Lecture Notes in Computer Science **11728**

More information about this series at http://www.springer.com/series/7407

Igor V. Tetko · Věra Kůrková ·
Pavel Karpov · Fabian Theis (Eds.)

Artificial Neural Networks and Machine Learning – ICANN 2019

Deep Learning

28th International Conference on Artificial Neural Networks
Munich, Germany, September 17–19, 2019
Proceedings, Part II

Springer

Editors
Igor V. Tetko
Helmholtz Zentrum München - Deutsches Forschungszentrum für Gesundheit und Umwelt (GmbH)
Neuherberg, Germany

Pavel Karpov
Helmholtz Zentrum München - Deutsches Forschungszentrum für Gesundheit und Umwelt (GmbH)
Neuherberg, Germany

Věra Kůrková
Institute of Computer Science
Czech Academy of Sciences
Prague 8, Czech Republic

Fabian Theis
Helmholtz Zentrum München - Deutsches Forschungszentrum für Gesundheit und Umwelt (GmbH)
Neuherberg, Germany

ISSN 0302-9743 ISSN 1611-3349 (electronic)
Lecture Notes in Computer Science
ISBN 978-3-030-30483-6 ISBN 978-3-030-30484-3 (eBook)
https://doi.org/10.1007/978-3-030-30484-3

LNCS Sublibrary: SL1 – Theoretical Computer Science and General Issues

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 fast development of machine learning methods is influencing all aspects of our life and reaching new horizons of what we have previously considered being Artificial Intelligence (AI). Examples include autonomous car driving, virtual assistants, automated customer support, clinical decision support, healthcare data analytics, financial forecast, and smart devices in the home, to name a few, which contribute to the dramatic improvement in the quality of our lives. These developments, however, also bring risks for significant hazards, which were not imaginable previously, e.g., falsification of voice, videos, or even manipulation of people's opinions during elections. Many such developments become possible due to the appearance of large volumes of data ("Big Data"). These proceedings include the theory and applications of algorithms behind these developments, many of which were inspired by the functioning of the brain.

The International Conference on Artificial Neural Networks (ICANN) is the annual flagship conference of the European Neural Network Society (ENNS). The 28th International Conference on Artificial Neural Networks (ICANN 2019) was co-organized with the final conference of the Marie Skłodowska-Curie Innovative Training Network European Industrial Doctorate "Big Data in Chemistry" (http://bigchem.eu) project coordinated by Helmholtz Zentrum München (GmbH) to promote the use of machine learning in Chemistry. The conference featured the main tracks "Brain-Inspired Computing" and "Machine Learning Research." Within the conference the First International Workshop on Reservoir Computing as well as five special sessions were organized, namely:

Artificial Intelligence in Medicine
Informed and Explainable Methods for Machine Learning
Deep Learning in Image Reconstruction
Machine Learning with Graphs: Algorithms and Applications
BIGCHEM: Big Data and AI in chemistry

A Challenge for Automatic Dog Age Estimation (DogAge) also took place as part of the conference. The conference covered all main research fields dealing with neural networks. ICANN 2019 was held during September 17–19, 2019, at Klinikum rechts der Isar der Technische Universität München, Munich, Germany.

Following a long-standing tradition, the proceedings of the conference were published as Springer volumes belonging to the *Lecture Notes in Computer Science* series. The conference had a historical record of 494 article submissions. The papers went through a two-step peer-review process by at least two and in majority of cases by three or four independent referees. In total, 503 Program Committee (PC) members and reviewers participated in this process. The majority of PC members had Doctoral degrees (88%) and 52% of them were also Professors. These reviewers were assigned 46 articles. The others were PhD students in the last years of their studies, who

reviewed one to two articles each. In total, for the 323 accepted articles, 975 and 985 reports were submitted for the first and the second revision sessions. Thus, on average, each accepted article received 6.1 reports. A list of reviewers/PC Members, who agreed to publish their names, are included in these proceedings.

