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Information Systems and Artificial Intelligence: Integration Aspects

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Preface

Es ist nicht genug zu wissen,
man muß auch anwenden;
es ist nicht genug zu wollen,
man muß auch tun.

Goethe

The First Workshop on "Information Systems and Artificial Intelligence" took place at the FAW Ulm, March 19–21, 1990. Its focus was on "Information- and Knowledge-Representation Systems". The special interest groups 1.1.4 (Knowledge Representation) and 2.5.2 (Methods for Developing Information Systems and Their Application) of the GI e.V. (German Computer Science Society) were responsible for the organization.

Knowledge-based systems have been successfully developed in practice for a number of years. However, they are often "only" stand-alone systems; integrating them into existing information environments, e. g. making available real production data to an expert system, often either fails or is only solved in a dissatisfying way. Possible reasons for this might be on one hand the lack of know-how about the different features of various experimental AI techniques, and on the other the lack of more classical information and database system technology. The possibility for change led the special interest groups "Knowledge Representation" and "Methods for the Development of Information Systems and their Application" to organize a joint workshop entitled *"Information Systems and Artificial Intelligence: Integration Aspects"*.
The papers in this volume illustrate how approaches integrating Artificial Intelligence and Database technology may be developed.

Database and Artificial Intelligence Techniques: A New Approach Towards Information Systems?

Information systems are not only characterized by their conceptual design, but also by their application domain. New technologies and systems resulting from database and expert systems have influenced methods of analysis, design and specification, leading to realization approaches which play an important role in the development of information systems.
When developing and realizing expert and/or database systems, differences can be found at both the system-technical level and at the conceptual level.
For the integration of expert and database systems into information systems, basically two strategies are suggested in the literature:

a) coupling of both systems, and
b) extension of existing technologies.

Coupling Approaches

The objective of coupling approaches is to enable autonomous systems — in this case restricted to database and expert systems — to communicate in order to increase their efficiency and application adequacy with regard to joint problem-solving. The requirements for such a coupling are usually realized via "interface" concepts. Different coupling approaches can be found in the literature; we distinguish approaches with distinct database and distinct expert system aspects respectively.
An alternative to coupling approaches is the extension of existing systems with additional abilities. Such extensions may lead to better performance of the resulting systems and are referred to here as "additive approaches".

Additive Approaches

Usually, what is described is the development of a new DB model which is either able to manage complex structures or has been extended by data models and processing facilities based on a resolution calculus; it might also include heuristic processing mechanisms.
In the area of Expert Database Systems — which can be regarded as the bottom-up approach for realizing knowledge-based systems — it is rather AI methods that are applied. Extension approaches can be classified into

a) approaches in which the existing (logic) programming environment is extended with database facilities, and
b) approaches in which a database system is extended with deductive abilities.

Since the different extension approaches come primarily from database technology, there exists a conceptual distance from AI technologies. This becomes clear when dealing with knowledge representation. A great number of articles on this subject can be found in current publications.

"Non-classical" Information Systems

"Non-classical" information systems are meant to build up a new class of systems, using an interdisciplinary approach allowing an assignment within the framework of artificial intelligence and the further development of data models. These are tailored with regard to the applications which are to be realized. At the moment there exists neither a procedure for constructing these systems nor a hypothetical system architecture. This type of information system should combine expert and database system functionality.
Due to the requirements that such systems pose, they can only be realized in an interdisciplinary fashion. Although this workshop focusses on Database- and Artificial Intelligence techniques, aspects of software engineering and insights from programming language disciplines have also to be taken into consideration. It will have to be analysed whether "non-classical" information systems within this context provide research potential for the next years. Different approaches in this direction are also described in the current literature.

Scope of the Papers

The basic consideration was to have two representatives — one from the Artificial Intelligence and one from the Database Systems field — talk on the topic determined by each respective section. The different views were meant to generate the basis of potential ideas and to support the discussion.

With regard to the contents, the workshop was divided into 6 sections with 18 talks. A panel session on experiences from practice resulted in additional ideas to be discussed.

The workshop started with an overview talk on the topic **Databases and Artificial Intelligence** given by the invited speaker John Mylopoulos of the University of Toronto. The specific topics covered in the workshop were:

- Logic Programming and Deductive Databases
- Non-Monotonic Logic
- Conceptual Model and Knowledge Representation
- Database Support for Knowledge-Based Systems
- Database Systems and Expert Systems: A New Approach for Information Systems?
- Requirements Analysis vs. Knowledge Acquisition

Logic Programming and Deductive Databases: Stefan Böttcher of IBM Deutschland GmbH in Stuttgart described the integration of a deductive database with logic programming being pursued in the EUREKA project PROTOS. The logic programming language PROTOS-L (developed for that purpose) was explained as well.

Rainer Manthey of the ECRC in Munich talked about two basic problems; for their solution it was necessary to rely upon terms and methods of database technology:

a) the efficient checking of integrity conditions, and
b) the efficient answering of queries on recursive rules.

Non-Monotonic Logic: Gerhard Brewka of the GMD in St. Augustin described the approaches of non-monotonic reasoning and explained the advantages and disadvantages.

