

A Priori Semantics, Conceptual Modeling And the Role of Formal Methods

Position Statement

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1. Introduction

In Software Production conceptual modeling is a core task. It significantly impacts cost and quality of the produced software. There is a variety of approaches to conceptual modeling. One of the most often mentioned candidate approaches for improvement of software quality is formal methods. I'll try to show that their impact is limited principally and what it is based on.

Within this statement a formal method is one that can be tailored for use in any universe of discourse (UOD) and the outcomes of which in principal don't depend on the individuals following the method's proceeding model. This definition of 'formal method' relies on Gethmann's definition of formal language as one which is independent of both the speakers as well as the topic to be talked about. I assume methods to consist of a language and a proceeding model. Further the language of a formal method is assumed to be a formal one. In the sequel I'll focus on the modeling language, i.e. the language a modeling approach proposes for modeling purpose.

2. Modeling - state of practice

During conceptual modeling usually 2 different kinds of concepts are used. The first kind depends on the UOD at hand. The second kind doesn't. Its instances are more or less frequently used with respect to various UODs what in fact indicates their UOD independence. To illustrate this I discuss an aspect of conceptual modeling based on the diagram in figure 1.

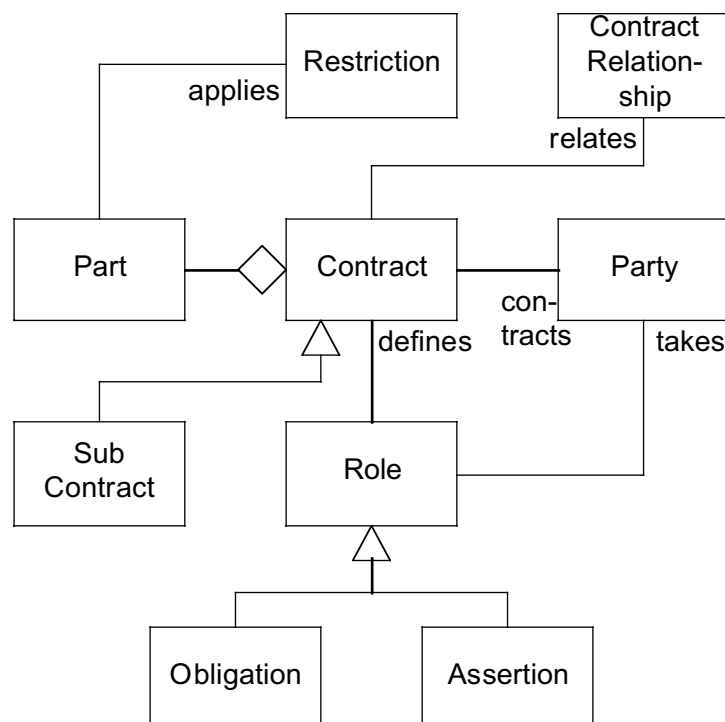


Figure 1 A very high level contract model represented

The model represented by the diagram deals with contracts as they might appear in a bank or insurance company. It states that parties contract on contracts on parts of which restrictions apply. Further contracts define roles which either are obligations or assertions. Finally parties take roles and sub contracts are contracts. Obviously various object types as well as relationship types are used within this description to state certain facts concerning the UOD. Conceptual modeling typically relies on that.

A more explicit description of the model in question could be like follows. Within the UOD there appear entity types 'Restriction', 'Contract', 'Contract Relationship', 'Sub Contract', 'Party', 'Role', 'Obligation' and 'Assertion'. Among them there exist associations such as 'applies', 'defines', 'contracts', and 'takes'. As is well known this relationships relate the entity types they –seen as a line in the diagram- connect. Both the entity types and associations are assumed to have an extent, i.e. a set of entities or association instances respectively. These for every state of affairs within the UOD are the UOD phenomena being recognized as instances of the mentioned concepts. 'Cardinality' and 'identifying attribute' are concepts used to specify extent related constraints of the state of affairs within the UOD.

3. Abstraction concepts

The more explicit model description now employs the usage of a semantic model, namely the ER model as a means of identifying and classifying UOD phenomena as well as the definition of their inter relationships. The ER model so far used just employs the concepts 'entity type' and 'association' but usually is extended by 'value' and 'attribute'. Within this position paper they are collectively called abstraction concepts.