Based on the reviewers' comments, 202 articles were accepted and more than 100 articles were rejected after the first review. The remaining articles received an undecided status. The authors of the accepted articles as well as of those with undecided status were requested to address the reviewers' comments within two weeks. On the basis of second reviewers' feedback, another 121 articles were accepted and the authors were requested to include reviewers' remarks into the final upload. Based on these evaluations, diversity of topics, as well as recommendations of reviewers, special session organizers, and PC Chairs, 120 articles were selected for oral presentations. Out of the total number of 323 accepted articles (65% of initially submitted), 46 manuscripts were short articles with a length of five pages each, while the others were full articles with an average length of 13 pages.

The accepted papers of the 28th ICANN conference were published as five volumes:

Volume I Theoretical Neural Computation
Volume II Deep Learning
Volume III Image Processing
Volume IV Text and Time series analysis
Volume V Workshop and Special Sessions

The authors of accepted articles came from 50 different countries. While the majority of the articles were from academic researchers, the conference also attracted contributions from manifold industries including automobile (Volkswagen, BMW, Honda, Toyota), multinational conglomerates (Hitachi, Mitsubishi), electronics (Philips), electrical systems (Thales), mobile (Samsung, Huawei, Nokia, Orange), software (Microsoft), multinational (Amazon) and global travel technology (Expedia), information (IBM), large (AstraZeneca, Boehringer Ingelheim) and medium (Idorsia Pharmaceuticals Ltd.) pharma companies, fragrance and flavor (Firmenich), architectural (Shimizu), weather forecast (Beijing Giant Weather Co.), robotics (UBTECH Robotics Corp., SoftBank Robotics Group Corp.), contract research organization (Lead Discovery Center GmbH), private credit bureau (Schufa), as well as multiple startups. This wide involvement of companies reflects the increasing use of artificial neural networks by the industry. Five keynote speakers were invited to give lectures on the timely aspects of intelligent robot design (gentle robots), nonlinear dynamical analysis of brain activity, deep learning in biology and biomedicine, explainable AI, artificial curiosity, and meta-learning machines.

These proceedings provide a comprehensive and up-to-date coverage of the dynamically developing field of Artificial Neural Networks. They are of major interest both for theoreticians as well as for applied scientists who are looking for new

innovative approaches to solve their practical problems. We sincerely thank the Program and Steering Committee and the reviewers for their invaluable work.

September 2019

Igor V. Tetko
Fabian Theis
Pavel Karpov
Věra Kůrková

Organization

General Chairs

Igor V. Tetko	Helmholtz Zentrum München (GmbH), Germany
Fabian Theis	Helmholtz Zentrum München (GmbH), Germany

Honorary Chair

Věra Kůrková (ENNS President)	Czech Academy of Sciences, Czech Republic

Publication Chair

Pavel Karpov	Helmholtz Zentrum München (GmbH), Germany

Local Organizing Committee Chairs

Monica Campillos	Helmholtz Zentrum München (GmbH), Germany
Alessandra Lintas	University of Lausanne, Switzerland

Communication Chair

Paolo Masulli	Technical University of Denmark, Denmark

Steering Committee

Erkki Oja	Aalto University, Finland
Wlodzislaw Duch	Nicolaus Copernicus University, Poland
Alessandro Villa	University of Lausanne, Switzerland
Cesare Alippi	Politecnico di Milano, Italy, and Università della Svizzera italiana, Switzerland
Jérémie Cabessa	Université Paris 2 Panthéon-Assas, France
Maxim Fedorov	Skoltech, Russia
Barbara Hammer	Bielefeld University, Germany
Lazaros Iliadis	Democritus University of Thrace, Greece
Petia Koprinkova-Hristova	Bulgarian Academy of Sciences, Bulgaria
Antonis Papaleonidas	Democritus University of Thrace, Greece
Jaakko Peltonen	University of Tampere, Finland
Antonio Javier Pons Rivero	Universitat Politècnica de Catalunya, Spain
Yifat Prut	The Hebrew University Jerusalem, Israel
Paul F. M. J. Verschure	Catalan Institute of Advanced Studies, Spain
Francisco Zamora-Martínez	Veridas Digital Authentication Solutions SL, Spain

