University of Konstanz
Modelling of complex, self-organised systems
Jun.Prof.Tatjana Petrov

Probabilistic Modelling for Computer Scientists
WS 2018-19
Assignment 4
Due: 3.12.2018

Exercise 1 (Algorithms for Qualitative Model Checking)   **3 points**

Let $D = (S, \mathbf{P}, s_{init}, AP, L)$ be a finite DTMC and $a, b \in AP$. Give algorithms (in pseudocode) to compute the following sets and briefly explain the complexity of your algorithm.
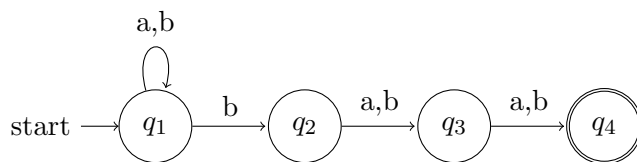
a) $S_{=0} = \{s \in S | Pr(s \models a \cup b) = 0\}$

b) $S_{=1} = \{s \in S | Pr(s \models a \cup b) = 1\}$

Exercise 2   **2.5 points**

Using subset construction for automata determinization, determinize the following automaton:

$L(\mathcal{A}) = \{w \in \Sigma^* | b \text{ is in the third position from the end}\}$

Exercise 3 (Zeroconf protocol in Figure 10.4 in book)   **2.5 points**

a) $Pr(\Diamond\Box\{s_8\}) = 1$

b) $Pr(\Diamond\Box\{s_6\}) > 0$

c) $Pr(\Diamond\Box\{s_6, s_8\}) = 1$

d) $Pr(\Box\Diamond\{s_6, s_8\}) = 1$

e) $Pr(\Box\Diamond\{s_6\}) > 0$

Exercise 4 (BONUS)   **4 points**

Write pseudocode for detection of BSCC's in a directed graph with n states and adjacency matrix $A \in \{0, 1\}^{n*n}$.

(Hint: To get inspired, search Tarjan's connected components algorithm)

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Exercise 5 (ω-regular Properties)   **4 points**

Non-deterministic Büchi automata are strictly more expressive than deterministic ones. Recall the "powerset construction", which is used to compute a deterministic finite automaton from a non-deterministic one.

a) Construct a non-deterministic Büchi automaton for the language $(a + b)^* a^\omega$, apply the powerset construction to determinize this automaton and compare the languages of the resulting automaton and the original one by either showing their equivalence or giving a counterexample separating the languages.

b) Consider the following DTMC:
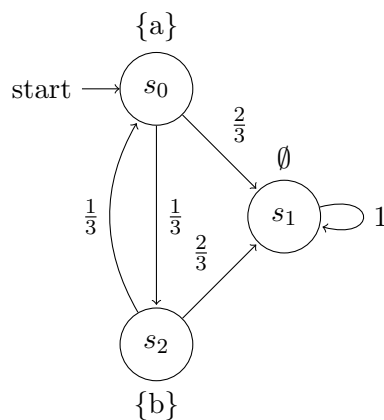
Give a formal definition for the cross-product between a *non-deterministic* Büchi-Automaton and a DTMC.

Apply this definition to the DTMC D and the NBA from a). What problems arise?

(Note on the course: Adapted from Prof. Joost-Pieter Katoen's course titled "Modelling and Verification of Probabilistic Systems", available at http://moves.rwth-aachen.de/teachings/ws-1516/movep15/.)