Timed automata

金钊，王璐璐，白宗磊

北京大学信息科学与技术学院

2017/6/1

Outline

10.3 Semantics of timed automata

state

state

- a suitable notion of the state of computation of a timed automaton consists of a pair (l, v)
- l is the control location the automaton is in
- v is the valuation determined by the current clock values

timed transition system

timed transition system $T(A)$

Let $A = (L, l_0, E, \mathrm{I})$ be a timed automaton over a set of clocks C and a set of actions Act. We define the timed transition system $T(A)$ generated by A as $T(A) = (Proc, Lab, \{\xrightarrow{\alpha} | \alpha \in Lab\})$

timed transition system

timed transition system $T(A)$

其中:

- $Proc = \{(l, v) | (l, v) \in L * (C \rightarrow R_{\geq 0}) \quad and \quad v \vDash I(l)\}$. states are of the form (l, v), where l is a location of the timed automaton and v is a valuation that satisfies the invariant of l.
- $Lab = Act \cup R_{\geq 0}$ is the set of labels $(R_{\geq 0} : time - elapsing \quad step)$
- the transition relation is defined by:
  - $(l, v) \xrightarrow{a} (l^{'}, v^{'})$ if there is an edge $(l \xrightarrow{g,a,r} l^{'}) \in E$ such that $v \vDash g, v^{'} = v[r] \quad and \quad v^{'} \vDash I(l^{'})$
  - $(l, v) \xrightarrow{d} (l, v + d)$ for all $d \in R_{\geq 0}$ such that $v \vDash I(l) \quad and \quad v + d \vDash I(l)$

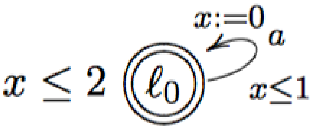
where: g is the guard, a is the action, r is the set of clocks to be reset, I assigns invariants to locations.

timed transition system

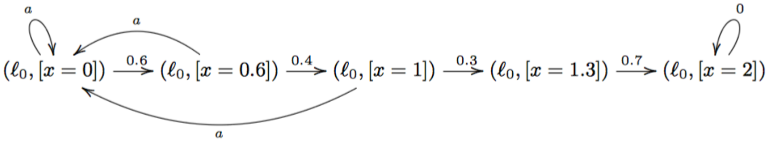
timed transition system $T(A)$

Let v_0 denote the valuation such that $v_0(x) = 0$ for all $x \in C$. If v_0 satisfies the invariant of the initial location l_0, we shall call (l_0, v_0) the initial state (or initial configuration) of $T(A)$.

Example

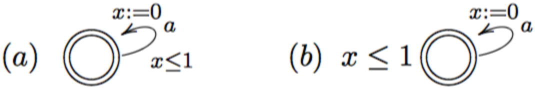


A small part of the transition system $T(A)$ is shown below (there are in fact uncountably many different reachable states for every x in the interval $[0, 2]$)

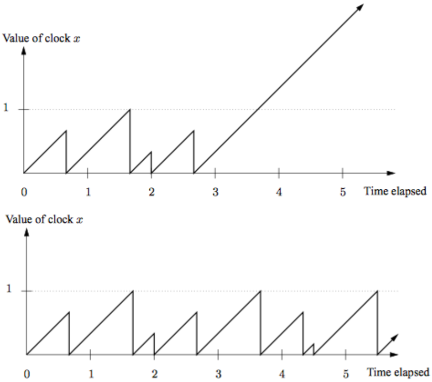


Notice:

There is a fundamental difference between situations where a clock constraint is used in the guard and where it is used in the invariant.



Notice:



In the timed automaton (b), $x <= 1$ is used in the invariant. This means that it is never possible to delay more than 1 time unit

Exercise:

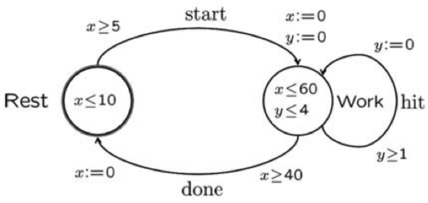


Figure 10.3 A small Jobshop.

A Worker alternates between resting and working. The clock x is used for constraining the time spent by the Worker in these two modes, and the clock y is used to control the frequency with which the Worker is hitting nails while working.

谢谢大家！