Communications in Computer and Information Science 442

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Information Processing and Management of Uncertainty in Knowledge-Based Systems

15th International Conference, IPMU 2014
Montpellier, France, July 15-19, 2014
Proceedings, Part I

Springer

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ISSN 1865-0929 e-ISSN 1865-0937
ISBN 978-3-319-08794-8 e-ISBN 978-3-319-08795-5
DOI 10.1007/978-3-319-08795-5
Springer Cham Heidelberg New York Dordrecht London

Library of Congress Control Number: 2014942459

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Typesetting: Camera-ready by author, data conversion by Scientific Publishing Services, Chennai, India

Printed on acid-free paper

Springer is part of Springer Science+Business Media (www.springer.com)

Preface

Here we provide the proceedings of the 15th International Conference on Information Processing and Management of Uncertainty in Knowledge-based Systems, IPMU 2014, held in Montpellier, France, during July 15–19, 2014. The IPMU conference is organized every two years with the focus of bringing together scientists working on methods for the management of uncertainty and aggregation of information in intelligent systems.

This conference provides a medium for the exchange of ideas between theoreticians and practitioners working on the latest developments in these and other related areas. This was the 15th edition of the IPMU conference, which started in 1986 and has been held every two years in the following locations in Europe: Paris (1986), Urbino (1988), Paris (1990), Palma de Mallorca (1992), Paris (1994), Granada (1996), Paris (1998), Madrid (2000), Annecy (2002), Perugia (2004), Malaga (2008), Dortmund (2010) and Catania (2012).

Among the plenary speakers at past IPMU conferences, there have been three Nobel Prize winners: Kenneth Arrow, Daniel Kahneman, and Ilya Prigogine. An important feature of the IPMU Conference is the presentation of the Kampé de Fériet Award for outstanding contributions to the field of uncertainty. This year, the recipient was Vladimir N. Vapnik. Past winners of this prestigious award were Lotfi A. Zadeh (1992), Ilya Prigogine (1994), Toshiro Terano (1996), Kenneth Arrow (1998), Richard Jeffrey (2000), Arthur Dempster (2002), Janos Aczel (2004), Daniel Kahneman (2006), Enric Trillas (2008), James Bezdek (2010), Michio Sugeno (2012).

The program of the IPMU 2014 conference consisted of 5 invited academic talks together with 180 contributed papers, authored by researchers from 46 countries, including the regular track and 19 special sessions. The invited academic talks were given by the following distinguished researchers: Vladimir N. Vapnik (NEC Laboratories, USA), Stuart Russell (University of California, Berkeley, USA and University Pierre et Marie Curie, Paris, France), Inés Couso (University of Oviedo, Spain), Nadia Berthouze (University College London, United Kingdom) and Marcin Detyniecki (University Pierre and Marie Curie, Paris, France).

Industrial talks were given in complement of academic talks and highlighted the necessary collaboration we all have to foster in order to deal with current challenges from the real world such as Big Data for dealing with massive and complex data.

The success of IPMU 2014 was due to the hard work and dedication of a large number of people, and the collaboration of several institutions. We want to acknowledge the industrial sponsors, the help of the members of the International Program Committee, the reviewers of papers, the organizers of special sessions, the Local Organizing Committee, and the volunteer students. Most of all, we

appreciate the work and effort of those who contributed papers to the conference. All of them deserve many thanks for having helped to attain the goal of providing a high quality conference in a pleasant environment.

May 2014

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Invited Talks

Learning with Nontrivial Teacher

Vladimir Vapnik

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Abstract. In this talk I will discuss a new learning paradigm which uses an intelligent agent (nontrivial teacher), the so called Learning Using Privileged Information (LUPI) paradigm. In the LUPI learning paradigm in order to machine find a good decision rule using small number of training examples (say in pattern recognition problem) teacher during training session adds to the training examples some additional information (privileged information) such as comments, explanations, metaphoric reasoning, and so on. This information will not be available for testing. I will discuss the property of new learning model and the role of nontrivial teacher it relation to the general problem of inference and construction intelligent (that use different from brute force methods) machines.

New Challenges in Fuzzy Reasoning: When Practice and Theory Meet

Marcin Detyniecki

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Abstract. Fuzzy reasoning is a seminal tool for intelligent systems. It enables handling imprecise information and uncertain knowledge in real-world applications. Fuzzy reasoning can be seen as a process that finds a solution for a system of relational assignment equations. Generally, it is formulated as a compositional rule of inference, based on the modus ponens as deduction mechanism. This type of approximate reasoning is typically exploited in fuzzy rule-based systems. This general framework has played a key role in the success of fuzzy logic in general, and in particular, in the eyes of the general public with a number of intelligent applications.

