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Editorial

Advances in artificial neural networks, machine learning and computational intelligence

This special issue of *Neurocomputing* presents 16 original articles that are extended versions of selected papers from the *24th European Symposium on Artificial Neural Networks (ESANN)*, a major event for researchers in the fields of artificial neural networks, machine learning, computational intelligence, and related topics. This single track conference occurs annually in Bruges, Belgium, a UNESCO World Heritage Site by one of the most beautiful medieval city centers in Europe. It is organised in collaboration by UCL (Université Catholique de Louvain—Louvain-la-Neuve) and KULeuven (Katholiek Universiteit—Leuven) and is steered by Prof. Michel Verleysen from UCL. In addition to regular sessions, the conference welcomes special sessions organised by renowned scientists in their respective fields. These sessions focus on particular topics, such as medical applications, physics, deep learning, indefinite proximity learning, information visualisation, incremental learning and advances in learning with kernels.

The contributions in this special issue show that *ESANN* covers a broad range of topics in neural computing and neuroscience, from theoretical aspects to state-of-the-art applications. More than 120 researchers from 20 countries participated in the *24th ESANN in April 2016*. Around 100 oral and poster communications have been presented this year. Based on the reviewers' and special session organisers' recommendations, as well as on the quality of the oral presentations at the conference, a number of authors were invited to submit an extended version of their conference paper for this special issue of *Neurocomputing*. All extended manuscripts were thoroughly reviewed once more by at least two independent experts and the 16 articles presented in this volume were accepted for publication. They can be grouped as follows.

Kernels

(1) *Measuring the Expressivity of Graph Kernels through the Rademacher Complexity*
Luca Oneto, Nicolò Navarin, Michele Donini, Alessandro Sperduti, Fabio Aiolli, Davide Anguita

This paper proposes different formal definitions of expressiveness of a kernel by exploiting the most recent results in the field of Statistical Learning Theory for the purpose of analyzing the differences between state-of-the-art Graph Kernels. The proposal has been tested on a series of real world datasets and results confirm some known properties of Graph Kernels.

(2) *Exploiting Sparsity to Build Efficient Kernel Based Collaborative Filtering for Top-N Item Recommendation*
Mirko Polato, Fabio Aiolli

This work proposes a collaborative filtering kernel-based framework for the top-N recommendation task, and it provides a method for sparsifying dot-product kernels in order to improve the efficiency. It also analyses, both theoretically and empirically, the elements which influence the sparsity of standard cosine kernels, in particular the effects of the long-tail distribution, which is peculiar in collaborative filtering datasets.

(3) *Fast Kernel Spectral Clustering*
Rocco Langone, Johan Suykens

The paper presents an algorithm, called Fixed-Size Kernel Spectral Clustering (FSKSC), that allows to cope with very large datasets. It is based on an unconstrained formulation of the Kernel Spectral Clustering (KSC) primal optimization problem defined on an approximate explicit feature map induced by Nyström approximation.

Indefinite proximity learning

(4) *Efficient Kernelization of Discriminative Dimensionality Reduction*
Alexander Schulz, Johannes Brinkrolf, Barbara Hammer

In the field of discriminative dimensionality reduction, the Fisher-t-SNE is restricted to vectorial data. This paper proposes an extension that relies only on the similarity between examples. Doing so, any kind of non-vectorial data for which similarity is available can benefit from those Di-Di methods, in particular from the visualization point of view.

(5) *Types of (Dis-)Similarities and Adaptive Mixtures thereof for Improved Classification Learning*
Thomas Villmann, David Nebel, Marika Kaden, Andrea Bohnsack

The paper proposes a framework to categorize similarity and dissimilarity measures. It introduces the notion of rank equivalence and related absolute rank equivalence measures allowing to compare not only similarity measures but also similarity measures with respect to dissimilarity measures. An adaptive mixture approach of (dis)similarity measures is also proposed for LVQ networks.

Regression and mathematical models

(6) *Modelling of Parametrised Processes via Regression in the Model Space of Neural Network*
Witali Aswolinskiy, Felix Reinhart, Jochen J. Steil

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The paper presents a method for decoupling the training of models when the models have parameters linked to the process being modelled. It focuses on two quite related models, extreme learning machine and echo state network. It shows that, rather than creating one single model using both process parameters and model parameters, it is easier in terms of learning (leading to better results in terms of generalisation) to train a kind of meta model whose output will be, given a set of process parameter values, a model tuned for those process parameters. The method is applied in two interesting real applications: wire bonding and robotic manipulator.

(7) *Converting SVDD Scores into Probability Estimates: Application to Outlier Detection*
Meriem El Azami, Carole Lartizien, Stéphane Canu

This paper presents an outlier detection method based on SVDD (Support Vector Data Description). To achieve this, SVDD is generalized such that the model produces several level sets, sharing the same center, that are used to produce probability estimates. The proposed method provides robust and interpretable results for outlier detection at the cost of an increased complexity.

Deep learning

(8) *An Analysis of Convolutional Long-Short Term Memory Recurrent Neural Networks for Gesture Recognition*
Pablo Barros, Eleni Tsironi, Cornelius Weber, Stefan Wermter

This work introduces Convolutional Neural Networks with Long Short-Term Memory (CNNLSTMs) in order to successfully learned gestures varying in duration and complexity. Feature maps undergo a deconvolution process that enables the visualization of the original image pixels that cause specific activation.

