Revitalising Old Thoughts: Class diagrams in light of the early Wittgenstein

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Abstract

The early work of Ludwig Wittgenstein aimed at outlining a set of postulates about the use of language to describe the world. This work bears a remarkable resemblance to the methodologies developed for data modelling. This paper discusses the features and constraints of object-oriented data modelling with UML class diagrams in light of the early theories developed by Wittgenstein and first published in 1921. The later criticism towards this theory illustrates some of the limitations of class diagrams as a language for describing the world.

Introduction

The paper will discuss how object-oriented modelling can be seen as an example of a *logically perfect language* as described by Ludwig Wittgenstein (Wittgenstein, 1961/1921).

Since the introduction of object orientation as a paradigm for computer programming in the 1960s (Dahl & Nygaard, 1966), a large body of techniques and modelling languages have emerged. Of these, UML (OGM, 2001) is currently establishing as a de facto standard in corporations world wide. It has therefore been chosen to serve as basis for the discussion in this paper. UML offers a wide variety of tools that enable modellers to describe and design different aspects of a computerised information system. This paper will concentrate on the aspect of *structural modelling* and in particular what is called *class diagrams*.

Wittgenstein's project

In his first book, Tractatus Logico-Philosophicus (Wittgenstein, 1961/1921), Wittgenstein's aim is to describe the conditions which would have to be fulfilled by a logically perfect language. In doing so, his concern is not with the psychological issues of language use with the intention of conveying some meaning content. Nor does he discuss the epistemological issue of the relationship between thoughts and language on the one hand and that to which it refers on the other. The relation of interest to Wittgenstein is the one that a fact must have to another fact in order for it to be a symbol for that other (Russel, 1922). This kind of symbolism presupposes the idea of a unique meaning or reference for each symbol or combination of symbols. A perfect language thus has a one to one correspondence between simple facts and symbols or between combinations of facts and the related combination of symbols.

> 4.5[1]: It now seems possible to give the most general propositional form: that is, to give a description of the propositions of *any* sign-language *whatsoever* in such a way that every possible sense can be expressed by a symbol satisfying the description, and every symbol satisfying the description can express a sense, provided that the meanings of names are suitably chosen.
>
> (Wittgenstein, 1961/1921)

Wittgenstein establishes the world as divided into facts (1.2). The objects (facts) can occur in combinations (states of affairs) and these are depicted in thoughts and propositions that have something (form) in common with the real state of affair.

[1] The Tractatus is organised as numbered postulates. There are 7 main postulates, 1 through 7, each with a number of sub- and subsub- postulates hierarchically numbered. Hence 4.5 indicates the fifth main comment to postulate 4.

2.04: The totality of existing states of affairs is the world.

2.06: The existence and non-existence of states of affairs is reality. [...]

2.063: The sum-total of reality is the world.

3: A logical picture of facts is a thought.

3.1: In a proposition a thought finds an expression that can be perceived by the senses.

Object-oriented modelling with UML

I assume the basic idea and features of object-oriented modelling to be known to the reader (See f.ex (Fowler & Kendall, 2000) for an introduction to UML), and will therefore only present the different features briefly. Focus will be on the philosophical aspects of the different elements and in particular their relation to Wittgenstein's theory.

Class Diagram

> "A diagram that shows a collection of declarative (static) model elements, such as classes, types, and their contents and relationships." (OGM, 2001)

The intention of a class diagram is to give a static description of a subsection of the world (Universe of Discourse) suitable to be implemented in an object oriented programming language. The different objects of this subworld are grouped into classes that are given a set of attributes as well as operations, and the classes are connected to one another as a graph to illustrate the corresponding connections between the respective objects of the real world.

4.0311: One name stands for one thing, another for another thing, and they are combined with one another. In this way the whole group – like a *tableau vivant* – presents a state of affairs.

The class diagram represents a picture of a part of the world in the same manner as Wittgenstein claims that the world consists of facts that may be coupled together in ‘states of affairs’ and that propositions in the language are images of these facts and states of affairs. The class diagram is a structural model representing a structure of the corresponding phenomena in the referential scope of the world. For Wittgenstein, this scope was the whole world, or more precisely that of which we can speak and think. Of the unthinkable one cannot speak.

4.001: The totality of propositions is language.

4.01: A proposition is a picture of reality.

A proposition is a model of reality as we imagine it.

5.6: *The limits of my language* mean the limits of my world.

In the same manner that the scope of a class diagram is limited to what is explicitly captured in the elements of it, the world of Wittgenstein is also limited by what is describable by the language.

Class

> "A description of a set of objects that share the same attributes, operations, methods, relationships, and semantics." (OGM, 2001)

Object-oriented modelling involves different abstraction mechanisms in order to describe the common structure of similar phenomena. The daclaration of a class represents an abstraction of substance (Nygaard, 1986).

2.021: Objects make up the substance of the world.

3.344: What signifies in a symbol is what is in common to all the symbols that the rules of logical syntax allow us to substitute for it.

The main element of an object-oriented model is *the class*, which represents an abstract collection of objects with some (for the purpose suitable) common set of properties. *Components* of a *system* (i.e. part of the world) are modelled into *objects* that are in turn classified as members of a *class*. Of each *class* we can instantiate *objects* that represent a 'simulation' of the *components* in the *system* that we have modelled (Andersen, 1997).

When building a class diagram we are thus initially on the outlook for phenomena with some common set of properties that together form a generalised description of this kind of phenomenon. What qualifies as a class within a given system can be seen in light of the following proposition from the Tractatus:

> 2.02331: Either a thing has properties that nothing else has, in which case we can immediately use a description to distinguish it from the others and refer to it; or, on the other hand, there are several things that have the whole set of their properties in common, in which case it is quite impossible to indicate one of them.