Although approximate inference mechanisms and the underlying logic have been intensively studied, we observe that theoretical results do not necessarily address the challenges found in applications. Neither have the applied researchers integrated formal results in the engineering solution. This contribution aims at bringing some light to this matter.

In 1994, in a plenary talk titled "Fuzzy Logic and Soft Computing: Issues, Contentions and Perspectives", Lotfi Zadeh attributed the criticism towards fuzzy logic to a misunderstanding of what it is. He argued that fuzzy logic is used in two different senses: the narrow one, in which it is considered as a logical system which is an extension of multivalued logic; the broader sense, in which it is considered from a set-theory point of view as theory of classes with unsharp boundaries. At that time Zadeh pointed out that the success in terms of application, measured by the rapid growth in their number and their variety, is due to the fact that fuzzy logic in the broad sense has not only an enhanced ability to model real world problems thanks to its generality and expressive power, but also a capacity to achieve tractability and robustness with low solution cost. He also pointed out that, although there has been a certain progress in the understanding of this logic, the foundations needed to become firmer and its impact within mathematics more substantive.

Twenty years later, we observe that the theoretical foundations of fuzzy logic have been extremely well addressed, in particular in the logical strict sense. In parallel, fuzzy reasoning in the broad sense has been able to address complex issues in control, data analysis, and natural knowledge management in several application domains. Today, in order to take

fuzzy logic, and in particular fuzzy reasoning, to next level of performance, we need a better mutual understanding and interaction between researchers focusing on abstract theoretical structures and those focusing on operational intelligent systems. Twenty years ago Zadeh claimed that we need more foundations for fuzzy logic in the narrow sense. I advocate that now is time to reinforce the foundations of the *broad* fuzzy logic.

In this presentation centred on fuzzy reasoning, I will illustrate the gap that exists between available theoretical explanations, which are *de facto* fuzzy logic in the narrow sense, and practitioners expectations, who exploit fuzzy logic in a broad sense. In particular, I will use some successful applications in *multimedia information management* to show some paradoxical behaviours that may occur, *in practice*, when using standard fuzzy inference mechanisms. I will analyse these exemples from different perspectives by, in the one hand, formalising the underlying practical abstract motivations, and in the other hand, by providing theoretical explanations of the existing limitations. Moreover, I will show preliminary works - neither purely practical, neither theoretical - that provide some answers to the observed behaviours. These examples are intended to open some new tracks between the narrow and the broad fuzzy logic, around which the applied and the theoretical researcher can put up to start an exchange and a mutual understanding.

Acknowledgments. Results and reflections presented here are the result of a long collective work with different researchers from around the world, each having its own theoretical or applicative perspective. Without forgetting all with whom I have had enlightening discussions, I would to like to acknowledge my gratitude in particular to Sabrina Tollari, Marie-Jeanne Lesot, Maria Rifqi, Bernadette Bouchon-Meunier, Nicolas Labroche, Adrien Revault d'Allonnes, Christophe Marsala and all, my present and past, doctorate students.

What Does Your Body Tell Me...., Oh, ... and What Does It Tell You?

Nadia Berthouze

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Abstract. Recent years have seen the emergence of technology that involves and requires users to be engaged through their body. This has opened the possibility to better understand and exploit this modality to capture, respond to and regulate users' affective experience. Indeed, various studies in psychology have shown that our posture and body movement do communicate to others how we feel, and the intensity with which we feel, to the same extent that facial expressions and tone of voice do (for a review, see [1]). At the same time, studies have shown that body expressions are not only a window into one's emotional experience but they are also a mean to affect and regulate this experience (for a review, see [2]): the way we stand and the way we move affect our emotional state, our cognitive abilities and our attitude towards the events and environment that surround us and that we evaluate. In my talk, I will present a set of case studies that aim to show how these two sides of bodily expression can be used to design better and more effective technology.

Using applications in computer games [3,4], in physical rehabilitation [5] and in human-avatar interaction [6], I will show how body expressions can be used to automatically capture how the person feels. In doing so, I will also discuss the challenges raised by collecting, labelling and modelling naturalistic body expressions, as well as possible directions to address them. I will also bring into light how the availability of new devices and sensors make it possible to extend the study of body to aspects of it that are still under-investigated: touch behaviour as an extension of body behaviour [7] and muscle activity as the engine of body expressions.

Using the above case studies, I will discuss how this information could be used to adapt technology to better respond to the need of the user or of the goal to be achieved [8]. In particular, I will discuss how tracking the emotional states of the person through their body expressions offers new possibilities for self-directed rehabilitation. Emotional states are often forgotten when rehabilitation technology is designed with the main focus being on correcting movement. Unfortunately, correcting movement is not all what physical rehabilitation is about [9].

