BOOK REVIEW

"Approximate Reasoning in Expert Systems",
M.M. Gupta, A. Kandel, W. Bandler and J.B. Kiszka (Eds.),
(North-Holland, Amsterdam, 1985), 836 pages.

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INTRODUCTION.

Fifty papers for over eight hundred pages, the book is big ! The title in itself is fuzzy : what is meant by 'approximate reasoning', what is really an expert system, or, when can it be said that a system is **not** an expert system ? Matching of the topics of the papers with the title is a fuzzy one, which is a good thing due to the diversity of the concepts suggested by the title. For some papers, and as good as they might be, there is a complete mismatch : they have nothing to do with the proposed and promising title. The book presents valuable developments on extended topics, but it could have contained less and better focussed papers. Finally, it appears as a very useful source of information for the knowledge engineering fuzzy (or not) community.

THE PAPERS.

Part I of the book, 'The theory of approximate reasoning', starts with a now classical paper from **L.A. Zadeh** presenting fuzzy logic as a framework for the management of uncertainty in expert systems, with emphasis on "what conventional techniques can't do" (at least effectively or correctly). **E. Hisdal** shows how to build up fuzzy or infinite-valued logic on top of two-valued logic, providing a meaning to the grade of membership concept (this paper is a summary of a part of the author's TEE model). **H.T. Nguyen and I.R. Goodman**'s paper discusses basic issues on approximate reasoning for knowledge-based systems : formal languages, semantic evaluation procedures, general logical systems, uncertainty measures and admissibility. **S.T. Wierzchon** postulates a possible attempt to the modelling of uncertainty, starting from the notion of interval-valued measure. He relates his work to G. Shafer's belief functions and to M. Sugeno's fuzzy measures. **M. Mizumoto** presents an extension of ordinary fuzzy reasoning, with rules (If A then B) **and** facts (A') composed of conjunctions of n fuzzy propositions (deducted results are presented on reference tables depending on the type of the corresponding implication rule). **L. Bourrely** and **E. Chouraqui** present the description and the formalization of a specific model for reasoning by analogy. It is implemented in the ARCHES expert system (Archaeology).

J. **Kacprzyk** uses L.A. Zadeh's theory of commonsense knowledge (collection of dispositions, i.e. propositions with implicit fuzzy quantifiers) in multicriteria, multistage and group decision making. S. **Weber** proposes a modification of Lukaciewicz logic and he applies it to the measure of the fuzziness of a fuzzy set and to distances between fuzzy sets. **M.K. Chakraborty, S. Sarkar and M. Das**' paper presents basic tools, based on fuzzy relations, for aplications to fuzzy clustering analysis and decision making problems. **E. Trillas and L. Valverde** discuss inference rules and implication connectives : what is first defined ? (developments on Modus Ponens and related concepts, to clarify some ideas on approximate reasoning by fuzzy sets or multivalued logic). **R.R. Yager** presents a typology of forms for the construction of multiple attribute decision functions (emphasis is on a close connection between logical-linguistic connections of OR and AND and the cooperative and individualistic methods of aggregation, respectively). **S.K. Pal** describes algorithms for automatic evaluation of feature quality in pattern recognition, segmentation of grey levels and providing a quantitative index for edgy image. He uses index of fuzziness, entropy and pi-ness in a set, to deal with these decision-making problems. In a short note, **Ph. Smets and P. Magrez** show that for any measure of information content of an evidence, there exists a strictly monotone transformation of the measure that is additive for distinct evidences. **A. de Luca** introduces and investigates the notion of a dispersion measure of a fuzzy set ; additive energy and entropy measures are fully discussed (a continuation of classical papers on entropy measures). **D. Dubois and H. Prade** explore Zadeh's generalized Modus Ponens. They show that the choice of an implication function is linked to the choice of the conjunction operator used for aggregating an a priori possibility distribution with a conditional possibility distribution (related topics : Modus Tollens, chaining of rules, truth qualification, etc., are also explored). **S.H. Pan** investigates the category of topological fuzzy lattices and **Liu Zuoshu** explores fuzzy set-valued mappings (these two papers contain interesting developments, but their relationship with the title of the book is not evident).

Part II, 'Theoretical developments in expert systems' starts with **B.R. Gaines and M.L.G. Shaw**'s basic paper on knowledge and psychology as Fifth Generation Computer Systems (FGCS) technologies, in connection with expert systems (how to adequately represent knowledge is discussed, as it will be discussed for many years : human reasoning and its logical and philosophical foundations constitute a never ending exploration). **J.B. Kiszka, M.M. Gupta and P.N. Nikiforuk** present some properties of expert control systems, grouping preceding presentations (an application to electric drives is given).

