Lecture Notes in Artificial Intelligence 10369

Subseries of Lecture Notes in Computer Science

More information about this series at http://www.springer.com/series/1244

Alessandro Antonucci · Laurence Cholvy
Odile Papini (Eds.)

Symbolic and Quantitative Approaches to Reasoning with Uncertainty

14th European Conference, ECSQARU 2017
Lugano, Switzerland, July 10–14, 2017
Proceedings

Springer

Editors
Alessandro Antonucci
IDSIA
Lugano
Switzerland

Laurence Cholvy
ONERA
Toulouse
France

Odile Papini
Aix-Marseille University
Marseille
France

ISSN 0302-9743 ISSN 1611-3349 (electronic)
Lecture Notes in Artificial Intelligence
ISBN 978-3-319-61580-6 ISBN 978-3-319-61581-3 (eBook)
DOI 10.1007/978-3-319-61581-3

Library of Congress Control Number: 2017943848

LNCS Sublibrary: SL7 – Artificial Intelligence

Printed on acid-free paper

This Springer imprint is published by Springer Nature
The registered company is Springer International Publishing AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Preface

The biennal ECSQARU conference is a major forum for advances in the theory and practice of reasoning under uncertainty. Contributions are provided by researchers in advancing the state of the art and practitioners using uncertainty techniques in applications. The scope of the conference includes, but is not limited to, fundamental and representation issues, reasoning, and decision-making in both qualitative and quantitative paradigms.

Previous ECSQARU conferences were held in Compiègne (2015), Utrecht (2013), Belfast (2011), Verona (2009), Hammamet (2007), Barcelona (2005), Aalborg (2003), Toulouse (2001), London (1999), Bonn (1997), Fribourg (1995), Granada (1993), and Marseille (1991).

The 14th European Conference on Symbolic and Quantitative Approaches to Reasoning with Uncertainty (ECSQARU 2017) was held in Lugano, Switzerland, during July 10–14, 2017. The event was co-located with the 10th International Symposium on Imprecise Probability: Theories and Applications (ISIPTA 2017).

A young researcher award granted by Springer for excellent research in the area of symbolic and quantitative approaches to reasoning with uncertainty was assigned to Nico Potyka.

The papers in this volume were selected from 63 submissions, after a strict single-blind review process by the members of the Program Committee. In addition, the volume contains the abstracts of five invited talks by outstanding researchers in the field: Leila Amgoud, Alessio Benavoli, Jim Berger, Didier Dubois, and Eyke Hüllermeier.

We would like to thank all the members of the Program Committee and the additional reviewers for their timely and valuable reviews. We also thank the members of the Organizing Committee for their work and contribution to the success of the conference.

We gratefully acknowledge operational support from IDSIA (Istituto Dalle Molle di Studi sull'Intelligenza Artificiale), USI (Università della Svizzera Italiana), and SUPSI (Scuola Universitaria Professionale della Svizzera Italiana) as well as financial support from ONERA.

July 2017

Alessandro Antonucci
Laurence Cholvy
Odile Papini

Organization

Executive Committee

Conference Chairs

Alessandro Antonucci	IDSIA, Switzerland
Laurence Cholvy	ONERA, France
Odile Papini	Aix-Marseille University, France

Organizing Committee

Alessandro Antonucci	IDSIA, Switzerland
Giorgio Corani	IDSIA, Switzerland

Program Committee

Leila Amgoud	IRIT, France
Nahla Ben Amor	LARODEC, Tunisia
Salem Benferhat	CRIL, France
Concha Bielza	Technical University of Madrid, Spain
Isabelle Bloch	ENST, France
Claudette Cayrol	IRIT, France
Giulianella Coletti	University of Perugia, Italy
Giorgio Corani	IDSIA, Switzerland
Inés Couso	University of Oviedo, Spain
Fabio G. Cozman	University of São Paulo, Brazil
Fabio Cuzzolin	Oxford Brookes University, UK
Luis De Campos	University of Granada, Spain
Thierry Denœux	UTC, France
Sébastien Destercke	UTC, France
Didier Dubois	IRIT, France
Florence Dupin de Saint-Cyr	IRIT, France
Zied Elouedi	LARODEC, Tunisia
Patricia Everaere	University of Lille 1, France
Alessandro Facchini	IDSIA, Switzerland
Hélène Fargier	IRIT, France
Laurent Garcia	University of Angers, France
Laura Giordano	University of Eastern Piedmont, Italy
Lluis Godo	CSIC-IIIA, Spain
Anthony Hunter	University College London, UK
Katsumi Inoue	National Institute of Informatics, Japan
Souhila Kaci	LIRMM, France

