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A Future for Knowledge Acquisition

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Preface

Knowledge acquisition is a scientific field focused on understanding how knowledge may be elicited from humans for the purpose of understanding, supporting or automating complex problem solving behavior. The problem of knowledge acquisition only came to the foreground when the technology was sufficiently mature to allow the construction of large knowledge systems. Before that, knowledge acquisition took place in an ad hoc way. It is now understood that knowledge acquisition is the most important part of building a complex knowledge system, and that solid methodologies need to be in place.

The European Knowledge Acquisition Workshop (EKAW) is the prime forum for tracking the advances in this area in Europe. It is complementary to the Japanese Knowledge Acquisition Workshop (JKAW) and the yearly Banff Knowledge Acquisition Workshop (KAW). This eight edition of EKAW was held in Hoegaarden near Brussels and confirms the important trends of the last years. It also confirms the depth and progress obtained in the area of methodology, formalisation of knowledge acquisition models, and practical application. In spite of such impressive results, it is often heard that up to now the knowledge-based direction has failed to deliver on its promises. According to some it is even doubtful whether it ever had the potential of doing so. In view of this apparent impasse, EKAW'94 has set itself two main objectives.

The first objective is to demonstrate that work in the mainstream of knowledge acquisition *is* leading to useful results. There are presently several systems available and in use that demonstrate the potential of knowledge technology. The state of the art in knowledge systems is far beyond the rule-based model. The old knowledge extraction view has been replaced with a prominent modelling view. Knowledge level modelling, method configuration approaches, automated knowledge acquisition, knowledge standards, exchange, and reuse are now becoming reality. All of these help to overcome the complexity problems associated with building intelligent systems that up to now hampered widespread deployment of the technology. The various papers in this volume are representative data-points of these trends.

As for its second objective, EKAW'94 puts the knowledge acquisition enterprise in a broader context. This new context derives from the new perspectives on knowledge that are being developed within Knowledge Acquisition and in other areas of Artificial Intelligence or other sciences. For example from linguistics, philosophy of science, learning science, psychology, and sociology one learns how knowledge can be viewed as a social phenomenon, ever evolving and situation specific. This is often seen as an argument against the feasibility of knowledge-based approaches. However, at the same time technological developments in hypermedia and networking are providing us with new tools to explore exactly these issues. These developments offer new opportunities for different and unexplored uses of knowledge technology that are beginning to shape a new future for knowledge engineering.

New uses: in the last few years knowledge acquisition has focussed on consolidation of research results, in part by developing more applications. However, developments in business management and sociology indicate new opportunities for the techniques that we now master. In particular business process re-engineering, knowledge management, and social learning are hot topics and crucial features of successful organisations in the future. This is the case for European organisations in particular, since the larger European market requires ever greater flexibility and adaptability. The knowledge engineering community contributes to this its particular view on the business process, namely the knowledge perspective. For this community, 'knowledge as a crucial asset for success' is more than a cliché but is backed up by solid techniques and methodologies.

New technologies: knowledge engineering has focussed on building intelligent problem solvers or decision support systems, mostly single user and running on a single computer. New technological developments in hyper- and multimedia, and in networking, are creating new ways to put ideas into practice. These developments are a perfect complement to the new uses that were mentioned above. For example the developments in networking allow for realising the infrastructure that is necessary for effective knowledge management in small and medium sized organisations. Similar technology on a larger scale (i.e., the information highways that are being planned for Europe and the US) will allow for easier exchange and reuse of knowledge descriptions.

EKAW'94 featured special contributions to foster debate on the above mentioned topics. Dr. J. Stewart (Institut Pasteur) reports on the consequences of approaching the problems of mind and knowledge from a constructivist perspective. Ken Ford (University of West Florida), on the other hand, argued that positions like these easily go too far in rejecting useful ideas on mental representations. Dr. Attardi (University of Pisa) described evolutions in computing technology and how they are changing the way in which we work, as well as the tools we may find useful.

While preparing for EKAW'94 extensive use was made of the World-Wide Web (WWW). An EKAW WWW server[1] was set up both as an experiment and as a way to support the practical organisation of the workshop. For example, an interactive review form reduced the time and effort to produce and process reviews. The server offers most papers on line, integrated communication between authors, EKAW organisation, and contributers to the discussions, public commentary and annotations, local organisation and registration information. At any time one could find the most recent organisational information (detailed program, deadlines for registration, accommodation). Participants could also use it for confirming registration or accommodation reservation. The use of WWW was an experiment in itself that is fully in line with the trends that

[1] The server can be reached at http://arti.vub.ac.be/www/ekaw/welcome.html

were identified above. In the future, easier access to knowledge technology will enhance the effectiveness of businesses, and in particular the smaller ones. The new uses and new technologies will create a market on which specialised services can develop (remote knowledge systems, active documents, intelligent software agents, goal-oriented data use, sharing and reuse of knowledge, ...). For all of these the experience and know-how of knowledge engineering is central.

Overview

This volume contains a selection of the key papers presented at EKAW'94. Other papers were presented in poster form. The following gives the main themes underlying the papers.

