An Instrument for a Purpose Driven Comparison of Modelling Frameworks: Lecture Notes in AI

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An Instrument for a Purpose Driven Comparison of Modelling Frameworks

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Abstract. During the past decade a number of modelling frameworks for knowledge based systems have been developed. In this paper an approach to the comparison of modelling frameworks is proposed, based on the aims and purposes behind the frameworks. A purpose oriented comparison of the frameworks DESIRE, CommonKADS, PROTÉGÉ-II, MIKE, VITAL and KARL provides insight in their differences and similarities.

1 Introduction

During the past decade much research within the field of knowledge engineering has focussed on the development of frameworks to support the design of knowledge based systems. To understand and appreciate the differences between the different modelling frameworks a number of comparisons between languages and frameworks have been made.

Problem-oriented comparison (comparison based on the application of an approach to one given problem) to both languages (Treur & Wetter, 1993; Harmelen, Lopez de Mántaras, Malec & Treur, 1993) and modelling frameworks (Linster, 1991, 1994; Fensel, 1995; Schreiber & Birmingham, 1996) as a joint activity, has increased understanding of different modelling frameworks. An advantage of problem-oriented comparison is that a well-described problem in which specific aspects of a problem are highlighted provides a concrete basis for comparison. A disadvantage is that the problem needs to be sufficiently well-defined to allow for comparison and sufficiently broad to be able to identify strengths and weaknesses of approaches. Another disadvantage is that solutions may differ significantly making comparison difficult.

Fensel and van Harmelen (1994) compared KADS languages on the basis of *modelling primitives*. An advantage of this approach to comparison is the well defined scope of application. A disadvantage is that the approach bases comparison on syntactical ('superficial') similarities and not on the semantic background.

Another approach to the comparison of modelling frameworks is to analyse the purposes and aims behind a framework. A method for *purpose-driven comparison* of

languages is proposed in (Revise, 1996), in which a number of goals behind the design of two formal specification languages are identified and compared. Design choices are related to the goals pursued. An advantage of purpose-driven comparison is that a list of possible purposes provides a well-defined basis for comparison. Disadvantages are that the purposes behind an approach have not always been made explicit, and that the concrete implications of differences are not always obvious.

In this paper an instrument for a purpose-driven comparison of *modelling frameworks* is proposed: purpose-driven and not problem-driven, modelling framework comparison and not language comparison. As a result, modelling frameworks are characterised on the basis of the goals they have been designed to pursue, and on the design choices made to achieve these goals within the framework.

2 An Instrument to Compare Modelling Frameworks

To design an instrument with which modelling frameworks can be compared: (a) existing comparisons of languages and frameworks were studied and analysed (Treur & Wetter, 1993; Harmelen, Lopez de Mántaras, Malec & Treur, 1993; Fensel & Harmelen, 1994; Linster, 1991, 1994; Fensel, 1995; Schreiber & Birmingham, 1996); (b) a number of frameworks and languages were analysed on the basis of available

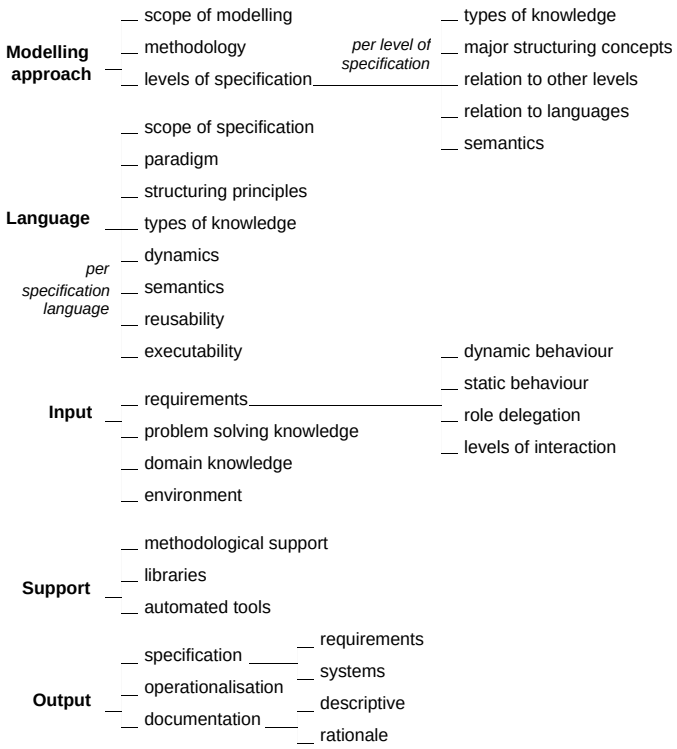

Fig. 1. Purposes of a modelling framework organised as elements per category.

literature (including Mazza, Fairclough, Melton, de Pablo, Scheffer, and Stevens, 1994; Sage & Palmer, 1990; Revise, 1996) and, in some cases on the basis of hands-on experience; and (c) research groups (from the Vrije Universiteit Amsterdam, Universiteit van Amsterdam, University of Karlsruhe, Stanford University, Open University and Université de Paris-Sud) evaluated the instrument and the specific results for their modelling framework.