M. Delgado, J.L. Verdegay and M.A. Vila analyze the decision problem of testing a fuzzy hypothesis by a bayesian approach, with potential application to expert systems. In a second paper, the authors show how a Biobjective Linear Programming Problem can be solved by means of a fuzzy approach (applications of expert systems to operational research problems are to be considered). Starting with the notions of Diversity, and its components, F. Azorin studies several fuzzy interpretations of Size and Shape (analyses on fuzziness and randomness). B. Bouchon describes different forms of approximate reasoning (fuzzy inferences, combination of evidence, use of t-norms, etc.) for expert systems applications. A. Di Nola, W. Pedrycz and S. Sessa deal with fuzzy-relation-equations-based algorithms for inference mechanism (the paper contains a numerical example on a fuzzy expert controller). Based on the theory of fuzzy switching functions, M. Mukaidono describes an algorithm for constructing a fuzzy logic expression representing a given fuzzy set. E.C. Payne gives an environment for rapid prototyping (use of the KEE system, a commercial software package for knowledge engineering). S. Gottwald and W. Pedrycz discuss theoretical questions on the design of fuzzy controllers (realizations of the fuzzy controller, interactivity of control rules, use of fuzzy equations, etc.). The many topics of D. C. Rine's paper include Artificial Intelligence, expert systems, rule-based knowledge data bases, 'smart' data base systems, PROLOG, LISP, multiple-valued logic and associative memories. Management support of security systems, using fuzzy logic, is also discussed. M. E. Cohen and D. L. Hudson describe the three classical phases in pattern recognition/classification : definition of the problem, feature extraction, and classification, with emphasis on a new classification method they have developed. The method is then illustrated in two different medical areas. Li Junian, Liu Yaozeng and Lu Chenghan present a detailed medical diagnosis application : differential diagnosis of acute abdomen, it is based on a floating-model recognition method. J. A. Reggia, D. S. Nau, Y. Peng and B. Perricone describe their GSC model (Generalization of the Set Covering problem) after a summary of diagnostic reasoning. Applications of the model in medical (abductive) expert systems are finally discussed. A. Lagomasino and A. P. Sage investigate representation and aggregation of information within a structured framework of interrelated events. They review various structured frameworks for inference and they develop a general framework for imprecise inference. M. Vitek introduces 'possibility seeking systems', a sort of self-organized systems with social planning and social control. They are considered as a higher form of expert systems, where on the place of experts appear theorists. Th. Whalen and B. Schott present fINDex, an expert system that suggests appropriate forecasting techniques for sales predictions. It is a production system with approximate linguistic reasoning derived from fuzzy logic.

Liu Xihui, Wang Peizhuang and Chen Yiping's paper deals with approximate reasoning in earthquake engineering. A fuzzy mathematical model (using random sets) for earthquake generated damage prediction is proposed and followed by an application. M. Zemankowa-Leech and A. Kandel present a fuzzy relational data base model, fully illustrated with examples, that can serve as the data base in expert systems. A.R. Rocha's paper is devoted to a theoretical approach of expert sensory systems (spatial sensory encoding and processing). Special attention is brought to the somesthetic system, responsible for the perception of touch, pressure, joint position, muscle tension, etc.

Part III of the book, 'Applications of Expert Systems', starts with E. Avni, A. Kandel and M.M. Gupta's paper on CAD/CAE and expert systems. It introduces a new framework for data base management systems in Computer-Aided Process Design / Computer Aided Engineering, with a fuzzy linguistic approach. K.S. Ray and D.D. Majumder have developed intelligent control strategies, with fuzzy set theory, for a 210 MW steam generating unit. The application is fully described. Using now probabilistic sets in extended fuzzy expressions, K. Hiroka, Y. Arai and W. Pedrycz present a human-like control method (with ambiguous instructions in terms of membership and vagueness) of an industrial arm-robot with five joints. It is given a lot of illustrations and experimental results. B.N. Chatterji's paper is related to scene analysis. H. Mieno and A. Ishikawa's paper is concerned with automating the restoration of facial configuration, given the skull of an unidentified person (applications in Legal Medicine). M. Ben-Bassat shows how to structure the knowledge for medical diagnosis, his approach is followed by a description of a clinician-oriented control strategy for diagnostic expert systems (the work is based on the author's experience with MEDAS, RDAS and TOXDAS medical expert systems). J. Anderson, W. Bandler, L.J. Kohout and C. Trayner discuss various design considerations of a diagnostic expert system for hospital use. The search technique, the route-choosing technique, the use of multiple centres and the use of some degree of parallel processing are explained in the fuzzy diagnostic technique. D.L. Hudson, M.E. Cohen and P.C. Deedwania describe EMERGE, a rule-based expert system initially developed for chest pain analysis in an emergency room. The system uses certainty factors (to determine the seriousness of the illness) and inexact reasoning (in a phrase matching algorithm). B. Raman and E.E. Kerre's paper is concerned with the use of fuzzy instructions in order to run a ship between two continents which are dissipated by a small corridor with varying width (a fuzzy algorithm is described). H. Ogawa, K.S. Fu and J.T.P. Yao present SPERIL-II, an expert system for damage assessment of existing structures, they use fuzzy sets and Dempster-Shafer's theory in inexact inferences (four examples using the system are given).

L. Appelbaum and E.H. Ruspini discuss the basic concepts leading to the implementation of ARIES, an approximate reasoning inference engine. The system provides machanisms for the representation and manipulation of multiple degrees of propositional truth, as defined by several criteria of truth, belief, or likelihood (or desirability, preference, etc.). **W. Bandler** and **L.J. Hohout** explore the interrelations among fuzzy logical operators, from a Checklist Paradigm. **A. D'Angelo, G. Guida, M. Pighin and C. Tasso's** paper is focused on the representation and use of meta-knowledge in rule-based expert systems (a novel meta-level architecture is presented).

CONCLUDING REMARKS.

Because it includes a diversity of concepts and developments, review papers, various formalizations of approximate reasoning and pratical applications with expert systems (or other systems, more or less expert), the book is very informative and can help many researchers or practitioners in finding new ideas for future use, design or implementation of intelligent / expert / smart / knowledge-based / ... systems.