

Exercises for Aggregation, Composition, and Generalization in UML

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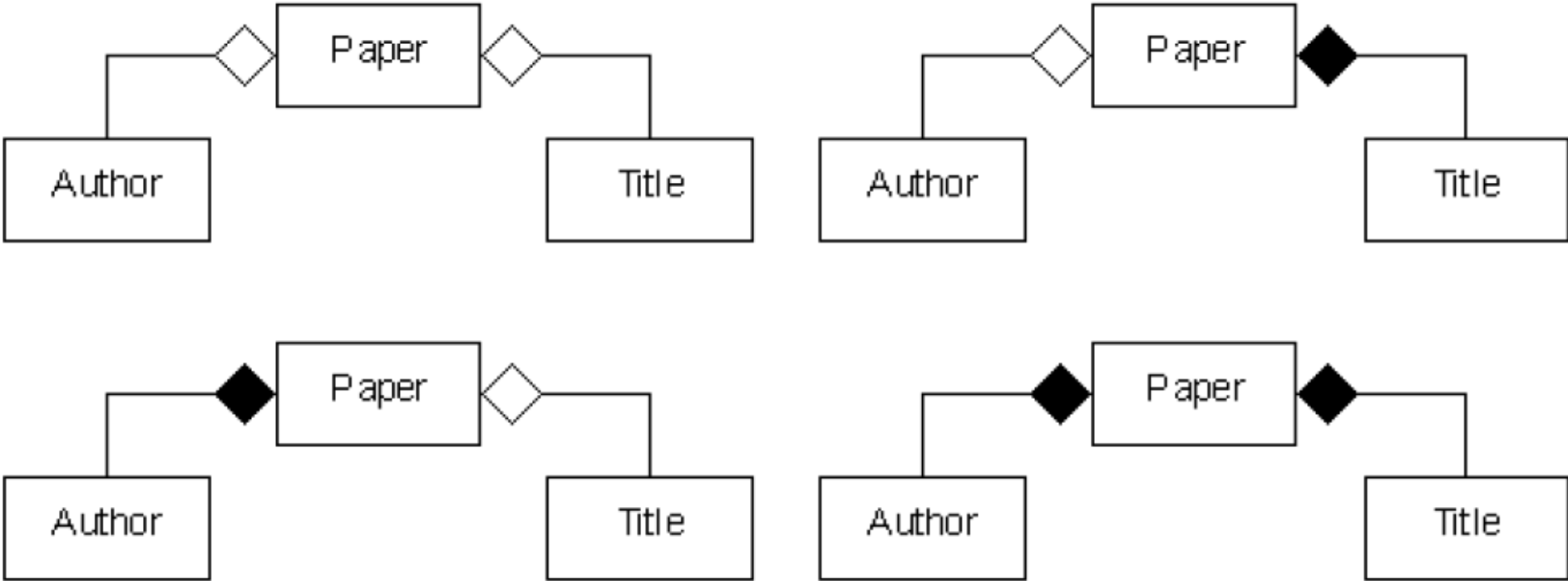
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Exercises

