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Foreword

Starting in the late 1950s with the work of Marvin Minsky, John Mc Carthy, Herbert Simon and Allan Newell, serious attempts have been made to construct intelligent computer-based systems. The pioneering efforts of these researchers lead to the development of the field of Artificial Intelligence. This approach is most noted for its interesting paradigms and structures such as knowledge-based systems. These efforts have been most noted for there reliance on symbolic information processing techniques and the use of logic as a representation and inference mechanism. Furthermore, the approach of Artificial Intelligence can be seen to be at a very high level of human cognition.

At about the same time, another approach to the modeling of human intelligence, neural networks, was also being initiated. As opposed to the Artificial Intelligence approach, this effort is noted for its reliance on numerical representations and was based on modeling low level cognitive processes. A strong emphasis on learning is very characteristic of this methodology.

At a slightly later time, the early 1960s, another tool for the modeling of human cognition was being initiated. This approach, the development of fuzzy logic, can be more generally seen as the beginning of the concern for the inclusion of the modeling of uncertainty in the construction of intelligent systems. Furthermore, this approach provides a linkage between the two previous paradigms in that it provides a machinery for the numeric representation of the types of constructs developed in Artificial Intelligence.

As we now approach the middle of the 1990s, we see the coming together of these three directions. The purpose of this book is to look at the current state of this unification in the construction of intelligent computing. This very diverse and fast moving endeavour cannot be covered in one volume and we concentrate on the role of uncertainty in the construction of intelligent systems, which is the main topic of the IPMU Conference.

Imperfect knowledge is at the center of all the computing methods for the construction of intelligent systems and its representation is a key point. The management of uncertainty has been one of the main domains of research in this direction since the 1970s and different streams have been developed. Two of them, theory of evidence and causal networks, are extensively presented in part 1 and parts 2 and 3 are respectively devoted to contributions related to these topics. More classical are the probabilistic approaches, developed in part 4, but their involvement in inference strategies as well as knowledge representation is really a question of the day. Another approach for the management of uncertainty, discussed in part 5 is possibility theory, which was introduced in the framework of fuzzy set theory, but

has found an autonomy in possibilistic logic. Part 6 presents contributions in the domain of classical or non standard logics. Finally, the management of imperfect knowledge can also find solutions in chaotic modeling, presented in part 7. The last part of the book is devoted to more applied problems : software reusability in part 8, management of uncertainty in image and speech processing, scheduling, decision-making and scientific discovery in part 9.

In part 1, G. Shafer presents precise conditions under which Bayes nets can be said to have a causal interpretation. P. Smets gives a survey of the mathematical models proposed to represent quantified beliefs and their comparison.

Part 2 contains new elements on the foundations of evidence theory, in a reasoning setting (Kohlas and Brachinger) or as algebraic structures (Daniel). The problems of coherence (Wang and Wang) and aggregation of belief measures (Ramer et al.) are addressed, as well as their utilization in decision-making (Mellouli).

Part 3 presents developments on causal networks, proposing several methodologies to perform approximate computations in complex graphs (David et al., Xu, Acid and Campos), and heuristic algorithms for the propagation of uncertainty (Cano and Moral). A link is established between Bayesian networks and relational database models (Wong et al.). Decision influence diagrams are considered with values of evidence (Ezawa) or fuzzy utilities (Lopez). Finally, causal networks are introduced in a knowledge system environment (Liang et al.).

Part 4 deals with concepts derived from probability theory: qualitative methods to represent uncertainty (Wellman, Parsons and Saffiotti), probability intervals (Campos) or bounds (Gilio). Probabilities are regarded in a fuzzy framework from various points of view (Ralescu, Georgescu et al., Bertoluzza et al.). Informational methods are used for statistical problems (Morales et al., Pardo et al.) and for the management of dynamical systems.

In part 5, a possibilistic representation of uncertainty is applied to the updating problem for the management of constraints (Dubois et al.), to the definition of reliability when statistical information is not relevant to the situation (Cappelle and Kerre) and to semantic nets (Sandri and Bittencourt). Possibilistic logic is related to modal interpretability logic (Hajek) and to the use of default rules (Benferhat). Abductive reasoning is presented (Gebhart and Kruse), as well as approaches to the notion of dependence (Farinas del Cerro and Herzig) in a possibilistic environment.

Part 6 presents various works in classical or non-classical logic. Recent non-standard logics are first presented or developed (Trillas et al., Abar, Guiasu, Gasquet and Herzig, Besnard and Moinard). In artificial intelligence, the problem of consistency (Studeny), the introduction of assertions (da Silva and Costa Pereira) and the generation of explanations (Bigham) are addressed. Approximate reasoning is a framework for researches regarding the handling of partially sound rules

(Gottwald) and theorem-proving techniques (Brüning and Schaub). A multiple-valued propositional logic (Escalada-Imaz and Manya) and a modal many-valued logic (Godo et al.) are finally studied.

Chaos is the central problem studied by authors in part 7. Image processing (Gan) and medical applications underlie most of the work on modeling (Sakai et al., Cohen et al.) and control (Bernard-Weil) of dynamical systems subject to chaotic behavior.

Part 8 is devoted to software reusability. Reliability (Park), uncertainty management (Klösch, Simos), data representation properties (Bakhouch), fuzzy measures of understandability (Balentine et al.), and natural representation of programs (Mittermeir) are key points in these papers.

Finally, part 9 presents applications of uncertainty management methods: in image processing, a pixel-based labeling method (Minoh and Maeda) and fuzzy summarization or classification of data (Zhang and Ralescu, Bothe, Botticher) are proposed. Fuzzy methods are also presented for multisensor information processing (Nimier). Associative memories are used for the control of disturbed processes (Ferreiro Garcia). Temporal reasoning based on intervals is used for real-time scheduling problems (Anger and Rodriguez). Orderings are constructed for choice-making when the available information is partial (Guénoche). Discovery of scientific laws is approached with a management of inaccuracies (Moulet). Practical applications of stochastic fractals are presented in image analysis (Höfer, Pandit).

Thanks must be expresses to the contributors to this volume, as well as the organizers of invited sessions at IPMU in which several of these papers have been presented: C. Bertoluzza, M. Cohen, D. Hudson, S. Ovchinnikov, A. Ralescu, M. Samadzadeh, K. Zand.

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