Finally, I will conclude by discussing how designers of full body technology could take advantage of what the body has to offer. I will present psychology and HCI research that aims to provide a principled approach

to the design of body movement to steer the user's emotional states towards what is most appropriate to the accomplishment of the task at hand [2,10].

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Table of Contents – Part I

Invited Talks

Preference Relations and Families of Probabilities: Different Sides of the Same Coin 1
Inés Couso

Unifying Logic and Probability: A New Dawn for AI? 10
Stuart Russell

On Uncertainty and Imprecision on the Web of Data

Two Procedures for Analyzing the Reliability of Open Government Data 15
Davide Ceolin, Luc Moreau, Kieron O'Hara, Wan Fokkink, Willem Robert van Hage, Valentina Maccatrozzo, Alistair Sackley, Guus Schreiber, and Nigel Shadbolt

Classification with Evidential Associative Rules 25
Ahmed Samet, Eric Lefèvre, and Sadok Ben Yahia

Towards Evidence-Based Terminological Decision Trees 36
Giuseppe Rizzo, Claudia d'Amato, Nicola Fanizzi, and Floriana Esposito

Uncertainty in Ontology Matching: A Decision Rule-Based Approach . . . 46
Amira Essaid, Arnaud Martin, Grégory Smits, and Boutheina Ben Yaghlane

Decision Support and Uncertainty Management in Agri-Environment

A Practical Application of Argumentation in French Agrifood Chains . . . 56
Madalina Croitoru, Rallou Thomopoulos, and Nouredine Tamani

Soft Fusion of Heterogeneous Image Time Series 67
Mar Bisquert, Gloria Bordogna, Mirco Boschetti, Pascal Poncelet, and Maguelonne Teisseire

Fuzzy Argumentation System for Decision Support 77
Nouredine Tamani and Madalina Croitoru

Applying a Fuzzy Decision Tree Approach to Soil Classification 87
Mariana V. Ribeiro, Luiz Manoel S. Cunha, Heloisa A. Camargo, and Luiz Henrique A. Rodrigues

Towards the Use of Sequential Patterns for Detection and Characterization of Natural and Agricultural Areas 97
Fabio Guttler, Dino Ienco, Maguelonne Teisseire, Jordi Nin, and Pascal Poncelet

Application of E^2M Decision Trees to Rubber Quality Prediction 107
Nicolas Sutton-Charani, Sébastien Destercke, and Thierry Denœux

An Interval Programming Approach for an Operational Transportation Planning Problem 117
Valeria Borodin, Jean Bourtembourg, Faicel Hnaien, and Nacima Labadie

Fuzzy Modeling of a Composite Agronomical Feature Using FisPro: The Case of Vine Vigor 127
Cécile Coulon-Leroy, Brigitte Charnomordic, Marie Thiollet-Scholtus, and Serge Guillaume

Fuzzy Implications

On Fuzzy Polynomial Implications 138
Sebastia Massanet, Juan Vicente Riera, and Daniel Ruiz-Aguilera

Implications Satisfying the Law of Importation with a Given Uninorm 148
Sebastia Massanet and Joan Torrens

Laws of Contraposition and Law of Importation for Probabilistic Implications and Probabilistic S-implications 158
Michał Baczyński, Przemysław Grzegorzewski, and Wanda Niemyska

Clustering

Sequential Clustering for Event Sequences and Its Impact on Next Process Step Prediction 168
Mai Le, Detlef Nauck, Bogdan Gabrys, and Trevor P. Martin

A Fuzzy Semisupervised Clustering Method: Application to the Classification of Scientific Publications 179
Irene Diaz-Valenzuela, Maria J. Martin-Bautista, and Maria-Amparo Vila

Using a Fuzzy Based Pseudometric in Classification 189
Sandra Sandri, Flávia Martins-Bedê, and Luciano Dutra

Fuzzy Measures and Integrals

Quasi-Lovász Extensions on Bounded Chains 199
Miguel Couceiro and Jean-Luc Marichal

Efficient and Scalable Nonlinear Multiple Kernel Aggregation Using the Choquet Integral 206
Lequn Hu, Derek T. Anderson, Timothy C. Havens, and James M. Keller

On the Informational Comparison of Qualitative Fuzzy Measures 216
Didier Dubois, Henri Prade, and Agnès Rico

Maxitive Integral of Real-Valued Functions 226
Marco E.G.V. Cattaneo

Fuzzy Weber Sets and Lováz Extensions of Cooperative Games 236
Nobusumi Sagara

Set Function Representations of Alternatives' Relative Features 246
Eiichiro Takahagi

