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Wintersemester 2016/17

Software Design, Modeling, and Analysis in UML

http://swt.informatik.uni-freiburg.de/teaching/WS2016-17/sdmauml

Exercise Sheet 3

Early submission: Monday, 2016-11-21, 12:00 Regular submission: Tuesday, 2016-11-22, 8:00

Exercise 1 (3/20 Points)

Consider the following system state

$$\sigma = \{1_N \mapsto \{m \mapsto \{1_N\}, s \mapsto \{2_N\}, v \mapsto 3\}, 2_N \mapsto \{m \mapsto \{3_N\}, s \mapsto \emptyset, v \mapsto 27\}\}$$

over the signature

$$\mathscr{S} = (\{Int\}, \{Node\}, \{m : Node_{0,1}, s : Node_*, v : Int\}, \{Node \mapsto \{m, s, v\}\})$$

modelling a sensor network.

(i) Give an object diagram which represents σ. (2)

(ii) Provide an object diagram which is a partial object diagram of σ. (1)

Exercise 2 (6/20 Points + 3 Bonus)

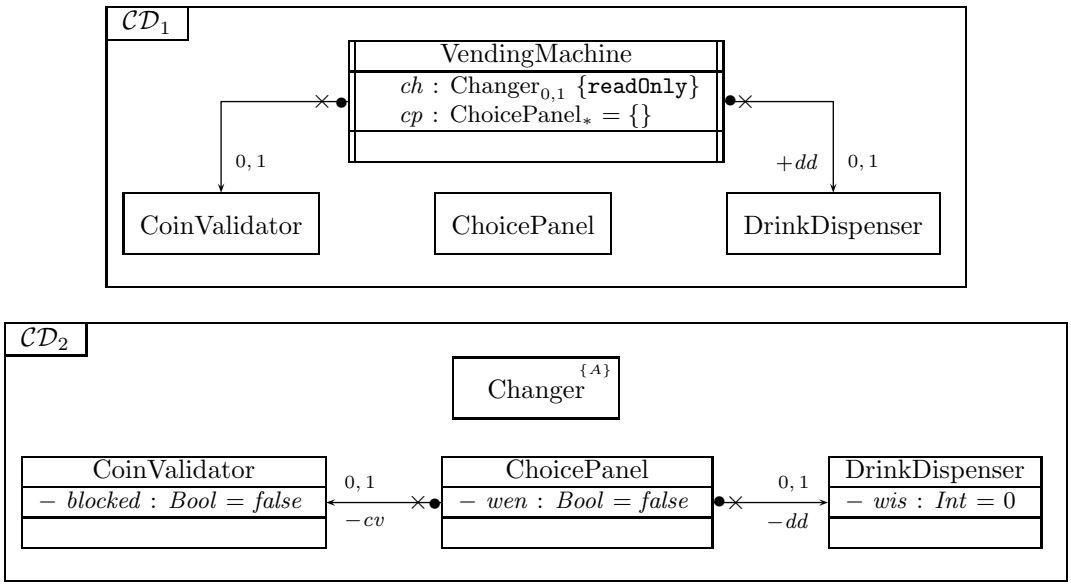

Figure 1: Class Diagrams for Exercise 2

Consider the set of class diagrams $\mathscr{CD}$ shown in Figure 1.

(i) Provide $\mathscr{S}(\mathscr{CD})$. (3)

(ii) A vending machine is supposed to have exactly one drink dispenser, i.e.

context VendingMachine inv : not oclIsUndefined (dd)

and similarly at least one coin validator. Each choice panel belonging to one vending machine has to be linked to the coin validator and the drink dispenser of the vending machine, i.e.

$$\textsf{context}\ \ v : \text{VendingMachine}, p : \text{ChoicePanel}\ \textsf{inv}:$$
$$v.cp\ \textsf{->}\ \textsf{Exists}(i \mid i = p)\ \textsf{implies}\ p.cv = v.cv\ \textsf{and}\ p.dd = v.dd$$

Give a system state wrt. $\mathscr{CD}$ (and wrt. a structure $\mathscr{D}$ of your choice) such that the system state satisfies the requirements given above. (2)

(iii) Propose a change to your system state from the previous task such that the changed system state is a proper system state wrt. $\mathscr{CD}$ (and $\mathscr{D}$) but does not satisfy the requirements. (1)

(iv) What is the size of the smallest (in number of alive objects) non-trivial system state which satisfies the requirements given above?