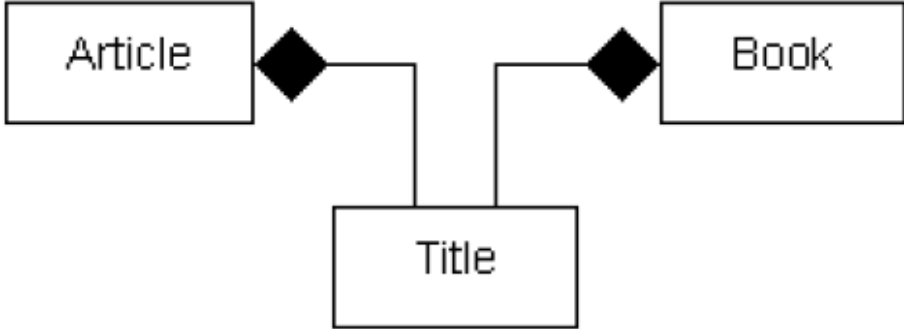
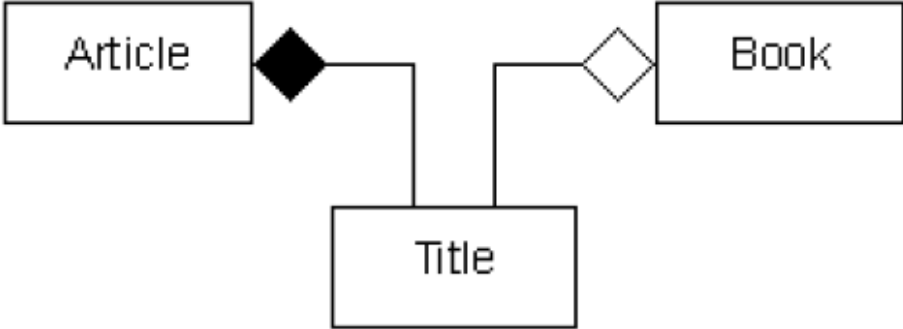
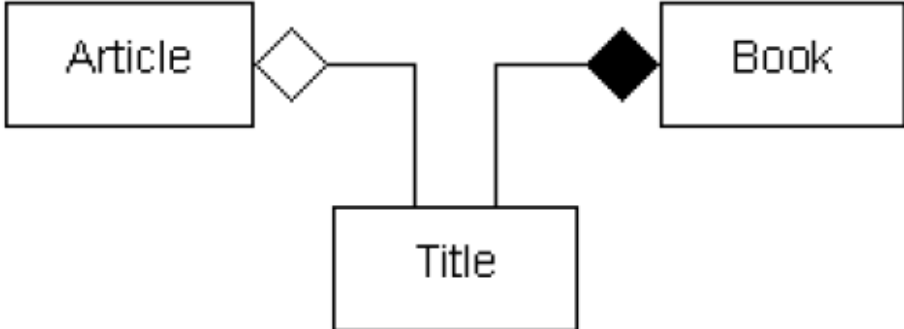
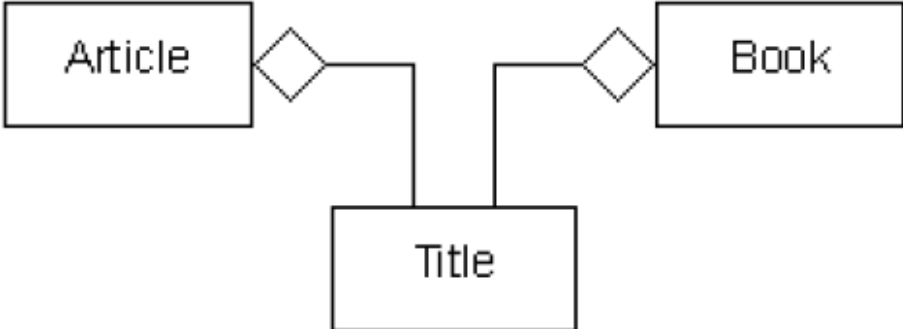
Below we show different modeling alternatives A1, A2, A3, and A4 for different universes of discourse. Each modeling alternative consists of a collection of class diagrams with slightly different features. For each modeling alternative carry out the following.

- Extend the class diagrams by specifying the most appropriate multiplicities for all present association ends. Choose only from the following, most common multiplicities: 0..1, 0..*, 1, 1..*.
- Show the OCL constraints underlying the class diagrams, i.e., present which restrictions are stated by the white diamond or the black diamond.
- Explain the differences between the models by showing object diagrams. For this, follow the method given below.
- Choose your favourite class diagram and explain in verbal form why you think your choice is the best choice.