Program Committee

Nesreen Ahmed	Intel Labs, USA
Narges Ahmidi	Helmholtz Zentrum München (GmbH), Germany
Tetiana Aksenova	Commissariat à l'énergie atomique et aux énergies alternatives, France
Elie Aljalbout	Technical University Munich, Germany
Piotr Antonik	CentraleSupélec, France
Juan Manuel Moreno-Arostegui	Universitat Politècnica de Catalunya, Spain
Michael Aupetit	Qatar Computing Research Institute, Qatar
Cristian Axenie	Huawei German Research Center Munich, Germany
Davide Bacciu	University of Pisa, Italy
Noa Barbiro	Booking.com, Israel
Igor Baskin	Moscow State University, Russia
Christian Bauckhage	Fraunhofer IAIS, Germany
Costas Bekas	IBM Research, Switzerland
Barry Bentley	The Open University, UK
Daniel Berrar	Tokyo Institute of Technology, Japan
Soma Bhattacharya	Expedia, USA
Monica Bianchini	Università degli Studi di Siena, Italy
François Blayo	NeoInstinct, Switzerland
Sander Bohte	Centrum Wiskunde & Informatica, The Netherlands
András P. Borosy	QualySense AG, Switzerland
Giosuè Lo Bosco	Universita' di Palermo, Italy
Farah Bouakrif	University of Jijel, Algeria
Larbi Boubchir	University Paris 8, France
Maria Paula Brito	University of Porto, Portugal
Evgeny Burnaev	Skoltech, Russia
Mikhail Burtsev	Moscow Institute of Physics and Technology, Russia
Jérémie Cabessa	Université Panthéon Assas (Paris II), France
Francisco de Assis Tenório de Carvalho	Universidade Federal de Pernambuco, Brazil
Wolfgang Graf zu Castell-Ruedenhausen	Helmholtz Zentrum München (GmbH), Germany
Stephan Chalup	University of Newcastle, Australia
Hongming Chen	AstraZeneca, Sweden
Artem Cherkasov	University of British Columbia, Canada
Sylvain Chevallier	Université de Versailles, France
Vladimir Chupakhin	Janssen Pharmaceutical Companies, USA
Djork-Arné Clevert	Bayer, Germany
Paulo Cortez	University of Minho, Portugal
Gennady Cymbalyuk	Georgia State University, USA
Maximilien Danisch	Pierre and Marie Curie University, France
Tirtharaj Dash	Birla Institute of Technology and Science Pilani, India
Tyler Derr	Michigan State University, USA

