Exercise Sheet 4

Early submission: Monday, 2012-07-16, 12:00  Regular submission: Tuesday, 2012-07-17, 12:00

Exercise 1: Regions  (3/20 Points)

Recall that we started to indicate the equivalence classes on clock valuations of $X = \{x, y\}$ in the graph shown in Figure 1. A point $(p, q)$ in the graph represents the unique clock valuation $\{x \mapsto p, y \mapsto q\}$. Please complete the drawing by indicating all equivalence classes according to the definition of equivalence from the lecture. As usual, convince the tutors of the correctness of your proposal.

Exercise 2: Region Construction [1]  (5/20 Points)

Consider the timed automaton $A$ in Figure 2. In the tutorial, we had the impression that location $\ell_2$ is not reachable. Prove this statement by constructing the region automaton.

Note: this is not exactly the same automaton from the previous exercise sheet!
Exercise 3: Deadlock  

(i) Please give (possibly from (correctly cited) literature) an exact formal definition of deadlock in Uppaal, i.e. please explain (formally) when exactly does

\[ \mathcal{A} \models E \leftrightarrow \text{deadlock} \]

hold using the definitions from the lecture.

Consider the following examples:

a) ![Diagram](image1.png)

b) ![Diagram](image2.png)

c) ![Diagram](image3.png)

d) ![Diagram](image4.png)

e) ![Diagram](image5.png)

Do they have a deadlock according to your definition (wherever it comes from)? And according to Uppaal (i.e., what does Uppaal’s deadlock check yield)?

(ii) How does deadlock relate to livelock?

(iii) What is checking for deadlocks good for?

Exercise 4: Model-Checking with Uppaal

Consider the Off/Light/Bright model from Exercise Sheet 4.

(i) Use the model checker to verify whether the original user can reach the Bright location.

(ii) Use the model checker to verify whether your modified user from Sheet 4, Exercise 2, part (iii) cannot reach the Bright location as requested.

(iii) Check whether the original user is able to keep the lamp at location Bright for more than 5 time units.

(iv) Check whether the original user is able to switch the lamp to Bright twice.

Explain your approach.

References