Give one example of such a smallest system state and argue why it is smallest. (3 Bonus)

Hint: system states can be represented by object diagrams.

Exercise 3 (3/20 Points)

For each of the following OCL expressions discuss whether (and why) it is or is not well-formed when considering visibility.

(i) $\textsf{context}$ DrinkDispenser $\textsf{inv}$: $wis \geq 0$ (1)

(ii) $\textsf{context}$ ChoicePanel $\textsf{inv}$: $cv.blocked\ \textsf{implies not}\ wen$ (2)

Exercise 4 (6/20 Points)

Consider the object diagram shown in Figure 2.

(i) Provide a class diagram $\mathcal{CD}$ such that the object diagram in Figure 2 is a (partial) object diagram of a system state of $\mathcal{CD}$. Point out and explain your design decisions. (3)

(ii) Assume that the object diagram in Figure 2 has been created at a meeting with a customer who needs new software for a web-shop and who has been asked to describe a typical intermediate system state.

To investigate the suitability of the structure design represented by the class diagram, two use cases should be considered.

The first use case is concerned with adding items to a session. Technically, adding for example item "ZCY539" to session "S002" amounts to the user's web-browser sending a message including name "ZCY539" and id "S002" to an instance of FrontEnd, which is then responsible to establish a link from the Session object with id "S002" to the Item object with name "ZCY539".

Is this principally possible using the associations from your class diagram? (1)

(iii) A second use case considers the payment. When the user initiates payment (by sending a corresponding message to the Session via the FrontEnd), the total sum for the items in the session should be computed, where combinations of certain items result in a discount. Whether payment has just been initiated will only be determined by internal (i.e., private) information of the Session. The rules to compute the discounts should be kept in the BackEnd. Now we observe that there are links missing which enable a Session to obtain the final amount to be paid (including discounts) when payment is initiated.

Propose two different changes to your class diagram such that the Session can get the final amount once payment is initiated and explain how they solve the identified issue.

Which one would you recommend to the customer? (2)

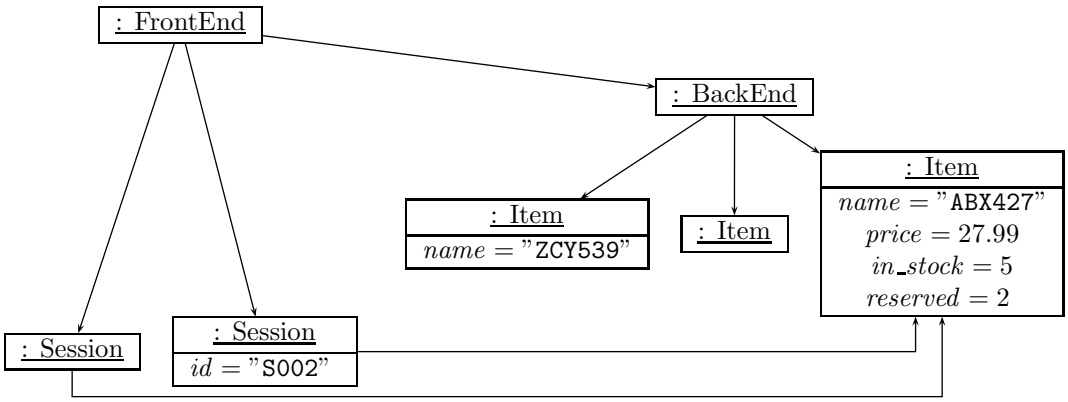

Figure 2: Web-Shop Object Diagram.

Exercise 5 (2/20 Points)

Provide a Rhapsody "object model diagram"[1] corresponding to your class diagram from Exercise 4. Please submit an archive (zip, tgz, ...) of your Rhapsody project.

Hints:

- *To use Rhapsody, connect to host* `architor.informatik.uni-freiburg.de` *with some RDP client.*
- *The host can (for limited number of licences) only run a limited number of parallel instances of Rhapsody. If you don't get a license, please try again later. If the problem persists, contact us.*

[1] In a Rhapsody model, classes and their structural relationships are specified by so-called *Object Model Diagrams*.