2-additive Choquet Optimal Solutions in Multiobjective Optimization Problems 256
Thibaut Lust and Antoine Rolland

A Characterization of the 2-Additive Symmetric Choquet Integral Using Trinary Alternatives 266
Brice Mayag

Choquet Integral on Multisets 276
Yasuo Narukawa and Vicenç Torra

Rescaling for Evaluations Using Inclusion-Exclusion Integral 284
Aoi Honda, Ryoji Fukuda, and Jun Okamoto

Construction of a Bi-capacity and Its Utility Functions without any Commensurability Assumption in Multi-criteria Decision Making 294
Christophe Labreuche

Non-Classical Logics

Multi-valued Representation of Neutrosophic Information 304
Vasile Patrascu

Formalising Information Scoring in a Multivalued Logic Framework 314
Adrien Revault d'Allonnes and Marie-Jeanne Lesot

Tableau Calculus for Basic Fuzzy Logic BL 325
Agnieszka Kułacka

Possibilistic vs. Relational Semantics for Logics of Incomplete Information 335
Mohua Banerjee, Didier Dubois, and Lluis Godo

Resolution in Linguistic First Order Logic Based on Linear Symmetrical Hedge Algebra 345
Thi-Minh-Tam Nguyen, Viet-Trung Vu, The-Vinh Doan, and Duc-Khanh Tran

Data Analysis

A Fuzzy Set Based Evaluation of Suppliers on Delivery, Front Office Quality and Value-Added Services 355
Margaret F. Shipley, Gary L. Stading, and Jonathan Davis

A Fuzzy Rulebase Approach to Remap Gridded Spatial Data: Initial Observations 366
Jörg Verstraete

Fast and Incremental Computation for the Erosion Score 376
Gilles Moyse and Marie-Jeanne Lesot

Complexity of Rule Sets Induced from Incomplete Data Sets Using Global Probabilistic Approximations 386
Patrick G. Clark and Jerzy W. Grzymala-Busse

A Possibilistic View of Binomial Parameter Estimation 396
Gilles Mauris

Real-World Applications

A New Approach to Economic Production Quantity Problems with Fuzzy Parameters and Inventory Constraint 406
József Mezei and Kaj-Mikael Björk

Approximate Reasoning for an Efficient, Scalable and Simple Thermal Control Enhancement 416
Afef Denguir, François Trousset, and Jacky Montmain

Robust Statistical Process Monitoring for Biological Nutrient Removal Plants 427
Nabila Heloulou and Messaoud Ramdani

Considering Psychological Conditions in a Tsunami Evacuation Simulation 437
Saori Iwanaga and Yoshinori Matsuura

β-Robust Solutions for the Fuzzy Open Shop Scheduling 447
Juan José Palacios, Inés González-Rodríguez, Camino R. Vela, and Jorge Puente Peinador

Aggregation

Aggregation Operators on Bounded Partially Ordered Sets, Aggregative Spaces and Their Duality 457
Mustafa Demirci

Smart Fuzzy Weighted Averages of Information Elicited through Fuzzy Numbers 466
Andrea Capotorti and Gianna Figá-Talamanca

Analytical Hierarchy Process under Group Decision Making with Some Induced Aggregation Operators 476
Binyamin Yusoff and José Maria Merigó-Lindahl

Calibration of Utility Function and Mixture Premium 486
Jana Špirková

Probabilistic Networks

The General Expression of the Prior Convergence Error: A Proof 496
Janneke H. Bolt

On SPI for Evaluating Influence Diagrams 506
Rafael Cabañas, Anders L. Madsen, Andrés Cano, and Manuel Gómez-Olmedo

On Causal Compositional Models: Simple Examples 517
Radim Jiroušek

How to Create Better Performing Bayesian Networks: A Heuristic Approach for Variable Selection 527
Esma Nur Cinicioglu and Gülseren Büyükuğur

Recommendation Systems and Social Networks

A Highly Automated Recommender System Based on a Possibilistic Interpretation of a Sentiment Analysis 536
Abdelhak Imoussaten, Benjamin Duthil, François Trousset, and Jacky Montmain

Suggesting Recommendations Using Pythagorean Fuzzy Sets illustrated Using Netflix Movie Data 546
Marek Z. Reformat and Ronald R. Yager

Evidential Communities for Complex Networks 557
Kuang Zhou, Arnaud Martin, and Quan Pan

Fuzzy Systems

Probabilistic Fuzzy Systems as Additive Fuzzy Systems 567
Rui Jorge Almeida, Nick Verbeek, Uzay Kaymak, and João Miguel Da Costa Sousa

