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Software Design, Modeling, and Analysis in UML

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

Exercise Sheet 4

Early submission: Monday, 2015-12-07, 12:00   Regular submission: Tuesday, 2015-12-08, 10:00

Exercise 1 (7/20 Points)

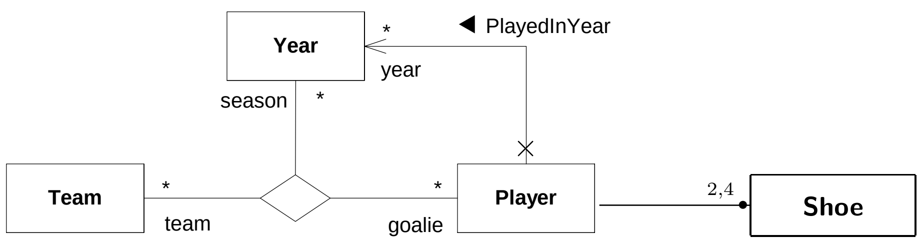

Figure 1: League model (OMG, 2011, 44).

(i) Provide the signature defined by the class diagram in Figure 1. Assume that class **Team** has the boolean basic type attribute '*hasLicence*' (not shown in the diagram). (3)

(ii) Give an interesting (!) system state which illustrates the new notion of links. (2)

(iii) To which value does the OCL constraint

$$\mathsf{context}\ Player\ \mathsf{inv} : team\ \texttt{->}\ \mathsf{forAll}(t \mid t.hasLicence)$$

evaluation in your system state from (ii)?

(Argue based on the value of *self.team*, that is, compute $I[\![self.team]\!]((\sigma, \lambda), \beta)$ for at least one interesting binding of *self* by β.) (2)

Exercise 2 (5/20 Points)

Consider the class diagram in Figure 1.
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 association end *season* accordingly.

(i) Provide the OCL constraints induced by the ternary association *after the change.* (3)

(ii) Another modeler claims that the change does not have the desired effect, that is, that it is not the case that those system states of the changed class diagram which are consistent with the constraints in the diagram also respect the rule, and vice versa.

Provide a convincing counter example. (1)

(iii) Do you have an own proposal to fix the issue? (1)

(a) Bidirectional. (b) Unidirectional.

Figure 2: Bidirectional vs. unidirectional links.

Exercise 3 (4/20 Points)

In some older UML textbooks one finds the claim that the two class diagrams shown in Figure 2(a) and Figure 2(b) are *semantically* equivalent. (They (obviously) do induce different signatures.)

(i) Prove this claim wrong (wrt. the semantics defined in our course) by providing a convincing counter-example. (2)

(ii) One way to prove that diagrams are *not* semantically equivalent is to give an OCL constraint which is satisfied by all system states of one but not by all system states of the other signature.

Provide (and — of course — explain) such an OCL constraint. (2)

Hint: To be semantically *equivalent means that the induced sets of system states* $\Sigma_{\mathscr{S}_1}^{\mathscr{D}}$ *and* $\Sigma_{\mathscr{S}_2}^{\mathscr{D}}$ *are the same (or at least isomorphic) when using the same domain if* $\mathscr{S}_1$ *is the signature of Figure 2(a) and* $\mathscr{S}_2$ *is the signature of Figure 2(b).*

Exercise 4 (4/20 Points)

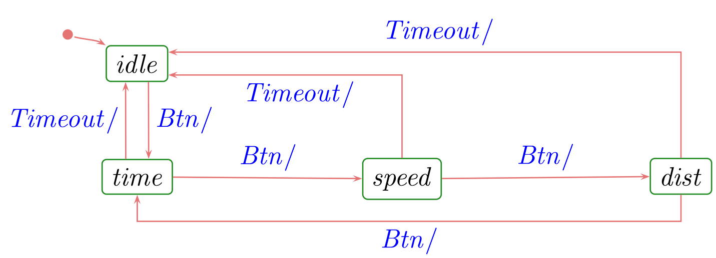

Figure 3: State machine model of the behaviour of a simple bicycle computer for Exercise 4.

(i) Give the core state machine corresponding to the diagram shown in Figure 3. (2)

(ii) Provide a Rhapsody model of the core state machine in Figure 3. (2)

Exercise 5 **(5 Bonus)**

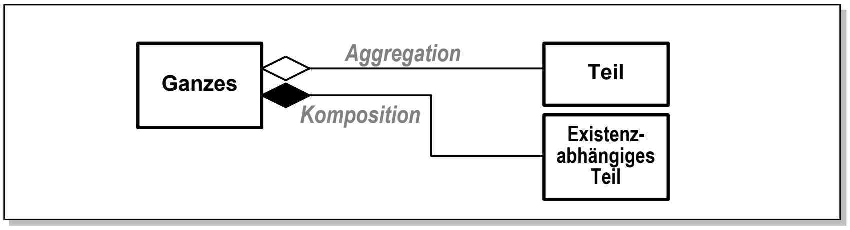

Figure 4: Aggregation and composition.Oestereich (2006)

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 4).

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.

References

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

OMG (2011). Unified modeling language: Superstructure, version 2.4.1. Technical Report formal/2011-08-06.