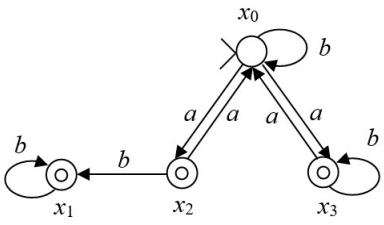
Analysis and Control of Cyber-Physical Systems

Homework 6 — 24 May 2021

Problem 1. Consider the state transition system T described by the automaton in figure.



(a) Determine a state transition system T' that simulates T but is not simulated by it. Justify your answer.

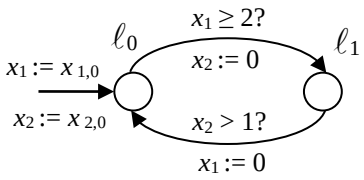
(b) Compute the set $Pre_b(\{x_0, x_1\})$.

(c) Consider the following partition: $\Pi = \{\pi_1, \pi_2\}$ with $\pi_1 = \{x_0 x_3\}$ and $\pi_2 = \{x_1, x_2\}$. Is the corresponding equivalence relation a bisimulation over the states of T? Justify your answer.

(d) Determine a minimal bisimulation over the states of T and the corresponding quotient state transition system, showing the steps of the procedure you have used.

Problem 2. Determine a timed automaton with external inputs to describe the following system. A door is initially locked. When a button is pushed twice in less that 2 s door is unlocked. Once the door is unlocked, if not further pushed within 12 seconds, the door is locked again

Problem 3. Consider the timed automaton in figure where to each location two timers x_1 and x_2 are associated. The initial value of the timers is $x_{1,0} := (0, 1]$ and $x_{2,0} := 1$.

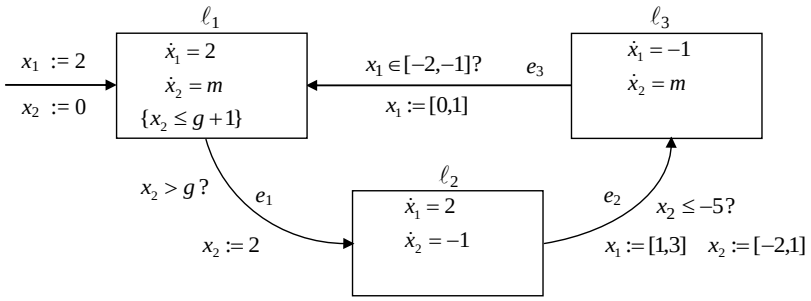


(a) Determine the regions in the continuous state space X of this automaton.

(b) Determine the number of equivalence classes of the corresponding bisimulation for its time-abstract state transition system and discuss if this number is smaller than or identical to the bound N_S.

(c) Determine the region graph of this automaton starting from the given initial condition.

Problem 4. Consider the hybrid automaton H in figure, where (g, m) denote the day and the month in which you were born.



(a) Discuss to which subclasses of HA automaton H belongs.

(b) Discuss if there exists a timed automaton equivalent to H. If the answer is positive, determine such a timed automaton.