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Jean-Jacques Rousseau · Bill Kapralos
Editors

Pattern Recognition, Computer Vision, and Image Processing

ICPR 2022 International Workshops
and Challenges

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Foreword

The organizers of the 26th International Conference on Pattern Recognition (ICPR 2022) are delighted to present the Proceedings of the event. The conference took place at Palais des Congrès de Montréal in Montreal, Canada, and we are thrilled to share the outcomes of this successful event.

We would like to express our heartfelt gratitude to the International Association for Pattern Recognition (IAPR) for sponsoring the conference, which allowed us to bring together a diverse group of researchers and experts in this field. Without their support, this conference would not have been possible.

We also want to extend our special thanks to the Workshop Chairs who provided excellent leadership in organizing the workshops. We appreciate the tireless efforts they put into making the workshops a success. We would also like to acknowledge the authors and presenters of the articles and workshops for their contributions. The high quality of their work and presentations enriched the conference.

Finally, we would like to thank the attendees for their participation, which made ICPR 2022 a truly collaborative and inspiring event. We hope that the Proceedings will serve as a valuable resource for those interested in pattern recognition and inspire future research in this field.

August 2022

Henrik I. Christensen
Michael Jenkin
Cheng-Lin Liu

Preface

The 26th International Conference on Pattern Recognition Workshops (ICPRW 2022) were held at the Palais des congrès de Montréal in Montreal, Quebec, Canada on Sunday August 21, 2022, one day earlier than the main ICPR conference. 27 workshop submissions were received and were carefully reviewed by the IAPR Conferences and Meetings committee and the workshop chairs. Considering their decisions and anticipated attendance, 24 workshops were selected and 21 workshops actually took place. Many of these workshops received a sponsorship or endorsement from the International Association for Pattern Recognition (IAPR).

ICPR 2022 marked the return of the conference to its in-person format (although workshops had the option of being held in person or remotely). This meant meeting colleagues face to face again, and making new connections to support scientific collaborations and (perhaps) even new friendships. The purpose of publishing the proceedings of a scientific conference such as ICPR 2022 include to:

- Establish a permanent record of the research presented;
- Report on the current research concerns and accomplishments of the conference participants;
- Make new research visible to scientific and other publics to promote collaboration, innovation, and discovery;
- Disseminate the latest research findings to a wider audience, in support of researchers, academics, industry, and other practitioners; and,
- Support the shared goal of staying up to date with developments in the fast moving field of artificial intelligence.

These volumes constitute the refereed proceedings of the twenty-one (21) workshops that were held in conjunction with ICPR 2022. The wide range of topics that it contains is a testament to the ever-widening concerns of AI researchers as they creatively find ways to apply artificial intelligence to domains further from its historical concerns. ICPR 2022 workshops covered domains related to pattern recognition, artificial intelligence, computer vision, and image and sound analysis. Workshop contributions reflected the most recent applications related to healthcare, biometrics, ethics, multimodality, cultural heritage, imagery, affective computing, and de-escalation. The papers included in these proceedings span four volumes and stem from the following workshops:

Volume I:

T-CAP 2022: Towards a Complete Analysis of People: From Face and Body to Clothes

HBU: 12th International Workshop on Human Behavior Understanding

SSL: Theories, Applications, and Cross Modality for Self-Supervised Learning Models

MPRSS 2022: Multimodal Pattern Recognition for Social Signal Processing in Human-Computer Interaction

FAIRBIO: Fairness in Biometric Systems

AIHA: Artificial Intelligence for Healthcare Applications

MDMR: Multimodal Data for Mental Disorder Recognition

Volume II:

MANPU 2022: 5th International Workshop on coMics ANalysis, Processing and Understanding

FOREST: Image Analysis for Forest Environmental Monitoring

MMFORWILD: MultiMedia FORensics in the WILD

IMTA: 8th International Workshop on Image Mining, Theory and Applications

PRHA: Pattern Recognition in Healthcare Analytics

IML: International Workshop on Industrial Machine Learning

Volume III:

PatReCH: 3rd International Workshop on Pattern Recognition for Cultural Heritage

XAIE: 2nd Workshop on Explainable and Ethical AI

PRRS: 12th Workshop on Pattern Recognition in Remote Sensing

CVAUI: Computer Vision for Analysis of Underwater Imagery

UMDBB: Understanding and Mitigating Demographic Bias in Biometric Systems

Volume IV:

