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Preface

Special Issue on Genetic Fuzzy Systems and the Interpretability–Accuracy Trade-off

This special issue encompasses four papers devoted to the recent developments in the field of "Genetic fuzzy systems and the trade-off between interpretability and accuracy". The issue was originated from several contributions presented at the First International Workshop on Genetic Fuzzy Systems (GFS2005) that was held in Granada, Spain, March 17–19, 2005. Six conference papers were selected and the authors were asked to develop extended versions which were submitted to the special issue. Each of them was revised by at least three referees and finally four of them were accepted according to the reviewers' evaluations.

System modelling with fuzzy rule-based systems comes with two contradictory requirements in the obtained model: the *interpretability*, capability the behaviour of the real system in an understandable way, and the *accuracy*, capability to faithfully represent the real system.

Obtaining high degrees of interpretability and accuracy is a contradictory purpose and, in practice, one of the two properties prevails over the other. While linguistic fuzzy modelling (mainly developed by linguistic or Mamdani-type fuzzy systems) is focused on the interpretability, precise fuzzy modelling (mainly developed by Takagi–Sugeno–Kang fuzzy systems) is focused on the accuracy.

The relatively easy design of fuzzy systems, their attractive advantages, and their emergent proliferation have made fuzzy modelling suffer a deviation from the seminal purpose directed towards exploiting the descriptive power of the concept of a linguistic variable. Instead, in the last few years, the prevailing research in fuzzy modelling has focused on increasing the accuracy as much as possible, paying little attention to the interpretability of the final model. Nevertheless, a new tendency in the fuzzy modelling scientific community that looks for a good balance between interpretability and accuracy is increasing in importance.

In order to successfully get this interpretability–accuracy trade-off, the use of genetic algorithms to search optimal fuzzy models is especially helpful. Indeed, they have a powerful search capability that allows them to deal with difficult objective functions and to perform multiobjective optimization. Moreover, they can deal with flexible representation structures with mixed coding schemes and constrains. These features are explored by the

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papers collected in this special issue by providing useful genetic fuzzy systems to obtain the desired trade-off.

In the first paper, entitled "Analysis of interpretability–accuracy tradeoff of fuzzy systems by multiobjective fuzzy genetics-based machine learning", H. Ishibuchi and Y. Nojima examine the interpretability–accuracy trade-off in fuzzy rule-based classifiers using a multiobjective fuzzy genetics-based machine learning algorithm. The proposal is based on a hybrid version between the Michigan and Pittsburgh approaches, which is implemented in the framework of multiobjective evolutionary optimization. The GBML algorithm simultaneously maximizes the accuracy of fuzzy rule sets and minimizes their complexity. The accuracy is measured by the number of correctly classified training patterns while the complexity is measured by the number of fuzzy rules and/or the total number of antecedent conditions of fuzzy rules.

J. González et al. introduce another proposal on the use of multiobjective evolutionary algorithms in the contribution "Improving the accuracy while preserving the interpretability of fuzzy function approximators by means of multiobjective evolutionary algorithms". They present a modification of the well known NSGA-II algorithm for the problem of modelling a fuzzy system for function approximation induced from a set of training data that applies expert mutation operators to avoid the generation of less adapted solutions. The fundamental principles of genetic algorithms are hybridized with those of classical optimization algorithms, thus achieving an algorithm that provides the power of evolutionary algorithms at the same time that one fitting the solutions with the desired degree of precision. The simulations performed show that the synergy of the different paradigms and techniques used produce outstanding results for the design of fuzzy systems.

The paper "Genetic learning of accurate and compact fuzzy rule based systems based on the 2-tuples linguistic representation" by R. Alcalá et al. uses a new linguistic rule representation model that allows the lateral displacement of a label considering only one parameter. The paper proposes a new method to derive linguistic fuzzy systems by means of an *a priori* evolutionary learning of the data base (automatically specifying the number of labels and the lateral displacements) and a simple rule generation method to quickly learn the associated rule base. Since this rule generation method is run from each data base definition generated by the evolutionary algorithm, its choice is an important aspect. The authors propose two new *ad hoc* data-driven rule generation methods, analyzing their influence and that of other rule generation methods in the proposed learning approach.

Finally, Van Broekhoven et al. present an interesting application to classify river sites according to their suitability as a habitat for macroinvertebrates in the contribution entitled "Interpretability-preserving genetic optimization of linguistic terms in fuzzy models for fuzzy ordered classification: an ecological case study". Fuzzy ordered classifiers are used to assign fuzzy labels to river sites expressing their suitability as a habitat for a certain macroinvertebrate taxon, taking into account three abiotic properties of the considered river site. The models are built using expert knowledge and evaluated on data collected in the Province of Overijssel in the Netherlands. Apart from a performance measure for crisp classifiers commonly used in the aquatic ecology domain, the percentage of correctly classified instances; two additional performance measures for fuzzy (ordered) classifiers are introduced in the paper: the percentage of correctly fuzzy classified instances and the average deviation. Furthermore, results of an interpretability-preserving genetic optimization of the linguistic terms are presented.

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