

Founding Editors

Gerhard Goos

Karlsruhe Institute of Technology, Karlsruhe, Germany

Juris Hartmanis

Cornell University, Ithaca, NY, USA

Editorial Board Members

Elisa Bertino

Purdue University, West Lafayette, IN, USA

Wen Gao

Peking University, Beijing, China

Bernhard Steffen 

TU Dortmund University, Dortmund, Germany

Gerhard Woeginger 

RWTH Aachen, Aachen, Germany

Moti Yung

Columbia University, New York, NY, USA

More information about this series at <http://www.springer.com/series/7409>

Andreas Holzinger · Peter Kieseberg ·
A Min Tjoa · Edgar Weippl (Eds.)

Machine Learning and Knowledge Extraction

4th IFIP TC 5, TC 12, WG 8.4, WG 8.9, WG 12.9
International Cross-Domain Conference, CD-MAKE 2020
Dublin, Ireland, August 25–28, 2020
Proceedings

Editors

Andreas Holzinger 
Human-Centered AI Lab,
Institute for Medical Informatics,
Statistics and Documentation
Medical University Graz
Graz, Austria

xAI Lab, Alberta Machine
Intelligence Institute
University of Alberta
Edmonton, AB, Canada

Peter Kieseberg 
UAS St. Pölten
St. Pölten, Austria

Edgar Weippl
SBA Research
Vienna, Austria

Research Group Security and Privacy
University of Vienna
Vienna, Austria

A Min Tjoa 
Institute of Software Technology
and Interactive Systems
Technical University of Vienna
Vienna, Austria

ISSN 0302-9743 ISSN 1611-3349 (electronic)
Lecture Notes in Computer Science
ISBN 978-3-030-57320-1 ISBN 978-3-030-57321-8 (eBook)
<https://doi.org/10.1007/978-3-030-57321-8>

LNCS Sublibrary: SL3 – Information Systems and Applications, incl. Internet/Web, and HCI

© IFIP International Federation for Information Processing 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

The International Cross Domain Conference for MACHine Learning & Knowledge Extraction (CD-MAKE) is a joint effort of IFIP TC 5, TC 12, IFIP WG 8.4, IFIP WG 8.9, and IFIP WG 12.9 and is held in conjunction with the International Conference on Availability, Reliability and Security (ARES). The 4th conference was organized at the University College Dublin, Ireland and was held as a virtual event, due to the Corona pandemic. A few words about the International Federation for Information Processing (IFIP):

IFIP is the leading multi-national, non-governmental, apolitical organization in Information and Communications Technologies and Computer Sciences, is recognized by the United Nations (UN), and was established in the year 1960 under the auspices of the UNESCO as an outcome of the first World Computer Congress held in Paris in 1959.

IFIP is incorporated in Austria by decree of the Austrian Foreign Ministry (September 20, 1996, GZ 1055.170/120-I.2/96) granting IFIP the legal status of a non-governmental international organization under the Austrian Law on the Granting of Privileges to Non-Governmental International Organizations (Federal Law Gazette 1992/174).

IFIP brings together more than 3,500 scientists without boundaries from both academia and industry, organized in more than 100 Working Groups (WGs) and 13 Technical Committees (TCs).

CD stands for “Cross-Domain” and means the integration and appraisal of different fields and application domains to provide an atmosphere to foster different perspectives and opinions. The conference fosters an integrative machine learning approach, taking into account the importance of data science and visualization for the algorithmic pipeline with a strong emphasis on privacy, data protection, safety, and security. It is dedicated to offer an international platform for novel ideas and a fresh look on methodologies to put crazy ideas into business for the benefit of humans. Serendipity is a desired effect and shall cross-fertilize methodologies and transfer of algorithmic developments.

The acronym MAKE stands for “MACHine Learning & Knowledge Extraction,” a field of artificial intelligence (AI) that, while quite old in its fundamentals, has just recently begun to thrive based on both novel developments in the algorithmic area and the availability of vast computing resources at a comparatively low costs.

