Book Reviews

Ontologie und Axiomatik der Wissensbasis von LILOG

Gudrun Klose, Ewald Lang, and Thomas Pirlein, editors
(Technische Universität Berlin, Universität Wuppertal, and IBM Deutschland GmbH)

Berlin and Heidelberg: Springer-Verlag,
(Series Informatik Fachberichte 307,
edited by W. Brauer), 1992, x + 253 pp.
Paperbound, ISBN 0-387-55306-1

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Running from 1985 to July 1990, IBM Germany's LILOG Project (LInguistic and LOGical Methods and tools for the computational processing of German; Herzog and Rollinger 1991) is one of the largest NLP projects carried out to date, involving extensive (invited) cooperations between IBM and German universities (Hamburg, Stuttgart, Osnabrück, Tübingen, Saarbrücken, and Trier). The goal of the project was to produce a system capable of 'understanding' input texts and of demonstrating that understanding by answering questions. The selected domain of discourse was a tourist information desk: the system was to accept as input texts concerning the center of Düsseldorf and demonstrate its understanding of those texts by being able to answer typical questions that visiting businesspeople might want to ask. A complete NLP system such as this naturally involves practically every area of computational linguistics, and the question of whether the project as a whole should be judged successful or not is rather less interesting than the wealth and breadth of the issues addressed within its subprojects. In particular, the book reviewed, *Ontologie und Axiomatik der Wissensbasis von LILOG* (The Ontology and Axioms of the LILOG Knowledge Base), focuses on two fundamental problems of NLP: the construction of knowledge bases for given domains (termed 'knowledge engineering') and the establishment of principled connections between such knowledge bases and language. The book is, therefore, very timely. It relates directly to the concerns of the DARPA Knowledge Sharing Efforts and to increasingly active discussions on general domain-independent 'ontologies' for organizing knowledge.

The book is a collection of 19 papers and commentaries (three in English, the rest in German) on issues brought into focus during a LILOG-internal workshop on ontology construction. The views presented are, accordingly, both historical—looking back on the development of the knowledge base—and experimental—looking forward to how the job could be done better. This is very valuable, escaping as it does from the genre of 'result presentation' where the major concern is to show how well a particular project succeeded. Here we see behind the scenes a little, discovering how the project developed, how decisions in different parts of the project had consequences (often negative) for other parts of the project, and where different positions have been taken by individuals and particular groups within the project as a whole. Thus, what some might consider 'mistakes' or 'failures' are here often documented and openly

discussed: a vital exercise for building on this work and for undertaking similar work in the future. In many ways, what *did not* work proves itself to be more interesting than the actual, often partial, solutions found (for example, under demo-stress!).

The contributions to the book are divided into four sections: aspects of knowledge modeling in NLP systems; knowledge modeling and linguistic expression; knowledge modeling and inference; and development and management of the knowledge base. Appendices also contain the complete definition of the final ontology, the texts used for bounding both the knowledge to be represented and the required linguistic competence, and the syntax of the formalism used for representing the ontology, L_{LILOG}.

Part 1 consists of papers by Klose and Pirlein, Lang (plus commentary from Simmons), and von Luck. Klose and Pirlein give an overview of the modeling task undertaken in LILOG, relating the task to the detailed scenario in which the resulting system was to function. This scenario, together with the texts relevant for the scenario, permits a broad classification of knowledge 'clusters' that the knowledge representation needs to cover: this includes space, objects, qualities, changes, energy and movement, etc. An overview of the system architecture and a worked example of analysis showing the use of the knowledge base is also presented. In its final state, the knowledge base consisted of approximately 700 sort definitions plus 300 axioms allowing complex inferences to be performed. The architecture as a whole then suggests three ways in which the knowledge base can be evaluated: from the adequacy of the inferences that the knowledge base axioms support, from the support for generation and analysis that the knowledge base affords, and from its 'cognitive' adequacy as a model of possible cognitive representations. Each of these aspects is addressed by other papers in the book. The paper by Lang is a very important paper for ontology design in general; a shorter version of the paper appears (in English) in Lang's contribution to the Herzog and Rollinger (1991) collection. Lang's basic point, building on a view of semantics developed by Bierwisch and himself over many years, is that it is necessary to maintain a sharp theoretical and practical distinction between linguistic knowledge and conceptual knowledge; he also maintains that a genuine ontology should be pitched at the conceptual, nonlinguistic level. He provides numerous examples of how the final knowledge base of the LILOG system fails to separate these kinds of knowledge, with the result that the sort hierarchy contains incompatible concept-types that compromise inference capabilities and make a principled solution to the problem of how to relate knowledge and language impossible. Whether one agrees with the distinction that Lang argues for or not, any ontology constructed should be able to meet his criticisms. Simmons's commentary on the paper further supports the linguistic/nonlinguistic distinction with examples of the confusion that ensues when it is not maintained. Von Luck's paper then attempts to demonstrate the value of employing 'naive theories' of the commonsense world for both linguistic analysis (e.g., disambiguation) and for supporting inferencing in the domain.