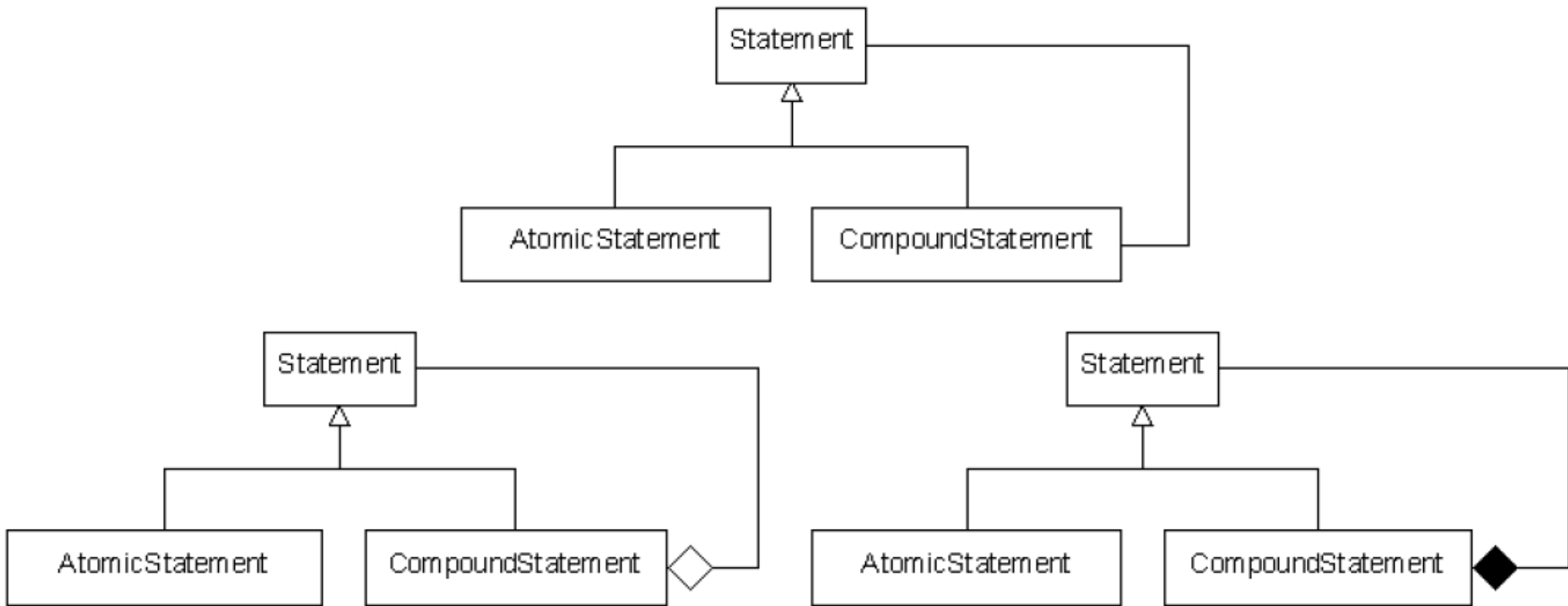
Alternative A1



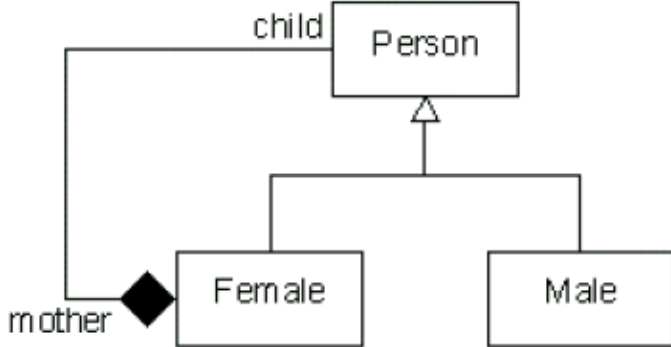
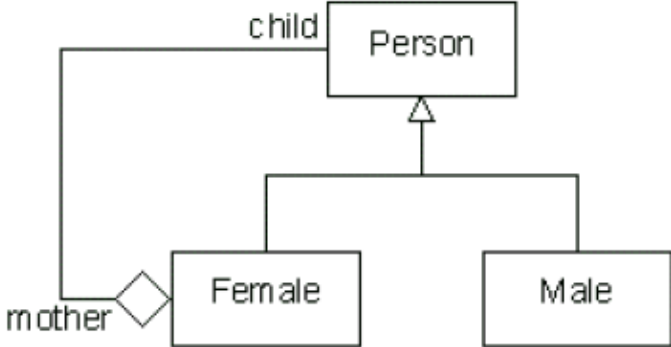