Measure Inputs to Fuzzy Rules 577
Ronald R. Yager

Interpretability in Fuzzy Systems Optimization: A Topological Approach 588
Ricardo de Aldama and Michaël Aupetit

Author Index 599

Table of Contents – Part II

Fuzzy Logic in Boolean Framework

Supplier Selection Using Interpolative Boolean Algebra and Logic Aggregation 1
Ksenija Mandic and Boris Delibasic

Finitely Additive Probability Measures in Automated Medical Diagnostics 10
Milica Knežević, Zoran Ognjanović, and Aleksandar Perović

Demonstrative Implecations of a New Logical Aggregation Paradigm on a Classical Fuzzy Evalution Modal of «Green» Buildings 20
Milan Mrkalj

Structural Functionality as a Fundamental Property of Boolean Algebra and Base for Its Real-Valued Realizations 28
Dragan G. Radojević

Management of Uncertainty in Social Networks

Fuzzy Concepts in Small Worlds and the Identification of Leaders in Social Networks 37
Trinidad Casasús-Estellés and Ronald R. Yager

Generating Events for Dynamic Social Network Simulations 46
Pascal Held, Alexander Dockhorn, and Rudolf Kruse

A Model for Preserving Privacy in Recommendation Systems 56
Luigi Troiano and Irene Díaz

Classification of Message Spreading in a Heterogeneous Social Network 66
Siwar Jendoubi, Arnaud Martin, Ludovic Liétard, and Boutheina Ben Yaghlane

Measures of Semantic Similarity of Nodes in a Social Network 76
Ahmad Rawashdeh, Mohammad Rawashdeh, Irene Díaz, and Anca Ralescu

From Different to Same, from Imitation to Analogy

Imitation and the Generative Mind 86
Jacqueline Nadel

Conditions for Cognitive Plausibility of Computational Models of Category Induction 93
Daniel Devatman Hromada

3D-Posture Recognition Using Joint Angle Representation 106
Adnan Al Alwani, Youssef Chahir, Djamal E. Goumidi, Michèle Molina, and François Jouen

Gesture Trajectories Modeling Using Quasipseudometrics and Pre-topology for Its Evaluation 116
Marc Bui, Soufian Ben Amor, Michel Lamure, and Cynthia Basileu

Analogy and Metaphors in Images 135
Charles Candau, Geoffrey Ventalon, Javier Barcenilla, and Charles Tijus

Soft Computing and Sensory Analysis

Fuzzy Transform Theory in the View of Image Registration Application 143
Petr Hurtík, Irina Perfilieva, and Petra Hodáková

Improved F-transform Based Image Fusion 153
Marek Vajgl and Irina Perfilieva

Visual Taxometric Approach to Image Segmentation Using Fuzzy-Spatial Taxon Cut Yields Contextually Relevant Regions 163
Lauren Barghout

Multi-valued Fuzzy Spaces for Color Representation 174
Vasile Patrascu

A New Edge Detector Based on Uninorms 184
Manuel González-Hidalgo, Sebastia Massanet, Arnau Mir, and Daniel Ruiz-Aguilera

Database Systems

Context-Aware Distance Semantics for Inconsistent Database Systems 194
Anna Zamansky, Ofer Arieli, and Kostas Stefanidis

An Analysis of the SUDOC Bibliographic Knowledge Base from a Link Validity Viewpoint 204
Léa Guizol, Olivier Rousseaux, Madalina Croitoru, Yann Nicolas, and Aline Le Provost

A Fuzzy Extension of Data Exchange 214
Jesús Medina and Reinhard Pichler

Fuzzy Set Theory

Fuzzy Relational Compositions Based on Generalized Quantifiers 224
Martin Štěpnička and Michal Holčapek

A Functional Approach to Cardinality of Finite Fuzzy Sets 234
Michal Holčapek

Piecewise Linear Approximation of Fuzzy Numbers Preserving the Support and Core 244
Lucian Coroianu, Marek Gagolewski, Przemysław Grzegorzewski, M. Adabitabar Firozja, and Tahereh Houlari

Characterization of the Ranking Indices of Triangular Fuzzy Numbers 254
Adrian I. Ban and Lucian Coroianu

New Pareto Approach for Ranking Triangular Fuzzy Numbers 264
Oumayma Bahri, Nahla Ben Amor, and Talbi El-Ghazali

MI-groups: New Approach 274
Martin Bacovský

Measurement and Sensory Information

On Combining Regression Analysis and Constraint Programming 284
Carmen Gervet and Sylvie Galichet

Graph-Based Transfer Learning for Managing Brain Signals Variability in NIRS-Based BCIs 294
Sami Dalhoumi, Gérard Derosiere, Gérard Dray, Jacky Montmain, and Stéphane Perrey

