Advance Model Checking

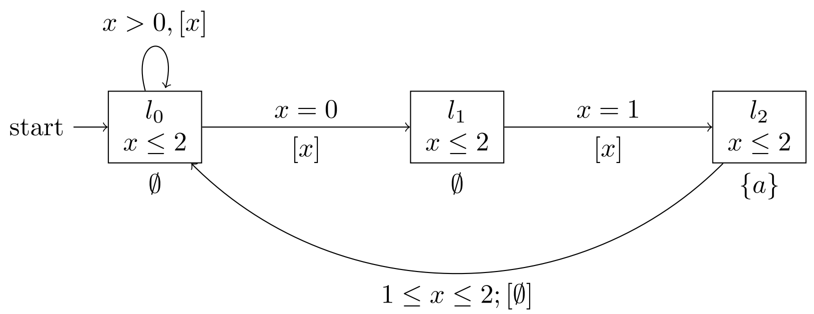
Ex-9: Submit on 4^{th} of July.*

July 3, 2012

1 Region Graph Construction

(3 Points)

For the following TImed automaton TA:

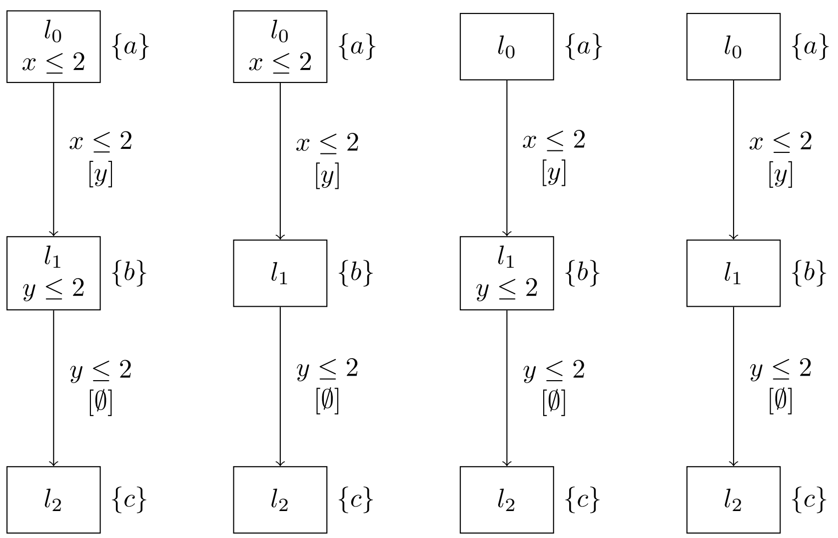


1. Determine the region transition system $RTS(TA, true)$.
2. Determin the set of states $Sat(\exists\Diamond^{<4} a)$.

2 Identify!

(2 Points)

Give TCTL formulas that indentify the following timed automata.



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3 Stability

(3 Points)

Consider the transition system of a given timed automaton T. We have discrete transition between state as $\langle l, \eta \rangle \xrightarrow{t} \langle l', \eta' \rangle$ for $t = (l, g, X, l')$ where $\eta \models Inv(l) \wedge g, \eta' = resetX\ in\ \eta$ and $\eta' \models Inv(l')$. We have a delay transition between states as $\langle l, \eta \rangle \xrightarrow{\delta} \langle l, \eta + \delta \rangle$ for $\delta \in \mathbb{R}_{\geq 0}$. We write $\langle l, \eta \rangle \xrightarrow{t,\delta} \langle l', \eta' \rangle$ for $\langle l, \eta \rangle \xrightarrow{\delta} \langle l, \eta + \delta \rangle \xrightarrow{t} \langle l', \eta' \rangle$.

We can construct the region automata R for T [1]. A transition in R $(l, r) \to (l', r')$, where l, l' are location of T, and r, r' are clock equivalent classes, is,

- **Pre-Stable:** If for every $\eta \in r$ there is a $\eta' \in r', \delta \in \mathcal{R}_{\geq 0}$ s.t.$\langle l, \eta \rangle \xrightarrow{t,\delta} \langle l', \eta' \rangle$.
- **Post-Stable:** If for every $\eta' \in r'$ there is a $\eta \in r, \delta \in \mathcal{R}_{\geq 0}$ s.t.$\langle l, \eta \rangle \xrightarrow{t,\delta} \langle l', \eta' \rangle$.

Shew that the transitions in the region automaton R are pre-stable but not necessarily post stable.

4 Distributive Property

(2 Points)

Prove or disprove,

$$\forall \Diamond^I \Phi \ \wedge \ \forall \Diamond^I \Psi = \forall \Diamond^I (\Phi \wedge \Psi)$$

Where I is an Interval.

5 Dead!

(Good Graces)

For a ordinary transition system, we have the following notion of fairness of runs and their logical characterization,

- ***Unconditional Fairness:*** $\Box \Diamond \Psi$.
- ***Strong Fairness:*** $\Box \Diamond \Phi \to \Box \Diamond \Psi$.
- ***Weak Fairness:*** $\Diamond \Box \Phi \to \Box \Diamond \Psi$.

where Φ *stands for "some action is enabled" and* Ψ *means "Some action is taken".*

We define three kinds of dead lock state in timed automata,

- **Pure Action Lock:** A state cannot perform any action, but time can progress.
- **Timed Action Lock:** State can neither perform nor time can progress indefinitely.
- **Zeno time lock:** All infinite runs starting from the state are Zeno.

Find similar logical characterization for the above mentioned DEAD states. Give temporal formula to capture the various kind of dead locks.

[1] as per the construction in "The BOOK" pg 709 section 9.3,2