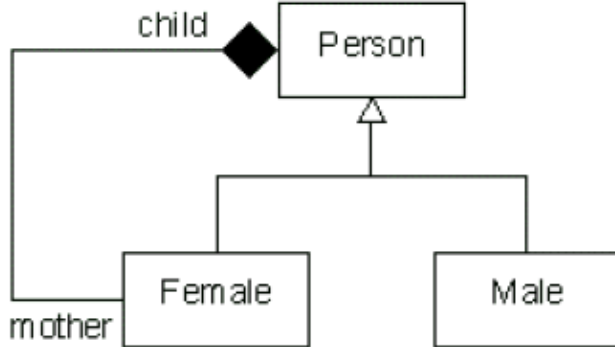
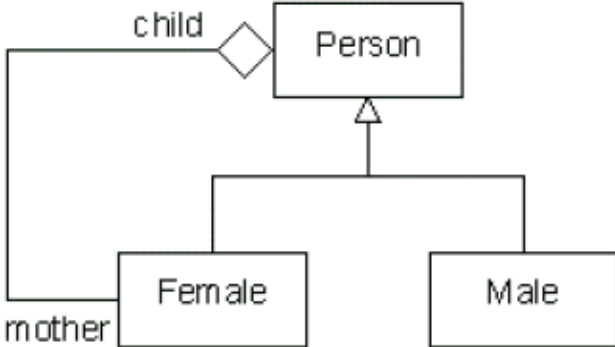
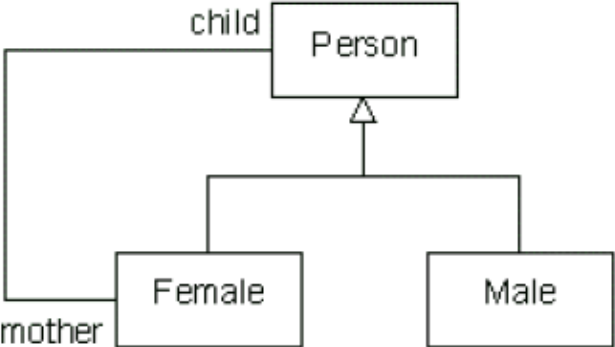
Alternative A2



