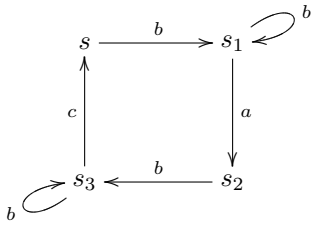
Tutorial 9

Exercise 1*

Consider the following labelled transition system.



Using the game characterization for recursive Hennessy-Milner formulae decide whether the following claims are true or false and discuss what properties the formulae describe:

- $s \overset{?}{\models} X$ where $X \overset{\min}{=} \langle c \rangle tt \vee \langle Act \rangle X$
- $s \overset{?}{\models} X$ where $X \overset{\min}{=} \langle c \rangle tt \vee [Act] X$
- $s \overset{?}{\models} X$ where $X \overset{\max}{=} \langle b \rangle X$
- $s \overset{?}{\models} X$ where $X \overset{\max}{=} \langle b \rangle tt \wedge [a] X \wedge [b] X$

Exercise 2

Consider an autonomous elevator which operates between two floors. The requested behaviour of the elevator is as follows:

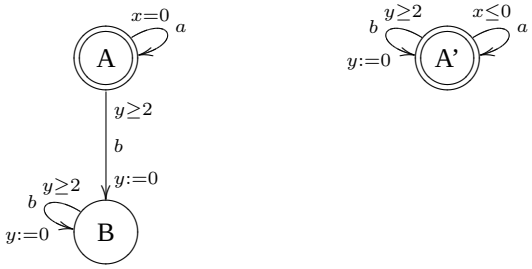
- The elevator can stop either at the ground floor or the first floor.
- When the elevator arrives at a certain floor, its door automatically opens. It takes at least 2 seconds from its arrival before the door opens but the door must definitely open within 5 seconds.
- Whenever the elevator's door is open, passengers can enter. They enter one by one and we (optimistically) assume that the elevator has a sufficient capacity to accommodate any number of passengers waiting outside.
- The door can close only 4 seconds after the last passenger entered.
- After the door closes, the elevator waits at least 2 seconds and then travels up or down to the other floor.

Your tasks are:

- Suggest a timed automaton model of the elevator. Use the actions *up* and *down* to model the movement of the elevator, *open* and *close* to describe the door operation and the action *enter* which means that a passenger is entering the elevator.
- Provide two different timed traces of the system starting at the ground floor with the door open.

Exercise 3

Consider the following timed automata and for each pair decide whether their initial states are (i) timed bisimilar (ii) untimed bisimilar.



Exercise 4

Let T be a timed transition system. Let us consider a labelled transition system T' where every time-delay action $d \in \mathbb{R}^{\geq 0}$ is replaced with the silent action τ. We now define that two states p and q from the timed transition system T are *time abstracted bisimilar* if and only if p and q are weakly bisimilar in T'.

- Is the notion of time abstracted bisimilarity equivalent to untimed bisimilarity?
- If yes, prove your claim. If no, give a counter example.