(9) *Deep Reservoir Computing: A Critical Experimental Analysis*
Claudio Gallicchio, Alessio Micheli, Luca Pedrelli

The paper investigates the properties of several stacked architectures of recurrent neural networks. In particular, short-term memory capacity is measured, as well as network time dynamics by perturbing it and observing the propagation of the perturbation through the layers. Several structural parameters of the network are also considered, their impact on the network behaviour is shown, and the representation computed by the various layers is studied.

Medical applications

(10) *Combining Machine Learning Models for the Automatic Detection of EEG Arousals*
Isaac Fernandez-Varela, Elena Hernandez-Pereira, Diego Alvarez-Estevez and Vicente Moret-Bonillo

This application paper proposes a two-phase method in order to be able to detect EEG arousals, which is linked to sleep disorders. The first phase is a signal processing step dealing with various biological signals and the second phase uses machine learning techniques in order to detect arousals. Individual algorithm outputs are combined to produce more stable results.

(11) *Bag-of-steps: Predicting lower-limb fracture rehabilitation length by weight loading analysis*
Albert Pla, Natalia Mordvanyuk, Beatriz Lòpez, Marco Raaben, Taco J. Blokhuis, Herman R. Holstlag

The problem of predicting the duration of rehabilitation for patients suffering from lower-limb fracture is seen in this paper as particular case of bag-of-words (called here bag-of-steps). The idea is to transform signals from insole force sensors into a series of discrete steps that are considered as words for bag-of-words methods. The obtained representation becomes the input for classical discrimination methods to evaluate short or long rehabilitation.

Physics

(12) *Learning in Quantum Control: High-Dimensional Global Optimization for Noisy Quantum Dynamics*
Pantita Palittapongarnpim, Peter Wittek, Ehsan Zahedinejad, Shakib Vedaie, Barry C. Sanders

This work introduces the use of differential evolution algorithms in quantum control. The method can be massively parallel and vectorized and achieve better fidelity and scalability than obtained using greedy algorithms.

(13) *Quantum Clustering in Non-spherical Data Distributions: Finding a Suitable Number of Clusters*
Raul Vicente Casaña-Eslava, Ian H. Jarman, Paulo J. Lisboa, José D. Martín-Guerrero

Inspired from quantum mechanics principles to find structures, Quantum Clustering (QC) is an innovative clustering approach. This method needs n hyperparameter σ as input to be used in a Parzen estimator. This work presents a framework to find suitable values for this parameter.

Robotics and reinforcement learning

(14) *Grounding the Experience of a Visual Field through Sensorimotor Contingencies*
Alban Laflaquière

Traditional artificial perceptions use hand-crafted features specific to a task or an environment. This paper proposes a formalism that describes how sensorimotor regularities can be captured in a predictive model and thus let a robot adapts its sensory inputs to new ecosystems.

Visualization

(15) *Supporting Model Building through Interactive Visualisation*
Cagatay Turkay, Aidan Slingsby, Kaisa Lahtinen, Sarah Butt, Jason Dykes

Interactive visualisations in Machine Learning must not deviate from scientifically valid and actionable models. These works propose an interactive system that eases the construction and documentation of theory-driven models. It can be operated efficiently by social scientists.

(16) *What You See Is What You Can Change: Human-Centered Machine Learning by Interactive Visualisation*
Dominik Sacha, Michael Sedlmair, Leishi Zhang, John A. Lee, Jaakko Peltonen, Daniel Weiskopf, Stephen C. North, Daniel A. Keim

This work presents a conceptual framework to model human interactions with Machine Learning components in the Visual Analytics process. This framework is instantiated for several examples and existing softwares. Furthermore five open challenges are described at the intersection of ML and VA researches.

The guest editors would like to thank all authors for their interesting contributions and all reviewers for their excellent work. Authors and reviewers were asked to respect a very tight schedule, which allowed this issue to be published in less than a year after the conference, in a timely manner before the *ESANN* meeting. We would also like to thank the *Neurocomputing* editorial board for giving us the opportunity to publish this issue, as well as *Elsevier*'s people for the very efficient and seamless management of the publication procedure.

Hereby we would like to express special thanks to Jacqueline Zhu, Sudharshan Raj, and Vera Kamphuis form the *Elsevier* editorial office and Prof. Zidong Wang, Editor-in-Chief of the *Neurocomputing* Journal. Our most sincere gratitude goes to Prof. Michel Verleysen for his strong support of this special issue and his excellent conference organization. Increasing numbers of submissions

and participants emphasizes the high quality standards that *ESANN* has attained under his leadership in Europe and worldwide. It is a pleasure for us to invite all authors and interested readers of this issue to the next *ESANN* in April 2017 (see http://esann.org).

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Gaëlle Bonnet-Loosli got her PhD in Computer Science in 2006 from the INSA of Rouen, France. After being a Post-doc at IRSTEA (Clermont-Ferrand) focused on learning frontiers for viability problems, she got an Assistant Professor position at the engineering school Polytech-Clermont in 2008. She has been Head of the Mathematic and Modeling Department in the same school since 2015. Her research focuses on kernel methods used in non-standard setting (such as indefinite cases) and more recently on deep kernels.

Romain Hérault is an Assistant Professor in the Information Systems Architecture (ASI) department of INSA Rouen, France, and researcher at the LITIS laboratory. After obtaining a master thesis in Signals and Images in Biology and Medicine from the University of Angers, he received his Ph.D. in Computer Science, Information and Systems at the University of Technology of Compiègne where he was a lecturer. Today at LITIS, he devotes himself to artificial learning applied to signals, from deep learning, to dimension reduction. His fields of application range from the analysis of sports gestures to medical imagery.