Model Checking WS 2012: Assignment 1

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Due 18.10.2012

Exercise 1

a) Graphically describe an automaton which accepts the numbers 20 to 28 written in Roman style, i.e., the language is { XX, XXI, XXII, XXIII, XXIV, XXV, XXVI, XXVII, XXVIII }.

b) Given the infinite sets of words *abc*, *abcabc*, *abcabcabc*, ..., *a*, *aa*, *aaa*, *aaaa*, ... Graphically specify the automaton which accepts exactly the words described above. Define the automaton as 5-tupel. Is it deterministic? Is it complete?

Exercise 2

Let $Q := (S_Q, I_Q, \Sigma_Q, T_Q, F_Q)$ be a finite automaton where $S_Q := \{A, B, C\}$, $I_Q := \{A, B\}$, $\Sigma_Q := \{a, b\}$, $T_Q := \{(A,b,B), (B,a,B), (B,a,C), (C,b,C), (C,b,A)\}$ and $F_Q := \{A\}$.

Let $R := (S_R, I_R, \Sigma_R, T_R, F_R)$ be a finite automaton where $S_R := \{1,2,3\}$, $I_R := \{1\}$, $\Sigma_R := \{a, b\}$, $T_R := \{(1,b,2), (1,b,3), (2,b,2), (3,a,3), (3,a,2), (1,a,3), (2,a,2)\}$ and $F_R := \{1\}$.

Draw the product automaton $P := Q \times R$ for automata Q and R as defined above.

Exercise 3

For finite automaton A as defined below, check if A is deterministic, complete and if $L(K(A)) = \overline{L(A)}$ holds. Justify your answers. Show the power automata.

a) Let $A := (S, I, \Sigma, T, F)$ be a finite automaton where $S := \{A, B\}$, $I := \{A\}$, $\Sigma := \{a, b\}$, $T := \{(A,a,B), (A,b,B), (B,a,B), (B,b,B), (B,a,A), (B,a,B)\}$ and $F := \{A\}$.

b) Let $A := (S, I, \Sigma, T, F)$ be a finite automaton where $S := \{A, B\}$, $I := \{A, B\}$, $\Sigma := \{a, b\}$, $T := \{(A,b,B), (B,b,B), (B,a,A)\}$ and $F := \{A\}$.

Exercise 4

Let A and B be two finite automata and $P := A \times B$ the product automaton of A and B. Do the following two statements hold? If so then give a proof sketch for the claim. Otherwise, provide a *concrete* counterexample, i.e. concrete A, B and P refuting the claim.

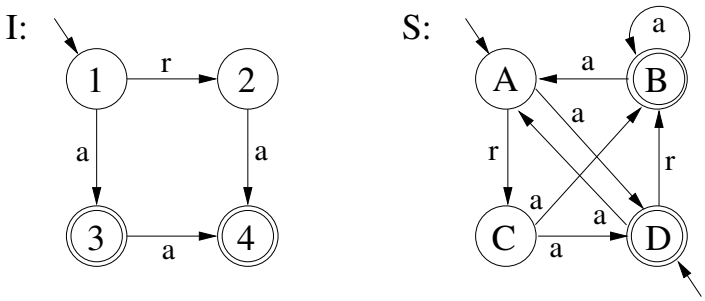
a) If both A and B are deterministic then P is deterministic.

b) If P is deterministic then both A and B are deterministic.

Exercise 5

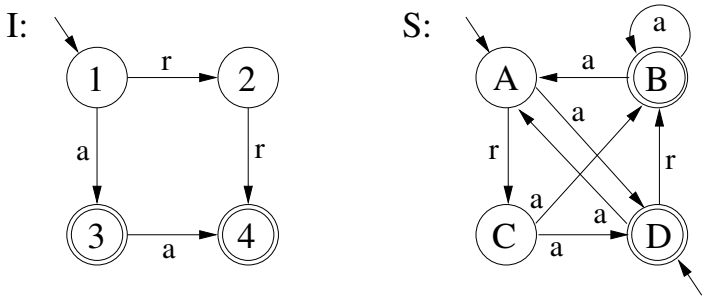
a) Given two FA A_I and A_S describing an implementation I and specification S, respectively. Explain in detail how to check whether I conforms to S, given A_I and A_S. Illustrate your explanations using set diagrams.

b) Check conformance of implementation I and specification S given as FA on the right.



Exercise 6

Check conformance of implementation I and specification S given as FA on the right.



Bonus Exercise

Read sections I and III "Software Model Checking" in the survey on software verification[1] and describe the approach of counterexample-guided abstraction refinement (CEGAR).

[1] V. D'Silva, D. Kroening, G. Weissenbacher: A Survey of Automated Techniques for Formal Software Verification. IEEE TCAD 27(7), 2008. The article can be found in KUSSS.