Machine learning (ML) studies algorithms that can learn from data to gain knowledge from experience and to generate decisions and predictions. A grand goal is in understanding intelligence for the design and development of algorithms that work autonomously (ideally without a human-in-the-loop) and can improve their learning behavior over time. The challenge is to discover relevant structural and/or temporal patterns (“knowledge”) in data, which is often hidden in arbitrarily high dimensional spaces, and thus simply not accessible to humans. Knowledge extraction is one of the

oldest fields in AI and sees a renaissance, particularly in the combination of statistical methods with classical ontological approaches. AI is currently undergoing a kind of Cambrian explosion and is the fastest-growing field in computer science today thanks to the usable successes in ML. There are many application domains, e.g., in medicine, etc., with many use cases from our daily lives, e.g., recommender systems, speech recognition, autonomous driving, etc. The grand challenges lie in sensemaking, in context understanding, and in decision-making under uncertainty, as well as solving the problem of explainability. Our real world is full of uncertainties and probabilistic inference enormously influenced AI generally and ML specifically. The inverse probability allows to infer unknowns, to learn from data, and to make predictions to support decision-making. Whether in social networks, recommender systems, health applications, or industrial applications, the increasingly complex data sets require a joint interdisciplinary effort bringing the human-in-control and to foster ethical, social issues, accountability, retractability, explainability, causability, and privacy, safety and security. This requires robust ML methods.

To acknowledge all those who contributed to the efforts and stimulating discussions would be impossible in a preface like this. Many people contributed to the development of this volume, either directly or indirectly, so it would be sheer impossible to list all of them. We herewith thank all local, national, and international colleagues and friends for their positive and supportive encouragement. Finally, we thank the Springer management team and the Springer production team for their professional support.

Thank you to all – Let's MAKE it!

June 2020

Andreas Holzinger
Peter Kieseberg
Edgar Weippl
A Min Tjoa

Organization

CD-MAKE Conference Organizers

Andreas Holzinger	Medical University and Graz University of Technology, Austria, and xAI Lab, Alberta Machine Intelligence Institute, University of Alberta, Canada
Peter Kieseberg	FH St.Pölten, Austria
Edgar Weippl (IFIP WG 8.4 Chair)	SBA Research, University of Vienna, Austria
A Min Tjoa (IFIP WG 8.9. Chair, Honorary Secretary IFIP)	TU Vienna, Austria

Program Committee

Amin Anjomshoaa	SENSEable City Laboratory, MIT Massachusetts Institute of Technology, USA
Jose Maria Alonso	CiTiUS, University of Santiago de Compostela, Spain
Mounir Ben Ayed	University of Sfax, Tunisia
Christian Bauckhage	ML/AI Lab, University of Bonn, Germany
Smaranda Belciug	University of Craiova, Romania
Jiang Bian	University of Florida, USA
Chris Biemann	Language Technology Group, FB Informatik, Universität Hamburg, Germany
Ivan Bratko	University of Ljubljana, Slovenia
Guido Bologna	Computer Vision and Multimedia Lab, Université de Genève, Switzerland
Francesco Buccafurri	Università degli Studi Mediterranea di Reggio Calabria, Italy
Federico Cabitza	Università degli Studi di Milano-Bicocca, DISCO, Italy
Mirko Cesarini	Università degli Studi di Milano-Bicocca, Italy
Ajay Chander	Stanford University, Fujitsu Labs of America, USA
Tim Conrad	Freie Universität Berlin, Institut für Mathematik, Medical Bioinformatics Group, Germany
Gloria Cerasela Crisan	Vasile Alecsandri University of Bacau, Romania
Andre Calero-Valdez	RWTH Aachen University, Germany
Angelo Cangelosi	Machine Learning and Robotics Lab, The University of Manchester, UK
Josep Domingo-Ferrer	UNESCO Chair in Data Privacy, Universitat Rovira i Virgili, Spain
Massimo Ferri	University of Bologna, Italy

