POLYSYNTACTIC META MODELING: HISTORICAL ROOTS IN THE WORK OF RAIMUNDUS LULLUS

Hans-Georg Fill

Universitätsassistent, University of Vienna, Research Group Knowledge Engineering
Währingerstraße 29, 1090 Vienna, AT
hans-georg.fill@univie.ac.at; http://homepage.dke.univie.ac.at/fill

Keywords: ***Legal Visualization, Meta Modeling, Ars brevis***

Abstract: *Several legal visualizations today are based on model based approaches. For developing such approaches it can be reverted to polysyntactic meta modeling techniques to define modeling languages, algorithms and visualizations on a syntactic, machine processable level for expressing semantic relationships. In this paper we review historical roots of polysyntactic meta modeling in the work of the Catalan philosopher Raimundus Lullus and draw relations to currently used approaches. Thereby we gain insights not only on the historical developments of model based visualization approaches but also on the semantic mechanisms underlying these approaches.*

1. Introduction

As has been discussed previously, one way to formally describe legal visualizations is the use of model based approaches, e.g. [Kahlig (2011)]. Thereby, visualizations are composed of elements of a modeling language. The modeling language thus defines the syntactic and semantic space for creating visualizations in a formal, machine-processable way. The particular advantage of this approach for legal visualizations is that it enables to exactly keep track of how a visualization is composed and how semantics are assigned to its individual parts. In addition, algorithms and procedures can be defined based on the modeling language to process the models specified with the language and to describe, how the modeling language shall be used for creating valid visualizations [Karagiannis and Kühn (2002)].

When designing new types of model based legal visualizations, which cannot be created by using existing modeling languages, several aspects have to be taken into account. These encompass not only the specification of the syntax and semantics of the modeling language. At the same time, also the future application of the modeling language needs to be considered. For example, if the legal visualizations shall be processed by a certain algorithm, e.g. to automatically analyze the quality and complexity of a visualization based on pre-defined criteria, the modeling language needs to be designed accordingly. Similarly, also aspects such as smooth human interaction or the semantic scope of the modeling language play an important role. In the following we will subsume these activities of designing new model based approaches under the term “meta modeling” - as opposed to “modeling”, which stands for the concrete creation of model based visualizations.

With the following contribution we will further investigate the inner workings of meta modeling and thus contribute to a better understanding of how to use meta modeling for the specification of visualizations. This will be accomplished by revisiting a type of a model based visualization that has been designed by the Catalan philosopher Raimundus Lullus. Although this type of visualization has so far not been used for legal visualizations, we will show that its constituents and mechanisms contribute interesting generic insights into the working of model based visualizations. They may therefore act as a basis for the development of new types of legal visualizations.

The remainder of the paper is structured as follows: in section 2 we will briefly describe the foundations of our view on meta modeling by using the notion of a ‘polysyntactic’ view. Section 3 will outline the visualization method designed by Raimundus Lullus and section 4 will discuss the insights that can be gained through this method. The paper will conclude with an outlook in section 5.

2. Polysyntactic Meta Modeling

When designing model based visualizations it can be distinguished between three levels. At first the model level that stands for the actual visualization; second, the meta model level that defines the modeling language, the modeling procedure and potential algorithms; and third, the meta meta model level that defines the language that is used for defining the modeling language and the language for the algorithms.

In order to realize model based visualizations using information technology, the elements of these levels have to be specified in some machine processable format. For this purpose, it can either be reverted to formats that are readily defined and that provide all means to be directly processed by a machine such as a standard programming language. As an alternative, domain specific languages can be used that are specifically designed for a particular purpose, e.g. to describe the composition of modeling languages. In order to make these domain specific languages processable by machines, not only the syntax of these languages has to be exactly specified in the way of a formal language cf. [Tarski (1936)]. Also, the interpretation of the syntax in terms of its concrete behavior on a machine needs to be added. This can be accomplished by mapping valid expressions of the syntax to expressions in a language whose syntax and behavior are exactly defined, e.g. the previously mentioned programming languages. Similarly, also the expressions in a programming language are mapped to another language, i.e. in the end the actual machine code that is directly executed by hardware. When looking at these mappings in more details, it becomes apparent that everything we deal with are actually only syntactic specifications and their mappings, which ultimately define the semantics that can be processed by a machine, cf. [Messer (1999)]. From this we derive the notion of a “polysyntactic view”, i.e. the use of multiple syntactic specifications, cf. [Fill (2011)].