Knowledge Modelling Frameworks

Several frameworks are now in place for performing the knowledge modelling task. Modelling at the knowledge level is generally seen as a way to give depth to knowledge acquisition. Ongoing work that is reported in this volume focuses on formalisation, comparison, and extensions to cooperative and multi-agent task settings. Schreiber, Wielinga, Akkermans, Van de Velde, and Anjewierden (*CML: The CommonKADS Conceptual Modelling Language*) summarize the major features of CML, which is a language at the core of the latest KADS developments. Ruiz, van Harmelen, Aben, and van de Plassche (*Evaluating a Formal Modelling Language*) give criteria for evaluating formal languages for knowledge level modelling and they apply these criteria to the language $(ML)^2$. The paper of Fensel and Poeck (*A Comparison of Two Approaches to Model-based Knowledge Acquisition*) gives a thorough comparison of two different approaches to model-based knowledge acquisition: the MIKE approach influenced strongly by KADS and the CRLM approach based on role-limiting methods. Dieng (*Agent-Based Knowledge Acquisition*) proposes a modelling framework that emphasizes the description of multiple agents, their roles, cooperation, and reasoning capabilities. This complements single agent modelling techniques with the aim of building cooperative and distributed knowledge systems.

On the other hand knowledge modelling frameworks are not unchallenged, as witnessed by two other papers. Schmalhofer, Aitken, and Bourne (*Beyond the Knowledge Level: Descriptions of Rational Behavior for Sharing and Reuse*) put forward arguments against present trends in knowledge level modelling as a predictive framework. Instead they argue for behavior descriptions of systems in a given context rather than performance prediction from knowledge and goals. Compton, Preston, Kang, and Yip (*Local Patching Produces Compact Knowledge Bases*) describe a series of experiments with real and artificial experts on the effectiveness of incremental local changes to a collection of ripple-down rules. To the extent that this works, it implies that knowledge-level models and functional architectures are not necessary.

Generic Components

Knowledge acquisition frameworks also serve as frameworks for reuse. When they are used by a substantial group of people, research can focus on an identification of generic components. Such efforts are now taking place: looking to identify generic task structures, problem solving methods, and also ontologies which can be reused across applications.

For a long time now problem solving methods have been regarded as key reusable elements. Breuker (*Components of Problem Solving and Types of Problems*) gives a typology of tasks with the goal of identifying suitable problem solving methods. This work fits within the KADS framework and is one of the cornerstones of the KADS expertise modelling library. A thorough analysis of diagnostic problem solving resulting in the identification of generic problem solving methods is reported by Benjamins (*On a Role of Problem Solving Methods in Knowledge Acquisition – Experiments with Diagnostic Strategies.*), while Cañamero (*Modelling Plan Recognition for Decision Support*) provides a detailed investigation of another class of problem solving methods, geared towards decision support.

More recently, ontologies are receiving attention as a means to facilitate reuse of complex components. The contribution of van Heijst and Schreiber (*CUE: Ontology Based Knowledge Acquisition*) shows how a better formalisation and structuring of ontologies can play a major role in streamlining further knowledge acquisition in the domain of medical systems. Pirlein and Studer (*KARO: An Integrated Environment for Reusing Ontologies*) also propose an extension of a methodological framework and its supporting environment in order to better support the identification of ontologies and their use in a knowledge acquisition project.

At yet another level one is starting to investigate reuse of the knowledge acquisition process. Geldof and Slodzian (*From Verification to Modelling Guidelines*) describe a set of reusable components for meta-projects, i.e., projects about knowledge engineering projects. They illustrate, using verification as a case-study, how a reflective implementation of a knowledge acquisition tool is used to capture and reuse knowledge engineering know-how.

Methodology

There are still gaps in current methodology, particularly in the areas of user modelling, verification, and validation. Several papers address these gaps. Andrienko and Andrienko (*AFORIZM Approach: Creating Situations to Facili-*

tate Expertise Transfer) propose and demonstrate knowledge elicitation techniques based on the presentation of situations to induce the recollection and verbalisation of expertise. These situations are generated by the use of spatial metaphors and graphic images. Improvements of the MACAO methodology are described by Aussenac (*How to Combine Data Abstraction and Model Refinement: a Methodological Contribution in MACAO*). Concrete experiments on combining MACAO with elements of KADS lead to methodological guidelines on how to combine the detailed analysis of expert knowledge with the selection and adaptation of generic models. Brazier and Treur (*User Centered Knowledge Based System Design: a Formal Modelling Approach*) focus on an area in knowledge level modelling that has, up till now, received less attention, namely the modelling of how the user perceives a system and therefore can interact with it. Tourtier and Boyera (*Validating at Early Stages with a Causal Simulation Tool*) present an approach and a tool to capture and validate knowledge about the dynamics of a system. Their approach has the advantage of being applicable before the conceptual model has been operationalised. Yost, Klinker, Linster, Marques, and McDermott (*The SBF Framework, 1989-1994: From Applications to Workplaces*) show that knowledge acquisition must be part of the larger context of analysing business processes.

Architectures and Applications

Knowledge acquisition frameworks and methodologies can be used for a variety of purposes, some of which are less obvious than others. Major, Cupit, and Shadbolt (*Applying the REKAP Methodology to Situation Assessment*) describe the application of their methodology to a problem of situation assessment, covering knowledge acquisition, design, and implementation aspects of system development. Arcos and Plaza (*Integration of Learning into a Knowledge Modelling Framework*) describe NOOS, a reflective architecture allowing for the description and implementation of inference as well as learning components and, most importantly, their integration and combination. Along similar lines, although with greater focus on resolving issues in machine learning, Rouveirol and Albert (*Knowledge Level Model of a Configurable Learning System*) describe the use of knowledge level models to configure learning algorithms and systems. Their approach makes explicit the alternatives in algorithms and biases. Automated (re-)configuration of applications is also the topic of Stroulia and Goel (*Reflective, Self-Adaptive Problem Solvers*). They describe a reflective system capable of identifying gaps in its knowledge and redesigning its own task structure.

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