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LEHRSTUHL FÜR INFORMATIK 2
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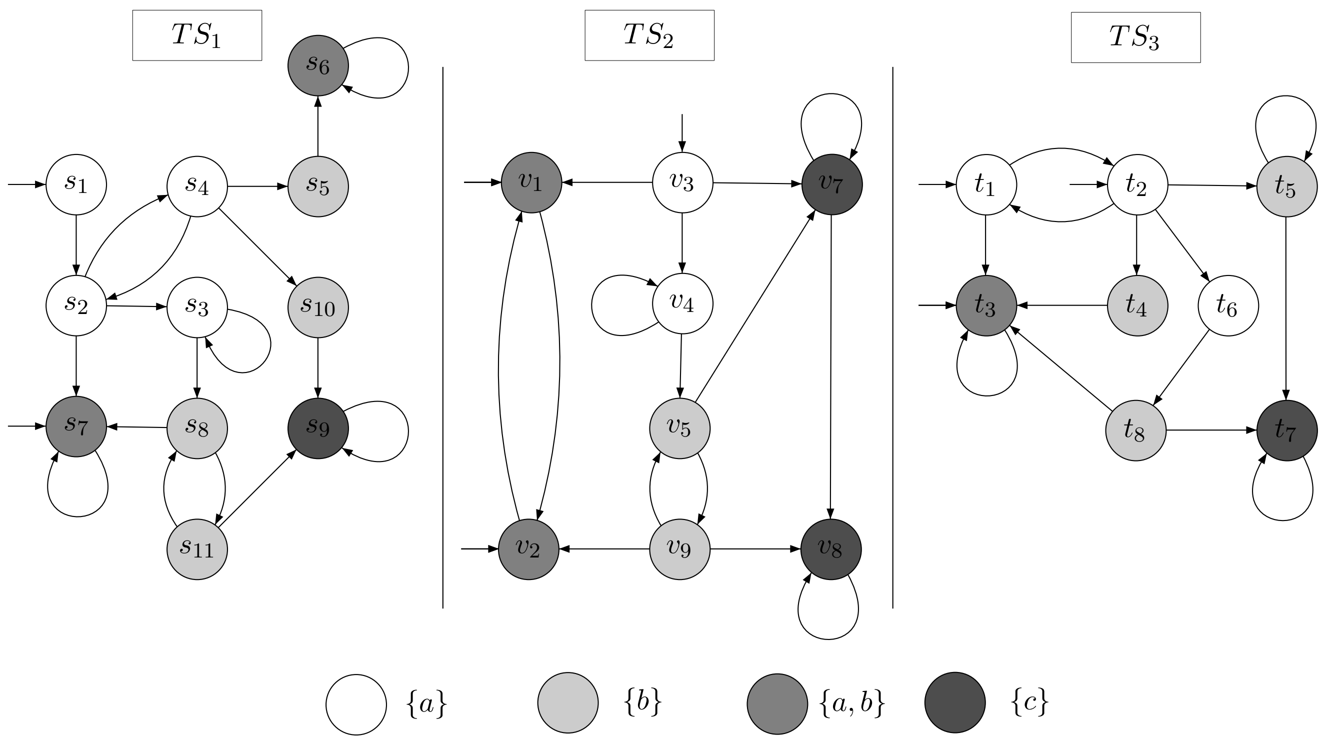
Advanced Model Checking
Winter term 2010/2011

– Series 4 –

Hand in on November 24'th before the exercise class.

