Model Checking (VO)   SS 2008   LVA 703521

**First name:** _____

Last name: _____

Matriculation number: _____

- Write your name and matriculation number on every page.

- 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	22	
2	24	
3	35	
4	19	
Σ	100	
Grade		

Exercise 1 (18 + 4 points)

Consider the following NBA $\mathcal{A}$ (where labels are omitted).
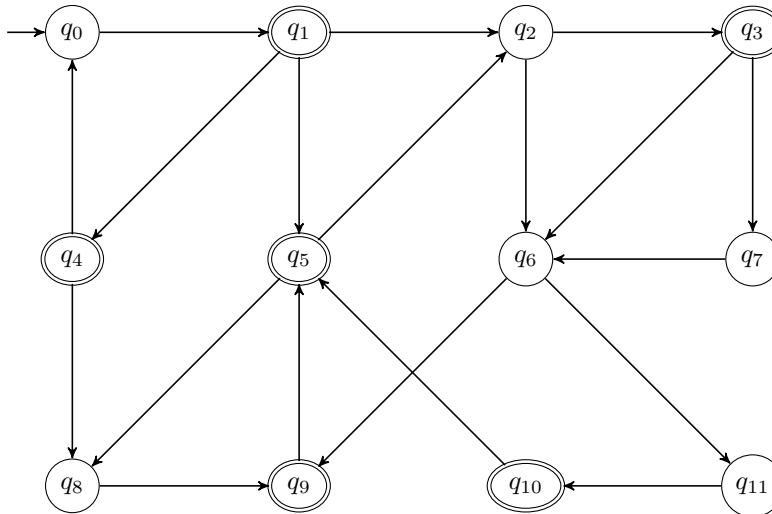
- Fill the table which is obtained when using the algorithm of Yannakakis et. al. where successors are taken in order, i.e., successor q_i is taken before q_j iff $i < j$.

  Here, you should at least write down a new line whenever the set of marked or flagged states are changed. You may abbreviate q_i by i and you may use $\{1 - 4, 6\}$ to indicate the set $\{q_1, q_2, q_3, q_4, q_6\}$, etc.

outer_dfs-stack	inner_dfs-stack	marked	flagged
ε	ε	$\varnothing$	$\varnothing$

- Is there an accepting run of $\mathcal{A}$? If so, which run is extracted by the algorithm?

Exercise 2 (12 + 12 points)

- Consider the following language:

$$\begin{pmatrix} 0 \\ 1 \end{pmatrix}^* \begin{pmatrix} 0 \\ 0 \end{pmatrix} \left(\begin{pmatrix} 1 \\ 1 \end{pmatrix} \begin{pmatrix} 1 \\ 0 \end{pmatrix} \begin{pmatrix} 1 \\ 1 \end{pmatrix} \right)^\omega$$

  Write down an F1S- or S1S-formula for this language and shortly explain your formula. If you used S1S, do you think it is possible with F1S?

- Intuitively construct NFAs $\mathcal{A}_1$ and $\mathcal{A}_2$ for the languages $a(ba)^*$ and bab^*. Then construct an NBA $\mathcal{A}_3$ for the language $(a(ba)^*) \cdot (bab^*)^\omega$ using the construction from the lecture. Write down all three automata $\mathcal{A}_1$, $\mathcal{A}_2$, and $\mathcal{A}_3$.

Exercise 3 (34 + 1 points)

Consider the following timed automaton.

$$x \geqslant 1 : \{y\}$$

red
$x < 2$

green

$$y \geqslant 1 : \{x\}$$
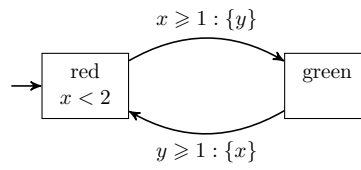
- Construct the reachable part of the region transition system for this automaton. (It has 17 states.)

- Does the timed automata have a time-lock?

Exercise 4 (19 points)

Recall the definition of simulation equivalence $\simeq$:

- $TS_1 = (S_1, \rightarrow_1, I_1, AP, L_1) \preceq TS_2 = (S_2, \rightarrow_2, I_2, AP, L_2)$ if there is a simulation relation R for TS_1 and TS_2:

  - for all $s \in I_1$ there exists $t \in I_2$: sRt
  - whenever sRt then $L_1(s) = L_2(t)$
  - whenever sRt and $s \rightarrow_1 s'$ then there exists t': $t \rightarrow_2 t'$ and $s'Rt'$

- $\simeq \; = \; \preceq \cap \succeq$

Proof that $\simeq$ is an equivalence relation (reflexive, symmetric, transitive). Whenever you define some simulation relation R then you do not have to formally show that R really is a simulation relation.