

Software Design, Modeling, and Analysis in UML

<http://swt.informatik.uni-freiburg.de/teaching/WS2015-16/sdmauml>

Exercise Sheet 7

Early submission: Monday, 2016-02-08, 12:00 Regular submission: Tuesday, 2016-02-09, 10:00

Exercise 1 **(14/20 Points)**

Consider the LSC shown in Figure 1.

- (i) Provide the abstract syntax of the body of the pre-chart and the main-chart, i.e. two LSC body tuples. (3)
- (ii) Point out one example each for
 - universal chart,
 - hot and cold location,
 - condition,
 - simultaneous region,
 - hot inclusive local invariant,
 - coregion,
 - activation mode, and
 - pre-chart

in Figures 1 or 2 (use the terms of task (i) if appropriate to be more precise).

If there is no example in Figures 1 and 2, make up an (as small as possible) own LSC. For your own example, the mathematical representation is not necessary. (2)

- (iii) Construct the TBA for pre- and main-chart (separately). (3)

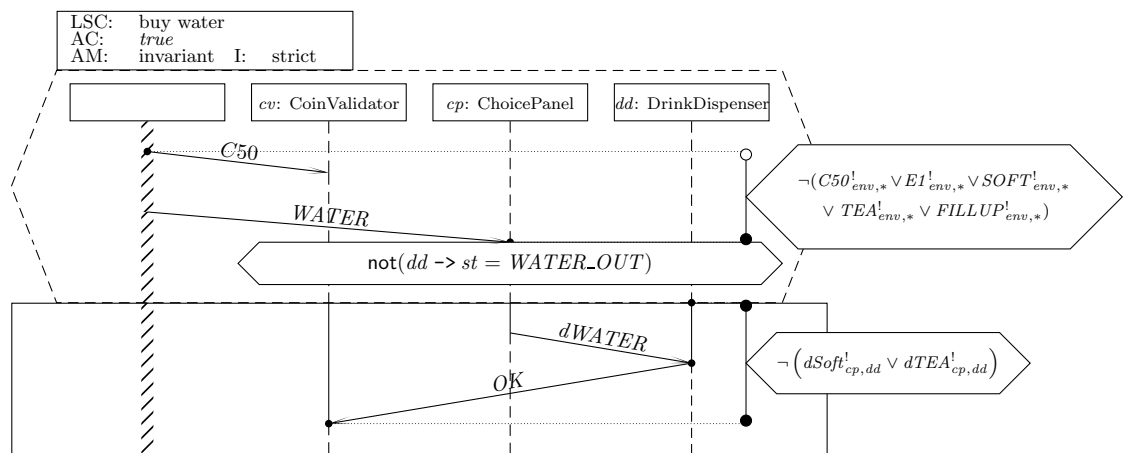


Figure 1: LSC Requirement on Vending Machine.

- (iv) Consider the vending machine Rhapsody model available with this exercise sheet via ILIAS.
- Provide one computation of the model which *trivially* satisfies the LSC. (2)
 - Provide one computation of the model which *non-trivially* satisfies the LSC. (2)
 - The computation from the previous task: is it the shortest (number of events) possible, non-trivially satisfying one? If no, provide a strictly shorter computation, if yes, provide a strictly longer computation. (2)

Hint: convince your reader of your claim by (A) arguing why the computation you consider is indeed a computation of the model and (B) relate the computation you consider to the TBA of the LSC as constructed above.

Exercise 2 (4/20 Points + 5 Bonus)

Consider the LSC shown in Figure 1. The local invariant in the pre-chart reads

$$\neg(C50!_{env,*} \vee E1!_{env,*} \vee SOFT!_{env,*} \vee TEA!_{env,*} \vee FILLUP!_{env,*}).$$

- (i) It is claimed that using just

$$\neg(E1!_{env,*} \vee SOFT!_{env,*} \vee TEA!_{env,*} \vee FILLUP!_{env,*})$$

does not change the meaning of the LSC at all. Argue why that claim holds. (2)

Hint: the interpretation is ‘strict’.

- (ii) What would be the intuition of the LSC if we used the even weaker constraint

$$\neg(SOFT!_{env,*} \vee TEA!_{env,*} \vee FILLUP!_{env,*})$$

in the local invariant of the pre-chart? (2)

Hint: Discuss which additional computations are accepted if we weaken the pre-chart.

In your opinion, which constraint better formalises the original (informal) user requirement “if one inserts enough money and chooses water while there is water in stock, then one finally gets some water (and nothing else)”?

- (iii) It is claimed that the LSC obtained by using the constraint

$$\neg(E1!_{env,*} \vee SOFT!_{env,*} \vee TEA!_{env,*}) \quad (*)$$

in the local invariant of the pre-chart is *not satisfied* by the vending machine model.

Prove that claim by providing a computation of the model which *does not* satisfy the LSC using constraint (*). (5 Bonus)

Hint: the solution is a tricky corner case which depends on a design error in the vending machine model. It has actually not been uncovered by human inspection, but by an automatic exhaustive analysis of the behaviour.

If you get stuck, you may ask Milan for more hints; or describe the cases and hypotheses which you investigated unsuccessfully in order to demonstrate the violation.

Exercise 3 (10 Bonus)

Propose a change to the vending machine model such that

- the “user experience” of the vending machine changes as little as possible,
- the LSC with constraint (1) is satisfied by the changed model.

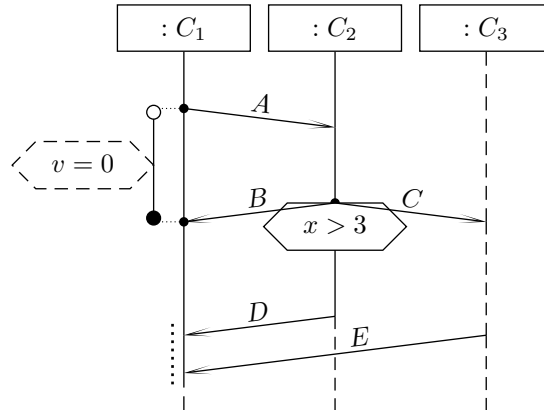


Figure 2: Example LSC with condition and local invariant.

Discuss: what is the idea of your change? How does the user experience change, i.e. which computations of the original model are not possible any more? And how would these computations relate to real world scenarios of people using a vending machine which behaves according to the model? Do you consider these changes acceptable (for customers trying to buy drinks at the vending machine, as well as for the merchants which offer drinks through the vending machine and, e.g., care for fill-up)?

Exercise 4

(2/20 Points)

Consider the local invariant and the condition LSC in Figure 2.

- (i) Describe in your own words the requirements expressed by the local invariant and the condition. (1)

Hint: In particular, when (and when not) the values of expressions $v = 0$ and $x > 3$ are considered and which effect they have if the expression is (or is not) satisfied.

- (ii) Describe in your own words how the meaning changes if the temperatures were exchanged, i.e., if the local invariant was hot and the condition cold. (1)