AI4MFDD: Workshop on Artificial Intelligence for Multimedia Forensics and Disinformation Detection

AI4D: AI for De-escalation: Autonomous Systems for De-escalating Conflict in Military and Civilian Contexts

AMAR: 3rd International Workshop on Applied Multimodal Affect Recognition

Writing this preface, we were acutely aware of our special responsibilities towards those who will access the Proceedings for future reference. Unlike us and the contributors to these volumes, future readers will not have the benefit of having lived through the moment in which the research was conducted and presented. As background, leading to August 2022, there were two overarching meta-stories in the news: the COVID pandemic and social justice. COVID restrictions were lifted in piecemeal fashion leading to the conference dates, and began the long tail of the end of the pandemic. For conference attendees, wearing face masks was a live issue since masks indoors remained strongly recommended. International travel was still heavily impacted by COVID restrictions, with some participants being unable to travel either due to their COVID status or to the difficulty in meeting the range of COVID testing and inoculation requirements required. The public health theme continued with a new virus called ‘Monkeypox’ appearing on the scene.

On social justice, the May 25, 2020 murder of George Floyd by Minneapolis police officers continued to cast its shadow. During the summer of 2022, there continued to be protests and other actions to demand an end to anti-Black racism. In parallel, in Canada, Indigenous communities led protests and actions to demand an end to anti-Indigenous racism, and to acknowledge the historical circumstances that explain the discoveries of

remains of children in unmarked burial sites at former residential schools. As conference attendees and participants, we lived through this cultural moment and were marked by it. However, future readers may need to supplement these volumes with research into the circumstances in which the research was conceptualized, conducted, and received. Philosophers of science make a relevant distinction here. Since Karl Popper, they speak of the context of discovery and the context of justification. Justification in science is relatively well understood, as it relates to the collection and analysis of data in pursuit of evidence for evaluating hypotheses in conformity with norms referenced to as the ‘scientific method’. However, where do the initial questions or leaps of insights come from? The context of discovery is not as well understood. Still, it is widely believed that the social and personal conditions of researchers play an active role. We included a reference to the COVID-19 pandemic and social justice movements as widely shared preoccupations at the time of ICPR 2022 to aid a future reader who may wonder about the context of discovery of what is reported.

We acknowledge that future readers will no doubt enjoy benefits that we cannot enjoy. Specifically, they may be able to better assess which lines of research presented in the Proceedings proved the more beneficial. There are also concrete things: as we write, we do not know whether we are in a COVID pandemic hiatus or at its end; future readers will know the answer to this question.

The organization of such a large conference would not be possible without the help of many people. Our special gratitude goes to the Program Chairs (Gregory Dudek, Zhouchen Lin, Simone Marinai, Ingela Nyström) for their leadership in organizing the program. Thanks go to the Track Chairs and Area Chairs who dedicated their time to the review process and the preparation of the program. We also thank the reviewers who have evaluated the papers and provided authors with valuable feedback on their research work.

Finally, we acknowledge the work of conference committee members (Local Arrangements Chair and Committee Members, Finance Chairs, Workshop Chairs, Tutorial Chairs, Challenges Chairs, Publicity Chairs, Publications Chairs, Awards Chair, Sponsorship and Exhibition Chair) who strongly contributed to make this event successful. The MCI Group, led by Anjali Mohan, made great efforts in arranging the logistics, which is highly appreciated.

August 2022

Jean-Jacques Rousseau
Bill Kapralos

Organization

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Johana Hansen	McGill University, Canada
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Sponsorship and Exhibition Chair

Hong Zhang	China
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Challenges Chairs

Marco Bertini	University of Florence, Italy
Dimosthenis Karatzas	Universitat Autònoma de Barcelona, Spain

Track 1: Artificial Intelligence, Machine Learning for Pattern Analysis

Battista Biggio	Università degli Studi di Cagliari, Italy
Ambra Demontis	Università degli Studi di Cagliari, Italy
Gang Hua	Wormpex AI Research, University of Washington, USA
Dacheng Tao	University of Sydney, Australia

