

Editorial

Advances in machine learning and computational intelligence

In their ongoing path towards consolidation and acceptance as standard fields of scientific knowledge, Machine Learning, Neural Computation and related areas (such as Computational Intelligence, Soft Computing and Evolutionary Computation) may be said to have entered the first stages of maturity after a not-too-long and fruitful period of adolescence. Over this period, the early excitement about their potential as data analysis tools has been tempered by real-world challenges and their competition with fields with which they share many research goals, such as Multivariate Statistics.

As part of this evolution, these fields have veered, from an initial focus on bio-plausible models that aimed to realize the promises of Artificial Intelligence and explained the workings of human cognition, towards algorithmic developments oriented to multivariate data analysis, as well as towards a direct convergence with probability theory and statistics in the form of Statistical Machine Learning. Interestingly, over the last few years, and fuelled by the many discoveries in neurosciences brought about by advances in measurement techniques, the research on bio-plausible models has made a reappearance at the forefront of aca-

demical research, as exemplified by the recent contents of reference journals in the same league of Neurocomputing.

This special issue of Neurocomputing presents 16 original articles, which are extended versions of selected papers from the 16th European Symposium on Artificial Neural Networks (ESANN).

ESANN is a single-track conference held annually in Bruges, Belgium, one of the most beautiful medieval towns in Europe. ESANN is organized by Prof. Michel Verleysen from Universite Catholique de Louvain, Belgium. In addition to regular sessions, the conference welcomes special sessions focused on particular topics such as machine learning in cancer research, methodology and standards for data analysis, neural networks for computational neuroscience, machine learning and pattern recognition for spectral data, etc. The contributions in this special issue show that ESANN covers a broad range of topics in neural computation and neuroscience from theoretical aspects to state-of-the-art applications and many related themes in signal processing, machine learning, and computational intelligence. More than 120 researchers from 16 countries and 4 continents

participated in the 16th ESANN in April, 2008. They presented 87 contributions, and enjoyed the especially communicative atmosphere in Bruges. Based on the recommendations of special-session organizers, the reviews of the conference papers, and the quality of the presentations made 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 of these articles were thoroughly reviewed once more by at least two independent experts and, finally the 16 articles presented in this volume were accepted for publication.

In this special issue we can find a multitude of examples using neurocomputing and related techniques in different branches of research.

The first three papers analyse theoretical aspects of different learning systems and identify results on the learning dynamic, potential optimization schemes and strategies to get valid generalization estimates.

In the article of Aupetit the problem of multi-partitioning is considered such that the obtained partitions preserve the statistical characteristics of the original data set. The approach is applicable in cases where training and test data with homogeneous statistics are needed and can be used to determine such sets at optimal sizes.

In the article of Witoelar and Biehl theoretical properties of some prototype based classifiers are analyzed

by means of statistical physic techniques. The paper gives new insights in the learning behavior based on theoretical models of the learning dynamic.

The main thrust of the work by Barbero-Jimnez, Lpez-Lzaro, and Dorronsoro, is, even more explicitly, that of algorithmic improvement. The authors specifically explore how to achieve fast SVM training by studying, from a geometrical point of view, the presence of training cycles in two SVM training algorithms.

The next two papers consider research in the field of symbolic data representation and language processing. Cancedda and Mahe present an approach for early integration of different symbol representation for the processing of symbol sequences by means of factored sequence kernels.

In a work that combines statistical modeling and human language processing, Andriy Mnih, Zhang Yuecheng and Geoffrey Hinton build on an existing log-bilinear model that has been shown to improve on the more standard n-gram models. The authors show that, by adding a gating subnetwork, a non-linear subnetwork, or a combination of both to a log-bilinear language model, significant improvements in performance can be achieved.

The following three papers are subject of the investigation of feature selection techniques.

Lee and Verleysen provide a method for the quality assessment of dimen-

sionality reduction techniques. They compare different existing quality measures and develop simple criteria to assess the quality of those methods.

The other two papers deal with problems of nonlinear dimensionality reduction (NLDR) for models that are defined with multivariate data visualization in mind. In the first one, Onclinx, Wertz, and Verleysen present a general framework for NLDR aimed at projecting data on a non-Euclidean manifold, when their structure is too complex to be embedded in an Euclidean space. The methodology proposes an optimization procedure based on the trade-off between the trustworthiness and continuity of representation figures of merit.

The second work, by Alex, Hasenfuss and Hammer, has a more algorithmic target: alleviating the computational burden imposed by the analysis of massive datasets on NLDR visualisation algorithms such as Neural Gas (NG) and Self-Organising Maps (SOM). The authors propose single-pass extensions of the classical algorithm implementations based on a simple patch decomposition of the dataset, as well as fast batch optimisation schemes of the underlying cost function.

In the next part of the special issue two papers consider the field of reinforcement learning. Frenay and Saerens propose a new algorithm for reinforcement learning based on the markov game framework. It converges empirically to optimal mixed

policies in a simple and fast manner. Deisenroth et al. propose a reinforcement learning based approach to learn a gaussian process models in a control task. The last paper of Burwick is focused on the biological side of neural networks. He establishes relations to the winner-take-all concept known from different machine learning approaches.

The contributions in this issue cover a broad variety of topics, but also clearly show some trends in the current Neurocomputing research: many approaches try to identify or optimize evaluation criteria for known or new machine learning techniques or to identify concepts providing a better understanding of a specific machine learning technique by means of mathematical foundations or biological inspiration. There is also a consistent trend towards further optimizations of known machine learning techniques by means of convergence speed or an improved processing of huge data sets as they becoming more and more available in disciplines such as medicine and biology.

The guest editors would like to thank all authors for their submissions and the reviewers for their excellent work. Both authors and reviewers have been asked to work under a very tight schedule that has enabled the publication of this issue in less than a year after the conference, in a timely manner before the ESANN 2009 meeting. We would also like to thank the Neurocomputing editorial board for giving us the opportunity to publish this issue, and Elsevier as the publisher for the very efficient and seam-

less management of the publication procedure, which also contributed greatly to the meeting of a tight publication schedule. Hereby we would like to express special thanks to Ella Chen and Gary Anderton. Our most sincere gratitude goes to Prof. M. Verleysen for his strong support of this special issue and for the excellent job he has done organizing the conference. An increasing number of submissions and regular participants emphasizes the high standing this conference has achieved under Prof. Verleysens leadership in Europe and world wide. It is a pleasure for us to invite all authors and interested readers of this issue to future ESANN conferences, which are announced at <http://www.dice.ucl.ac.be/esann>.

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