ELSEVIER International Journal of Approximate Reasoning 24 (2000) 121–123
INTERNATIONAL JOURNAL OF APPROXIMATE REASONING
www.elsevier.com/locate/ijar

Editorial

# Reasoning with imprecise probabilities

This special issue contains a selection of articles from the First International Symposium on Imprecise Probabilities (ISIPTA). The symposium took place in Ghent, Belgium, during the month of June of 1999, under the organization of Gert de Cooman, Peter Walley, Serafin Moral and Fabio Cozman. The success of the symposium led to the decision to hold a second one, to happen in Cornell, USA, in 2001. It is a pleasure to bring some of the research topics discussed at the symposium to an influential journal; we hope readers will enjoy the articles with the same excitement we experienced during our stay in Ghent.

What was the scope of the symposium, and, consequently, what is the scope of this special issue? The term *imprecise probability* refers to any mathematical model that measures uncertainty without sharp, precise numerical probabilities. A variety of models have been developed with these characteristics; to name a few, probability intervals, sets of probabilities, capacities, belief functions, fuzzy measures, ordinal preferences. All these models, and several others, appear in the pages of this special issue. Such models have spread in a large number of fields, ranging from experimental psychology to controls engineering – with an extraordinary amount of work being produced by artificial intelligence researchers. Some of the models, as the case of belief functions, are interpretable not only from the point of view of imprecision in probability, but this issue will concentrate mainly in this aspect. Some of this work has been unfortunately duplicated in different fields, due to the lack of a common venue for discussion about imprecise probabilities and the variety of meanings of the same mathematical models has been very often a source of confusion. The objective of the symposium was to start such a discussion and clarify this approach to ignorance and uncertainty.

We feel this goal was achieved: the symposium displayed a healthy mix of computer scientists, statisticians, economists, engineers, philosophers, mathematicians, psychologists, all engaged in lively debate.

Dealing with imprecision, incompleteness and ambiguity in probability values is an essential aspect of realistic decision-making; perhaps this is the reason why artificial intelligence researchers have investigated so many models


PII: S0888-613X(00)00030-X

of imprecise probabilities. There is even the danger that a newcomer may feel overwhelmed with the wealthy of material to get acquainted with. To reduce this difficulty, this special issue contains several articles that provide broad surveys of important research topics and theories.

This special issue contains 10 articles. The first six articles can be read as surveys, even though they contain new results and new discussion.

The first article, by Peter Walley, is a broad comparison of many theories that deal with imprecise probabilities in some way. It tries to answer the question: Can there be a unified theory of imprecise probability? Different models are discussed and evaluated through the use of very simple examples.

The second article provides a different perspective: instead of a comparison among theories, it describes a complete theory of interval probability, under study for several years by Weichselberger and colleagues.

The next two papers discuss the computational aspects of sets of probabilities: how to represent them and how to generate probability and expectation intervals. Hansen et al. discuss the history of such computations and their modern solution with the use of sophisticated linear programming techniques, while Cozman discusses computations involving imprecise likelihoods and independence judgments.

The article by Capotorti and Vantaggi surveys a different approach to uncertainty, based on ordinal relations among events, but also considering the conditions for their representability by the different numerical approaches. The various axioms and calculi in the literature are reviewed and new systems are proposed.

The survey by Mukerji is an introduction to the contributions of imprecise probability to the field of economics. In the last few years, artificial intelligence has begun to address the problems arising from "communities" – groups of artificial agents, groups of virtual agents, groups that mix human and artificial agents. Economic theory deals with large collectives, and the tools of economists are now becoming more widespread in the analysis of artificial communities. We are honored to bring Mukerji's insights and experience on these issues to an artificial intelligence audience.

The remaining four papers describe narrower, deeper investigations into technical aspects of imprecise probabilities. Vicig's article presents a detailed analysis of the concept of epistemic independence, while Biazzo and Gilio's article develops generalization of de Finetti's fundamental theorem, giving its application to the computation of probability bounds for conditional events. Both articles follow the powerful de Finettian school; together they convey much of the spirit of that school.

Finally, the articles by Denneberg and by Chateuneuf and Vergnaud look at technical aspects of the theory of capacities. The former looks at representations of monotone capacities and suitable ways of defining the product of two capacities verifying some basic properties. The latter investigates the

combination of information using belief functions, and how to anticipate the value of a future piece of information when we know its focal events.

Finally we would like to thank Gert de Cooman and Peter Walley who co-organized with us ISIPTA'99 conference and helped us in the selection and edition of this special issue.

Fabio G. Cozman
*Sao Paulo, Brazil*
*fgcozman@usp.br*

Serafín Moral
*Granada, Spain*
*smc@decsai.ugr.es*