

# Lecture Notes in Computer Science

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286

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B. Bouchon R.R. Yager (Eds.)

## Uncertainty in Knowledge-Based Systems

International Conference on Information Processing  
and Management of Uncertainty in Knowledge-Based Systems  
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Selected and Extended Contributions

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## FOREWORD

The past decade has witnessed an exponential growth of activity centering on the development of expert systems for a wide variety of applications ranging from medical diagnosis to stock portfolio selection.

Much of the information which is resident in the knowledge base of a typical expert system is imprecise, incomplete or not totally reliable. For this reason, problems relating to the management of uncertainty in expert systems and, more generally, knowledge-based systems, have begun to attract a great deal of attention on the part of information scientists, probabilists, statisticians and logicians. Even members of the artificial intelligence community, most of whom have been and still are disdainful of probability theory, are reluctantly facing up to the need for methods of approximate, qualitative, and probabilistic reasoning, especially in the context of inference from common sense knowledge.

Despite the obvious need for such methods, only a few of the currently available expert system shells have any kind of a mechanism for dealing with uncertainty. When available, such mechanisms are mostly ad hoc in nature and do not provide a rigorous framework for dealing with certainty factors in ways that lend themselves to validation. What is the explanation for this state of affairs?

The problem is that the conventional probability-based methods do not fit well the types of uncertainty which are encountered in a typical expert system. In the first place, much of the information in the knowledge base of an expert system is in the form of rules which are lexically imprecise, i.e., contain fuzzy predicates in both their antecedents and consequents. And second, many of the probabilities which are needed for Bayesian-style computations are known imprecisely and/ or incompletely.

An effective system for dealing with lexical imprecision is provided by fuzzy logic. The more difficult problem of how to deal with gaps in the knowledge of probabilities is usually avoided by making a liberal use of assumptions concerning conditional independence or, more generally, invoking the maximum entropy principle. An unsatisfactory feature of this approach is that it yields results which are based on assumptions which may or may not be valid. On the other hand, the alternative of making no assumptions concerning the unknown probability distributions has the drawback of leading to results which are insufficiently specific or altogether vacuous. A possible way out of this dilemma is to allow assumptions which are dispositional rather than categorical in nature. Such assumptions will, in gen-

eral, lead to dispositional conclusions. It may well turn out to be the case that, realistically, this is the best that can be achieved with any conceivable schema for the management of uncertainty in expert systems. What this means is that the categorical approaches which are currently in vogue may be intrinsically incapable of solving the problem.

Be that as it may, it is evident that the management of uncertainty in knowledge-based systems presents many complex and as yet not fully understood problems. A number of these problems are addressed directly or indirectly in the papers assembled in this volume, many of which were presented at the International Conference on Information Processing and Management of Uncertainty in Knowledge-Based Systems, which was held in Paris in 1986.

The Paris Conference was the first international conference on the subject of uncertainty in knowledge-based systems. It brought together many of the leading contributors to information processing and the management of uncertainty, and it laid the foundation for exchanges of information and scientific collaboration cutting across national boundaries. One of the visibly important results of this collaboration is the present volume. Drs. Bernadette Bouchon of France and Ronald Yager of the United States, who jointly organized the Conference, edited the volume and contributed to its contents, deserve our thanks and congratulations. Their efforts have culminated in a truly international collection of papers which for the first time bring together highly authoritative analyses of the issues which are central to the conception and design of knowledge-based systems.

Lotfi A. Zadeh, Berkeley

June 1987

## TABLE OF CONTENTS

### Foreword

Lotfi A. Zadeh

### I. Preliminary Papers

On the management of information imperfection in knowledge based systems Andrew P. Sage .....	3
Representing knowledge and evidence for decision Henry E. Kyburg, Jr.....	30
Possibilistic qualification and default rules Ronald R. Yager .....	41
Propagation of uncertainties and inaccuracies in knowledge-based systems Bernadette Bouchon, Sylvie Desprès .....	58

### II. Approaches to Uncertainty

#### a) Evidence theory

Qualitative Markov networks Khaled Mellouli, Glenn Shafer, Prakash Shenoy .....	69
The principle of minimum specificity as a basis for evidential reasoning Didier Dubois, Henri Prade .....	75
Approximate inference and interval probabilities Enrique H. Ruspini .....	85
Derivation of some results on monotone capacities by Möbius inversion Alain Chateauneuf, Jean-Yves Jaffray .....	95
Using probability-density functions in the framework of evidential reasoning Pascal V. Fua .....	103
O-theory. A probabilistic alternative to fuzzy set theory Edward M. Oblow .....	111

## **b) Fuzzy Set Theory**

Efficient deduction in fuzzy logic Roger Martin-Clouaire .....	123
Fuzziness and expert system generation Mark Frydenberg, Stephen I. Gallant .....	137
Fuzzy preferences in decision-making Javier Montero, Juan Tejada .....	144
An axiomatics for fuzzy information Michel De Glas .....	151
Knowledge modelling in fuzzy expert systems John Darzentas .....	159
Some recent advances on the possibility measure theory Wang Zhenyuan .....	173

## **c) Probability theory**

Probabilistic inferential engines in expert systems : how should the strength of rules be expressed Gerardo Steve .....	179
A framework for assigning probabilities in knowledge-based systems Sheldon Shen .....	189
Probabilistic reasoning using graphs Judea Pearl .....	200

## **d) General Issues**

A calculus for belief-intervals representation of uncertainty Dimitar Driankov .....	205
Knowledge base organization in expert systems Simonetta Frediani, Lorenza Saitta .....	217
A consistency-recovering system for inference engines Roberto Garigliano .....	225

Credibility of abducible multiple causes of observed effects Anio O. Arigoni .....	234
---	-----

Use of pattern classification in medical decision making Moses E. Cohen, Donna L. Hudson .....	245
---	-----

### III. Applications

The use of fuzzy information retrieval techniques in construction of multi-centre knowledge-based systems Ladislav J. Kohout, Wyllis Bandler .....	257
--	-----

Application of possibility and necessity measures to documentary information retrieval Henri Prade, Claudette Testemale .....	265
---	-----

The use of fuzzy information retrieval in knowledge-based management of patients' clinical profiles Ladislav J. Kohout, Moncef Kallala .....	275
--	-----

Management of uncertainty in a medical expert system Donna L. Hudson, Moses E. Cohen .....	283
---	-----

Consensus and knowledge acquisition E. Plaza, Claudi Alsina, Ramon Lopez de Mantaras, J. Aguilar, Jaume Agusti .....	294
---	-----

Knowledge representation model which combines conceptual graphs and fuzziness for machine learning Ehud Bar-On, Gideon Amit, Rachel Or-Bach .....	307
---	-----

An investigation of pictographic form in relation to mechanisms of knowledge acquisition Michael Bonaventura, M.C. Fairhurst .....	319
--	-----

HOLMES-I, a prolog-based reason maintenance system for collecting information from multiple experts Rafail Ostrovsky .....	329
--	-----

Modeling uncertainty in human perception Panos A. Ligomenides .....	337
--	-----

Uncertainty reduction techniques in an expert system for fault tree construction	
Sergio F. Garriba, Enrico Guagnini, Piero Mussio .....	347

#### **IV. Information Theoretic Approach**

Characterizing information measures : Approaching the end of an era	
Janos Aczel .....	359
Characterization of some measures of information theory and the sum form functional equations	
Pl. Kannappan .....	385
Information gain with preference	
Pierre Gomel .....	395
Information entropy and state observation of a dynamical system	
Robert Vallée .....	403