Sergey Dolenko	Moscow State University, Russia
Shirin Dora	University of Amsterdam, The Netherlands
Werner Dubitzky	Helmholtz Zentrum München (GmbH), Germany
Wlodzislaw Duch	Nicolaus Copernicus University, Poland
Ujjal Kr Dutta	Indian Institute of Technology Madras, India
Mohamed El-Sharkawy	Purdue School of Engineering and Technology, USA
Mohamed Elati	Université de Lille, France
Reda Elbasiony	Tanta University, Egypt
Mark Embrechts	Rensselaer Polytechnic Institute, USA
Sebastian Engelke	University of Geneva, Switzerland
Ola Engkvist	AstraZeneca, Sweden
Manfred Eppe	University of Hamburg, Germany
Peter Erdi	Kalamazoo College, USA
Peter Ertl	Novartis Institutes for BioMedical Research, Switzerland
Igor Farkaš	Comenius University in Bratislava, Slovakia
Maxim Fedorov	Skoltech, Russia
Maurizio Fiasché	F-engineering Consulting, Italy
Marco Frasca	University of Milan, Italy
Benoît Frénay	Université de Namur, Belgium
Claudio Gallicchio	Università di Pisa, Italy
Udayan Ganguly	Indian Institute of Technology at Bombay, India
Tiantian Gao	Stony Brook University, USA
Juantomás García	Sngular, Spain
José García-Rodríguez	University of Alicante, Spain
Erol Gelenbe	Institute of Theoretical and Applied Informatics, Poland
Petia Georgieva	University of Aveiro, Portugal
Sajjad Gharaghani	University of Tehran, Iran
Evgin Goceri	Akdeniz University, Turkey
Alexander Gorban	University of Leicester, UK
Marco Gori	Università degli Studi di Siena, Italy
Denise Gorse	University College London, UK
Lyudmila Grigoryeva	University of Konstanz, Germany
Xiaodong Gu	Fudan University, China
Michael Guckert	Technische Hochschule Mittelhessen, Germany
Benjamin Guedj	Inria, France, and UCL, UK
Tatiana Valentine Guy	Institute of Information Theory and Automation, Czech Republic
Fabian Hadiji	Goedle.io, Germany
Abir Hadriche	University of Sfax, Tunisia
Barbara Hammer	Bielefeld University, Germany
Stefan Haufe	ERC Research Group Leader at Charité, Germany
Dominik Heider	Philipps-University of Marburg, Germany
Matthias Heinig	Helmholtz Zentrum München (GmbH), Germany
Christoph Henkelmann	DIVISIO GmbH, Germany

Jean Benoit Héroux	IBM Research, Japan
Christian Hidber	bSquare AG, Switzerland
Martin Holeňa	Institute of Computer Science, Czech Republic
Adrian Horzyk	AGH University of Science and Technology, Poland
Jian Hou	Bohai University, China
Lynn Houthuys	Thomas More, Belgium
Brian Hyland	University of Otago, New Zealand
Nicolangelo Iannella	University of Oslo, Norway
Lazaros Iliadis	Democritus University of Thrace, Greece
Francesco Iorio	Wellcome Trust Sanger Institute, UK
Olexandr Isayev	University of North Carolina at Chapel Hill, USA
Keiichi Ito	Helmholtz Zentrum München (GmbH), Germany
Nils Jansen	Radboud University Nijmegen, The Netherlands
Noman Javed	Université d'Orléans, France
Wenbin Jiang	Huazhong University of Science and Technology, China
Jan Kalina	Institute of Computer Science, Czech Republic
Argyris Kalogeratos	Université Paris-Saclay, France
Michael Kamp	Fraunhofer IAIS, Germany
Dmitry Karlov	Skoltech, Russia
Pavel Karpov	Helmholtz Zentrum München (GmbH), Germany
John Kelleher	Technological University Dublin, Ireland
Adil Mehmood Khan	Innopolis, Russia
Rainer Kiko	GEOMAR Helmholtz-Zentrum für Ozeanforschung, Germany
Christina Klüver	Universität Duisburg-Essen, Germany
Taisuke Kobayashi	Nara Institute of Science and Technology, Japan
Ekaterina Komendantskaya	University of Dundee, UK
Petia Koprinkova-Hristova	Bulgarian Academy of Sciences, Bulgaria
Irena Koprinska	University of Sydney, Australia
Constantine Kotropoulos	Aristotle University of Thessaloniki, Greece
Ilias Kotsireas	Wilfrid Laurier University, Canada
Athanasios Koutras	University of Peloponnese, Greece
Piotr Kowalski	AGH University of Science and Technology, Poland
Valentin Kozlov	Karlsruher Institut für Technologie, Germany
Dean J. Krusienski	Virginia Commonwealth University, USA
Adam Krzyzak	Concordia University, Canada
Hanna Kujawska	University of Bergen, Norway
Věra Kůrková	Institute of Computer Science, Czech Republic
Sumit Kushwaha	Kamla Nehru Institute of Technology, India
Anna Ladi	Fraunhofer IAIS, Germany
Ward Van Laer	Ixor, Belgium
Oliver Lange	Google Inc., USA
Jiyi Li	University of Yamanashi, Japan
Lei Li	Beijing University of Posts and Telecommunications, China

