## Lecture Notes in Artificial Intelligence 12256

## Subseries of Lecture Notes in Computer Science

#### Series Editors

Randy Goebel
University of Alberta, Edmonton, Canada
Yuzuru Tanaka
Hokkaido University, Sapporo, Japan
Wolfgang Wahlster
DFKI and Saarland University, Saarbrücken, Germany

### Founding Editor

Jörg Siekmann

DFKI and Saarland University, Saarbrücken, Germany

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

Vicenç Torra · Yasuo Narukawa · Jordi Nin · Núria Agell (Eds.)

# Modeling Decisions for Artificial Intelligence

17th International Conference, MDAI 2020 Sant Cugat, Spain, September 2–4, 2020 Proceedings



Editors
Vicenç Torra
Department of Computing Science
Umeå University
Umeå, Sweden

Jordi Nin D
Department of Operations,
Innovation and Data Sciences
ESADE
Sant Cugat, Spain

Yasuo Narukawa Department of Management Science Tamagawa University Tokyo, Japan

Núria Agell Department of Operations, Innovation and Data Sciences ESADE Sant Cugat, Spain

ISSN 0302-9743 ISSN 1611-3349 (electronic) Lecture Notes in Artificial Intelligence ISBN 978-3-030-57523-6 ISBN 978-3-030-57524-3 (eBook) https://doi.org/10.1007/978-3-030-57524-3

LNCS Sublibrary: SL7 - Artificial Intelligence

#### © Springer Nature Switzerland AG 2020

This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

The publisher, the authors and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, expressed or implied, with respect to the material contained herein or for any errors or omissions that may have been made. The publisher remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

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

#### **Preface**

This volume contains papers that were presented at the 17th International Conference on Modeling Decisions for Artificial Intelligence (MDAI 2020), in Sant Cugat del Vallès, Spain, September 2–4, 2020. Due to the COVID-19 pandemic the conference was canceled. Nevertheless, the submission process was already opened and we remained committed to the publication of the conference proceedings.

This conference followed MDAI 2004 (Barcelona), MDAI 2005 (Tsukuba), MDAI 2006 (Tarragona), MDAI 2007 (Kitakyushu), MDAI 2008 (Sabadell), MDAI 2009 (Awaji Island), MDAI 2010 (Perpinyà), MDAI 2011 (Changsha), MDAI 2012 (Girona), MDAI 2013 (Barcelona), MDAI 2014 (Tokyo), MDAI 2015 (Skövde), MDAI 2016 (Sant Julià de Lòria), MDAI 2017 (Kitakyushu), MDAI 2018 (Mallorca), and MDAI 2019 (Milan).

The aim of MDAI is to provide a forum for researchers to discuss different facets of decision processes in a broad sense. This includes model building and all kinds of mathematical tools for data aggregation, information fusion, and decision-making; tools to help make decisions related to data science problems (including, e.g., statistical and machine learning algorithms as well as data visualization tools); and algorithms for data privacy and transparency-aware methods so that data processing procedures and the decisions made from them are fair, transparent, and avoid unnecessary disclosure of sensitive information.

The MDAI conference included tracks on the topics of (a) data science, (b) machine learning, (c) data privacy, (d) aggregation functions, (e) human decision-making, (f) graphs and (social) networks, and (g) recommendation and search.

The organizers received 46 papers from 17 different countries, 24 of which are published in this volume. Each submission received at least three reviews from the Program Committee and a few external reviewers. We would like to express our gratitude to them for their work.

The conference was supported by ESADE-Institute for Data-Driven Decisions (esadeD3), the European Society for Fuzzy Logic and Technology (EUSFLAT), the Catalan Association for Artificial Intelligence (ACIA), the Japan Society for Fuzzy Theory and Intelligent Informatics (SOFT), and the UNESCO Chair in Data Privacy.

July 2020

Vicenç Torra Yasuo Narukawa Jordi Nin Núria Agell

## **Organization**

#### **General Chairs**

Jordi Nin ESADE, Universitat Ramon Llull, Spain ESADE, Universitat Ramon Llull, Spain Núria Agell

#### **Program Chairs**

Vicenc Torra Umeå University, Sweden Yasuo Narukawa Tamagawa University, Japan

#### **Advisory Board**

Didier Dubois Institut de Recherche en Informatique de Toulouse,

CNRS, France

San Francisco State University, USA Jozo Dujmović

Lluis Godo IIIA-CSIC, Spain

Kaoru Hirota Beijing Institute of Technology, JSPS Beijing Office,

China

Systems Research Institute, Polish Academy Janusz Kacprzyk

of Sciences, Poland

University of Tsukuba, Japan Sadaaki Miyamoto

Sandra Sandri Instituto Nacional de Pesquisas Espaciais, Brazil

Michio Sugeno Tokyo Institute of Technology, Japan

Machine Intelligence Institute, Iona Collegue, USA Ronald R. Yager

## **Program Committee**

Vladimir Estivill-Castro

Laya Aliahmadipour Shahid Bahonar University, Iran

Esteve Almirall ESADE, Spain

Plamen Angelov Lancaster University, UK

IIIA-CSIC, Spain Eva Armengol

Universidad Pública de Navarra, Spain Edurne Barrenechea Gloria Bordogna Consiglio Nazionale delle Ricerche, Italy Humberto Bustince Universidad Pública de Navarra, Spain Alina Campan North Kentucky University, USA

De Montfort University, UK Francisco Chiclana Universidad de Oviedo, Spain Susana Díaz

Universitat Rovira i Virgili, Spain Josep Domingo-Ferrer Yasunori Endo University of Tsukuba, Japan