Exercise 1 (3 points)

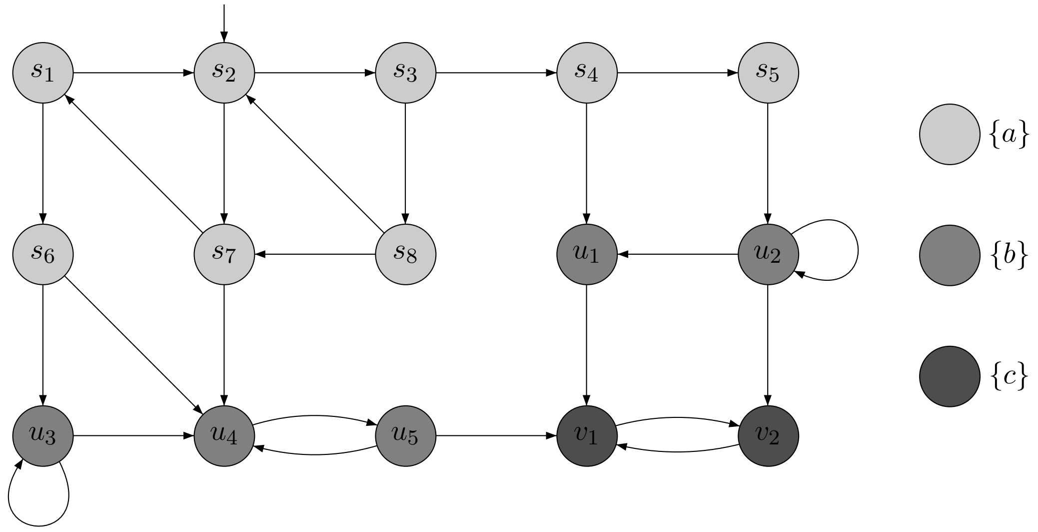
Consider three transitions systems given on the next Figure:



For each $i, j \in \{1 \ldots 3\} \times \{1 \ldots 3\}$, $i \neq j$, determine whether $TS_i \approx TS_j$ or $TS_i \not\approx TS_j$. Justify your answer.

Exercise 2 (1 + 1 + 1 points)

Given transition systems TS:



Questions:

(a) Depict the divergence-sensitive expansion $\overline{TS}$.

(b) Determine the divergence-stutter-bisimulation quotient $(\overline{TS})/\approx$. Apply the algorithm and give for each iteration the partition of the state space.

(c) Depict $TS/{\approx^{div}}$.

Exercise 3 (4 points)

Let $TS = (S, Act, \rightarrow, I, AP, L)$ be a transition system. A stutter simulation for TS is a relation $\mathcal{R}$ on S such that for all $(s_1, s_2) \in \mathcal{R}$:

1. $L(s_1) = L(s_2)$.
2. If $s_1' \in Post(s_1)$ with $(s_1, s_1') \notin \mathcal{R}$, 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 is said to be stutter simulated by s_2, denoted $s_1 \preceq_{st} s_2$, iff there exists a stutter simulation for (s_1, s_2).

A stutter simulation $\mathcal{R}$ for TS is called divergence-sensitive if for all pairs $(s_1, s_2) \in \mathcal{R}$ and each infinite path fragment $\pi_1 = s_{0,1}\, s_{1,1}\, s_{2,1} \ldots$ in TS with $s_{0,1} = s_1$ and $(s_{i,1}, s_2) \in \mathcal{R}$ for all $i \geq 0$ there exists a transition $s_2' \in Post(s_2)$ with $(s_{j,1}, s_2') \in \mathcal{R}$ for some $j \geq 1$. We write $s_1 \preceq_{st}^{div} s_2$ iff there exists a divergence-sensitive stutter simulation $\mathcal{R}$ for (s_1, s_2).

Question:

Assume that for all $\forall\text{CTL}^*_{\setminus\bigcirc}$ formulae Φ and two states s_1 and s_2 in TS we have $s_2 \models \Phi \Rightarrow s_1 \models \Phi$. Show that $s_1 \preceq_{st}^{div} s_2$.

Hint:

Define $\mathcal{R} = \{(s_1, s_2) \in S \times S \mid \forall \Phi \in \forall\text{CTL}^*_{\setminus\bigcirc}. s_2 \models \Phi \Rightarrow s_1 \models \Phi\}$ and show that $\mathcal{R}$ is a divergence-sensitive stutter simulation relation. This is proven by checking the conditions of the divergence-sensitive stutter simulation.