Advances in computational intelligence: theory, methods, applications

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The Session on "Advances in Computational Intelligence: theory, methods, applications" is part of the *International Conference on Numerical Analysis and Applied Mathematics 2005 (ICNAAM 2005)* that was held between 16-20 September 2005 in Rhodes, Greece. The Session aimed at providing an up-to-date view of computational intelligence approaches to knowledge engineering, data modelling and complex problem solving; showing how computational intelligence can be applied to challenging real-world problems.

1 Introduction

Computational Intelligence (CI) is a rapidly expanding research field related to the major issue of making computers more intelligent. CI involves such approaches as fuzzy systems, neural networks, classification, machine learning, evolutionary computation, that facilitate "intelligent" behavior in complex and changing circumstances. CI research is being carried out by an increasingly large number of engineers, scientists and mathematicians and also a growing number of companies are employing CI techniques on learning problems for data analysis.

Although the emphasis of this session was primarily on CI, it covered interdisciplinary applications as well. The research presented is relevant to researchers who: (a) work on various aspects of CI in both theory (neural network methods, fuzzy logic methods etc.) and practice (classification, modelling etc.); (b) want to explore the dimensions of CI and identify important research issues; (c) want to design and develop CI applications for real-life problems; (d) are already running projects that use CI and want to exchange experiences and share information with other colleagues.

Next, a brief description of the session papers is presented.

2 The Papers

Adamopoulos et al. [1] explore short-term prediction of complex binary data. These binary patterns, referred to as perfect predictors, yield risk-free prediction of the value of the next bit of a binary sequence. The proposed approach is tested on binary data sets generated by applying a simple binary transformation on the data of the *logistic function* $x_{n+1} = rx_n(1 - x_n)$ for a variety of values of the *"nonlinearity parameter"*, r. Despite the chaotic nature of the logistic function and the complexity of the obtained binary data sets, an unexpected high number of prediction rules was revealed. In some cases predictability up to 100% was obtained.

Anastasiadis and Tucker [2] compare several computational intelligence methods using datasets produced by microarrays. This type of bioinformatics technology produces gene expression data that are characterized by many variables, involving up to thousands of genes. Training classifiers from these data to identify gene expression patterns of a disease or biological condition is very challenging. The authors use the prostate cancer and the B-cell-virus datasets which consist of small sample-sizes with very high dimensionality, and evaluate the performance of bayesian classifiers, neural networks, C5 and statistical regression.

Couceiro et al. [3] investigate the representations of an arbitrary set of vertices of an n-dimensional cube in terms of convex sets. They compared various representation in terms of their complexity. The notion of complexity used in the representations is based on the union, symmetric difference and ternary median operations.

Convexity of a set of vertices refers to Hamming distance or, equivalently, to the intersection of cubes with supporting hyperplanes.

Magoulas and Anastasiadis [4] propose an approach that generates perturbations of the candidate points produced by stochastic algorithms based on the q–distribution of the nonextensive statistical mechanics. This approach is used to equip two stochastic search algorithms, a hybrid diffusion algorithm and the particle swarm optimizer with a nonextensive schedule. The modified algorithms are tested in nonlinear functions minimization with benchmarks from the neural networks and the optimization domains.

Petalas et al. [5] work focuses on Cognitive Maps (CMs) as models of system behavior through representing concepts and relationships. Fuzzy Cognitive Maps for example contain nodes–concepts and weighted edges that connect the nodes and represent the cause and effect relationships among them. Both nodes and edges are fuzzy sets and are bounded in ranges provided by the experts for the problem under consideration. Membership functions are firstly determined for each fuzzy set, and fuzzification and defuzzification processes are applied for the initial crisp values. In this work, the authors propose Interval Cognitive Maps (ICMs) and a formulation for their training that is based on optimizing an objective function. ICMs share the same structure with FCMs but their main difference is that the concepts and the weights of FCMs are not fuzzy sets but rather interval numbers.

References

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