Prof. Dr. A. Podelski, Dr. B. Westphal Wintersemester 2014/15

**Software Design, Modeling, and Analysis in UML**

http://swt.informatik.uni-freiburg.de/teaching/WS2014-15/sdmauml

# Exercise Sheet 3

Early submission: Monday, 2014-12-01, 12:00 Regular submission: Tuesday, 2014-12-02, 8:00

## Exercise 1 (10/20 Points)

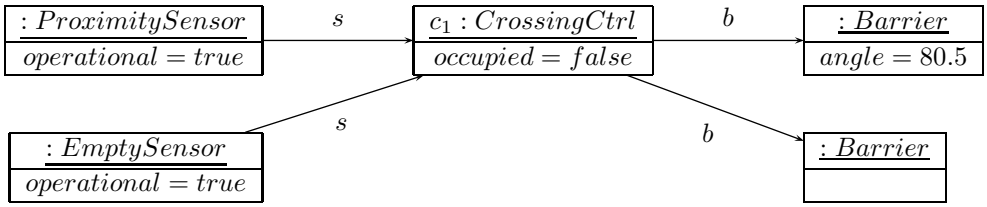


Figure 1: Object Diagram for Exercise 1.

Figure 1 shows an object diagram $G$ for a railway crossing system. Provide an extended signature $\mathscr{S}$ and a structure $\mathscr{D}$ such that $G$ is an object diagram wrt. $\mathscr{S}$ and $\mathscr{D}$.

(i) Convince the reader that $G$ is an object diagram wrt. $\mathscr{S}$ and $\mathscr{D}$. (3)

(ii) As there is no 1-to-1 mapping from object diagrams to extended signatures, you may have to make (design) decisions or follow conventions.

Point out and discuss your design decisions and conventions; in particular point out which aspects you feel should not be solved by imposing conventions but which should be discussed with the customer. (3)

(iii) Provide a Rhapsody "object model diagram" corresponding to $\mathscr{S}$. Discuss "corresponding": is there any difference between $\mathscr{S}$ and the Rhapsody object model diagram or is there a 1-to-1 relation? (4)

Please send an archive (zip, tgz, ...) of your Rhapsody project.

*Hints:*

- *To use Rhapsody, connect to* `archithor.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, tell me.*
- *In a Rhapsody model, classes and their structural relationships are specified by so-called* Object Model Diagrams.

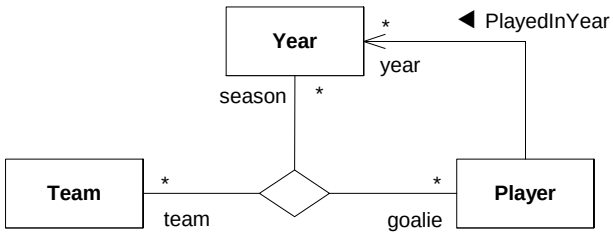


**Figure 7.21 - Binary and ternary associations**

Figure 2: League [OMG, 2007, 44].

## Exercise 2 (4/20 Points)

Consider the class diagram in Figure 2.
The class diagram seems to capture information about teams in a league. Assume that the diagram models a particular league where there is the (admittedly strange) rule saying that a player is not allowed to be the goalkeeper ("goalie") in more than 2 years. In order to reflect these rules in the diagram, a modeler proposes to change the multiplicity of the unnamed association accordingly. Please carry out the change and discuss whether the change has the desired effect, that is, that those system states induced by the changed class diagram which are consistent also respect the rule, and vice versa.

If you think that the proposal doesn't have the desired effect: do you have an own proposal to fix the issue?

## Exercise 3 (3/20 Points)

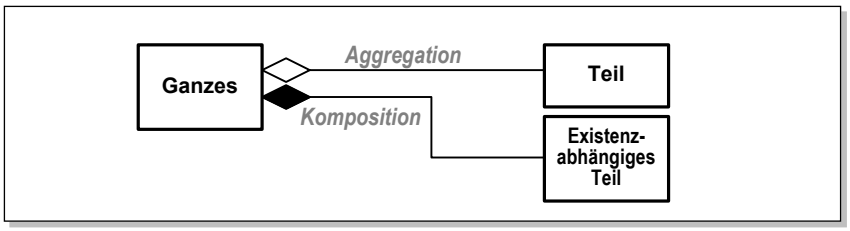


Figure 3: Aggregation and composition.[Oestereich, 2006]

In addition to the decorations of association ends discussed in the lecture, UML admits at most one end to be decorated with a hollow or solid "diamond", to indicate "aggregation" and "composition" (cf. Figure 3).

Integrate the semantics of aggregation and composition into the course's formal framework.

*Hint: That is, first assess what has to be covered (name it, cite it from the standard) and briefly explain its informal semantics as given by the standard.*
*Recall that we've seen that different "UML things" are of different semantical relevance: it ranges from, e.g., attribute types with prominent semantical relevance, over activeness which we postponed, to reading direction of association names which we don't even represent in the abstract syntax because of its weak semantical relevance.*
*Discuss into which class of relevance you think aggregation/composition belongs and treat it accordingly. For example, if you opt for prominent semantical relevance, you may have to extend the definition of signatures, to define the mapping from diagram to your extended signature, think about the impact on OCL and well-typedness etc.*


(a) Bidirectional. (b) Unidirectional.

Figure 4: Bidirectional vs. unidirectional links.

## Exercise 4 (3/20 Points)

In some older UML textbooks one finds the claim that the two class diagrams shown in Figure 4(a) Figure 4(b) are equivalent. Discuss this claim.

*Hint: Discuss the claim of semantical equivalence in the course's formal framework with the extended system states from Lectures 9 and 10. To be equivalent* formally *means that the induced set of system states is the same when using the same domain. One way to prove that diagrams are* not *equivalent formally is to give an OCL constraint which is satisfied by all (complete) object diagrams of one but not the other. If you follow the claim that the figures are equivalent* formally*, sketch a proof and discuss whether there are, e.g., still differences in pragmatics.*

# References

[Oestereich, 2006] Oestereich, B. (2006). *Analyse und Design mit UML 2.1, 8. Auflage*. Oldenbourg, 8. edition.

[OMG, 2007] OMG (2007). Unified modeling language: Superstructure, version 2.1.2. Technical Report formal/07-11-02.