Spiros Likothanassis	University of Patras, Greece
Christian Limberg	Universität Bielefeld, Germany
Alessandra Lintas	University of Lausanne, Switzerland
Viktor Liviniuk	MIT, USA, and Skoltech, Russia
Doina Logofatu	Frankfurt University of Applied Sciences, Germany
Vincenzo Lomonaco	Università di Bologna, Italy
Sock Ching Low	Institute for Bioengineering of Catalonia, Spain
Abhijit Mahalunkar	Technological University Dublin, Ireland
Mufti Mahmud	Nottingham Trent University, UK
Alexander Makarenko	National Technical University of Ukraine - Kiev Polytechnic Institute, Ukraine
Kleanthis Malialis	University of Cyprus, Cyprus
Fragkiskos Malliaros	University of Paris-Saclay, France
Gilles Marcou	University of Strasbourg, France
Urszula Markowska-Kaczmar	Wroclaw University of Technology, Poland
Carsten Marr	Helmholtz Zentrum München (GmbH), Germany
Giuseppe Marra	University of Firenze, Italy
Paolo Masulli	Technical University of Denmark, Denmark
Siamak Mehrkanoon	Maastricht University, The Netherlands
Stefano Melacci	Università degli Studi di Siena, Italy
Michael Menden	Helmholtz Zentrum München (GmbH), Germany
Sebastian Mika	Comtravo, Germany
Nikolaos Mitianoudis	Democritus University of Thrace, Greece
Valeri Mladenov	Technical University of Sofia, Bulgaria
Hebatallah Mohamed	Università degli Studi Roma, Italy
Figlu Mohanty	International Institute of Information Technology at Bhubaneswar, India
Francesco Carlo Morabito	University of Reggio Calabria, Italy
Jerzy Mościński	Silesian University of Technology, Poland
Henning Müller	University of Applied Sciences Western Switzerland, Switzerland
Maria-Viorela Muntean	University of Alba-Iulia, Romania
Phivos Mylonas	Ionian University, Greece
Shinichi Nakajima	Technische Universität Berlin, Germany
Kohei Nakajima	University of Tokyo, Japan
Chi Nhan Nguyen	Itemis, Germany
Florian Nigsch	Novartis Institutes for BioMedical Research, Switzerland
Giannis Nikolentzos	École Polytechnique, France
Ikuko Nishikawa	Ritsumeikan University, Japan
Harri Niska	University of Eastern Finland
Hasna Njah	ISIM-Sfax, Tunisia
Dimitri Nowicki	Institute of Cybernetics of NASU, Ukraine
Alessandro Di Nuovo	Sheffield Hallam University, UK
Stefan Oehmcke	University of Copenhagen, Denmark