To define the abstraction concepts occurring within the model it is sufficient to list them. It however already was discovered by Chen in his paper introducing the ER model that the definition of the concept 'abstraction concept' doesn't need to rely on UOD specifics. Recognizing a UOD phenomenon as a specific abstraction concept is its description by means of a formal language part. Clearly various rather different phenomena from various UODs might match a given definition in such a formal language. Consequently the formal definition, i.e. the definition in the formal language only together with context information uniquely identifies the respective phenomenon.

This context information involves intention of the individuals using the model. This context information is addressed by questions like: 'What kind of phenomena do we refer to as 'contract'?'. One cannot get rid of this context information since in using the model individuals need to know which formal structure is used to refer to which UOD phenomenon. The role of formal approaches to modeling consequently isn't replacement of intention but its improvement. This improvement is based on quality aspects based on conformance to formalism.

4. Impact of modeling on a priori concepts

The term 'a priori semantics' indicates that there is some kind of semantics available within the UOD description prior to informatics staff is being involved. This semantics is about the context mentioned above and the references to be made based on descriptions.

Informatics staff in modeling is engaged in analyzing the a priori given semantics with their means, i.e. semantic models trying to design a language which can be used by UOD experts in problem solving within or with respect to the UOD. Targeting that, based on their professional knowledge and skills, they often uncover conceptual weaknesses the UOD experts (at a given point in time) are not aware of. Further they often help to invent problem solutions which could not be found prior to their activity due to insufficient problem description or solution languages.

After a specific semantic model, i.e. a set of abstraction concepts has been specified to be used for modeling each of its members gives rise to quality aspect, namely conformity to the necessities of the respective concept. Usage of entity types and relationships, e.g. imply the quality aspects of entity integrity and referential integrity respectively. Further usage of entity types for their instances implies, e.g. the quality aspect of having the attributes specified.

Usage of associations in modeling for applied informatics on the formal level means specifying a multi dimensional relation on the extents of several entity types. Thus it allows specifying the mathematical properties of such relations by means of, e.g. cardinalities. Clearly quality aspects are set out focusing on the degree of conformity to the mathematical definition of the relation concept.

Additional impact of the semantic model turns out to be the case. Consider, e.g. figure 1. Recognizing phenomena as 'Contract' and 'Party' respectively helps asking questions like: 'Is there only parties involved

in contract issues?', 'What roles could non party legal subjects take in contract issues?'. Reasoning like this yields in a model version represented by the diagram in figure 2.

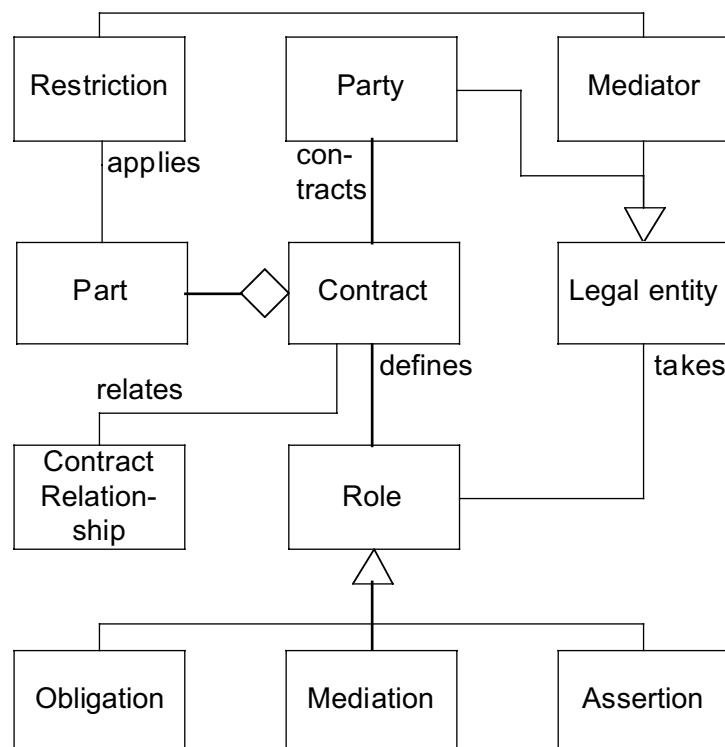


Figure 2 Revised contract model

The revised model is due to constraints:

- θ Only legal entities which are not contracting parties for a 'contract' c may take a 'mediation' role with respect to c.
- θ Only legal entities which 'contract' to a 'contract' c may take roles 'obligation' or 'assertion' with respect to c.
- θ The association 'relates' includes subordination.