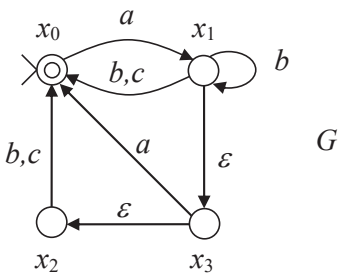
Analysis and Control of Cyber-Physical Systems

Homework 2 — 9 April 2020

Problem 1. Consider the nondeterministic finite automaton $G = (X, E, \Delta, x_0, X_m)$ in figure.



(a) Write the algebraic description of this NFA. Which are the nondeterministic structures in this model?

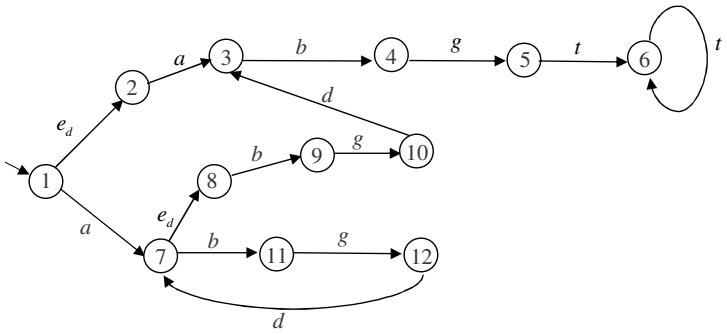
(b) Determine if the following words belong to the language $L(G)$ and to the language $L_m(G)$. You must also write all productions that generate these words if applicable.

$$(a)\ w_1 = ab; \qquad (b)\ w_2 = bb; \qquad (c)\ w_3 = aca;$$

(c) Determine a DFA G' equivalent to G.

(d) For all possible words w, discuss if DFA G' can be used as an observer to determine if G is in state x_0 after w has been generated.

Problem 2. Consider the DFA G shown in the following figure where the set of unobservable events is $E_{uo} = E_f = \{e_d\}$.



(a) Compute a table showing the set of consistent words and the set of consistent states for all observable words of length less than or equal to 2. Determine the diagnosis state for each observations listed on the table.

(b) Construct the diagnoser $Diag(G)$. Verify that it associates to all words in the previously constructed table the same diagnosis state determined at point (a).

(c) Determine if the diagnoser contains uncertain cycles and discuss if the fault is diagnosable.

Problem 3. Use the concurrent composition operator to find a DFA on alphabet $E = \{a, b, c\}$ accepting words such that:

- the projection on alphabet $E_1 = \{a, b\}$ is a string where a and b alternatively occur (ex: $abab\cdots$)
- the projection on alphabet $E_2 = \{b, c\}$ is a string where b and cc alternatively occurs (ex: $bccbcc\cdots$).

Compare this solution with the solution you gave in the previous homework.

All problems can be solved with software UMDES https://wiki.eecs.umich.edu/desuma/index.php/UMDES_Software_Library