Erkki Oja	Aalto University, Finland
Luca Oneto	Università di Pisa, Italy
Silvia Ortin	Institute of Neurosciences (IN) Alicante, Spain
Ivan Oseledets	Skoltech, Russia
Dmitry Osolodkin	Chumakov FSC R&D IBP RAS, Russia
Sebastian Otte	University of Tübingen, Germany
Latifa Oukhellou	The French Institute of Science and Technology for Transport, France
Vladimir Palyulin	Moscow State University, Russia
George Panagopoulos	École Polytechnique, France
Massimo Panella	Università degli Studi di Roma La Sapienza, Italy
Antonis Papaleonidas	Democritus University of Thrace, Greece
Evangelos Papalexakis	University of California Riverside, USA
Daniel Paurat	Fraunhofer IAIS, Germany
Jaakko Peltonen	Tampere University, Finland
Tingying Peng	Technische Universität München, Germany
Alberto Guillén Perales	Universidad de Granada, Spain
Carlos Garcia Perez	Helmholtz Zentrum München (GmbH), Germany
Isabelle Perseil	INSERM, France
Vincenzo Piuri	University of Milan, Italy
Kathrin Plankensteiner	Fachhochschule Vorarlberg, Austria
Isabella Pozzi	Centrum Wiskunde & Informatica, The Netherlands
Mike Preuss	Leiden University, The Netherlands
Yifat Prut	The Hebrew University of Jerusalem, Israel
Eugene Radchenko	Moscow State University, Russia
Rajkumar Ramamurthy	Fraunhofer IAIS, Germany
Srikanth Ramaswamy	Swiss Federal Institute of Technology (EPFL), Switzerland
Beatriz Remeseiro	Universidad de Oviedo, Spain
Xingzhang Ren	Alibaba Group, China
Jean-Louis Reymond	University of Bern, Switzerland
Cristian Rodriguez Rivero	University of California, USA
Antonio Javier Pons Rivero	Universitat Politècnica de Catalunya, Spain
Andrea Emilio Rizzoli	IDSIA, SUPSI, Switzerland
Florian Röhrbein	Technical University Munich, Germany
Ryan Rossi	PARC - a Xerox Company, USA
Manuel Roveri	Politecnico di Milano, Italy
Vladimir Rybakov	WaveAccess, Russia
Maryam Sabzevari	Aalto University School of Science and Technology, Finland
Julio Saez-Rodriguez	Medizinische Fakultät Heidelberg, Germany
Yulia Sandamirskaya	NEUROTECH: Neuromorphic Computer Technology, Switzerland
Carlo Sansone	University of Naples Federico II, Italy
Sreela Sasi	Gannon University, USA
Burak Satar	Uludag University, Turkey

Axel Sauer	Munich School of Robotics and Machine Intelligence, Germany
Konstantin Savenkov	Intento, Inc., USA
Hanno Scharr	Forschungszentrum Jülich, Germany
Tjeerd olde Scheper	Oxford Brookes University, UK
Rafal Scherer	Czestochowa University of Technology, Poland
Maria Secrier	University College London, UK
Thomas Seidl	Ludwig-Maximilians-Universität München, Germany
Rafet Sifa	Fraunhofer IAIS, Germany
Pekka Siirtola	University of Oulu, Finland
Prashant Singh	Uppsala University, Sweden
Patrick van der Smagt	Volkswagen AG, Germany
Maximilian Soelch	Volkswagen Machine Learning Research Lab, Germany
Miguel Cornelles Soriano	Campus Universitat de les Illes Balears, Spain
Miguel Angelo Abreu Sousa	Institute of Education Science and Technology, Brazil
Michael Stiber	University of Washington Bothell, USA
Alessandro Sperduti	Università degli Studi di Padova, Italy
Ruxandra Stoean	University of Craiova, Romania
Nicola Strisciuglio	University of Groningen, The Netherlands
Irene Sturm	Deutsche Bahn AG, Germany
Jérémie Sublime	ISEP, France
Martin Swain	Aberystwyth University, UK
Zoltan Szabo	Ecole Polytechnique, France
Kazuhiko Takahashi	Doshisha University, Japan
Fabian Theis	Helmholtz Zentrum München (GmbH), Germany
Philippe Thomas	Universite de Lorraine, France
Matteo Tiezzi	University of Siena, Italy
Ruben Tikidji-Hamburyan	Louisiana State University, USA
Yancho Todorov	VTT, Finland
Andrei Tolstikov	Merck Group, Germany
Matthias Treder	Cardiff University, UK
Anton Tsitsulin	Rheinische Friedrich-Wilhelms-Universität Bonn, Germany
Yury Tsoy	Solidware Co. Ltd., South Korea
Antoni Valencia	Independent Consultant, Spain
Carlos Magno Valle	Technical University Munich, Germany
Marley Vellasco	Pontifícia Universidade Católica do Rio de Janeiro, Brazil
Sagar Verma	Université Paris-Saclay, France
Paul Verschure	Institute for Bioengineering of Catalonia, Spain
Varvara Vetrova	University of Canterbury, New Zealand
Ricardo Vigário	University Nova's School of Science and Technology, Portugal
Alessandro Villa	University of Lausanne, Switzerland
Bruno Villoutreix	Molecular informatics for Health, France