Design of a Fuzzy Affective Agent Based on Typicality Degrees of Physiological Signals 304
Joseph Onderi Orero and Maria Rifqi

Aggregation

Multilevel Aggregation of Arguments in a Model Driven Approach to Assess an Argumentation Relevance 314
Olivier Poitou and Claire Saurel

Analogical Proportions and Square of Oppositions 324
Laurent Miclet and Henri Prade

Towards a Transparent Deliberation Protocol Inspired from Supply Chain Collaborative Planning 335
Florence Bannay and Romain Guillaume

Encoding Argument Graphs in Logic 345
Philippe Besnard, Sylvie Doutre, and Andreas Herzig

Formal Methods for Vagueness and Uncertainty in a Many-Valued Realm

On General Properties of Intermediate Quantifiers 355
Vilém Novák and Petra Murinová

A Note on Drastic Product Logic 365
Stefano Aguzzoli, Matteo Bianchi, and Diego Valota

Fuzzy State Machine-Based Refurbishment Protocol for Urban Residential Buildings 375
Gergely I. Molnárka and László T. Kóczy

Exploring Infinitesimal Events through MV-algebras and non-Archimedean States 385
Denisa Diaconescu, Anna Rita Ferraioli, Tommaso Flaminio, and Brunella Gerla

Graduality

Accelerating Effect of Attribute Variations: Accelerated Gradual Itemsets Extraction 395
Amal Oudni, Marie-Jeanne Lesot, and Maria Rifqi

Gradual Linguistic Summaries 405
Anna Wilbik and Uzay Kaymak

Mining Epidemiological Dengue Fever Data from Brazil: A Gradual Pattern Based Geographical Information System 414
Yogi Satrya Aryadinata, Yuan Lin, C. Barcellos, Anne Laurent, and Therese Libourel

Preferences

A New Model of Efficiency-Oriented Group Decision and Consensus Reaching Support in a Fuzzy Environment 424
Dominika Gołuńska, Janusz Kacprzyk, and Sławomir Zadrożny

Aggregation of Uncertain Qualitative Preferences for a Group of Agents 434
Paolo Viappiani

Choquet Expected Utility Representation of Preferences on Generalized Lotteries 444
Giulianella Coletti, Davide Petturiti, and Barbara Vantaggi

Utility-Based Approach to Represent Agents' Conversational Preferences 454
Kaouther Bouzouita, Wided Lejouad Chaari, and Moncef Tagina

Alternative Decomposition Techniques for Label Ranking 464
Massimo Gurrieri, Philippe Fortemps, and Xavier Siebert

Uncertainty Management in Machine Learning

Clustering Based on a Mixture of Fuzzy Models Approach 475
Miguel Pagola, Edurne Barrenechea, Aránzazu Jurío, Daniel Paternain, and Humberto Bustince

Analogical Classification: A Rule-Based View 485
Myriam Bounhas, Henri Prade, and Gilles Richard

Multilabel Prediction with Probability Sets: The Hamming Loss Case 496
Sébastien Destercke

Cooperative Multi-knowledge Learning Control System for Obstacle Consideration 506
Syafiq Fauzi Kamarulzaman and Seiji Yasunobu

Building Hybrid Fuzzy Classifier Trees by Additive/Subtractive Composition of Sets 516
Arne-Jens Hempel, Holger Hähnel, and Gernot Herbst

Philosophy and History of Soft Computing

Applying CHC Models to Reasoning in Fictions 526
Luis A. Urtubey and Alba Massolo

Probabilistic Solution of Zadeh's Test Problems 536
Boris Kovalerchuk

Some Reflections on Fuzzy Set Theory as an Experimental Science 546
Marco Elio Tabacchi and Settimo Termini

Fuzziness and Fuzzy Concepts and Jean Piaget's Genetic Epistemology 556
Rudolf Seising

Paired Structures in Logical and Semiotic Models of Natural Language 566
J. Tinguaro Rodríguez, Camilo Franco De Los Ríos, Javier Montero, and Jie Lu

Soft Computing and Sensory Analysis

A Fuzzy Rule-Based Haptic Perception Model for Automotive Vibrotactile Display 576
Liviu-Cristian Duţu, Gilles Mauris, Philippe Bolon, Stéphanie Dabic, and Jean-Marc Tissot

A Linguistic Approach to Multi-criteria and Multi-expert Sensory Analysis 586
José Luis García-Lapresta, Cristina Aldavero, and Santiago de Castro

Using Fuzzy Logic to Enhance Classification of Human Motion Primitives 596
Barbara Bruno, Fulvio Mastrogiovanni, Alessandro Saffiotti, and Antonio Sgorbissa

