Introduction to Model Checking (VO) WS 2011/2012 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	16	
2	14	
3	16	
4	14	
Σ	60	
Grade		

Exercise 1 (Writing Specifications, 8 + 8 points)

Consider the following properties over $AP = \{b, c\}$.

(i) If there are finitely many b's then there are finitely many c's.

(ii) The sequence of atomic properties is exactly $(\{b\}\ \varnothing\ \{b\}\ \{b, c\})^\omega$

For property (i) give a GNBA (over $\Sigma = 2^{AP}$) such that the corresponding language is the set of those words which satisfy the respective property, for property (ii) give an LTL-formula.

Exercise 2 (Understanding LTL, 14 points)

Prove or disprove:

$$(\mathsf{X}\,\mathsf{a})\,\mathsf{U}\,(\neg\mathsf{a}) \quad\equiv\quad \neg\mathsf{a}$$

First Hint: First try to understand the formula, afterwards it is easier to perform a *formal* proof or get a counterexample.
Second hint: If you do not want to perform a formal proof, you can also argue only on an *informal* level. If your reasoning covers all relevant issues, then you can still get 8 points.

Exercise 3 (Automation of Model Checking, 16 points)

Consider the following formula:

$$\varphi = ((\mathsf{a} \land \mathsf{X}\,\mathsf{b}) \,\mathsf{U}\, \neg\mathsf{a}) \land (\text{true} \,\mathsf{U}\, \mathsf{a})$$

Construct the automaton for φ using the improved translation.
$\mathcal{A}_\varphi = (\{q_0\} \uplus 2^n, 2^2, q_0, \delta, \dots)$ where

- The reduced Fischer Ladner closure is

  $cl'(\varphi) = \mathsf{a}, \mathsf{b},$

- $(c_1, \dots, c_n)^T \in \delta(q_0, (d_1, d_2)^T)$ iff

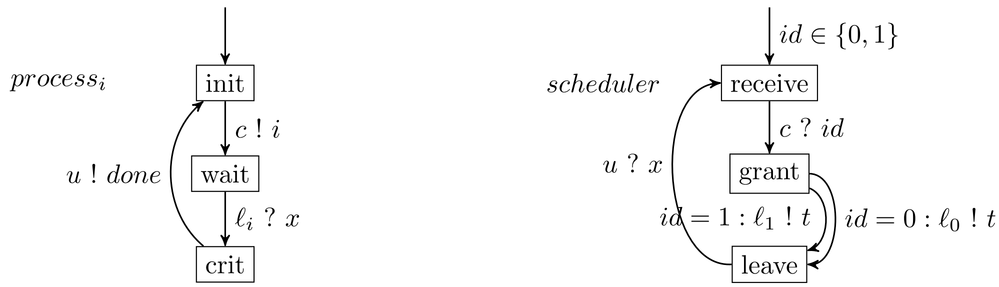
- $(c_1, \dots, c_n)^T \in \delta((b_1, \dots, b_n)^T, (d_1, d_2)^T)$ iff

- final state sets:

Explicitly give all incoming transitions of state $(1, \dots, 1)^T$.

Exercise 4 (Generation of Transition Systems, 14 points)

Consider the channel system $[process_0 \mid process_1 \mid scheduler]$ with $cap(\ell_0) = cap(\ell_1) = cap(u) = 0$ and $cap(c) = 1$ where for $process_i$ and $scheduler$ we have the following program graphs:



In the following diagram all reachable states for the corresponding transition system are given where the states are five-tuples of the following form:

(location process 0, location process 1, location scheduler, value of id, value of c)

Here, for the specification of states abbreviations like $(i, c, l, 1, \epsilon)$ are used for $(init, crit, leave, 1, \epsilon)$, etc.

Insert all transitions and mark initial states with an incoming edge.

	$(i, i, r, 0, \epsilon)$	$(i, i, r, 1, \epsilon)$	
$(i, w, r, 0, 1)$	$(w, i, r, 0, 0)$	$(i, w, r, 1, 1)$	$(w, i, r, 1, 0)$
$(c, i, l, 0, \epsilon)$	$(w, i, g, 0, \epsilon)$	$(i, w, g, 1, \epsilon)$	$(i, c, l, 1, \epsilon)$
$(c, w, l, 0, 1)$	$(w, w, g, 0, 1)$	$(w, w, g, 1, 0)$	$(w, c, l, 1, 0)$

For your own notes