University of Innsbruck | Institute of Computer Science
1st exam | 29 May 2009

Model Checking (VO) | SS 2009 | LVA 703521

First name: ____________________

Last name: ____________________

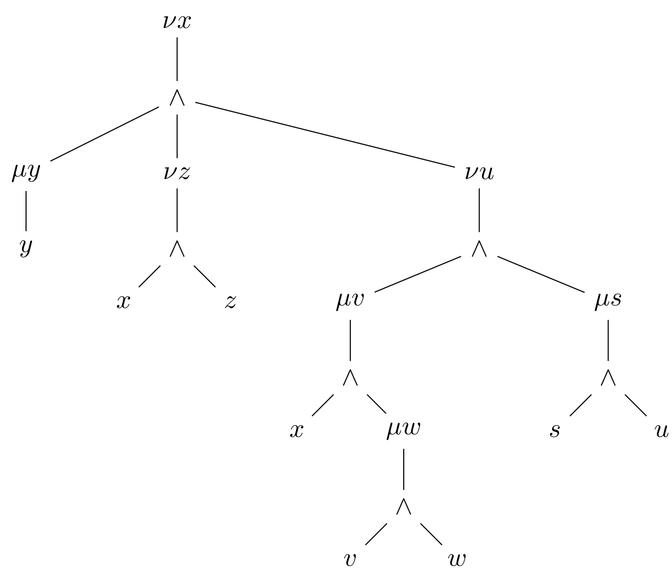
Matriculation number: ____________________

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

Exercise	Maximal points	Points
1	25	
2	25	
3	30	
4	20	
Σ	100	
Grade		

Exercise 1 ((2 + 4 + 6 + 8) + 5 points)

Consider the following formula φ.



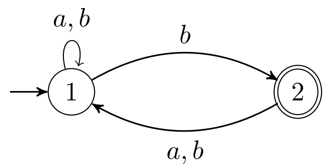
- For each call $\mathsf{touch}(\alpha)$ where $\alpha \in \{z, v, u, x\}$ write down the set of variables that are invalidated and the set of variables that are reseted.

$\mathsf{touch}(z)$:	$\mathsf{Valid} := \mathsf{Valid} \setminus$	$\mathsf{Reset} :=$
$\mathsf{touch}(v)$:	$\mathsf{Valid} := \mathsf{Valid} \setminus$	$\mathsf{Reset} :=$
$\mathsf{touch}(u)$:	$\mathsf{Valid} := \mathsf{Valid} \setminus$	$\mathsf{Reset} :=$
$\mathsf{touch}(x)$:	$\mathsf{Valid} := \mathsf{Valid} \setminus$	$\mathsf{Reset} :=$

- Determine $[\![\varphi]\!]$. Just give the result (and apply the algorithm in a lazy way)

Exercise 2 (18 + 3 + 4 points)

Consider the following NBA $\mathcal{A}$ over $\Sigma = \{a, b\}$.



- Compute the $\mathcal{A}$-equivalence classes by constructing the transition profile automaton.

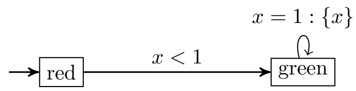
- Let $\mathcal{B} = \Sigma^\omega \setminus \mathcal{L}(\mathcal{A})$. Describe $\mathcal{B}$ in your own words.

- From the lecture we know that $\mathcal{B} = \bigcup_{(i,j)\in I} U_i \cdot U_j^\omega$ for some index-set I where $U_1, \ldots, U_n$ are the $\sim_\mathcal{A}$ equivalence-classes that correspond to the transition profiles.

  In this examples there is some j and I such that $\mathcal{B} = \bigcup_{i\in I} U_i \cdot U_j^\omega$. What is the transition profile that corresponds to U_j?

Exercise 3 (30 points)

Consider the following timed automaton TA.



Formally apply the algorithm for TCTL-model checking to determine $TA \models \Phi$ where $\Phi = \mathsf{E}\, \neg\mathsf{green}\, \mathsf{U}^{>1} \mathsf{green}$.

For the solution it suffices to determine whether the initial state is in the satisfiability set. However, whenever you need to determine whether some state s satisfies a CTL formula then all reachable states of s have to be constructed.

Exercise 4 (10 + 10 points)

Let TS be a transition system. Let $R_1, \ldots, R_n$ be bisimulations for TS. Prove or disprove the following statements.

(i) $U = \bigcup_{1 \leqslant i \leqslant n} R_i$ is a bisimulation for TS.

(ii) $I = \bigcap_{1 \leqslant i \leqslant n} R_i$ is a bisimulation for TS.