Theory of Hybrid Systems
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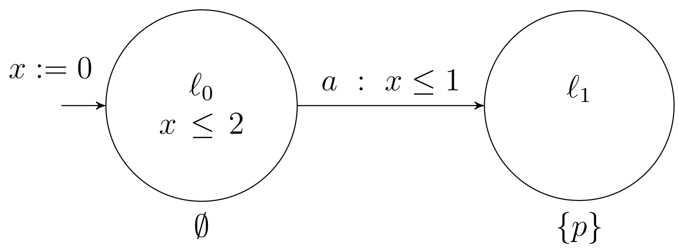
Modeling and Analysis of Hybrid Systems - SS 2015

Series 5

Exercise 1

Consider the TCTL formula $\Phi = A\mathcal{F}p$ and the following timed automaton $\mathcal{T}$:



(a) Does $\mathcal{T} \models \Phi$ hold, i.e., does $\mathcal{T}$ satisfy the TCTL formula Φ in its initial state?

(b) Please determine $RTS(\mathcal{T}, \Phi)$. It is sufficient to present the reachable fragment. Note that the TCTL formula Φ has no time bounds, therefore you do not need to introduce any auxiliary clock z.

(c) Does $\mathcal{T}$ have a path leading to a time-lock? If so, how can we recognize it on $RTS(\mathcal{T}, \Phi)$?

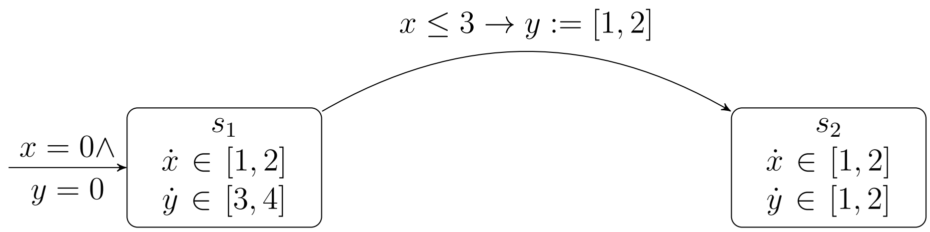
(d) Please apply the CTL model checking algorithm presented in the lecture to determine whether $RTS(\mathcal{T}, \Phi) \models \hat{\Phi}$, i.e., whether $RTS(\mathcal{T}, \Phi)$ satisfies $\hat{\Phi} = A\mathcal{F}p$ in its initial state. Does it hold that

$$\mathcal{T} \models \Phi \qquad \textit{iff} \qquad RTS(\mathcal{T}, \Phi) \models \hat{\Phi} \quad ?$$

If not, why?

Exercise 2

Consider the following initialized rectangular automaton $\mathcal{A}$:



(a) Transform $\mathcal{A}$ into an initialized singular automaton $\mathcal{A}_1$ and specify a function f_1 mapping $\mathcal{A}$-states to $\mathcal{A}_1$-states, such that a state s is reachable in $\mathcal{A}$ iff $f_1(s)$ is reachable in $\mathcal{A}_1$.

(b) Transform $\mathcal{A}_1$ into an initialized stopwatch automaton $\mathcal{A}_2$ and specify a function f_2 mapping $\mathcal{A}_1$-states to $\mathcal{A}_2$-states, such that a state s is reachable in $\mathcal{A}_1$ iff $f_2(s)$ is reachable in $\mathcal{A}_2$. You are allowed to set stopwatch values to any constants.

(c) Transform $\mathcal{A}_2$ into a timed automaton $\mathcal{A}_3$ and specify a function f_3 mapping $\mathcal{A}_2$-states to $\mathcal{A}_3$-states, such that a state s is reachable in $\mathcal{A}_2$ iff $f_3(s)$ is reachable in $\mathcal{A}_3$. You are allowed to set clock values to any constants.

(d) Transform the timed automaton $\mathcal{A}_3$ such that clocks are reset to the value 0, only.