Gabriele Kern-Isberner	TU Dortmund University, Germany
Sébastien Konieczny	CRIL, France
Jérôme Lang	LAMSADE, France
Florence Le Ber	ENGEES, France
Philippe Leray	University of Nantes, France
Churn-Jung Liau	Academia Sinica, Taiwan
Weiru Liu	Queen's University Belfast, UK
Peter Lucas	Radboud University Nijmegen, The Netherlands
Francesca Mangili	IDSIA, Switzerland
Pierre Marquis	University of Artois, France
Maria Vanina Martinez	UNS, Argentina
Andrés Masegosa	NTNU, Norway
David Mercier	University of Artois, France
Enrique Miranda	University of Oviedo, Spain
Serafín Moral	University of Granada, Spain
Farid Nouioua	LSIS, France
Jose M. Peña	Linköping University, Sweden
Davide Petturiti	University of Perugia, Italy
Henri Prade	IRIT, France
Silja Renooij	Utrecht University, The Netherlands
Karim Tabia	CRIL, France
Choh Man Teng	IHMC, USA
Matthias Troffaes	Durham University, UK
Barbara Vantaggi	Sapienza University of Rome, Italy
Linda Van der Gaag	Utrecht University, The Netherlands
Leon van der Torre	University of Luxembourg, Luxembourg
Jiří Vomlel	UTIA, Czech Republic
Renata Wassermann	University of São Paulo, Brazil
Éric Würbel	LSIS, France

Additional Reviewers

Jérôme Delobelle	CRIL, France
Eduardo Fermé	University of Madeira, Portugal
Marcelo Finger	University of São Paulo, Brazil
Tommaso Flaminio	University of Insubria, Italy
Diogo Patrão	A.C. Camargo Cancer Center, Brazil
Martin Plajner	UTIA, Czech Republic
Ahmed Samet	IRISA, France
Nicolas Schwind	AIST, Japan
Gerardo. I. Simari	UNS, Argentina
Che-Ping Su	University of Melbourne, Australia
Sara Ugolini	University of Siena, Italy
Srdjan Vesic	CRIL, France
Chunlai Zhou	Renmin University of China, China

Sponsoring Institutions

USI/SUPSI IDSIA

ONERA THE FRENCH AEROSPACE LAB

Invited Talks

Evaluation Methods of Arguments: Current Trends and Challenges

Leila Amgoud

IRIT – CNRS, Toulouse, France

Argumentation is a reasoning process based on the justification of conclusions by arguments. Due to its explanatory power, it has become a hot topic in Artificial Intelligence. It is used for making decisions under uncertainty, learning rules, modeling different types of dialogs, and more importantly for reasoning about inconsistent information. Hence, an argument's conclusion may have different natures: a statement that is true or false, an action to do, a goal to pursue, etc. Furthermore, it has generally an *intrinsic strength*, which may represent different issues (the certainty degree of its reason, the importance of the value it promotes if any, the reliability of its source, …). Whatever its intrinsic strength (strong or weak), an argument may be weakened by other arguments (called *attackers*), and may be strengthened by others (called *supporters*). The overall acceptability of arguments needs then to be evaluated. Several evaluation methods, called semantics, were proposed for that purpose. In this talk, we show that they can be partitioned into three classes (extension semantics, gradual semantics, ranking semantics), which answer respectively to following questions:

1. What are the coalitions of arguments?
2. What is the overall strength of an argument?
3. How arguments can be rank-ordered from the most to the least acceptable ones?