The depiction of these things with their common set of properties constitute members (i.e. objects or instances) of a class. The different values of each of these properties (i.e. attributes) are discussed in the following section.

Attribute

> "A feature within a classifier that describes a range of values that instances of the classifier may hold." (OGM, 2001)

Wittgenstein described the issue of value-scope as different spaces within which each object must find its position.

> 2.0131: A spatial object must be situated in infinite space. (A spatial point is an argument-place.)
>
> A speck in the visual field, though it need not be red, must have some colour: it is, so to speak, surrounded by colour-space. Tones must have *some* pitch, objects of the sense of touch *some* degree of hardness, and so on.

In the language of object orientation we may say that each object has a set of attributes, and that each attribute may hold a value within a given range or value-space defined by the variable-type. The values of the attributes may change over time just as a person's age or the size of a bank account changes in the real world.

> 2.0271: Objects are what is unalterable and subsistent; their configuration is what is changing and unstable.

The configuration in Wittgenstein's postulate represents the attributes and their changing values. In object-oriented theory, this configuration is usually referred to as the *state* of an object or a system. What brings the system or the objects from one state to another, are *operations* (or *methods* in other methodologies).

Operation

> "A service that can be requested from an object to effect behaviour. An operation has a signature which may restrict the actual parameters that are possible." (OGM, 2001)

All objects of the world have certain affordances (i.e. abilities to act upon or be used by other elements of the surrounding world.) In object orientation, these special properties are represented by operations.

> 5.24: An operation manifests itself in a variable; [...]
>
> It gives expression to the difference between the forms.
>
> 5.25: The occurrence of an operation does not characterise the sense of a proposition. [...]

An operation does not alter the meaning of an object since it does not hold a value. It merely represents a disposition for behaviour or interaction between objects or propositions. One may claim though that the operations add to the characteristics of the group of objects instantiated from that particular class.

It should be noted that the concept of *operation* in the Wittgensteinean sense is truth-operations on simple propositions that produce new non-simple propositions without altering the initial sense or form. Operations as affordances of objects should therefor be considered a special case of the semantic content of *facts* or *states of affairs* in Wittgensteinean terms. The analogy between UML class diagrams and the Tractatus is once again more obvious when we consider *associations* – the final of the main elements discussed in this paper.

Association

> "The semantic relationship between two or more classifiers that specifies connections among their instances." (OGM, 2001)

Two or more classes that are associated indicate that the objects of these classes stand in a certain relation to one another.

> 2.0272: The configuration of objects produces states of affairs.
>
> 2.031: In a state of affairs objects stand in a determinate relation to one another.
>
> 4.1: Propositions represent the existence and non-existence of states of affairs.

In a class diagram, each association is usually accompanied by role-names enabling the modeller to 'read' the association like a proposition about the relationship between the two classes involved. This is very much the same function that Wittgenstein assigns to the elementary proposition.

> 3.203: A name means an object. The object is its meaning.
>
> 4.22: An elementary proposition consists of names. It is a nexus, a concatenation, of names.

Finally, Wittgenstein is concerned with the relationship between the propositions as expressions for our thoughts and reality as reference for establishing the truth of a proposition.

> 4.06: A proposition can be true or false only in virtue of being a picture of reality.

In data modelling one are not restricted to making true statements (or associations), since these are primarily intended for implementation on the computer. Still, most of the time, an information system is supposed to represent or depict some part of the real world, and hence will be evaluated according to its correspondence with it.

Conclusions

We have seen that Class diagrams – with certain reservations – can be described as an example of a logically perfect language according to Wittgenstein. Although later criticised by himself among others, it seems that Wittgenstein's *Tractatus* was not only a philosophical treatise, but also a contribution to a field then not known to the world of philosophy.

Language games

It is frequently claimed that the main aim of object orientation is to enable system developers to model the world in the same manner as they think of it themselves in a natural setting.

> " OOA – Object Oriented Analysis – is based on concepts that we first learned in kindergarden: objects and attributes, wholes and parts, classes and members." (Coad & Yourdon, 1991)

This bears a remarkable resemblance on the thought in the following postulate of the Tractatus:

> 3.2: In a proposition a thought can be expressed in such a way that elements of the propositional sign correspond to the objects of the thought.

The later Wittgenstein became himself one of the main critics of the Tractatus (Wittgenstein, 1958). What he realised was that language and meaning was constructed in social practices rather than from mathematical logical reasoning. There thus are an uncountable number of different language games coexisting in which words and propositions may carry different meaning. Adopting this latter view on language, it seems that the logically perfect language of class diagrams are not as close to natural thinking as may have been intended. In deed, it can be shown that students of data modelling struggle with the pragmatics of their prior linguistic experience when trying to fit their experiential world into categories and classes (Holmboe, 2002).

The analogy revisited

There is one central distinction between the descriptions of class diagrams and Wittgenstein's Tractatus. Wittgenstein's logically perfect language was intended to describe or depict the whole world (i.e. that of the world which is describable and thinkable). Class diagrams on the other hand, are provided in order to describe a subsection of reality or even a simplified picture of this subsection. This is a restriction of practical applicability. It is when we set out to build a class diagram for the entire world (i.e. what is describable in terms of classes etc.), that we come to realise the full extent of the parallel presented in this paper.

> 3: A logical picture of facts is a thought.
>
> 3.01: The totality of true thoughts is a picture of the world.

It is not hard to imagine that the task of modelling the whole world, or even an entire subsection of the world, is practically impossible. It has also been unsuccessfully attempted f.ex by researchers within AI.

We must therefore come to the conclusion that the closer class diagrams come to being a logically perfect language, the more difficult it becomes for people as social being to utilise it for describing the world as they understand it.

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