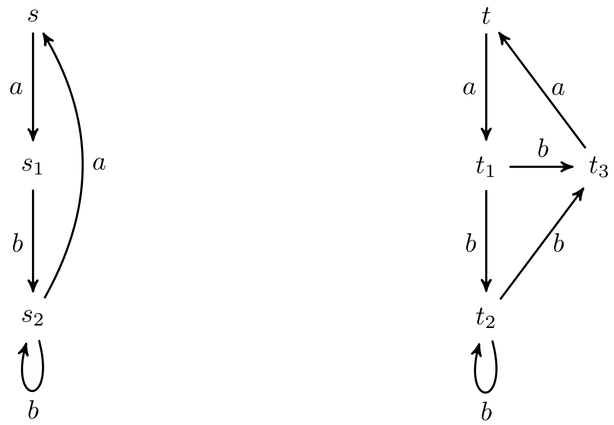
— Series 8 —

Hand in until December 17rd before the exercise class.

Exercise 1 (Strong bisimilarity as a game) (2 Points)

Decide whether $s \sim t$ in the following LTS. Either you give a universal wining strategy for the attacker (i.e., $s \not\sim t$) or for the defender (i.e., $s \sim t$). If $s \sim t$, you should also define a strong bisimulation relating the pair of processes.



Exercise 2 (Simulation) (2 Points)

A binary relation $\mathcal{R} \subseteq \mathsf{Prc} \times \mathsf{Prc}$ is a *simulation* iff whenever for each $(P, Q) \in \mathcal{R}$, and $\alpha \in Act$:

$$\text{if } P \xrightarrow{\alpha} P' \text{ then there is a transition } Q \xrightarrow{\alpha} Q' \text{such that } (P', Q') \in \mathcal{R}.$$

Two processes Q and P are in *simulation preorder* iff there is a simulation that relates them.

Modify the rules of the strong bisimulation game introduced in the lecture in such a way that it characterizes the simulation preorder.

Exercise 3 (Approximation algorithm for strong bisimilarity) (2 Points)

Using the iterative algorithm to compute the largest strong bisimulation over the LTS described by following equations in CCS:

$$\begin{aligned} P_1 &= a.P_2, \\ P_2 &= a.P_1, \\ P_3 &= a.P_2 + a.P_4, \\ P_4 &= a.P_3 + a.P_5, \\ P_5 &= nil. \end{aligned}$$

Exercise 4 (3 Points)

For each $i \geq 0$, the binary relation $\sim_i$ over Prc is defined as follows.

- for any $P, Q \in \mathsf{Prc}$, $P \sim_0 Q$ hold always;
- $P \sim_{i+1}$ Q holds iff, for each $\alpha \in Act$:
  if $P \stackrel{\alpha}{\to} P'$ then there is a transition $Q \stackrel{\alpha}{\to} Q'$ such that $P' \sim_i Q'$, and
  if $Q \stackrel{\alpha}{\to} Q'$ then there is a transition $P \stackrel{\alpha}{\to} P'$ such that $P' \sim_i Q'$.

Show that, for each $i \geq 0$,

1) the relation $\sim_i$ is an equivalence relation.

2) $\sim_i = \mathcal{F}^i(\mathsf{Prc} \times \mathsf{Prc})$ (you may find the definition of $\mathcal{F}$ in the lecture).