We analyze the three classes against a set of rationality principles, and show that extension semantics are fundamentally different from the two other classes. This means that in concrete applications, they lead to different results. Namely, in case of reasoning with inconsistent information, extension semantics follow the same line of research as well-known syntactic approaches for handling inconsistency, while the two other classes lead to novel and powerful ranking logics. We argue that there is no universal evaluation method. The choice of a suitable method depends on the application at hand. Finally, we point out some challenges ahead.

Bayes + Hilbert = Quantum Mechanics

Alessio Benavoli

IDSIA, Lugano, Switzerland

Quantum mechanics (QM) is based on four main axioms, which were derived after a long process of trial and error. The motivations for the axioms are not always clear and even to experts the basic axioms of QM often appear counter-intuitive. In a recent paper, we have shown that:

- It is possible to derive quantum mechanics from a single principle of self-consistency or, in other words, that QM laws of Nature are logically consistent;
- QM is just the Bayesian theory generalised to the complex Hilbert space.

In particular, we have considered the problem of gambling on a quantum experiment and enforced rational behaviour by a few rules. These rules yield, in the classical case, the Bayesian theory of probability via duality theorems. In our quantum setting, they yield the Bayesian theory generalised to the space of Hermitian matrices. This very theory is QM: in fact, we have derived all its four postulates from the generalised Bayesian theory. This implies that QM is self-consistent. It also leads us to reinterpret the main operations in quantum mechanics as probability rules: Bayes' rule (measurement), marginalisation (partial tracing), independence (tensor product). To say it with a slogan, we have obtained that quantum mechanics is the Bayesian theory in the complex numbers.

Encounters with Imprecise Probabilities

Jim Berger

Duke University, Durham, USA

Although I have not formally done research in imprecise probability over the last twenty years, imprecise probability was central to much of my research in other areas. This talk will review some of these encounters with imprecise probability, taking examples from four areas:

- Using probabilities of a "higher type" (I.J. Good's phrase), with an application to genome-wide association studies.
- Robust Bayesian bounds, with an application to conversion of p-values to odds.
- Importance (and non-importance) of dependencies in imprecise probabilities.
- Imprecise probabilities arising from model bias, with examples from both statistical and physical modeling.

Symbolic and Quantitative Representations of Uncertainty: An Overview

Didier Dubois

IRIT, CNRS and University of Toulouse, Toulouse, France

The distinction between aleatory and epistemic uncertainty is more and more acknowledged to-date, and the idea that they should not be handled in the same way becomes more and more accepted. Aleatory uncertainty refers to a summarized description of natural phenomena by means of frequencies of occurrence, which justifies a numerical approach based on probability theory. In contrast, epistemic uncertainty stems from a lack of information, and describes the state of knowledge of an agent. It seems to be basically qualitative, and is captured by sets of possible worlds of states of nature, one of which is the actual one. In other words, beliefs induced by aleatory uncertainty are naturally quantitative, while this is less obvious for beliefs stemming from epistemic uncertainty for which there are various approaches ranging from qualitative ones like three-valued logics and modal logics to quantitative ones like subjective probabilities. The qualitative approaches can be refined by considering degrees of beliefs on finite value scales or yet by means of confidence relations. Moreover aleatory and epistemic uncertainty may come together, and leads to the use of upper and lower probabilities.

In this talk, we review the various approaches to the representations of uncertainty, by showing similarities between quantitative and qualitative approaches. We give a general definition of an epistemic state or an information item, as defining a set of possible values, a set of plausible ones, a plausibility ordering on events. Moreover, epistemic states must be compared in terms of informativeness.

The basic mathematical tool for representing uncertainty is the monotonic set-function, called capacity of fuzzy measure. In the quantitative case, the most general model is based on convex probability sets, that is, capacities that stand for lower probabilities. In the qualitative case, the simplest non-Boolean approach is based on possibility and necessity measures. It is shown that possibility theory plays in the qualitative setting a role similar to the one of probability theory in the quantitative setting. Just as a numerical capacity can, under some conditions, encode a family of probability distributions, a qualitative capacity always encodes a family of possibility distributions. For decision purposes, Sugeno integral is similar to Choquet integral.

Logical reasoning under incomplete information can be achieved by means of a simplified version of epistemic logic whose semantics is in terms of possibility theory, in contrast with probabilistic reasoning. It can be extended to reasoning with degrees of beliefs using generalised possibilistic logic. Various ways of defining logics of uncertainty are outlined, absolute, comparative, or fuzzy.

