Introduction to Model Checking (VO) WS 2008/2009 LVA 703503

First name: ______________________________

Last name: ______________________________

Matriculation number: ______________________________

- Please answer all exercises in a readable and precise way.
- Please cross out solution attempts which are replaced by another solution.
- Please do not remove the staples of the exam.
- Cheating is not allowed. Everyone who is caught will fail the exam.

Exercise	Maximal points	Points
1(i)	12	
1(ii)	12	
2	18	
3	19	
4	9	
Σ	70	
Grade		

Exercise 1 (12 + 12 points)

Consider the following property.

Between every two neighboring occurrences of "green", "red" is valid all the time strictly in between. $(\star)$

One might formulate this property as the following LTL-formula φ.

$$\varphi = \neg \mathsf{F}\,(\mathsf{green} \wedge \neg(\mathsf{red}\,\mathsf{U}\,\mathsf{green}))$$

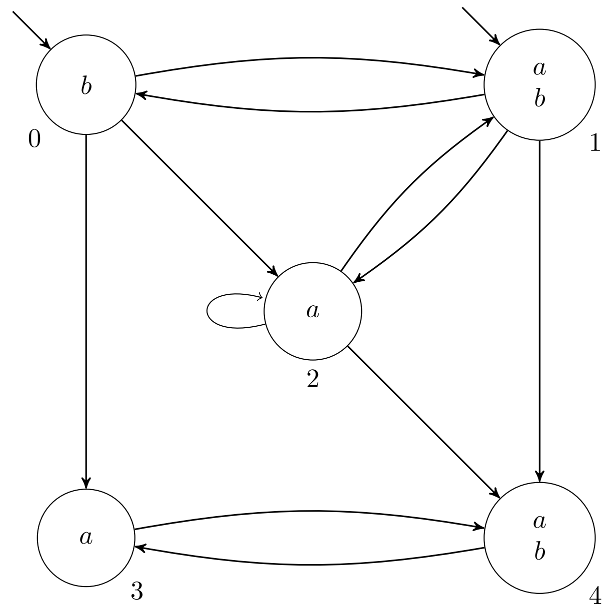
(i) φ is equivalent to the formula $\psi = \neg(\mathrm{true}\,\mathsf{U}\,(\mathsf{green} \wedge \neg(\mathsf{red}\,\mathsf{U}\,\mathsf{green})))$. Construct parts of the GNBA for ψ using the *improved* translation from LTL to GNBAs.

- $cl'(\psi) = \mathsf{green}, \mathsf{red},$
- $(c_1, \ldots)^T \in \delta((b_1, \ldots)^T, (d_1, d_2)^T)$ iff
- $(c_1, \ldots)^T \in \delta(q_0, (d_1, d_2)^T)$ iff

(ii) φ does not correspond to the textual property $(\star)$. Write down an infinite word w that distinguishes φ from $(\star)$. Moreover, write down an LTL-formula χ which corresponds to $(\star)$.

Exercise 2 (18 points)

Consider the following transition system *TS*.



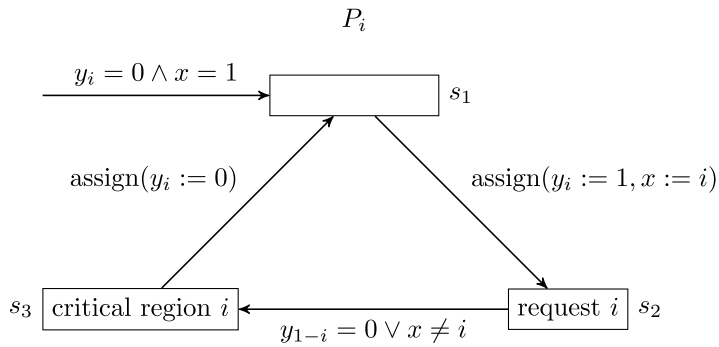
Perform CTL*-model checking for the formula

$$\Phi = \mathsf{E}\,(\mathsf{X}\,(a \wedge \neg b) \wedge \mathsf{X}\,\mathsf{A}\,(b\,\mathsf{U}\,\mathsf{G}\,a))$$

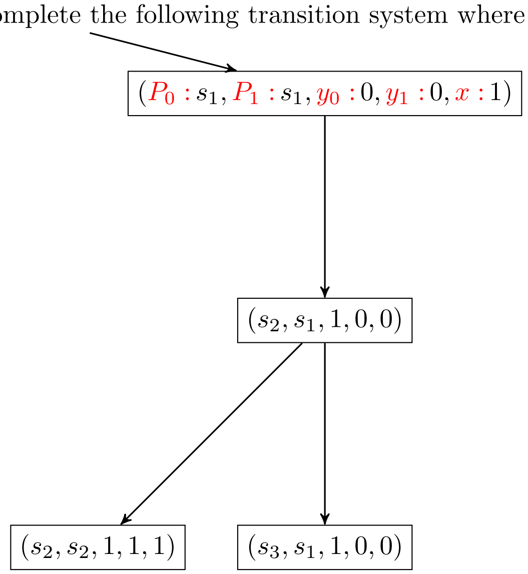
Here, the sets $Sat(\Psi)$ should be indicated for every non-atomic state-subformula Ψ of Φ. Note that the subformula $a \wedge \neg b$ of Φ should be seen as a state-formula. It is not necessary to perform the LTL-model checking explicitly, but write down each LTL-formula that is checked.

Exercise 3 (19 points)

Consider the following channel system $[P_0 \mid P_1]$ which models a mutual exclusion protocol of Pnueli. Here, communication is done via a shared variable x.



Complete the following transition system where the initial state indicates (in red) the representation of states.



Exercise 4 (9 points)

Each correct answer is worth 3 points. A wrong answer results in zero points. Giving no answer is worth 1 point.

	Yes	No
There is some GNBA $\mathcal{A}$ such that there is no NBA $\mathcal{B}$ with $\mathcal{L}(\mathcal{A}) = \mathcal{L}(\mathcal{B})$.		
When checking $TS \models \varphi$ for some LTL formula φ, as intermediate result one constructs a GNBA which accepts $\mathcal{L}(\varphi)$.		
If one wants to compute the intersection of NBAs then one can use a similar construction as for GNBAs: for $\mathcal{A}_i = (\mathcal{Q}_i, \Sigma, q_{0,i}, \delta_i, F_i)$ return $\mathcal{A} = (\mathcal{Q}_1 \times \mathcal{Q}_2, \Sigma, (q_{0,1}, q_{0,2}), \delta, F_1 \times F_2)$ where δ is defined as in the intersection automaton for GNBAs.		