Paolo Viviani	Università degli Studi di Torino, Italy
George Vouros	University of Piraeus, Greece
Christian Wallraven	Korea University, South Korea
Tinghuai Wang	Nokia, Finland
Yu Wang	Leibniz Supercomputing Centre (LRZ), Germany
Roseli S. Wedemann	Universidade do Estado do Rio de Janeiro, Brazil
Thomas Wennekers	University of Plymouth, UK
Stefan Wermter	University of Hamburg, Germany
Heiko Wersing	Honda Research Institute and Bielefeld University, Germany
Tadeusz Wieczorek	Silesian University of Technology, Poland
Christoph Windheuser	ThoughtWorks Inc., Germany
Borys Wróbel	Adam Mickiewicz University in Poznan, Poland
Jianhong Wu	York University, Canada
Xia Xiao	University of Connecticut, USA
Takaharu Yaguchi	Kobe University, Japan
Seul-Ki Yeom	Technische Universität Berlin, Germany
Hujun Yin	University of Manchester, UK
Junichiro Yoshimoto	Nara Institute of Science and Technology, Japan
Qiang Yu	Tianjin University, China
Shigang Yue	University of Lincoln, UK
Wlodek Zadrozny	University of North Carolina Charlotte, USA
Danuta Zakrzewska	Technical University of Lodz, Poland
Francisco Zamora-Martínez	Veridas Digital Authentication Solutions SL, Spain
Gerson Zaverucha	Federal University of Rio de Janeiro, Brazil
Junge Zhang	Institute of Automation, China
Zhongnan Zhang	Xiamen University, China
Pengsheng Zheng	Daimler AG, Germany
Samson Zhou	Indiana University, USA
Riccardo Zucca	Institute for Bioengineering of Catalonia, Spain
Dietlind Zühlke	Horn & Company Data Analytics GmbH, Germany

Exclusive Platinum Sponsor for the Automotive Branch

Keynote Talks

Recurrent Patterns of Brain Activity Associated with Cognitive Tasks and Attractor Dynamics (John Taylor Memorial Lecture)

Alessandro E. P. Villa

NeuroHeuristic Research Group, University of Lausanne,
Quartier UNIL-Chamberonne, 1015 Lausanne, Switzerland
alessandro.villa@unil.ch
http://www.neuroheuristic.org

The simultaneous recording of the time series formed by the sequences of neuronal discharges reveals important features of the dynamics of information processing in the brain. Experimental evidence of firing sequences with a precision of a few milliseconds have been observed in the brain of behaving animals. We review some critical findings showing that this activity is likely to be associated with higher order neural (mental) processes, such as predictive guesses of a coming stimulus in a complex sensorimotor discrimination task, in primates as well as in rats. We discuss some models of evolvable neural networks and their nonlinear deterministic dynamics and how such complex spatiotemporal patterns of firing may emerge. The attractors of such networks correspond precisely to the cycles in the graphs of their corresponding automata, and can thus be computed explicitly and exhaustively. We investigate further the effects of network topology on the dynamical activity of hierarchically organized networks of simulated spiking neurons. We describe how the activation and the biologically-inspired processes of plasticity on the network shape its topology using invariants based on algebro-topological constructions. General features of a brain theory based on these results is presented for discussion.

