Prof. Dr. Ir. Joost-Pieter Katoen

Tim Quatmann, Matthias Volk

Exercise 1 (Equivalences overview): (3 points)

Let $CTL\backslash_U$ be the sublogic of CTL that does not permit the until operator. Similarly, $CTL^*\backslash_U$ means CTL^* without until. Which of the following statements are correct for finite transition systems?

(a) $CTL\backslash_U$ equivalence is finer than $CTL\backslash_\bigcirc$ equivalence.

(b) $CTL\backslash_U$ equivalence is finer than divergence-sensitive stutter trace equivalence.

(c) $CTL\backslash_\bigcirc$ equivalence is finer than $LTL\backslash_\bigcirc$ equivalence.

(d) Divergence-sensitive stutter bisimulation equivalence is finer than $CTL\backslash_U$ equivalence.

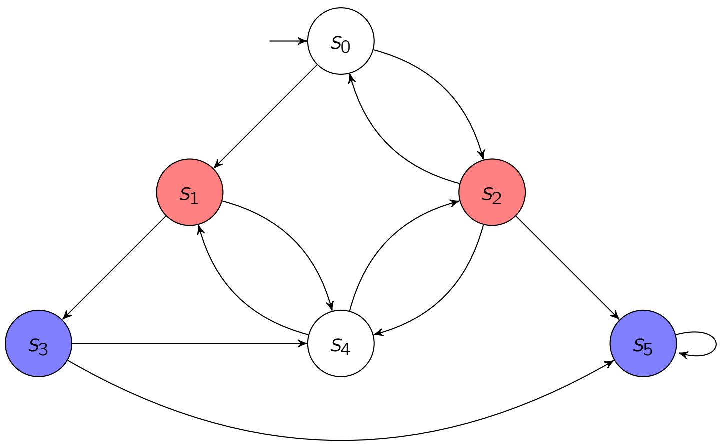
(e) Stutter trace equivalence is finer than $CTL\backslash_U$ equivalence.

(f) For AP-deterministic transition systems, stutter trace equivalence is finer than trace-equivalence.

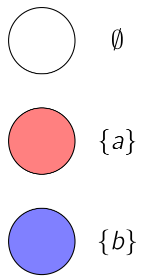
(g) For AP-deterministic transition systems, trace equivalence is finer than $CTL^*\backslash_U$ equivalence.

Exercise 2 (Simulation quotienting): (3 points)

Consider the following transition system TS. Compute the simulation preorder $\preceq_{TS}$ using (the first version of) the HHK algorithm presented in the lecture (slide 199). Whenever there are multiple states k such that $Sim_{old}(k) \neq Sim(k)$, then pick the largest such k.



(a) TS



(b) Legend

Exercise 3 (Stutter simulation): (4 points)

Let $TS = S, Act, \rightarrow, I, AP, L)$ be a finite transition system. A stutter simulation (cf. Exercise 3 from Sheet 4) for TS is a relation $\mathcal{R} \subseteq S \times S$ such that for all $(s_1, s_2) \in \mathcal{R}$ the following conditions hold:

(i) $L_1(s_1) = L_2(s_2)$.

(ii) If $s_1' \in Post(s_1)$ with $(s_1', s_2) \notin \mathcal{R}$, then there exists a finite path fragment $s_2\ u_1 \ldots u_n\ s_2'$ with $n \geq 0$ and $(s_1, u_i) \in \mathcal{R}$, $i = 1, \ldots, n$ and $(s_1', s_2') \in \mathcal{R}$.

$s_1 \in S$ is said to be stutter simulated by $s_2 \in S$, denoted $s_1 \preceq_{st}^{TS} s_2$, iff there exists a stutter simulation $\mathcal{R}$ for TS with $(s_1, s_2) \in \mathcal{R}$.
Show that $\preceq_{st}^{TS}$ is a preorder.