Proceedings

21st IEEE International Conference on Data Mining Workshops

ICDMW 2021

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21st IEEE International Conference on Data Mining Workshops

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2021 International Conference on Data Mining Workshops (ICDMW)

ICDMW 2021

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SENTIRE: Sentiment Elicitation from Natural Text for Information Retrieval and Extraction

DMS: Data Mining for Service

CLEATED: Continual Learning and Adaptation for Time Evolving Data

IncrLearn: Incremental classification and clustering, concept drift, novelty detection in big/fast data context

HDM: High Dimensional Data Mining

DMBIH: Data Mining in Biomedical Informatics and Healthcare

LITSA: Large-scale Industrial Time Series Analysis

UDML: Utility Driven Mining and Learning

MLLD: Mining and Learning in the Legal Domain

DLC: Deep Learning and Clustering

SSTDM: Spatial and Spatio-Temporal Data Mining

DMC: Data Mining and Machine Learning in Cybersecurity

EDMML: Evolutionary Data Mining and Machine Learning

SDM: Social Data Mining in the Post-pandemic Era

OEDM: Optimization Based Techniques for Emerging Data Mining Problems

IAAA: Intelligence-Augmented Anomaly Analytics

SFE-TSDM: Systematic Feature Engineering for Time-Series Data Mining

PhD Forum

Message from the ICDM 2021 General Chairs

On behalf of the organizing committee of the IEEE ICDM 2021 conference and our virtual host Auckland, New Zealand, it is our great pleasure to welcome you to the 2021 IEEE International Conference on Data Mining. Due to the COVID-19 global pandemic, IEEE ICDM 2021 will be hosted virtually for the second time.

Our goal is to run the conference in a way that replicates an in-person conference as best as we can, while leveraging events that can only happen virtually. We have live keynotes, tutorials, and special sessions. We also have speed-networking sessions, online activities, and are trialing a job matching program for the first time. Additionally, this is the first time there have been Reproducibility Chairs, and a Diversity and Inclusion Chair at ICDM. We hope to ultimately encapsulate this IEEE ICDM 2021 conference with our unique New Zealand hospitality.

The organization of a successful conference would not be possible without the dedicated efforts from many individuals. In particular, we would like to express our gratitude to the Program Chairs *Pauli Miettinen*, University of Eastern Finland (Finland), *James Bailey*, The University of Melbourne (Australia); Steering Committee Chair *Xindong Wu*, Mininglamp Academy of Sciences (China); Workshop Chairs *Bing Xue*, Victoria University of Wellington (New Zealand), *Mykola Pechenizkiy*, Eindhoven University of Technology (The Netherlands); Tutorial Chairs *Wei Liu*, University of Technology Sydney (Australia), *Katharina Morik*, TU Dortmund (Germany); Online Experience/Virtual Chair *Heitor Gomes*, University of Waikato (New Zealand); Publicity Chair *Diana Benavides Prado*, The University of Auckland (New Zealand); Finance Chair *Gillian Dobbie*, The University of Auckland (New Zealand); Sponsorship Chairs *Kaiqi Zhao*, The University of Auckland (New Zealand), *Philippe Fournier-Viger*, Harbin Institute of Technology (China), *Eva García-Martín*, Ekkono Solutions (Sweden); PhD Forum Chairs *Sibylle Hess*, Eindhoven University of Technology (The Netherlands), *Meng-Fen Chiang*, The University of Auckland (New Zealand), *Lisi Chen*, Inception Institute of Artificial Intelligence (IIAI) (UAE); Diversity and Inclusion Chair *Richi Nayak*, Queensland University of Technology (Australia); Job Matching Chairs *Albert Bifet*, University of Waikato (New Zealand), *Lin Liu*, University of South Australia (Australia); Panel Chairs *Chenliang Li*, Wuhan University (China), *Michael Witbrock*, The University of Auckland (New Zealand); Newcomers Chairs *Huan Liu*, Arizona State University (USA), *Katerina Taskova*, The University of Auckland (New Zealand); Local Arrangement Chair *Joerg Wicker*, The University of Auckland (New Zealand); Reproducibility Chairs *Dragi Kocev*, Jožef Stefan Institute (Slovenia), *Jacob Montiel*, University of Waikato (New Zealand); Award Committee Chair *Xia Ning*, The Ohio State University (USA).