François Bry of the ECRC in Munich explained the necessity to continue working with other kinds of logic, e. g., constructive logic. He reported about the insights gained within the framework of the ESPRIT projects, such as formalizing in logic programming, handling of negation and generating implementation approaches for models of non-monotonic logic and default reasoning in logic programming.

Conceptual Model and Knowledge Representation: Christof Peltason of the TU Berlin explained existing possibilities and experiences gained in connec-

tion with the realization of the knowledge representation system BACK (Berlin Advanced Computational Knowledge Representation System) within the framework of an ESPRIT project.
Bernhard Nebel of the DFKI in Saarbrücken extended the area of knowledge representation and talked about problems and approaches to solutions. Finally, he stated that knowledge representation formalisms are only useful when the processing of the represented knowledge may be efficiently realized — actually the problem is not completely solved.
Gunther Saake of the University of Braunschweig presented a layer model for the conceptual design. This shall help the software engineer to correctly interpret the user's requests. He sees a realization approach for his concept in the area of object-oriented databases.

Database Support for Knowledge-Based Systems: Günther Görz of the University of Hamburg emphasized the importance of database support for knowledge representation.
Bernd Walter of the University of Trier mentioned some basic considerations regarding database support for knowledge-based systems; in addition he presented the approaches pursued in the LILOG database.

Database Systems and Expert Systems: A New Approach for Information Systems? Dieter Hovekamp of VW-Gedas Berlin described how a KBMS was implemented in a PC environment; this was effected within the framework of the BMFT project WEREX.
Nelson Mattos of the University of Kaiserslautern presented an approach for realizing a prototype database-based knowledge management system. The functionality description of the KRISYS system and the differences from non-standard database approaches were presented as well.

Requirements Analysis vs. Knowledge Acquisition: Angela Voß of the GMD St. Augustin gave an overview of model-based knowledge acquisition. Different advantages and disadvantages as well as comparisons with conventional software development were discussed.
Helmut Thoma of Ciba Geigy AG in Basel, Switzerland reported on approaches to the information requirement analysis problem. His talk was influenced by practice and argued for a gradual build-up of knowledge and requirements in concrete form during system development.

Panel Session

In the discussion "Experiences from Practice", many participants of the workshop discussed the difficulties with which practice is still nowadays struggling in integrating information systems and expert systems. The session was chaired by Helmut Thoma, Ciba Geigy AG Basel, and he and Hans Peter Hoidn, Institut für Automation AG Zürich, Nelson Mattos, University of Kaiserslautern and Wolfgang Sager, Collogia Köln determined the main focal points and answered the questions arising.

H.-P. Hoidn reported on the practical aspects of implementing a knowledge base/database coupling in a major bank. They implemented a system for planning the batch control in the computer centre of the bank with KEE and Common Windows, with ORACLE and KEE-Connection for coupling object- and database systems. Experiences with performance evaluation and analyses of coupled (relational) database and expert systems, as they can hardly be effected in practice, were at the centre in attention of N. Mattos' explanations. In enterprises, knowledge-based systems have to be integrated on the technical, the management and the user level as realizations of innovative techniques in existing environments. W. Sager discussed those points of view in connection with his experience with AI techniques in the conventional environments within companies.

Nowadays the state of the art unfortunately comprises loose couplings of artificial intelligence systems and conventional systems, problems with integrated development tools, with too few project leaders or employees comprehending both techniques. In addition, the effort needed to actualize knowledge in the working phase is often underestimated.

The design of object classes and relations should start with a common model as the basis, e. g., a common entity relationship model. Special attention has to be given to the integrity of data, to the object system, and to the conception of transactions.

Expert Systems manipulate the data in a way that is unfavourable for database systems. Therefore, on coupling, the locality of processing should be better used, storage structures of the Database System should be better adapted to the working method of the Expert Systems, and Expert Systems calls should be adapted to the quantity-oriented interface of the Database System. Furthermore, an optimal Expert Systems/Database System coupling requires a distribution of tasks and design of interfaces that are well suited to each other; this could be proven in experiments.

Conclusions

As an exchange of experiences, the workshop was an important step forward to a mutual understanding between persons who are occupied in practice with information systems and database systems, and their colleagues working in the area of Artificial Intelligence, especially knowledge representation. The terminological as well as the conceptual differences between both areas could be seen in several discussions.

The consensus that emerged was that both groups should make steps to fulfill the existing requirements on new software systems by cooperation. Future developments will determine whether this leads to interdisciplinary work and real integration approaches.

Acknowledgement

I would like to thank those of my colleagues who helped to set up this workshop, and in particular the members of the organizing committee, G. Lausen, University of Mannheim, K. von Luck, C.-R. Rollinger, IBM Deutschland GmbH, R. Studer, University of Karlsruhe, and H. Thoma, Ciba-Geigy AG. Thanks go also to the people who helped in the local organisation at the FAW Ulm.

Whether this line of research bears fruit, only time can tell. But, whatever the outcome, I owe an inestimable debt to all participants for their good will and manifold assistance.

Ulm, October 1990 Dimitris Karagiannis

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