Unsupervised Learning: Passive and Active

Jürgen Schmidhuber

Co-founder and Chief Scientist, NNAISENSE, Scientific Director,
Swiss AI Lab IDSIA and Professor of AI, USI & SUPSI, Lugano, Switzerland

I'll start with a concept of 1990 that has become popular: unsupervised learning without a teacher through two adversarial neural networks (NNs) that duel in a mini-max game, where one NN minimizes the objective function maximized by the other. The first NN generates data through its output actions while the second NN predicts the data. The second NN minimizes its error, thus becoming a better predictor. But it is a zero sum game: the first NN tries to find actions that maximize the error of the second NN. The system exhibits what I called "artificial curiosity" because the first NN is motivated to invent actions that yield data that the second NN still finds surprising, until the data becomes familiar and eventually boring. A similar adversarial zero sum game was used for another unsupervised method called "predictability minimization," where two NNs fight each other to discover a disentangled code of the incoming data (since 1991), remarkably similar to codes found in biological brains. I'll also discuss passive unsupervised learning through predictive coding of an agent's observation stream (since 1991) to overcome the fundamental deep learning problem through data compression. I'll offer thoughts as to why most current commercial applications don't use unsupervised learning, and whether that will change in the future.

Machine Learning and AI for the Sciences—Towards Understanding

Klaus-Robert Müller

Machine Learning Group, Technical University of Berlin, Germany

In recent years machine learning (ML) and Artificial Intelligence (AI) methods have begun to play a more and more enabling role in the sciences and in industry. In particular, the advent of large and/or complex data corpora has given rise to new technological challenges and possibilities.

The talk will connect two topics (1) explainable AI (XAI) and (2) ML applications in sciences (e.g. Medicine and Quantum Chemistry) for gaining new insight. Specifically I will first introduce XAI methods (such as LRP) that are now readily available and allow for an understanding of the inner workings of nonlinear ML methods ranging from kernel methods to deep learning methods including LSTMs. In particular XAI allows unmasking clever Hans predictors. Then, ML for Quantum Chemistry is discussed, showing that ML methods can lead to highly useful predictors of quantum mechanical properties of molecules (and materials) reaching quantum chemical accuracies both across chemical compound space and in molecular dynamics simulations. Notably, these ML models do not only speed up computation by several orders of magnitude but can give rise to novel chemical insight. Finally, I will analyze morphological and molecular data for cancer diagnosis, also here highly interesting novel insights can be obtained.

Note that while XAI is used for gaining a better understanding in the sciences, the introduced XAI techniques are readily useful in other application domains and industry as well.

Large-Scale Lineage and Latent-Space Learning in Single-Cell Genomic

Fabian Theis

Institute of Computational Biology, Helmholtz Zentrum München (GmbH), Germany
http://comp.bio

Accurately modeling single cell state changes e.g. during differentiation or in response to perturbations is a central goal of computational biology. Single-cell technologies now give us easy and large-scale access to state observations on the transcriptomic and more recently also epigenomic level, separately for each single cell. In particular they allow resolving potential heterogeneities due to asynchronicity of differentiating or responding cells, and profiles across multiple conditions such as time points and replicates are being generated.

Typical questions asked to such data are how cells develop over time and after perturbation such as disease. The statistical tools to address these questions are techniques from pseudo-temporal ordering and lineage estimation, or more broadly latent space learning. In this talk I will give a short review of such approaches, in particular focusing on recent extensions towards large-scale data integration using single-cell graph mapping or neural networks, and finish with a perspective towards learning perturbations using variational autoencoders.

The Gentle Robot

Sami Haddadin

Technical University of Munich, Germany

Enabling robots for interaction with humans and unknown environments has been one of the primary goals of robotics research over decades. I will outline how human-centered robot design, nonlinear soft-robotics control inspired by human neuromechanics and physics grounded learning algorithms will let robots become a commodity in our near-future society. In particular, compliant and energy-controlled ultra-lightweight systems capable of complex collision handling enable high-performance human assistance over a wide variety of application domains. Together with novel methods for dynamics and skill learning, flexible and easy-to-use robotic power tools and systems can be designed. Recently, our work has led to the first next generation robot Franka Emika that has recently become commercially available. The system is able to safely interact with humans, execute and even learn sensitive manipulation skills, is affordable and designed as a distributed interconnected system.

Contents – Part II

Weights Initialization

Parameters Optimisation

Pruning Networks

Domain Knowledge Incorporation

Domain Adaptation Approaches

Multiclass