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**LEHRSTUHL FÜR INFORMATIK 2**
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# Introduction to Model Checking
# Winter term 2013/2014

## – Series 6 –

Hand in on December 4th before the exercise class or in the box in front of the chair's secretary's office.

### Exercise 1 (3 points)

Provide NBA $\mathcal{A}_1$ and $\mathcal{A}_2$ for the languages given by the expressions $(AC + B)^*B^\omega$ and $(B^*AC)^\omega$ and apply the product construction (using GNBA) to obtain an NBA $\mathcal{A}$ with $\mathcal{L}_\omega(\mathcal{A}) = \mathcal{L}_\omega(\mathcal{A}_1) \cap \mathcal{L}_\omega(\mathcal{A}_2)$. Justify, why $\mathcal{L}_\omega(\mathcal{G}) = \emptyset$ where $\mathcal{G}$ denotes the GNBA accepting the intersection.

### Exercise 2 (3 points)

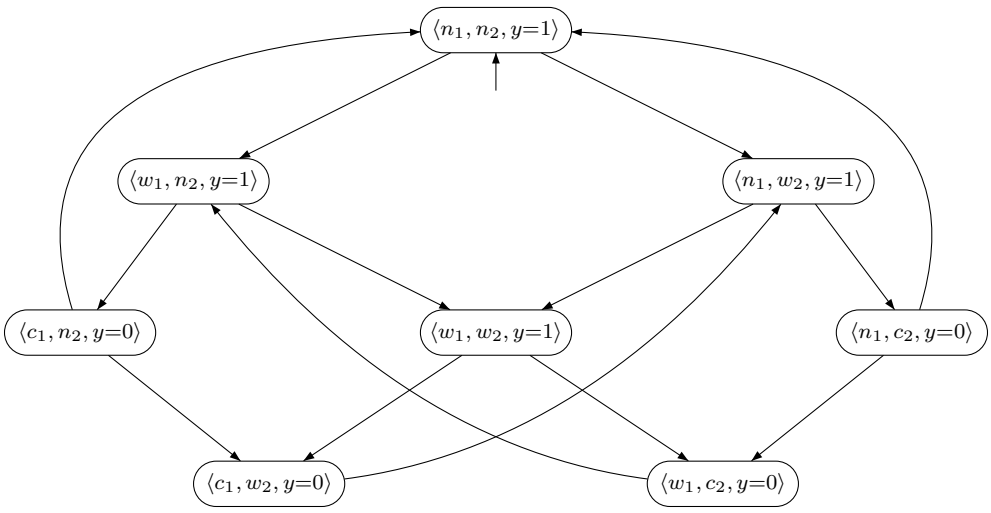


Figure 1: Mutual exclusion with semaphore (transition system representation).

Consider the transition system $\mathrm{T}_{Sem}$ for mutual exclusion with a semaphore. Let $P_{live}$ be the following $\omega$-regular property over $AP = \{ wait_1, crit_1 \}$:

"whenever process 1 is in its waiting location then it will eventually enter its critical section"

a) Introduce the necessary labels in $\mathrm{T}_{Sem}$.

b) Depict an NBA $\bar{\mathcal{A}}$ for the complement property $\bar{P}_{live} = \left(2^{AP}\right)^\omega \setminus P_{live}$.

c) Check whether $\mathrm{T}_{Sem} \models P_{live}$. Therefore:

(i) Depict the reachable fragment of the product $\mathrm{T}_{Sem} \otimes \bar{\mathcal{A}}$

(ii) Sketch the main steps of the nested depth-first search applied to $\mathrm{T}_{Sem} \otimes \bar{\mathcal{A}}$ for the persistence property "eventually forever $\neg F$" where $F$ is the acceptance set of $\bar{\mathcal{A}}$. In case the property is refuted, which counterexample is generated?

**Exercise 3** **(4 points)**

Show how the following pairs of LTL-formulas are related, i.e. whether they are equivalent, one implies the other, or they are incomparable:

$\Box\varphi \rightarrow \Diamond\psi$ and $\varphi \mathsf{U} (\psi \vee \neg\varphi)$

$\Diamond\Box\varphi \rightarrow \Box\Diamond\psi$ and $\Box(\varphi \mathsf{U} (\psi \vee \neg\varphi))$

$\Box\Diamond\varphi \rightarrow \Box\Diamond\psi$ and $\Box(\varphi \rightarrow \Diamond\psi)$

$\Diamond (\varphi \mathsf{U} \psi)$ and $\Diamond\psi$