This view can be directly applied to meta modeling in the sense that also the levels of model based visualizations are specified by a number of syntaxes that are mapped to each other. For example, we find that syntactic specifications are needed to express the concrete graphical representations of the visualizations on the model level, to specify the modeling language underlying the visualizations, the algorithms and so forth [Karagiannis and Kühn (2002)]. In order to realize model based visualizations, we therefore have to take into account these multiple syntaxes and their mappings to each other. These basic conceptions of polysyntactic meta modeling will in the following guide our analysis of the behavior of the model based visualization method by Raimundus Lullus.

3. The Method of Raimundus Lullus

The model based visualization method of the Catalan philosopher Raimundus Lullus (1232-1316 AC) has been originally described in his *Ars Magna* to analyze the combination of multiple types of categories. In the following we will briefly outline his method that has inspired later scientists such as Gottfried Wilhelm Leibnitz and that has also been regarded by some as the origin of modern computer theory cf. [Künzel and Cornelius (1991)]. The original motivation underlying the development of Lullus’ visualization method was to provide a means that could help in developing arguments for convincing people of other religions of the Christian mysteries of faith. He therefore designed an algebraic notation based on the three monotheistic religions together with a procedure for combining these concepts using mechanical visual models. In his *Ars brevis*, which is a shortened version of the Ars magna that Lullus compiled himself, he first defines an alphabet with the nine letters from B to K, cf. [Fidora (1999)]. To each of these letters he then assigns fundamental concepts and questions – see table 1.

	Figura A	Figura T	Questions and Rules	Subjects	Virtues	Vices
B	Goodness	Difference	Whether?	God	Justice	Avarice
C	Greatness	Concordance	What?	Angel	Prudence	Gluttony
D	Eternity/ Duration	Contrariety	Of what?	Heaven	Fortitude	Lust
E	Power	Beginning	Why?	Man	Temperance	Pride
F	Wisdom	Middle	How much?	Imaginative	Faith	Accidie
G	Will	End	Of what kind?	Sensitive	Hope	Envy
H	Virtue	Majority	When?	Vegetative	Charity	Ire
I	Truth	Equality	Where?	Elementative	Patience	Lying
K	Glory	Minority	How? and With what?	Instrumen-tative	Pity	Inconstancy

Table 1: Concepts and Questions in Lullus’ alphabet, Source: [Bonner (2011)]

These concepts and questions are then used in several combinatorial figures. These combinatorial figures are designed in the form of discs, where the single discs are cut out of paper and can be rotated[1]. From these we will only discuss two central ones here to give an idea of the mechanism. In figures 1 and 2 the Figura A and the Figura T are shown. In the Figura A as shown in figure 1, the subjects and predicates assigned to the letters can thus be combined, e.g. by 'Gloria' and 'Durans' for expressing that glory is durable. In the Figura T, further meanings of the symbols of the alphabet are described and again placed in the form of a disc - see figure 2. Furthermore, for this figure also three triangles are added. The first triangle contains the terms 'differentia' (difference), 'concordantia' (concordance), and 'contrarietate' (contrariety); the second triangle the terms 'principio' (beginning), 'medio' (middle), and 'fine' (end); and the third triangle the terms 'maioritate' (majority), 'aequalitate' (equality), and 'minoritate' (minority).

To support humans in finding conclusions, the method first requires choosing a combination of three letters which are then analyzed starting from the middle letter and by trying to combine them with the other letters. The choice of the letters shall be based on the user’s intellect and also the combination of the concepts requires human knowledge to derive conclusions. This is an interesting aspect as it means that the mechanism does not provide a complete specification of the semantics contained in the method but rather rests on human interaction and knowledge. However, certain restrictions for the combination still apply and thus permit to trace to a certain extent how the concepts have been combined to arrive at conclusions.

