Final Assignment "Timed Automata and UPPAAL" (Model Checking)

Deadline: Friday June 24, 2016.

This assignment has to be sent to r.langerak@utwente.nl. It consists of three parts, each of which can score a maximum of 30 points. Grade: (10 + total score) divided by 10. This assignment can be made individually or by a couple.

First part

1.a Consider the train gate controller example of slide 9, lecture "Timed Automata". Give an example of a series of timed transitions (including intermediate states) of the composed system (so the product construction of the three automata) showing a train approaching and finally leaving the gate.

1.b Consider the timed automaton in figure 1 of the paper "Timed Automata" by Rajeev Alur. Suppose initially we have a zone $[(s0, [0 \leq x \leq 4, 0 \leq y \leq 3])$. Give the zone after a sequence $a.b$ and show the intermediate steps in the derivation.

1.c Consider the timed automaton in figure 1 of the paper "Timed Automata" by Rajeev Alur. Give the zone automaton of the timed automaton, with initial state $(s0, [x = 0, y = 0])$.

Second part

Rush Hour is a puzzle where on a 6x6 board trucks and cars are placed in an initial position. The goal is to move the vehicles forward and backward in such a way that the red car can leave the board at the exit on the right. Here you see a picture:

and here you find more information, including the possibility to play online:
http://thinkfun.com/products/rush-hour/

2 Model the game in UPPAAL model and show how to find solutions. Make sure you can solve at least the following positions:

Can you also solve the two hard positions in the following URL?

https://quomodocumque.wordpress.com/2012/02/18/the-hardest-rush-hour-position/

Third part

A vessel where some chemical reaction takes place can be cooled by inserting two different rods, each with different cooling capacities. Only one rod can be inserted at a certain time. The vessel can be in three different states:

no rods: then the temperature T evolves according to the differential equation $T' = 0.1T - 10.0$

with rod1: equation is $T' = 0.1T - 11.2$

with rod2: equation is $T' = 0.1T - 12.0$ (so rod2 cools better than rod1).

A rod will be inserted if the temperature reaches 110 degrees. A rod that is in the vessel will be removed from the vessel if the temperature is between 102 and 105 degrees. When a rod is removed, it cannot be used for 20 time units.
Initial temperature is 102 degrees. The objective is to keep the temperature between 102 and 110 degrees. If the temperature is going up to 110 degrees but no rod is yet available, the system goes into a state `Overheating`.

3.a Specify the system in UPPAAL. Show that unfortunately it may reach state `Overheating`. What is the chance this happens within 100 time units?

3.b Someone forwards the idea that the fact that the `Overheating` state can be reached is due to rod2 cooling too well, and proposes to replace rod2 by a rod that is similar to rod1. What do you think of this idea?