Griffith University, Australia Universität Bremen, Germany Zoe Falomir

Giorgos Flouris

Camilo Andres Franco De

Los Rios

Katsushige Fujimoto

Joaquin Garcia-Alfaro

Michel Grabisch

Enrique Herrera-Viedma

Aoi Honda

Van-Nam Huynh

Masahiro Inuiguchi Simon James

Aránzazu Jurío Yuchi Kanzawa

Sema Kayapinar Kaya

Petr Krajča Marie-Jeanne Lesot

Jun Long

Jean-Luc Marichal Michael Mayo

Radko Mesiar Andrea

Mesiarová-Zemánková

Anna Monreale Javier Murillo

Toshiaki Murofushi Guillermo Navarro-Arribas

Tomaharu Nakashima Miguel Nunez-del-Prado

Anna Oganyan

Gabriella Pasi

Oriol Pujol Maria Riveiro

Pierangela Samarati H. Joe Steinhauer

László Szilágyi

Laszio Sziiagyi

Aida Valls Zeshui Xu Yuji Yoshida FORTH-ICS, Greece

Universidad de los Andes, Colombia

Fukushima University, Japan

Institut Mines-Télécom and Institut Polytechnique

de Paris, France

Université Paris I Panthéon-Sorbonne, France

Universidad de Granada, Spain

Kyushu Institute of Technology, Japan

JAIST, Japan

Osaka University, Japan Deakin University, Australia

Universidad Pública de Navarra, Spain Shibaura Institute of Technology, Japan

Munzur University, Turkey

Palacky University Olomouc, Czech Republic Université Pierre et Marie Curie (Paris VI), France National University of Defense Technology, China

University of Luxembourg, Luxembourg University of Waikato, New Zealand

Slovak University of Technology, Slovakia Slovak Academy of Sciences, Slovakia

University of Pisa, Italy

CIFASIS-CONICET, Argentina Tokyo Institute of Technology, Japan Universitat Autònoma de Barcelona, Spain

Osaka Prefecture University, Japan Universidad del Pacífico, Peru

National Institute of Statistical Sciences (NISS), USA

Università di Milano-Bicocca, Italy University of Barcelona, Spain Jönköping University, Sweden Università degli Studi di Milano, Italy

University of Skövde, Sweden

Sapientia-Hungarian Science University

of Transylvania, Hungary

Universitat Rovira i Virgili, Spain Southeast University, China University of Kitakyushu, Japan

#### **Additional Referees**

Jordi Casas Julián Salas Najeeb Jebreel Sergio Martinez Lluis Ashneet Khandpur Singh Rami Haffar

## **Supporting Institutions**

ESADE-Institute for Data-Driven Decisions
The European Society for Fuzzy Logic and Technology (EUSFLAT)
The Catalan Association for Artificial Intelligence (ACIA)
The Japan Society for Fuzzy Theory and Intelligent Informatics (SOFT)
The UNESCO Chair in Data Privacy

## **Contents**

Aggregation Operators and Decision Making	
A Characterization of Belief Merging Operators in the Regular Horn Fragment of Signed Logic	3
Bivariate Risk Measures and Stochastic Orders	16
Stochastic Orders on Two-Dimensional Space: Application to Cross Entropy	28
Modeling Decisions in AI: Re-thinking Linda in Terms of Coherent Lower and Upper Conditional Previsions	41
Ensemble Learning, Social Choice and Collective Intelligence:  An Experimental Comparison of Aggregation Techniques	53
An Unsupervised Capacity Identification Approach Based on Sobol' Indices	66
Probabilistic Measures and Integrals: How to Aggregate Imprecise Data Michał Boczek, Lenka Halčinová, Ondrej Hutník, and Marek Kaluszka	78
Distorted Probabilities and Bayesian Confirmation Measures	92
Constructive k-Additive Measure and Decreasing Convergence Theorems Ryoji Fukuda, Aoi Honda, and Yoshiaki Okazaki	104
Data science and Data Mining	
Generalization Property of Fuzzy Classification Function for Tsallis Entropy-Regularization of Bezdek-Type Fuzzy C-Means Clustering Yuchi Kanzawa	119

Nonparametric Bayesian Nonnegative Matrix Factorization	132
SentiRank: A System to Integrate Aspect-Based Sentiment Analysis and Multi-criteria Decision Support	142
Efficient Detection of Byzantine Attacks in Federated Learning Using Last Layer Biases.  Najeeb Jebreel, Alberto Blanco-Justicia, David Sánchez, and Josep Domingo-Ferrer	154
Multi-object Tracking Combines Motion and Visual Information Fan Wang, En Zhu, Lei Luo, and Jun Long	166
Classifying Candidate Axioms via Dimensionality Reduction Techniques Dario Malchiodi, Célia da Costa Pereira, and Andrea G. B. Tettamanzi	179
Sampling Unknown Decision Functions to Build Classifier Copies Irene Unceta, Diego Palacios, Jordi Nin, and Oriol Pujol	192
Towards Analogy-Based Explanations in Machine Learning	205
An Improved Bi-level Multi-objective Evolutionary Algorithm for the Production-Distribution Planning System	218
Modifying the Symbolic Aggregate Approximation Method to Capture Segment Trend Information	230
Efficiently Mining Gapped and Window Constraint Frequent Sequential Patterns  Hugo Alatrista-Salas, Agustin Guevara-Cogorno, Yoshitomi Maehara, and Miguel Nunez-del-Prado	240
Aggregating News Reporting Sentiment by Means of Hesitant Linguistic Terms	252
Decision Trees as a Tool for Data Analysis. Elections in Barcelona:  A Case Study	261

	Contents	xiii
Explaining Misclassification and Attacks in Deep Learning via Random Forests		273
Fair-MDAV: An Algorithm for Fair Privacy by Microaggregati Julián Salas and Vladimiro González-Zelaya	on	286
Author Index		299