Although Lullus’ method has been later criticized by Gottfried Wilhelm Leibniz in his dissertation [Leibniz, (1666), 58] for its precision, Leibniz built upon the basic mechanisms to develop his famous calculation engine [Heer (1959), 90-91]. For this purpose he transferred Lullus’ mechanism to the world of numbers, thereby eliminating the original metaphysical expressions of the ordinary

[1] In the medieval books of Lullus' work these discs are cut out of paper and attached with little strings to the pages so that they can be actually rotated in the book. For example, the copy in the Austrian National Library features this mechanism [De Lizarazo and Hieronymo (1619].

language. In this way, the first step towards the use of mathematically based language for computer processing was made [Fidora (2011), 2].

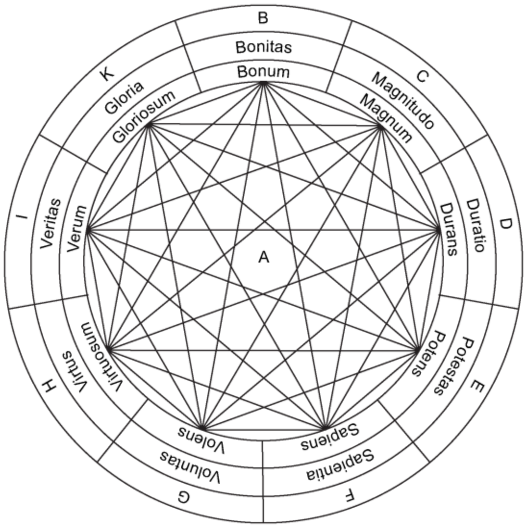

Figure 1: Figura A, redrawn from [Fidora (1999), 6]

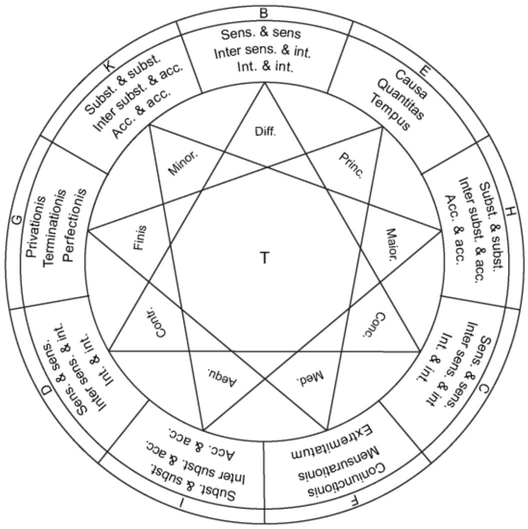

Figure 2: Figura T, redrawn from [Fidora (1999), 10]

4. Discussion

The visualization method of Raimundus Lullus can be characterized as an early form of a model based visualization. On the model level we find the actual combinations of concepts that have been previously defined on the meta level in the form of discs. With the discs the syntax of the modeling language is defined, i.e. the symbols, questions and concepts of the language and the rules how they can be combined to form valid expressions through the rotation mechanism. On the meta meta model level, the fundamental concepts that are provided for defining modeling languages are the discs together with the rotation mechanism. Furthermore, we also find polysyntactic aspects to be a core component of Lullus' visualization method: in order to make the method work, several syntaxes are combined. The mapping between the syntaxes for the concepts and questions is thereby accomplished through the letters B to K of the fundamental alphabet. The syntax of the visual representation is given by the shown representations of the discs, although it is not formally described.

In contrast to many of the modern model based legal visualization approaches, the method by Lullus does not follow a graph-like structure, as it is for example common for legal visualizations of processes. However, the use of discs with fixed concepts provides an intuitive and easily understandable way of combining existing concepts. Regarding semantics, Lullus's method shows several interesting features. On the one hand, pre-defined concepts are provided that can only be combined in the way foreseen by the method. In case of the discs it is thus for example not possible to combine several subjects in Figura A. In this way the semantic space of what can be expressed through the visualizations is limited. On the other hand, we find that the method explicitly requires human involvement in drawing conclusions. This stands in contrast to visualization methods that specify the semantics of the concepts or at the least the semantic relations between concepts more formally in order to let machines generate inferences, e.g. by using formal ontologies or rule based systems.

