

Introduction to Model Checking
 Summer term 2007

– Series 11 –

Hand in on June 29 before the exercise class.

Exercise 1

(3 + 1 points)

 a) Prove that $Sat(\exists(\Phi W \Psi))$ is the largest set T such that

$$T \subseteq Sat(\Psi) \cup \{s \in Sat(\Phi) \mid Post(s) \cap T \neq \emptyset\}.$$

 b) Prove that $Sat(\forall(\Phi W \Psi))$ is the largest set T such that

$$T \subseteq Sat(\Psi) \cup \{s \in Sat(\Phi) \mid Post(s) \subseteq T\}.$$

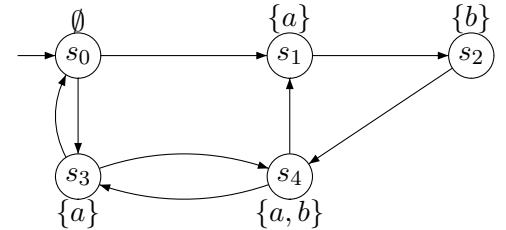
 Use the above characterizations to infer efficient algorithms for computing the set $Sat(\exists(\Phi W \Psi))$ and $Sat(\forall(\Phi W \Psi))$ in a direct manner!

Exercise 2

(4 points)

 Consider the CTL-formula $\Phi = \forall \square (a \rightarrow \forall \lozenge(b \wedge \neg a))$ together with the following CTL fairness assumption

$$\begin{aligned} fair = & \square \lozenge \forall \bigcirc (a \wedge \neg b) \rightarrow \square \lozenge \forall \bigcirc (b \wedge \neg a) \\ & \wedge \lozenge \square \exists \lozenge b \rightarrow \lozenge \lozenge b. \end{aligned}$$

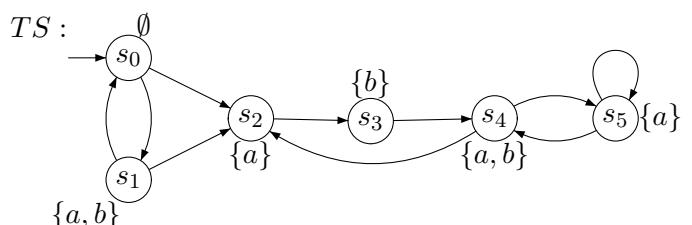
 Prove that $TS \models_{fair} \Phi$!


Exercise 3

(4 points)

 Consider the transition system TS , the strong fairness assumption $sfair$ and the CTL formula Φ :

$$\begin{aligned} TS : & \quad \xrightarrow{\quad} s_0 \xrightarrow{\quad} s_1 \xrightarrow{\quad} s_2 \xrightarrow{\quad} s_3 \xrightarrow{\quad} s_4 \xrightarrow{\quad} s_5 \\ sfair = & \square \lozenge (\exists \bigcirc (a \wedge \neg b)) \rightarrow \square \lozenge (\exists \bigcirc \neg a) \\ \Phi = & \exists \lozenge \exists \square a \end{aligned}$$


 Apply the fair CTL model checking algorithm from the lecture to check $TS \models_{sfair} \Phi$.

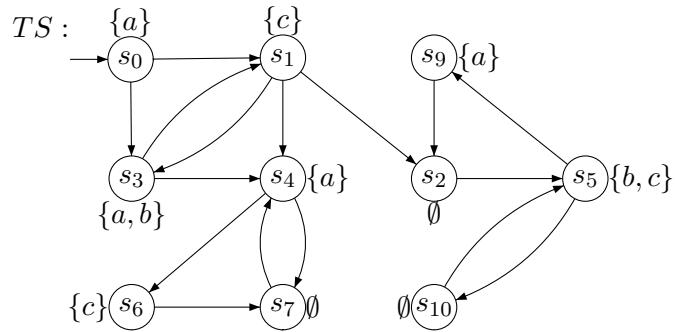
Sketch its main steps.

Hint: You do not need to formally apply the basic CTL and LTL model checking algorithms!

Exercise 4

(2 points)

Consider the following transition system TS over $AP = \{a, b, c\}$:



Provide a counterexample or an evidence for the following CTL-formulas, dependent on their validity:

a) $\Phi_1 = \forall((a \vee \neg b) \cup \forall \diamond c)$

b) $\Phi_2 = \exists \Box \exists \bigcirc \forall \diamond b$