Alternative A3



Alternative A4



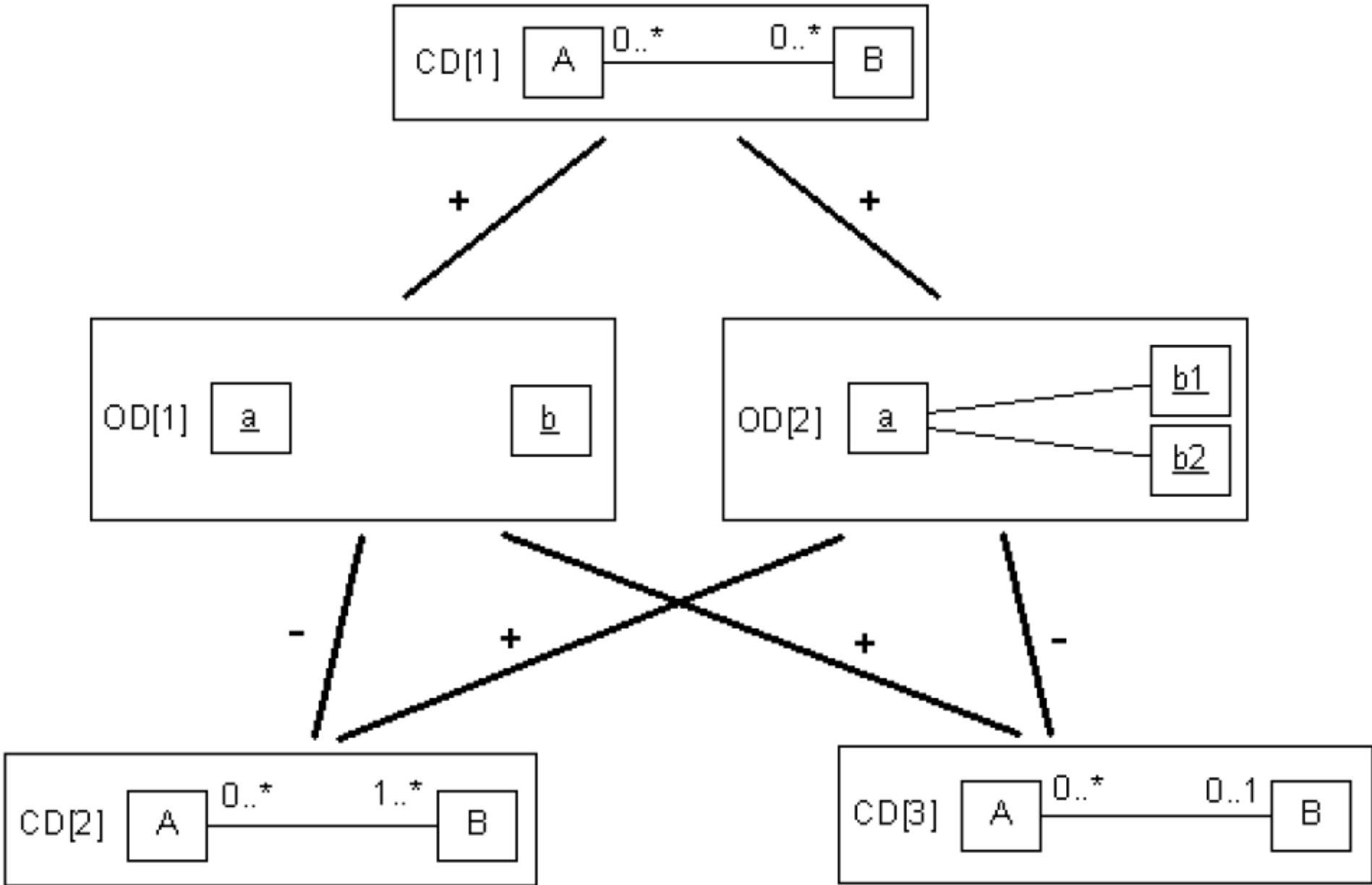
Method for Showing Differences between Models by Using Object Diagrams

In order to show with the use of object diagrams the differences between some alternative class diagrams $CD[1], \dots, CD[n]$ one proceeds as follows: Find object diagrams $OD[1], \dots, OD[k]$ and determine for each i from $1..n$ and for each j from $1..k$ whether $OD[j]$ is valid or invalid for $CD[i]$; the object diagrams must be chosen in such a way that for distinct pair (i_1, i_2) (from $1..n$ with $i_1 \neq i_2$) the validity vectors for class diagram $CD[i_1]$ and $CD[i_2]$

$$\begin{aligned} & [\text{valid}(CD[i_1], OD[1]), \dots, \text{valid}(CD[i_1], OD[k])] \\ & [\text{valid}(CD[i_2], OD[1]), \dots, \text{valid}(CD[i_2], OD[k])] \end{aligned}$$

are different.

