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Editorial

Reasoning with imprecise probabilities

This special issue of the *International Journal of Approximate Reasoning* (IJAR) grew out of the *4th International Symposium on Imprecise Probabilities and Their Applications* (ISIPTA'05), held in Pittsburgh, USA, in July 2005 (http://www.sipta.org/isipta05). The symposium was organized by Teddy Seidenfeld, Robert Nau, and Fabio G. Cozman, and brought together researchers from various branches interested in imprecision in probabilities. Research in artificial intelligence, economics, engineering, psychology, philosophy, statistics, and other fields was presented at the meeting, in a lively atmosphere that fostered communication and debate. Invited talks by Isaac Levi and Arthur Dempster enlightened the attendants, while tutorials by Gert de Cooman, Paolo Vicig, and Kurt Weichselberger introduced basic (and advanced) concepts; finally, the symposium ended with a workshop on financial risk assessment, organized by Teddy Seidenfeld.

The ISIPTA series started in 1999; the first one was held in Ghent, Belgium – followed by symposia held in Cornell, USA (in 2001), in Lugano, Switzerland (in 2003), and in Pittsburgh, USA (in 2005). The next edition of this biennial event will take place in Prague, Czech Republic, in July 2007 (http://www.sipta.org/isipta07). Selected papers from the first three symposia appeared in special issues of IJAR in 2000 and 2005, in a special issue of *Risk, Decision and Policy* in 2000, and in a special issue of *Annals of Mathematics and Artificial Intelligence* in 2005.

This special issue of IJAR contains ten articles; the first eight of them are revised versions of selected papers from ISIPTA'05. The first four papers deal with independence and graphical models; they are followed by two papers on probabilistic logic, and by two papers on decision–theoretic and combinatorial results. We close this special issue with a very special treat – the publication of Peter Williams' essay *Notes on Coherent Previsions*, a fundamental paper that appeared in 1975 as a technical report, and that has widely circulated since then. ISIPTA'05 marked the 30th anniversary of this paper, and we were fortunate to obtain a revised version from its author for this special issue. Williams' essay deals with foundations of probability, and addresses many profound questions that are basic to reasoning under uncertainty. The paper requires substantial background; for this reason, it is preceded by a short paper by Vicig, Zaffalon, and Cozman. This short paper offers commentary and guidance on Williams' influential work.

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The paper by Antonucci and Zaffalon focuses on algorithms for classification with Bayesian networks. Systems based on Bayesian networks can be used to predict the state of a target variable given an incomplete observation of the other variables in the network. The authors then employ the *conservative updating rule* to update probabilities; in general, the output of an updating algorithm for a target variable yields lower and upper probabilities. The paper addresses the problem of efficiently computing the conservative updating rule for robust classification with Bayesian networks.

The paper by Benferhat and Smaoui studies a new representation of possibilistic networks called hybrid possibilistic networks, which combine possibilistic networks with possibilistic logic. It presents a propagation algorithm through hybrid possibilistic networks, which is strictly more efficient (as confirmed by experimental studies) than the standard propagation algorithm.

The paper by de Campos and Cozman explores the computation of lower/upper expectations that must cohere with a collection of probabilistic assessments and a collection of judgments of epistemic independence. It presents algorithms (based on multilinear programming) both for independence among events and among random variables, and investigates separation properties of graphical models.

The paper by Cano, Gómez, Moral, and Abellán proposes new algorithms for inference in graph–theoretic representations called credal networks. A credal network consists of a directed acyclic graph associated with random variables and sets of marginal and conditional probabilities. The calculation of posterior probabilities offers serious computational challenges. The authors offer two new algorithms; the first one produces approximations through hill-climbing in the Shenoy–Shafer propagation scheme; the second one produces exact inferences through a branch-and-bound technique.

The paper by Gillett, Scherl, and Shafer presents a probabilistic logic whose sentences can be interpreted as asserting the acceptability of gambles described in terms of an underlying logic. It defines a measure–theoretic semantics in terms of probability distributions over interpretations of the underlying logic and a behavioral semantics in terms of the acceptability of gambles. The paper also provides a sound and complete inference procedure.

The paper by Lukasiewicz gives an overview of the author's recent work on nonmonotonic probabilistic logics under variable-strength inheritance with overriding. Moreover, it presents new algorithms and complexity results for probabilistic inference in these logics. It also describes the system NMPROBLOG, which implements the above algorithms for probabilistic inference.

The paper by Utkin and Augustin focuses on decision problems where uncertainty is represented through a recent generalization of Walley's Imprecise Dirichlet Model. This formulation is interesting in that it smoothly deals with incomplete observations, imprecise and vague assessments, and missing data. The authors present efficient algorithms for calculating optimal decisions with respect to several criteria, including Gamma-maximinity and E-admissibility, and connect their results to existing methods in the literature.

The paper by Wallner settles an important question that has been open for over a decade: how many extreme points can a set of probability measures specified by probability bounds have? The solution offered by Wallner not only shows this number to be at most $k!$ (where k is the dimension of the space), but it also uses remarkable proof techniques that are of interest in themselves.

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