Hugo Gamboa	PLUX Wireless Biosensors, Universidade Nova de Lisboa, Portugal
Panagiotis Germanakos	SAP SE, University of Cyprus, Cyprus
Randy Goebel	xAI Lab, University of Alberta, Canada
Pitoyo Hartono	Chukyo University, Japan
Barna Laszlo Iantovics	George Emil Palade University of Medicine, Pharmacy, Sciences and Technology of Targu Mures, Romania
Beatriz De La Iglesia	Knowledge Discovery & Data Mining Group, University of East Anglia, UK
Xiaoqian Jiang	University of California, San Diego, USA
Igor Jurisica	Krembil Research Institute, Canada
Epaminodas kapetanios	University of Westminster, UK
Andreas Kerren	ISOVIS Group, Linnaeus University, Sweden
Max Little	University of Birmingham, UK
Shujun Li	Kent Interdisciplinary Research Centre in Cyber Security (KirCCS), University of Kent, UK
Luca Longo	Technological University Dublin, Ireland
Daniele Magazzeni	Human-AI Teaming Lab, King's College London, UK
Bradley Malin	Vanderbilt University Medical Center, USA
Ljiljana Majnaric-Trtica	University of Osijek, Croatia
Yoan Miche	Nokia Bell Labs, Finland
Fabio Mercorio	Università degli Studi di Milano-Bicocca, Italy
Paolo Mignone	KDDE Lab, Università degli Studi di Bari Aldo Moro, Italy
Jan Paralic	Technical University of Kosice, Slovakia
Luca Romeo	Università Politecnica delle Marche, Istituto Italiano di Tecnologia, Italy
Pierangela Samarati	Università degli Studi di Milano-Bicocca, Italy
Andrzej Skowron	University of Warsaw, Poland
Catalin Stoean	University of Craiova, Romania
Dimitar Trajanov	Cyril and Methodius University, Macedonia
Daniel E. O'leary	University of Southern California, USA
Vasile Palade	Coventry University, UK
Camelia-M. Pintea	Technical University of Cluj-Napoca, Romania
Ivan Štajduhar	University of Rijeka, Croatia
Irena Spasic	Cardiff University, UK
Jianlong Zhou	University of Technology Sydney, Australia
Karin Verspoor	National Information and Communications Technology Australia, Australia
Jean Vanderdonckt	Université catholique de Louvain, Belgium

Contents

Explainable Artificial Intelligence: Concepts, Applications, Research Challenges and Visions	1
<i>Luca Longo, Randy Goebel, Freddy Lecue, Peter Kieseberg, and Andreas Holzinger</i>	
The Explanation Game: Explaining Machine Learning Models Using Shapley Values	17
<i>Luke Merrick and Ankur Taly</i>	
Back to the Feature: A Neural-Symbolic Perspective on Explainable AI.	39
<i>Andrea Campagner and Federico Cabitza</i>	
Explain Graph Neural Networks to Understand Weighted Graph Features in Node Classification.	57
<i>Xiaoxiao Li and João Saúde</i>	
Explainable Reinforcement Learning: A Survey	77
<i>Erika Puiutta and Eric M. S. P. Veith</i>	
A Projected Stochastic Gradient Algorithm for Estimating Shapley Value Applied in Attribute Importance	97
<i>Grah Simon and Thouvenot Vincent</i>	
Explaining Predictive Models with Mixed Features Using Shapley Values and Conditional Inference Trees	117
<i>Annabelle Redelmeier, Martin Jullum, and Kjersti Aas</i>	
Explainable Deep Learning for Fault Prognostics in Complex Systems: A Particle Accelerator Use-Case	139
<i>Lukas Felsberger, Andrea Apollonio, Thomas Cartier-Michaud, Andreas Müller, Benjamin Todd, and Dieter Kranzlmüller</i>	
eXDiL: A Tool for Classifying and eXplaining Hospital Discharge Letters.	159
<i>Fabio Mercorio, Mario Mezzanzanica, and Andrea Seveso</i>	
Cooperation Between Data Analysts and Medical Experts: A Case Study.	173
<i>Judita Rokošná, František Babič, Ljiljana Trtica Majnarič, and L'udmila Puzstová</i>	
A Study on the Fusion of Pixels and Patient Metadata in CNN-Based Classification of Skin Lesion Images	191
<i>Fabrizio Nunnari, Chirag Bhuvaneshwara, Abraham Obinwanne Ezema, and Daniel Sonntag</i>	

