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Advanced Model Checking
Summer term 2014

– Series 1 –

Hand in on April 23rd before the exercise class.

Exercise 1 (2 + 1 points)

Let $TS = (S, Act, \to, I, AP, L)$ be a transition system. The relations $\sim_n \subseteq S \times S$, $n \in \mathbb{N}$, are inductively defined by:

- $s_1 \sim_0 s_2$ iff $L(s_1) = L(s_2)$.
- $s_1 \sim_{n+1} s_2$ iff:
  - $L(s_1) = L(s_2)$,
  - for all $s_1' \in Post(s_1)$ there exists $s_2' \in Post(s_2)$ with $s_1' \sim_n s_2'$,
  - for all $s_2' \in Post(s_2)$ there exists $s_1' \in Post(s_1)$ with $s_1' \sim_n s_2'$.

Questions:

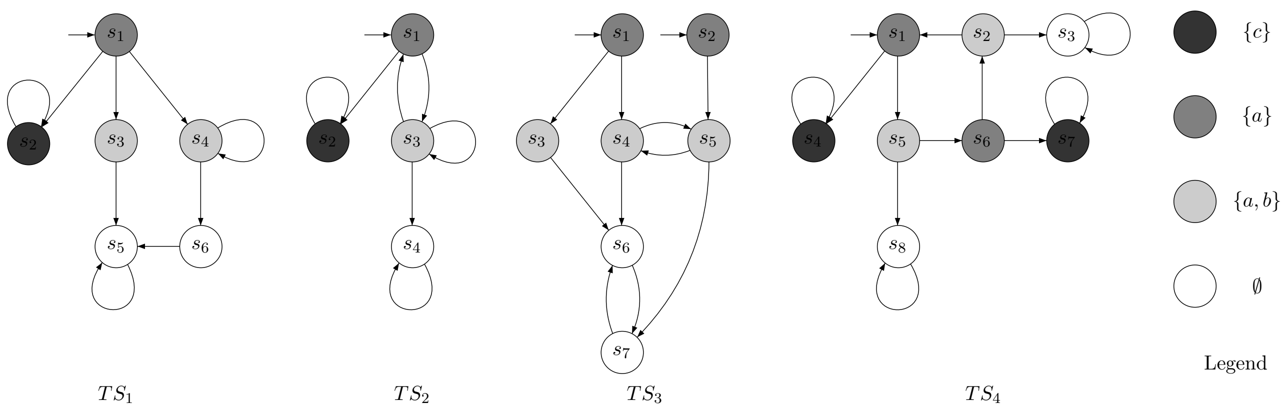
(i) Show that for *finite* TS it holds that $\sim_{TS} = \bigcap_{n \geq 0} \sim_n$, i.e.,

$$s_1 \sim_{TS} s_2 \text{ iff } s_1 \sim_n s_2 \text{ for all } n \geq 0$$

(ii) Does this also hold for infinite transition systems (provide either a proof or a counterexample)?

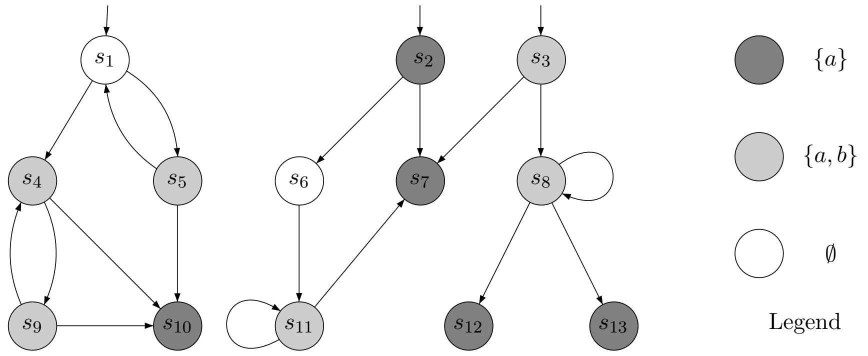
Exercise 2 (3 points)

Which of the following transition systems are bisimulation equivalent? Justify your answers by either providing a bisimulation relation or a $\text{CTL}_{\setminus U}$ formula that distinguishes the considered transition systems. (Note: a $\text{CTL}_{\setminus U}$ formula contains neither an U-operator nor one of its derived operators such as $\Diamond$ and $\Box$)



Exercise 3 (2 + 2 points)

Consider the transition system TS over $AP = \{a, b\}$ shown in the figure below:



(a) Determine the bisimulation equivalence $\sim_{TS}$ and depict the bisimulation quotient system $TS/\sim$.

(b) Provide CTL master formulae Φ_C for each bisimulation equivalence class $C \in S/\sim$.