Optimization of Human Perception on Virtual Garments by Modeling the Relation between Fabric Properties and Sensory Descriptors Using Intelligent Techniques 606
Xiaon Chen, Xianyi Zeng, Ludovic Koehl, Xuyuan Tao, and Julie Boulenguez-Phippen

Customization of Products Assisted by Kansei Engineering, Sensory Analysis and Soft Computing 616
Jose M. Alonso, David P. Pancho, and Luis Magdalena

Author Index 627

Table of Contents – Part III

Similarity Analysis

Robust Selection of Domain-Specific Semantic Similarity Measures from Uncertain Expertise 1
Stefan Janaqi, Sébastien Harispe, Sylvie Ranwez, and Jacky Montmain

Coping with Imprecision during a Semi-automatic Conceptual Indexing Process 11
Nicolas Fiorini, Sylvie Ranwez, Jacky Montmain, and Vincent Ranwez

A Fuzzy R Code Similarity Detection Algorithm 21
Maciej Bartoszuk and Marek Gagolewski

Fuzzy Logic, Formal Concept Analysis and Rough Set

L-Fuzzy Context Sequences on Complete Lattices 31
Cristina Alcalde and Ana Burusco

Variable-Range Approximate Systems Induced by Many-Valued L-Relations 41
Aleksandrs Eļkins, Sang-Eon Han, and Alexander Šostak

Introducing Similarity Relations in a Framework for Modelling Real-World Fuzzy Knowledge 51
Víctor Pablos-Ceruelo and Susana Muñoz-Hernández

An Approach Based on Rough Sets to Possibilistic Information 61
Michinori Nakata and Hiroshi Sakai

Antitone L-bonds 71
Jan Konecny

Minimal Solutions of Fuzzy Relation Equations with General Operators on the Unit Interval 81
Jesús Medina, Esko Turunen, Eduard Bartl, and Juan Carlos Díaz-Moreno

Generating Isotone Galois Connections on an Unstructured Codomain 91
Francisca García-Pardo, Inma P. Cabrera, Pablo Cordero, Manuel Ojeda-Aciego, and Francisco J. Rodríguez

Intelligent Databases and Information Systems

Fuzzy Core DBScan Clustering Algorithm 100
Gloria Bordogna and Dino Ienco

Estimating Null Values in Relational Databases Using Analogical Proportions 110
William Correa Beltran, Hélène Jaudoin, and Olivier Pivert

Exception-Tolerant Skyline Queries 120
Héléne Jaudoin, Olivier Pivert, and Daniel Rocacher

Towards a Gradual QCL Model for Database Querying 130
Ludovic Liétard, Allel Hadjali, and Daniel Rocacher

A Vocabulary Revision Method Based on Modality Splitting 140
Grégory Smits, Olivier Pivert, and Marie-Jeanne Lesot

Dealing with Aggregate Queries in an Uncertain Database Model Based on Possibilistic Certainty 150
Olivier Pivert and Henri Prade

Bipolar Comparison of 3D Ear Models 160
Guy De Tré, Dirk Vandermeulen, Jeroen Hermans, Peter Claeys, Joachim Nielandt, and Antoon Bronselaer

Theory of Evidence

A Logical Version of the Belief Function Theory 170
Laurence Cholvy

Evidential-EM Algorithm Applied to Progressively Censored Observations 180
Kuang Zhou, Arnaud Martin, and Quan Pan

A First Inquiry into Simpson's Paradox with Belief Functions 190
François Delmotte, David Mercier, and Frédéric Pichon

Comparison of Credal Assignment Algorithms in Kinematic Data Tracking Context 200
Samir Hachour, François Delmotte, and David Mercier

Towards a Conflicting Part of a Belief Function 212
Milan Daniel

Representing Interventional Knowledge in Causal Belief Networks: Uncertain Conditional Distributions Per Cause 223
Oumaima Boussarsar, Imen Boukhris, and Zied Elouedi

An Extension of the Analytic Hierarchy Process Method under the Belief Function Framework 233
Amel Ennaceur, Zied Elouedi, and Eric Lefèvre

Aggregation Functions

Pairwise and Global Dependence in Trivariate Copula Models 243
Fabrizio Durante, Roger B. Nelsen, José Juan Quesada-Molina, and Manuel Úbeda-Flores

On Additive Generators of Grouping Functions 252
Graçaliz Pereira Dimuro, Benjamín Bedregal, Humberto Bustince, Radko Mesiar, and María José Asiain

Fusion Functions and Directional Monotonicity 262
Humberto Bustince, Javier Fernandez, Anna Kolesárová, and Radko Mesiar