Track 2: Computer Vision and Robotic Perception

Olga Bellon	Universidade Federal do Parana, Brazil
Kosta Derpanis	York University, Canada
Ko Nishino	Kyoto University, Japan

Track 3: Image, Speech, Signal and Video Processing

Ana Fred	University of Lisbon, Portugal
Regina Lee	York University, Canada
Jingdong Wang	Baidu, China
Vera Yashina	Russian Academy of Sciences, Russian Federation

Track 4: Biometrics and Human-Computer Interaction

Kevin Bowyer	University of Notre Dame, USA
Kerstin Dautenhahn	University of Waterloo, Canada
Julian Fierrez	Universidad Autónoma de Madrid, Spain
Shiqi Yu	Southern University of Science and Technology, China

Track 5: Document Analysis and Recognition

Alexandra Branzan Albu	University of Victoria, Canada
Alicia Fornes	Universitat Autònoma de Barcelona, Spain
Koichi Kise	Osaka Prefecture University, Japan
Faisal Shafait	National University of Sciences and Technology, Pakistan

Track 6: Biomedical Imaging and Informatics

Hamid Abbasi
Ismail Bey Ayed
Lukas Käll
Dinggang Shen

Auckland Bioengineering Institute, New Zealand
Ecole de Technologie Superieure (ETS), Canada
KTH Royal Institute of Technology, Sweden
ShanghaiTech University, China

ICPR 2022 Workshops: Volume I

Towards a Complete Analysis of People: From Face and Body to Clothes (T-CAP)

Mohamed Daoudi	IMT Lille Douai, France
Roberto Vezzani	University of Modena and Reggio Emilia, Italy
Guido Borghi	University of Bologna, Italy
Marcella Cornia	University of Modena and Reggio Emilia, Italy
Claudio Ferrari	University of Parma, Italy
Federico Becattini	University of Florence, Italy
Andrea Pilzer	NVIDIA AI Technology Center, Italy

12th International Workshop on Human Behavior Understanding (HBU)

Albert Ali Salah	Utrecht University, The Netherlands
Cristina Palmero	University of Barcelona, Spain
Hugo Jair Escalante	National Institute of Astrophysics, Optics and Electronics, Mexico
Sergio Escalera	Universitat de Barcelona, Spain
Henning Müller	HES-SO Valais-Wallis, Switzerland

Theories, Applications, and Cross Modality for Self-Supervised Learning Models (SSL)

Yu Wang	NVIDIA, USA
Yingwei Pan	JD AI Research, China
Jingjing Zou	UC San Diego, USA
Angelica I. Aviles-Rivero	University of Cambridge, UK
Carola-Bibiane Schönlieb	University of Cambridge, UK
John Aston	University of Cambridge, UK
Ting Yao	JD AI Research, China

Multimodal Pattern Recognition of Social Signals in Human-Computer-Interaction (MPRSS 2022)

Mariofanna Milanova	University of Arkansas at Little Rock, USA
Xavier Alameda-Pineda	Inria, University of Grenoble-Alpes, France
Friedhelm Schwenker	Ulm University, Germany

Fairness in Biometric Systems (FAIRBIO)

Philipp Terhörst	Paderborn University, Germany
Kiran Raja	Norwegian University of Science and Technology, Norway
Christian Rathgeb	Hochschule Darmstadt, Germany
Abhijit Das	BITS Pilani Hyderabad, India
Ana Filipa Sequeira	INESC TEC, Portugal
Antitza Dantcheva	Inria Sophia Antipolis, France
Sambit Bakshi	National Institute of Technology Rourkela, India
Raghavendra Ramachandra	Norwegian University of Science and Technology, Norway
Naser Damer	Fraunhofer Institute for Computer Graphics Research IGD, Germany

2nd International Workshop on Artificial Intelligence for Healthcare Applications (AIHA 2022)

Nicole Dalia Cilia	Kore University of Enna, Italy
Francesco Fontanella	University of Cassino and Southern Lazio, Italy
Claudio Marrocco	University of Cassino and Southern Lazio, Italy

Workshop on Multimodal Data for Mental Disorder Recognition (MDMR)

Richang Hong	Hefei University of Technology, China
Marwa Mahmoud	University of Glasgow, UK
Bin Hu	Lanzhou University, China

ICPR 2022 Workshops: Volume II

5th International Workshop on coMics ANalysis, Processing and Understanding (MANPU 2022)