The instrument distinguishes five categories of elements of modelling frameworks. As shown in Figure 1: (1) the characteristics of the methodology behind the modelling framework including levels of specification, (2) the modelling and specification languages, (3) the support provided, (4) the input required to model and specify a knowledge-intensive system, and (5) the output of modelling and specification.

3 A Purpose Driven Comparison

The instrument has been used to compare six modelling frameworks originally designed for knowledge intensive domains and still currently subject of research: DESIRE, CommonKADS, PROTÉGÉ-II, MIKE, VITAL, and TASK. These modelling frameworks are designed to support the complete development process of knowledge intensive systems from knowledge acquisition to operationalisation. The modelling frameworks are each briefly described below.

DESIRE	A modelling framework within which tasks can be modelled, specified and operationalised is presented in Brazier, Treur, Wijngaards and Willems (1995, 1996) (knowledge based systems) and Brazier, Dunin-Keplicz, Jennings and Treur (1997) (multi-agent systems).
Common-KADS	An advanced and comprehensive methodology for integrated knowledge-based system development (Wielinga, Schreiber, Breuker, 1992; Hoog, Martil, Wielinga, Taylor, Bright, Velde, 1994).
PROTÉGÉ-II	A knowledge-acquisition shell including problem solving methods as well as tools for acquiring knowledge (Musen, 1990; Puerta, Egar, Tu & Musen, 1992; Gennari, Altman, Musen, 1994, Eriksson, Puerta, Gennari, Rothenfluh, Tu & Musen, 1995).
MIKE	An approach for the development of knowledge-based systems integrates semiformal specification techniques, formal specification techniques, and prototyping into a coherent framework (Angele, Fensel, Studer, 1996).
VITAL	An approach to structured knowledge-based system development including a knowledge engineering and a project management methodology (Shadbolt, Motta, Rouge, 1993).
TASK	A modelling framework designed to support the development of knowledge-based systems (Pierret-Golbreich, 1993;Talon and Pierret-Golbreich, 1996).

Analysis of the results for the six modelling frameworks shows that although shared purposes exist (as could be expected) differences between modelling frameworks have been made explicit. Below a number of similarities and differences are listed.

- All six modelling frameworks support reuse of generic components: models / problem solving methods & ontologies, domain independent & domain dependent.
- The frameworks MIKE, VITAL, and CommonKADS (all inspired by the KADS-I "philosophy") are very similar: the same (kinds of) models are distinguished.
- PROTÉGÉ-II provides the most support for knowledge acquisition: the PROTÉGÉ-II framework generates tools for each knowledge acquisition task.

- The MIKE framework provides extensive support for the representation of the raw material obtained via knowledge elicitation (e.g. video, texts, …).
- The VITAL framework provides extra support for the project management.
- The DESIRE framework provides support and tools for simulation of concurrent processes.
- The CommonKADS framework includes tools with which the environment of a knowledge-based system can be modelled.
- Strategic, dynamic interaction between components / systems / agents is explicitly modelled in meta-level architectures in DESIRE. TASK includes limited reflection and strategic knowledge as well. Limited reflection is included in $(ML)^2$ and NewKARL for other purposes.
- The KADS-like frameworks, the DESIRE framework and the TASK framework include a formal specification language with a formal semantics.
- Hybrid control is provided by both the TASK and the DESIRE frameworks.

The comparison of modelling frameworks, based on the purposes for which the frameworks have been designed, can be used to support the selection of a modelling framework. For example, to design a diagnostic reasoning system in a medical domain, for which specific knowledge needs to be acquired for large numbers of physicians, the PROTÉGÉ-II modelling framework provides the most support. If, however, a system is to be designed in which the reasoning behaviour and strategies of two co-operating agents is to be explicitly modelled, the DESIRE framework is most appropriate. If the environment of a system is of importance, the CommonKADS and MIKE modelling frameworks provide the most support. Strategical reasoning is supported by both TASK and DESIRE, reflective reasoning is most supported by DESIRE. All frameworks support prototyping to some extent, varying from automated prototype generation of the entire detailed specification language to hand-made partial prototyping of parts of the detailed specification language.

4 Conclusions

Application of the proposed instrument has made a number of distinctive characteristics of the different approaches explicit, providing a basis for comparison.

This instrument can play a useful role in structuring reuse and translation of parts of modelling frameworks, application specific models, libraries (see Motta, 1997), generic structures, etc.

The comparison of frameworks, based on the purposes for which the frameworks have been designed, can be used to support the selection of a modelling framework. The instrument provides a means to structure the comparison. The instrument can also be used as a ‘shopping list’: a shopping list for the knowledge engineer in search of models, tools and methodologies. The knowledge engineer should be able to combine parts of various modelling frameworks into a ‘new’ modelling framework which is most suited to the situation at hand. The instrument would benefit from consensus in the research community on terminology for the description of modelling frameworks - a goal that may one day be reached.

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