RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN

LEHRSTUHL FÜR INFORMATIK 2
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Introduction to Model Checking
Winter term 2013/2014

– Series 12 –

Hand in on January 29th before the exercise class or in the box in front of the chair's secretary's office.

Exercise 1 **(4 points)**

Consider the fragment ECTL of CTL which consists of formulas built according to the following grammar:

$$\Phi ::= a \mid \neg a \mid \Phi \wedge \Phi \mid \exists \varphi$$
$$\varphi ::= \bigcirc \Phi \mid \Box \Phi \mid \Phi \, \mathsf{U} \, \Phi$$

Therefore, ECTL-formulas are built by atomic propositions, negated atomic propositions, the boolean connective $\wedge$ and the path quantifier $\exists$ together with the modalities $\bigcirc$, $\Box$ and U .
For two transition systems $TS_1 = (S_1, Act, \rightarrow_1, I_1, AP, L_1)$ and $TS_2 = (S_2, Act, \rightarrow_2, I_2, AP, L_2)$, we define $TS_1 \subseteq TS_2$ iff $S_1 \subseteq S_2$, $\rightarrow_1 \subseteq \rightarrow_2$, $I_1 = I_2$ and $L_1(s) = L_2(s)$ for all $s \in S_1$.

(a) Prove, that for all ECTL-formulas Φ and all transition systems TS_1, TS_2 with $TS_1 \subseteq TS_2$, it holds:

$$TS_1 \models \Phi \quad \Longrightarrow \quad TS_2 \models \Phi.$$

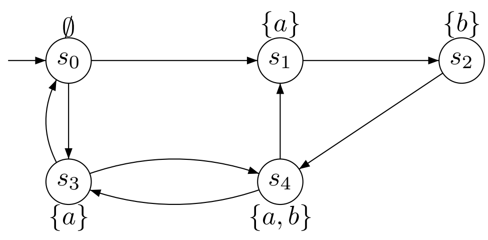
(b) Give a CTL-formula which is not equivalent to any other ECTL-formula. Justify your answer!

Exercise 2 **(3 points)**

Consider the CTL-formula $\Phi = \forall \Box \left(a \rightarrow \forall \Diamond \, (b \wedge \neg a) \right)$ together with the following CTL fairness assumption

$$fair = \Box \Diamond \forall \bigcirc \, (a \wedge \neg b) \rightarrow \Box \Diamond \forall \bigcirc \, (b \wedge \neg a)$$
$$\wedge \Diamond \Box \exists \Diamond \, b \rightarrow \Box \Diamond \, b.$$

Check that $TS \models_{fair} \Phi$!

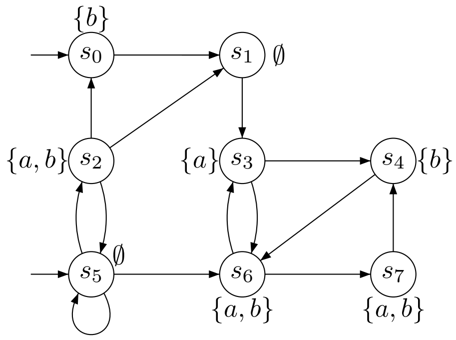


Exercise 3 **(3 points)**

Consider the CTL*-formula (over $AP = \{a, b\}$)

$$\Phi = \forall \Diamond \, \Box \, \exists \bigcirc \, \left(a \, \mathsf{U} \, \exists \Box \, b \right)$$

and the transition system TS outlined below:



Apply the CTL* Model Checking Algorithm to compute $Sat(\Phi)$ and decide whether $TS \models \Phi$.
Hint: You may infer the satisfaction sets for LTL formulas directly.