Jean-Christophe Burie	University of La Rochelle, France
Motoi Iwata	Osaka Metropolitan University, Japan
Miki Ueno	Osaka Institute of Technology, Japan

Image Analysis for Forest Environmental Monitoring (FOREST)

Alexandre Bernardino	Instituto Superior Técnico, Portugal
El Khalil Cherif	Instituto Superior Técnico, Portugal
Catarina Barata	Instituto Superior Técnico, Portugal
Alexandra Moutinho	Instituto Superior Técnico, Portugal
Maria João Sousa	Instituto Superior Técnico, Portugal
Hugo Silva	Instituto Superior de Engenharia do Porto, Portugal

MultiMedia FORensics in the WILD (MMFORWILD 2022)

Mauro Barni	University of Siena, Italy
Sebastiano Battiato	University of Catania, Italy
Giulia Boato	University of Trento, Italy
Hany Farid	University of California, Berkeley, USA
Nasir Memon	New York University, USA

Image Mining: Theory and Applications (IMTA-VIII)

Igor Gurevich	Federal Research Center Computer Science and Control of the Russian Academy of Sciences, Russian Federation
Davide Moroni	Institute of Information Science and Technologies, National Research Council of Italy, Italy

Maria Antonietta Pascali	Institute of Information Science and Technologies, National Research Council of Italy, Italy
Vera Yashina	Federal Research Center Computer Science and Control of the Russian Academy of Sciences, Russian Federation

**International Workshop on Pattern Recognition in Healthcare Analytics
(PRHA 2022)**

Inci Baytas	Bogazici University, Turkey
Edward Choi	Korea Advanced Institute of Science and Technology, South Korea
Arzucan Ozgur	Bogazici University, Turkey
Ayse Basar	Bogazici University, Turkey

International Workshop on Industrial Machine Learning (IML)

Francesco Setti	University of Verona, Italy
Paolo Rota	University of Trento, Italy
Vittorio Murino	University of Verona, Italy
Luigi Di Stefano	University of Bologna, Italy
Massimiliano Mancini	University of Tübingen, Germany

ICPR 2022 Workshops: Volume III

3rd International Workshop on Pattern Recognition for Cultural Heritage (PatReCH 2022)

Dario Allegra	University of Catania, Italy
Mario Molinara	University of Cassino and Southern Lazio, Italy
Alessandra Scotto di Freca	University of Cassino and Southern Lazio, Italy
Filippo Stanco	University of Catania, Italy

2nd Workshop on Explainable and Ethical AI (XAIE 2022)

Romain Giot	Univ. Bordeaux, France
Jenny Benois-Pineau	Univ. Bordeaux, France
Romain Bourqui	Univ. Bordeaux, France
Dragutin Petkovic	San Francisco State University, USA

12th Workshop on Pattern Recognition in Remote Sensing (PRRS)

Ribana Roscher	University of Bonn, Germany
Charlotte Pelletier	Université Bretagne Sud, France
Sylvain Lobry	Paris Descartes University, France

Computer Vision for Analysis of Underwater Imagery (CVAUI)

Maia Hoeberechts	Ocean Networks Canada, Canada
Alexandra Branzan Albu	University of Victoria, Canada

Understanding and Mitigating Demographic Bias in Biometric Systems (UMDBB)

Ajita Rattani	Wichita State University, USA
Michael King	Florida Institute of Technology, USA

ICPR 2022 Workshops: Volume IV

AI for De-escalation: Autonomous Systems for De-escalating Conflict in Military and Civilian Contexts (AI4D)

Victor Sanchez	University of Warwick, UK
Irene Amerini	Sapienza University of Rome, Italy
Chang-Tsun Li	Deakin University, Australia
Wei Qi Yan	Auckland University of Technology, New Zealand
Yongjian Hu	South China University of Technology, China
Nicolas Sidere	La Rochelle Université, France
Jean-Jacques Rousseau	York University, Canada

3rd Workshop on Applied Multimodal Affect Recognition (AMAR)

Shaun Canavan	University of South Florida, USA
Tempestt Neal	University of South Florida, USA
Saurabh Hinduja	University of Pittsburgh, USA
Marvin Andujar	University of South Florida, USA
Lijun Yin	Binghamton University, USA

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