5. Conclusion and Outlook

In summary we can conclude that the Lullian visualization method is an intuitive method that can be used to combine sets of pre-defined concepts for deriving new insights. The semantic interpretations are based on human intellect and do not rely on machine mechanics. Rather, the mechanics only support human users in finding conclusions by providing support for mastering the complexity of the combinations of the involved concepts. These principles may also serve as guidance for the future development of model based legal visualizations. As a core insight the modeling language should be kept as simple and intuitive as possible and consider how to involve humans in using the method. At the same time, mechanical aids can help users in assembling the right information and consider aspects that may have not been directly evident before. Such multi-modal aspects could therefore also be part of future types of legal visualizations, similar to the aspects that have been previously developed in the context of multi-sensory law, cf. [Brunschwig (2011)].

6. Acknowledgement

The author would like to thank Prof. Friedrich Lachmayer for initially pointing him to the work of Raimundus Lullus and in particular the Ars brevis.

7. References

Bonner, A., What Was Llull Up To?, In: Fidora, A. and Sierra, C. (Eds.), Ramon Llull: From the Ars Magna to Artificial Intelligence, Artificial Intelligence Research Institute, IIIA, Barcelona, P. 5-24 (2011).

Brunschwig, C. R., Multisensory Law and Legal Informatics - A Comparison of How these Legal Disciplines Relate to Visual Law. In: Geist, A., Brunschwig, C.R., Lachmayer, F. & Schefbeck, G (Eds.), Strukturierung der Juristischen Semantik – Structuring Legal Semantics, Festschrift für Erich Schweighofer, Editions Weblaw, Bern, p. 573-668 (2011).

Fidora, A., Raimundus Lullus: Ars brevis (Latin-German Translation), Felix Meiner Verlag, Hamburg (1999).

Fidora, A. and Sierra, C. (Eds.), Ramon Llull: From the Ars Magna to Artificial Intelligence, Artificial Intelligence Research Institute, IIIA, Barcelona, (2011).

Fill, H.-G., Semantic Interpretations of Legal Visualizations using a Polysyntactic View, In: Geist, A., Brunschwig, C.R., Lachmayer, F. and Schefbeck, G. (Eds.), Strukturierung der Juristischen Semantik – Structuring Legal Semantics, Festschrift für Erich Schweighofer, Editions Weblaw, Bern p. 245-256 (2011).

Heer, F., Leibniz – Auswahl, Deutsche Buch-Gemeinschaft, Berlin - Darmstadt – Wien (1959).

Kahlig, W., Visualisierungstypologie des Deutschen Privatrechts. In: Jusletter IT 24. Februar 2011, (2011).

Karagiannis, D., Kühn, H., Metamodelling Platforms, Proceedings of the 3rd International Conference EC-Web 2002 - Dexa 2002 (2002), Full version: http://www.dke.at/fileadmin/DKEHP/publikationen/metamodell/FullVersion_MMP_DexaECWeb2002.pdf retrieved 10-01-2013.

Künzel, W., Cornelius, H., Die Ars generalis ultima des Raymundus Lullus: Studien zu einem geheimen Ursprung der Computertheorie, Künzel, Berlin (1991).

Leibniz, G., Dissertatio de Arte Combinatoria (1666), In: Gerhardt, C.I. (Ed.), Leibnizens gesammelte Werke, Publisher: H.W. Schmidt (1858), http://www.google.at/books?id=FSM1AAAAIAAJ&hl=de retrieved 10-01-2013.

De Lizarazo, S., Hieronymo, P., Generalis et admirabilis methodus ad omnes scientias facilius (...) addiscendas, in qua (...) Raimundi Lullii ars brevis explicatur (etc.), Turiasonae: Carolus a Lavayer, Reference in the Austrian National Library: http://data.onb.ac.at/rec/LZ01606419 accessed 31-08-2012, (1619).

Messer, B., Zur Interpretation formaler Geschäftsprozeß- und Workflow-Modelle, In: Becker, J., König, W., Schütte, R., Wendt, O. and Zelewski, S. (Eds.), Wirtschaftsinformatik und Wissenschaftstheorie - Bestandaufnahme und Perspektiven, Gabler, Wiesbaden, P. 95-123 (1999).

Tarski, A., Der Wahrheitsbegriff in den formalisierten Sprachen, Studia Philosophica I, P. 261-405 (1936).