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Advanced Model Checking
Winter term 2010/2011

– Series 6 –

Hand in on December 8'st before the exercise class.

Exercise 1 $(1 + 1 + 1 = 3$ points)

Figure 1 shows on its left a transition system TS and on its right a reduced system $\hat{TS}$ that results from choosing $ample(s) = \{\alpha\}$. Check whether TS and $\hat{TS}$ are stutter trace equivalent. If they are not, indicate which of the conditions $(A1) - (A4)$ is (are) violated.

Answer the same question for the transition system in the reduction shown in Figures 2 and 3, where different colors indicate different state labels.

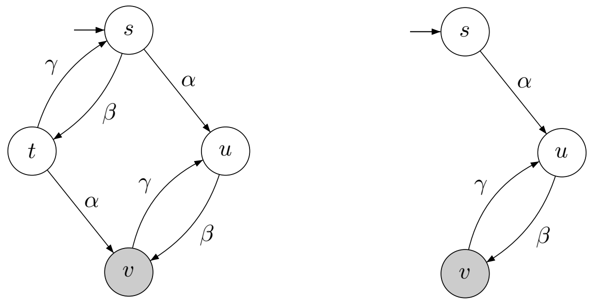


Abbildung 1: Transition system TS (left) and $\hat{TS}$ (right) for the Exercise 1

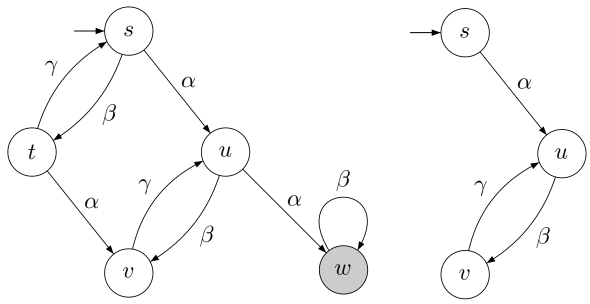


Abbildung 2: Transition system TS (left) and $\hat{TS}$ (right) for the Exercise 1

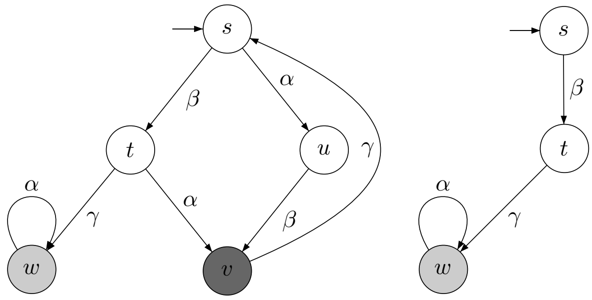
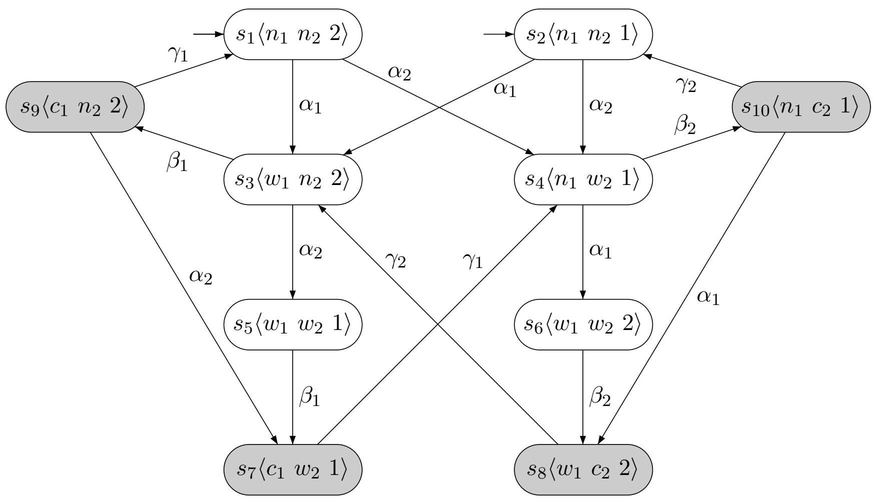


Abbildung 3: Transition system TS (left) and $\hat{TS}$ (right) for the Exercise 1

Exercise 2 **(1 + 1 = 2 points)**

Consider the transition system TS_{Pet} for the Peterson mutual exclusion algorithm.

(For more details of the algorithm, cf. page 45-47 of the book.)



Questions:

(a) Which actions are independent?

(b) Apply the partial order reduction approach to TS_{Pet} with "small" ample sets according to Algorithm 38 (page 622 of the book) for checking the invariant "always $\neg(crit_1 \wedge crit_2)$", where $AP = \{crit_1, crit_2\}$. Note that c_i in the figure is an abbreviation for $crit_i$.

Exercise 3 **(5 points)**

Let $TS = (S, Act, \rightarrow, I, AP, L)$ be an action-deterministic transition system and let $\mathcal{I}_{st}$ be the set of all pairs $(\alpha, \beta) \in Act \times Act$ of independent actions α and β where α or β (or both) is a stutter action. Let *stutter permutation equivalence* $\cong_{perm}$ be the finest equivalence on Act^* such that

$$\bar{\gamma}\alpha\beta\bar{\delta} \cong_{perm} \bar{\gamma}\beta\alpha\bar{\delta}$$

if $\bar{\gamma}, \bar{\delta} \in Act^*$ and $(\alpha, \beta) \in \mathcal{I}_{st}$.

The extension of $\cong_{perm}$ to an equivalence for infinite action sequences is defined as follows. If $\tilde{\alpha} = \alpha_1\alpha_2\alpha_3...$ and $\tilde{\beta} = \beta_1\beta_2\beta_3...$ are actions sequences in Act^ω, then $\tilde{\alpha} \sqsubseteq_{perm} \tilde{\beta}$ if for all finite prefixes $\alpha_1...\alpha_n$ of $\tilde{\alpha}$ there exists a finite prefix $\beta_1...\beta_m$ of $\tilde{\beta}$ with $m \geq n$ and a finite word $\bar{\gamma} \in Act^*$ such that

$$\alpha_1 ... \alpha_n \bar{\gamma} \cong_{perm} \beta_1 ... \beta_m$$

We then define the binary relation $\cong_{perm}^{\omega}$ on Act^{ω} by

$$\tilde{\alpha} \cong_{perm}^{\omega} \tilde{\beta} \quad \text{iff} \quad \tilde{\alpha} \sqsubseteq_{perm} \tilde{\beta} \quad \text{and} \quad \tilde{\beta} \sqsubseteq_{perm} \tilde{\alpha}$$

Questions:

(a) Show that $\cong_{perm}^{\omega}$ is an equivalence.