Part 2 consists of papers by Maienborn (plus comments by Geurts, Gerstl, and Lang), Novak, and Dobeš. Maienborn's paper, although suggesting that it is concerned with the 'cognitive' adequacy of the knowledge representation, in fact presents more linguistic evidence for the establishment of concepts in the ontology—in particular, the distinction between 'states' and 'events,' the selection of thematic roles Agent and Theme, and the use of a hierarchy of thematic roles. Contrasting the arguments given here with those of Lang is interesting, since while both vigorously maintain that there needs to be a sharp distinction between linguistic and nonlinguistic knowledge, the motivations that Maienborn provides for ontological categories seem to me to fall under what Lang would term linguistically motivated categories, which would not then, by his definition, be judged ontological at all. Geurts then adds his voice to the

confusion by saying that he does not believe in the distinction between semantic and conceptual information, although he is the only one in the book to take this position. However, his reliance on the power of logical inference to handle the undifferentiated mass of information that would result seems far removed from solving the everyday problems of large-scale ontological engineering. Maienborn also complains about restrictions imposed on linguistic (cognitive?) theorizing by the computational properties of the formalism available and Gerstl's commentary interprets this as symptomatic of more-or-less fruitless discussions held between differing camps in AI in general and LILOG in particular. Whereas the Lang/Bierwisch separation of linguistic and nonlinguistic information appears both linguistically important and practically useful, it also provided a basis for the LILOG linguists and knowledge representation people not to talk to one another. This is an especially unsatisfactory situation in an NLP system where, as a number of papers in the book argue, the knowledge representation needs to be 'linguistically responsible.' The original specification of the LILOG project did not, apparently, do enough to prevent this situation arising. The requirements of linguistic responsibility are taken further in the papers of Novak and Dobeš, who consider the addition of text generation to LILOG's capabilities. This move was carried out relatively late in the project as a whole, which created significant problems. Generation as a task needs access to every type of information maintained in LILOG and makes its own demands on that information. Novak points out that information concerning attitudes and beliefs, rhetorical organization, hearer/reader models, etc., are lacking from the knowledge base but are essential for generation. Moreover, the LILOG inference engine and background knowledge can help in generation, but cannot solve questions involving intentions, hearer models, and text structure. The ontology can also only help if it encodes distinctions that are *grammatically* relevant, and the mixture of types of concepts shown by Lang partly defeats this. Novak provides another perspective on the mixture by mentioning the rather different expectations held by workers on ontology depending on whether they are concerned with language or with knowledge representation. The former expect a linguistically motivated classification; the latter a theory of the commonsense world. These viewpoints only came to be combined late in LILOG's development.

Part 3 contains papers by Simmons (in English) on modeling spatial knowledge, Bollinger (plus comments by Röhrig and Neugebauer) on extensions to the formalism, Lorenz on the temporal component of the ontology, and Gänger and Wachsmuth (plus comments by Pirlein) on supporting inferences and flexible word choice by defining appropriate axioms in the knowledge base. Simmons's paper is a very good short introduction to the general theory of spatial representation presented in Lang, Carstensen, and Simmons (1991), and also makes several important comments on ontology design. The account will be of interest to anyone concerned with the representation of spatial relationships and their linguistic expression. Lorenz uses the temporal component of the ontology (which builds on accounts by Kamp, Allen, and Eberle) to illustrate some practical problems in commonsense knowledge modeling. In particular, the conflation of differing modeling strategies (e.g., shallow linguistically motivated categories and deep semantic/logical modeling) inflates the number of concepts to the detriment of the inferencing component. He shows that the very important work of consolidation by which deeper modeling gradually weeds out previous less deep modeling is essential; it is also generally disadvantageous to include too-shallow linguistically motivated categories, since they prevent axioms being expressed with sufficient generality. Gänger and Wachsmuth present a number of problems involved in modeling relations between concepts that need to have connections between them to support the use of related lexical items in question interpretation and answer generation. However, most