Finally we discuss the issue of uncertainty due to conflicting items of information. In the numerical setting this is naturally captured by the theory of evidence, that essentially models unreliable testimonies and their fusion. A general approach to the fusion of information items is outlined, proposing merging axioms that apply to quantitative and qualitative items of information. Finally, we show that using Boolean valued capacities, we can faithfully represent conflicting information coming from several sources. In this setting, necessity functions represent incomplete information while possibility measures represent precise but conflicting pieces of information.

This talk owes much to works performed with M. Banerjee, D. Ciucci, L. Godo, W. Liu and J. Ma, H. Prade, A. Rico, S. Schockaert, among others.

References

1. Banerjee, M., Dubois, D.: A simple logic for reasoning about incomplete knowledge. Int. J. Approx. Reason. **55**, 639–653 (2014)
2. Ciucci, D., Dubois, D.: A two-tiered propositional framework for handling multisource inconsistent information these proceedings (2017)
3. Dubois, D.: Representation, propagation, and decision issues in risk analysis under incomplete probabilistic information. Risk Anal. **30**, 361–368 (2010)
4. Dubois, D., Godo, L., Prade, H.: Weighted logics for artificial intelligence - an introductory discussion. Int. J. Approx. Reason. **55**(9), 1819–1829 (2014)
5. Dubois, D., Liu, W., Ma, J., Prade, H.: The basic principles of uncertain information fusion. An organised review of merging rules in different representation frameworks. Inf. Fusion **32**, 12–39 (2016)
6. Dubois, D., Prade, H., Rico, A.: Representing qualitative capacities as families of possibility measures. Int. J. Approx. Reason. **58**, 3–24 (2015)
7. Dubois, D., Prade, H., Schockaert, S.: Reasoning about uncertainty and explicit ignorance in generalized possibilistic logic. In: Proceedings of the ECAI 2014, pp. 261–266 (2014)
8. Ferson, S., Ginzburg, L.R.: Different methods are needed to propagate ignorance and variability. Reliab. Eng. Syst. Saf. **54**, 133–144 (1996)
9. Flage, R., Dubois, D., Aven, T.: Combined analysis of unique and repetitive events in quantitative risk assessment. Int. J. Approx. Reason. **70**, 68–78 (2016)
10. Grabisch, M.: Set functions, Games and Capacities in Decision-Making. Springer (2016)
11. Walley, P., Fine, T.: Varieties of modal: classificatory and comparative probabilities. Synthese **41**, 321–374 (1979)

Learning from Imprecise Data

Eyke Hüllermeier

Paderborn University, Paderborn, Germany

This talk addresses the problem of learning from imprecise data. Although it has been studied in statistics and various other fields for quite a while, this problem received renewed interest in the realm of machine learning more recently. In particular, the framework of superset learning will be discussed, a generalization of standard supervised learning in which training instances are labeled with a superset of the actual outcomes. Thus, superset learning can be seen as a specific type of weakly supervised learning, in which training examples are imprecise or ambiguous. We introduce a generic approach to superset learning, which is motivated by the idea of performing model identification and "data disambiguation" simultaneously. This idea is realized by means of a generalized risk minimization approach, using an extended loss function that compares precise predictions with set-valued observations. Building on this approach, we furthermore elaborate on the idea of "data imprecisiation": By deliberately turning precise training data into imprecise data, it becomes possible to modulate the influence of individual examples on the process of model induction. In other words, data imprecisiation offers an alternative way of instance weighting. Interestingly, several existing machine learning methods, such as support vector regression or semi-supervised support vector classification, are recovered as special cases of this approach. Besides, promising new methods can be derived in a natural way, and examples of such methods will be shown for problems such as classification, regression, and label ranking.

Contents

Belief Functions

Conditionals

Credal Sets, Credal Networks

Decision Theory, Decision Making and Reasoning Under Uncertainty

Fuzzy Sets, Fuzzy Logic

Logics

Orthopairs

Possibilistic Networks

Probabilistic Logics, Probabilistic Reasoning