

Advanced Model Checking Summer term 2014

– Solution 5 –

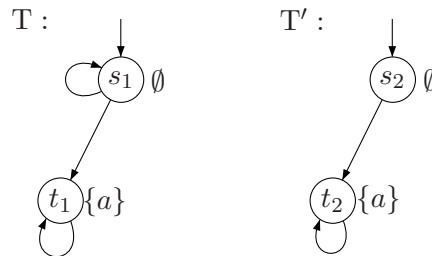
Exercise 1

(7 points)

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

- $CTL \setminus U$ equivalence is finer than $CTL \setminus O$ equivalence.
- $CTL \setminus U$ equivalence is finer than divergence-sensitive stutter trace equivalence.
- $CTL \setminus O$ equivalence is finer than $LTL \setminus O$ equivalence.
- Divergence-sensitive stutter bisimulation equivalence is finer than $CTL \setminus U$ equivalence.
- Stutter trace equivalence is finer than $CTL \setminus U$ equivalence.
- For AP-deterministic transition systems, stutter trace equivalence is finer than trace-equivalence.
- For AP-deterministic transition systems, trace equivalence is finer than $CTL^* \setminus U$ equivalence.

Solution:



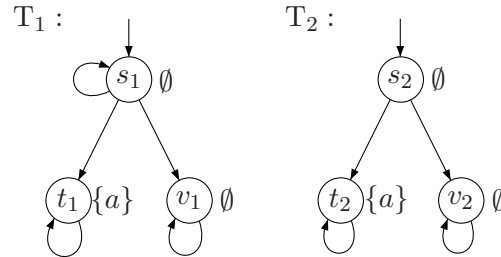
- Yes.
- Yes.
- Yes.
- No. As divergence-sensitive stutter bisimulation is equivalent to $CTL \setminus O$.
- No. Transition systems T and T' are stutter trace equivalent but not $CTL \setminus U$ equivalent.
- No. Transition systems T and T' are AP-deterministic and stutter trace equivalent but their traces are not equal.
- Yes.

Exercise 2

(3 points)

Consider the transition systems T_1 and T_2 in Figure .

- Show that $T_2 \preceq T_1$ by providing a simulation relation for (T_2, T_1) .
- Show that $T_1 \not\preceq T_2$ by providing a $\forall$ CTL formula $\Phi_{\forall}$ and a $\exists$ CTL formula $\Phi_{\exists}$ such that $T_1 \not\models \Phi_{\forall}$, but $T_2 \models \Phi_{\forall}$ and $T_1 \models \Phi_{\exists}$, but $T_2 \not\models \Phi_{\exists}$.



Solution:

- $R = \{(s_2, s_1), (t_2, t_1), (v_2, v_1)\}$ is a simulation relation.
- $\Phi_{\exists} = \exists \bigcirc (\emptyset \wedge \exists \bigcirc a)$. $T_1 \models \Phi_{\exists}$, but $T_2 \not\models \Phi_{\exists}$.
 $\Phi_{\forall} = \forall \bigcirc (a \vee \forall \bigcirc \emptyset)$. $T_2 \models \Phi_{\forall}$, but $T_1 \not\models \Phi_{\forall}$.