The European Legal Framework for Medical AI	209
<i>David Schneeberger, Karl Stöger, and Andreas Holzinger</i>	
An Efficient Method for Mining Informative Association Rules in Knowledge Extraction	227
<i>Parfait Bemarkisika and André Totohasina</i>	
Interpretation of SVM Using Data Mining Technique to Extract Syllogistic Rules: Exploring the Notion of Explainable AI in Diagnosing CAD	249
<i>Sanjay Sekar Samuel, Nik Nailah Binti Abdullah, and Anil Raj</i>	
Non-local Second-Order Attention Network for Single Image Super Resolution.	267
<i>Jiawen Lyn and Sen Yan</i>	
ML-ModelExplorer: An Explorative Model-Agnostic Approach to Evaluate and Compare Multi-class Classifiers	281
<i>Andreas Theissler, Simon Vollert, Patrick Benz, Laurentius A. Meerhoff, and Marc Fernandes</i>	
Subverting Network Intrusion Detection: Crafting Adversarial Examples Accounting for Domain-Specific Constraints.	301
<i>Martin Teuffenbach, Ewa Piatkowska, and Paul Smith</i>	
Scenario-Based Requirements Elicitation for User-Centric Explainable AI: A Case in Fraud Detection.	321
<i>Douglas Cirqueira, Dietmar Nedbal, Markus Helfert, and Marija Bezbradica</i>	
On-the-fly Black-Box Probably Approximately Correct Checking of Recurrent Neural Networks	343
<i>Franz Mayr, Ramiro Visca, and Sergio Yovine</i>	
Active Learning for Auditory Hierarchy.	365
<i>William Coleman, Charlie Cullen, Ming Yan, and Sarah Jane Delany</i>	
Improving Short Text Classification Through Global Augmentation Methods	385
<i>Vukosi Marivate and Tshephisho Sefara</i>	
Interpretable Topic Extraction and Word Embedding Learning Using Row-Stochastic DEDICOM.	401
<i>Lars Hillebrand, David Biesner, Christian Bauckhage, and Rafet Sifa</i>	
A Clustering Backed Deep Learning Approach for Document Layout Analysis	423
<i>Rhys Agombar, Max Luebbering, and Rafet Sifa</i>	

Calibrating Human-AI Collaboration: Impact of Risk, Ambiguity and Transparency on Algorithmic Bias 431
Philipp Schmidt and Felix Biessmann

Applying AI in Practice: Key Challenges and Lessons Learned. 451
Lukas Fischer, Lisa Ehrlinger, Verena Geist, Rudolf Ramler, Florian Sobieczky, Werner Zellinger, and Bernhard Moser

Function Space Pooling for Graph Convolutional Networks 473
Padraig Corcoran

Analysis of Optical Brain Signals Using Connectivity Graph Networks 485
Marco Antonio Pinto-Orellana and Hugo L. Hammer

Property-Based Testing for Parameter Learning of Probabilistic Graphical Models 499
Anna Saranti, Behnam Taraghi, Martin Ebner, and Andreas Holzinger

An Ensemble Interpretable Machine Learning Scheme for Securing Data Quality at the Edge 517
Anna Karanika, Panagiotis Oikonomou, Kostas Kolomvatsos, and Christos Anagnostopoulos

Inter-space Machine Learning in Smart Environments 535
Amin Anjomshoa and Edward Curry

Author Index 551