We owe special thanks to our sponsors of the conference, including the US National Science Foundation (NSF), School of Computer Science - The University of Auckland, IEEE Technical Committee on Intelligent Informatics, Google and Two Sigma. We thank the authors, keynote speakers, special session speakers, panelists, and tutorial speakers for agreeing to present their sessions virtually. We also thank the workshop organizers for running their workshops virtually.

Finally, we thank all researchers, practitioners and students who are working in the field of data mining for their support and promotion of ICDM over the years. We wish you a productive conference with new discoveries, new collaborations and a very enjoyable virtual experience.

Yun Sing Koh and Dacheng Tao

IEEE ICDM 2021 General Co-Chairs

Message from the ICDM 2021 Program Chairs

Since its inception in 2001, the IEEE International Conference on Data Mining (ICDM) has become a premier forum for researchers, users, practitioners, and developers to exchange and disseminate not only original research results but also new research directions in data mining. The 21st IEEE ICDM is being hosted this year in Auckland, New Zealand and run as an entirely virtual conference, due to the COVID-19 pandemic

It is our great pleasure to welcome you to ICDM 2021 and to present its proceedings to you. The ICDM conference is truly an international forum. During its nineteen-year history, the conference has been held in ten countries around the world. This year's conference continues this global trend: Our organizing and program committee members represent around 36 countries/regions. This year's conference was extremely competitive. We are pleased to announce 990 paper submissions from 46 different countries/regions for review. Best efforts were made to ensure each paper was reviewed by at least three program committee members and the selection was made on the basis of discussion among the reviewers, an area chair, and the program co-chairs. Like previous years, we implemented a triple-blind review process, ensuring that the reviewers do not know the identity of the authors or of the other individuals reviewing the same submission. This process is intended to remove bias during the paper discussions. This year, 98 regular papers (9.9\% acceptance rate) and 100 short papers were selected for inclusion in the proceedings and program (giving a total acceptance rate of 20\%). Of the papers that were submitted, 573 (57.9\%) had student first authors. These authors represent the future of our field.

In keeping with the goal of advancing the state-of-the-art in data mining, paper topics span a range of areas including: novel data mining algorithms in traditional areas, models and algorithms for new, structured, data types; deep learning and its applications; mining sequences and sequential data; mining spatial and temporal datasets; mining textual and unstructured datasets; high performance implementations of data mining algorithms; stream data mining; mining and link analysis in networked settings; data mining in electronic commerce (e.g., recommendation); web search, advertising, and marketing tasks; methodological aspects and the KDD process; and healthcare, epidemic modeling, and clinical research.

In addition to the technical presentations, our program also highlights three outstanding keynotes given by internationally renowned, distinguished scientists Jian Pei (Simon Fraser University), Masashi Sugiyama (RIKEN Center for Advanced Intelligence Project / The University of Tokyo) and Svetha Venkatesh (Deakin University). Four tutorials will be offered and 21 workshops will be run in conjunction with the main conference. A job matching program will also be run as part of the conference. We would like to thank all those who invested their substantial efforts into making this conference what it is, starting with all the authors of the 990 manuscripts for submitting content for the conference. Reviewing and selecting papers from a large set of submissions required the coordinated effort of many individuals. We want to thank the 55 Area Chairs and 398 Program Committee members who provided insightful feedback to the authors and helped with this selection process.

Organizing the ICDM 2021 program required the time and expertise of numerous contributors. We are very thankful for the outstanding work of Bing Xue and Mykola Pechenizkiy who served as Workshop Co-Chairs, Wei Liu and Katharina Morik who were the Tutorial Co-Chairs, Lisi Chen, Sibylle Hess and and Meng-Fen Chiang who organized the PhD Forum, Chenliang Li and Michael Witbrock who were the Panel Co-Chairs, Diana Benvides Prado who served as Publicity Chair, sponsorship chairs Kaiqi Zhao, Philippe Fournier-Viger and Eva Garcia Martin, newcomers chairs Huan Liu and Katerina Taskova, job matching chairs Albert Bifet and Lin Liu, reproducibility chairs Dragi Kocev and Jacon Montiel, Xia Ning who chaired the Best Paper Award Committee, and Joerg Wicker, Gillian Dobbie, Heitor Gomes who served as Local Arrangement Chair, Finance Chair and Online experience/virtual Chair respectively.