of the problems seem to arise from LILOG's methodology of separating the development of the concept hierarchy and the inference rules; Pirlein's commentary shows how adding to the concept hierarchy largely solves the problems discussed and thus demonstrates that the concept hierarchy and the axioms should only be developed together. He also describes this as another example of the desirability of taking the linguistic capabilities required in a system seriously as constraints on what has to be built in.

Part 4 contains papers by Gerstl (plus a commentary by Klose, Mezger, and Müller) and Börkel. Gerstl describes problems that arise in developing and maintaining a knowledge base when it grows to a significant size and undergoes modifications from distributed working groups. He proposes that a project should have a manual for knowledge engineering that sets out a protocol for making and commenting changes that are made to the knowledge base, lays out standardized formats for information display, etc. This is largely based on a systematization of the types of comments that are usually made in any piece of software as it is developed. However, as Klose et al. note in their commentary, the support that such a manual offers is quite weak, and what is really necessary are support tools that allow high-level access to highly interconnected data, with 'comments' that are intended to be part of the discussion of the development of the data automatically triggering electronic mail exchanges. The state of knowledge-engineering support tools within LILOG only improved in the latter half of the project with the move to more-graphical modes of interaction and this alone, as Gerstl notes, already solved some of the development environment problems. Finally, Börkel's paper shows something of the historical development of proposed solutions to representational problems in LILOG, focusing on the influence of the state of the implemented formalism and the modeling possibilities that that state afforded. Also interesting here are the changes in status for various components that he reports. For example, in the original LILOG plans the knowledge base had no particular importance in its own right, compared to its role as a major component in the second half of the project. Moreover, since the inference engine was not functional in the early stages of the project, many of the concepts that were defined and their related axioms could not be tested, often leaving them largely ad hoc. Partly as a consequence of this, there was no re-use of the knowledge base from the first phase of the project in the second phase.

The most important contribution of this book is to present a largely united front concerning issues of design criteria for domain models and ontologies and issues of the relationship between such bodies of knowledge and language. Based as it is on extensive practical efforts, the experiences reported here need to be seriously considered by workers in this area. The papers by Lang and Simmons are particularly important reading for ontology design and knowledge engineering. The book shows well that mixing linguistic information with 'conceptual' information leads to problems. Not so clear is the precise nature of the levels of information required. But since this question also lies at the center of all current discussions on ontology design, the book cannot be faulted for failing to present a solution. There are also lessons to be drawn here for the design of NLP systems in general. As made clear by the name of the LILOG project and its original task specification, there was an emphasis at the outset on a rather narrow kind of linguistics additionally subordinated to the task of extracting 'knowledge' that would support inferences. Thus there are extensive (and very valuable) treatments of syntax and formalisms, a proposal for representing domain knowledge, and a rather large gap in between. In relation to the state of knowledge today, as supported in this book, we can see that there was an underestimation of the role of language in the design of the system. There is no doubt still more organization to be imposed from

language than has yet been teased out; for example, Novak's suggestion of constructing an additional semantic 'ontology' for the purposes of generation, in addition to the conceptual ontology. The lack of less abstract linguistically motivated ontologies that can mediate between the supposed cognitively relevant deep ontologies and surface syntax is probably one source of continuing uncertainty over the levels required. This makes it difficult to construct the required abstractions, as shown by the rather small number of concepts (around 100) found in the final domain-*independent* part of the knowledge base, the ontology proper. What is particularly valuable, however, is the attempt to construct such representations on a realistic scale: this is a sure way to lead us away from interminable discussions over theoretical possibilities and toward genuine progress in both linguistic representations and domain modeling. As such, the work reported in this book is to be highly commended.

References

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