Solving Multi-criteria Decision Problems under Possibilistic Uncertainty Using Optimistic and Pessimistic Utilities 269
Nahla Ben Amor, Fatma Essghaier, and Hélène Fargier

Copula - Based Generalizations of OWA Operators 280
Radko Mesiar and Andrea Stupňanová

Generalized Product 289
Salvatore Greco, Radko Mesiar, and Fabio Rindone

Improving the Performance of FARC-HD in Multi-class Classification Problems Using the One-Versus-One Strategy and an Adaptation of the Inference System 296
Mikel Elkano, Mikel Galar, José Sanz, Edurne Barrenechea, Francisco Herrera, and Humberto Bustince

Pre-orders and Orders Generated by Conjunctive Uninorms 307
Dana Hliněná, Martin Kalina, and Pavol Král'

On Extensional Fuzzy Sets Generated by Factoraggregation 317
Pavels Orlovs and Svetlana Asmuss

Preassociative Aggregation Functions 327
Jean-Luc Marichal and Bruno Teheux

An Extended Event Reasoning Framework for Decision Support under Uncertainty 335
Wenjun Ma, Weiru Liu, Jianbing Ma, and Paul Miller

Adjoint Triples and Residuated Aggregators 345
María Eugenia Cornejo, Jesús Medina, and Eloisa Ramírez-Poussa

First Approach of Type-2 Fuzzy Sets via Fusion Operators 355
María Jesús Campión, Juan Carlos Candeal, Laura De Miguel, Esteban Induráin, and Daniel Paternain

Weakly Monotone Averaging Functions 364
Tim Wilkin, Gleb Beliakov, and Tomasa Calvo

Big Data - The Role of Fuzzy Methods

F-transform and Its Extension as Tool for Big Data Processing 374
Petra Hodáková, Irina Perfilieva, and Petr Hurtík

Fuzzy Queries over NoSQL Graph Databases: Perspectives for Extending the Cypher Language 384
Arnaud Castelltort and Anne Laurent

Learning Categories from Linked Open Data 396
Jesse Xi Chen and Marek Z. Reformat

The X-μ Approach: In Theory and Practice 406
Daniel J. Lewis and Trevor P. Martin

Imprecise Probabilities: From Foundations to Applications

Kolmogorov-Smirnov Test for Interval Data 416
Sébastien Destercke and Olivier Strauss

A Continuous Updating Rule for Imprecise Probabilities 426
Marco E.G.V. Cattaneo

Stable Non-standard Imprecise Probabilities 436
Hykel Hosni and Franco Montagna

Coherent T-conditional Possibility Envelopes and Nonmonotonic Reasoning 446
Giulianella Coletti, Davide Petturiti, and Barbara Vantaggi

Decision Making with Hierarchical Credal Sets 456
Alessandro Antonucci, Alexander Karlsson, and David Sundgren

A Propositional CONEstrip Algorithm 466
Erik Quaeghebeur

Multinomial Logistic Regression on Markov Chains for Crop Rotation Modelling 476
Lewis Paton, Matthias C.M. Troffaes, Nigel Boatman, Mohamud Hussein, and Andy Hart

Approximate Inference in Directed Evidential Networks with Conditional Belief Functions Using the Monte Carlo Algorithm 486
Wafa Laâmari, Narjes Ben Hariz, and Boutheina Ben Yaghlane

A Note on Learning Dependence under Severe Uncertainty 498
Matthias C.M. Troffaes, Frank P.A. Coolen, and Sébastien Destercke

Intelligent Measurement and Control for Nonlinear Systems

Brain Computer Interface by Use of Single Trial EEG on Recalling of Several Images 508
Takahiro Yamanoi, Hisashi Toyoshima, Mika Otsuki, Shin-ichi Ohnishi, Toshimasa Yamazaki, and Michio Sugeno

Model Reference Gain Scheduling Control of a PEM Fuel Cell Using Takagi-Sugeno Modelling 518
Damiano Rotondo, Vicenç Puig, and Fatiha Nejjari

Non-quadratic Stabilization for T-S Systems with Nonlinear Consequent Parts 528
Hoda Moodi, Jimmy Lauber, Thierry Marie Guerra, and Mohamad Farrokhi

Model Following Control of a Unicycle Mobile Robot via Dynamic Feedback Linearization Based on Piecewise Bilinear Models 539
Tadanari Taniguchi, Luka Eciolaza, and Michio Sugeno

An Anti-windup Scheme for PB Based FEL 549
Luka Eciolaza, Tadanari Taniguchi, and Michio Sugeno

Aggregation Functions

Some Aggregation Operators of General Misinformation 559
Doretta Vivona and Maria Divari

Author Index 565