Example

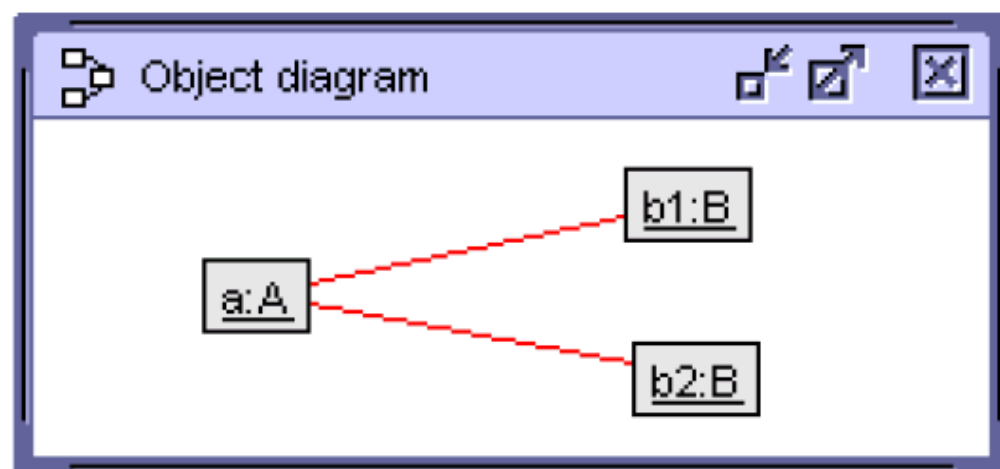
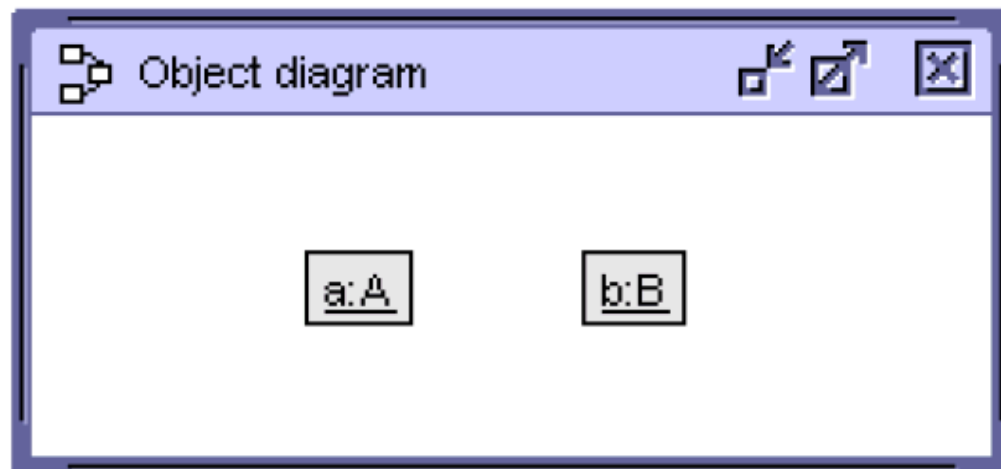


The above figure shows three simple class diagrams with different multiplicities and two object diagrams explaining the differences between the class diagrams. The three validity vectors for each class diagram look as follows.

[valid(CD[1],OD[1])=true , valid(CD[1],OD[2])=true]
 [valid(CD[2],OD[1])=false, valid(CD[2],OD[2])=true]
 [valid(CD[3],OD[1])=true , valid(CD[3],OD[2])=false]

Difference shown by	CD[1]	CD[2]	CD[3]
CD[1]	./.	OD[1]	OD[2]
CD[2]	see 1/2	./.	OD[1], OD[2]
CD[3]	see 1/3	see 2/3	./.

The above table captures the differences in form of a symmetric matrix. As shown in the figure below, the validity of an object diagram with respect to a class diagram may be checked with the USE tool, see [Gogolla et al., 2007].



Class invariants

Invariant	Result
A::CD1_multiplicity_0_star	true
A::CD2_multiplicity_1_star	false
A::CD3_multiplicity_0_1	true

1 constraint failed. 100%

Class invariants

Invariant	Result
A::CD1_multiplicity_0_star	true
A::CD2_multiplicity_1_star	true
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1 constraint failed. 100%

Validating Objects Diagrams in USE