The guidance of the Steering Committee Chair, Xindong Wu, and the General Co-Chairs, Yun Sing Koh and Dacheng Tao, were invaluable throughout each step of the conference organization and we wish to express our appreciation to them for their tireless efforts. We also would like to extend our special thanks to Juzhen Dong for the many hours she put in to maintain and enhance the Cyberchair web system to support the conference.

Finally, we thank the ICDM community for their support of this premier conference. We hope you enjoy the ICDM conference and that you are inspired by the ideas found in these papers.

James Bailey and Pauli Miettinen
ICDM 2021 Program Co-Chairs

Message from the Workshop Chairs

The 21th IEEE International Conference on Data Mining (IEEE ICDM 2021) is a premier and truly international conference for researchers and practitioners in the broad area of data mining. The ICDM Workshops program (IEEE ICDMW) aims to provide a platform for multiple workshops with a range of more focused topics to be discussed and explored, where attendees can present their original results, exchange research ideas, identify limitations, and explore new opportunities on the theoretical development and real-world applications of data mining techniques.

Due to the global COVID-19 pandemic, IEEE ICDMW was held on virtually on 7th December 2021, followed by the IEEE ICDM 2021 conference. This year, we receive 24 proposals. After the workshop proposal review, paper review and merging of workshops, the final IEEE ICDMW 2021 program consisted of 18 workshops, including 6 full-day and 12 half-day workshops. Overall, IEEE ICDMW received 266 papers while 131 papers (i.e. 50%) being presented in the final program. All the papers have been through a peer-review process to ensure high-quality papers being presented in the ICDMW 2021 proceedings.

A wide range of research topics in data mining have been included in IEEE ICDMW 2021, covering both theoretical research and real-world applications. Among the more traditional areas of data mining, ICDMW 2021 includes recommendation systems, information retrieval, information extraction, natural text, high-dimensional data mining, multi-source data, incremental learning, continual learning, sentiment analysis, deep learning, clustering, concept drift, novelty detection, feature engineering, time-series data mining, and data optimization. Furthermore, emerging research areas include data mining for bioinformatics, healthcare, engineering service, anomaly analytics, utility-driven data mining and learning, data in legal domain, spatial and spatio-temporal data mining, evolutionary computation based data mining, and cybersecurity.

It is no doubt that the success of ICDMW 2021 is a collective effort from many colleagues. Our particular thanks to all the workshop organizers for their delegate time and effort in preparing, and submitting their workshop proposals, managing their technical program committees, paper review, presentations, and invited talks from experts of their domains. Last but not least, we would like to thank all the reviewers for their thorough evaluations and constructive feedback to the papers, which ensure the high quality of the papers appeared in ICDMW 2021 and the support authors receive in further improving their work.

The PhD forum is featured by IEEE ICDM and continued to this year for the 10th year. As a tradition, the PhD forum aims to provide more opportunities for research students to present their works and communicate with their peers and senior researchers in the areas related to data mining. This forum particularly beneficial for PhD students in the early stage of their doctoral study, and MSc students who are planning to PhD study. The 2021 edition of the PhD forum includes 8 high-quality papers, spanning various topics of data mining and work in related fields including deep learning, crowdsourcing, statistical learning, anomaly detection, recommendation, and

reinforcement learning. Many thanks to the program committee members of the PhD forum this year, who helped with the selection of these high quality papers and who provided high quality review comments, under the guidance of the PhD forum Chairs Lisi Chen, Meng-Fen Chiang and Sibylle Hess.

The Workshop Chairs of IEEE ICDM 2021 would like to thank the Steering Committee Chair, Xindong Wu, and the General Chairs, Yun Sing Koh and Dacheng Tao, for their precious advices and leadership. We would also like to thank the Online Experience/Virtural Chair, Heitor Gomes, for the arrangement of the Workshops day. Furthermore, we also would like to thank the Program Chairs, Pauli Miettinen and James Bailey, for their substantial contribution to the organization of the conference, and the Finance Chair, Gillian Dobbie, for managing the finance and registration of the conference. Furthermore, special thanks to the Publicity Chair, Diana Benavides Prado, for her great effort on managing the conference web and social medias, and her valuable help with the call for workshop proposals and call for papers. Last but not least we would like to thank Giuseppe Di Fatta for passing their experience as Workshop Chairs from the past year edition. Thank you all for your great effort in making IEEE ICDMW 2021 a success!

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