

*Guest Editorial*

**Special Issue on Evolutionary Fuzzy Systems**

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During this two decades, evolutionary computation has been successfully used for the design of fuzzy systems under the name of Evolutionary Fuzzy Systems (EFSs) or Genetic Fuzzy Systems (GFSs)<sup>1,2,3,4,5,6</sup>. This is because the use of evolutionary computation can enhance several abilities of fuzzy systems, such as the generalization ability for unseen and uncertain data sets, the interpretability for users, and the applicability to real-world problems. A series of special issues on EFSs and GFSs<sup>7,8,9,10,11,12,13,14</sup> and a web bibliography compilation<sup>15</sup> clearly show that this research field is continuously growing and breaking in new research topics: novel representation schemes<sup>16</sup>, interpretability of fuzzy systems<sup>17</sup>, scalability issues<sup>18</sup>, subgroup discovery<sup>19</sup>, imbalanced datasets<sup>20</sup>, etc. This special issue includes the recent novel contributions to pattern classification, regression, association rule mining, and real-world applications.

The first four papers are related to pattern classification problems. Two of them develop novel classifiers different from usual rule-based ones. The others focus on data sets with different aspects from standard benchmark data sets.

The paper “An efficient inductive genetic learn-

ing algorithm for fuzzy relational rules” by A. González et al. proposes a genetic fuzzy rule learning algorithm for the design of a fuzzy relational rule model. The use of fuzzy relational rules enhances the knowledge representation ability of fuzzy models. The experimental study on pattern classification problems clearly shows that the proposed method can modify the generalization ability of fuzzy rule-based classifiers.

The paper “A study on the use of multiobjective genetic algorithms for classifier selection in FURIA-based fuzzy multiclassifiers” by K. Trawiński et al. presents an ensemble fuzzy classifier design by evolutionary multiobjective algorithms. FURIA is used to generate component classifiers. NSGA-II is used to optimize the combination of the component classifiers with respect to two of four objective functions: the training accuracy, the number of component classifiers in an ensemble, and two diversity measures. The effects of different objective functions are examined through the experiments.

The paper “Reducing the complexity of genetic fuzzy classifiers in highly-dimensional classification problems” by D. G. Stavrakoudis et al. deals with high dimensional problems like hyperspectral satel-

lite images and real-life data sets with a large number of features up to 12600. The proposed method successfully reduced the complexity of the classifiers comparing with some well-known machine learning methods and fuzzy classifiers.

The paper “Equalizing imbalanced imprecise datasets for genetic fuzzy classifiers” by A. M. Palacios et al. focuses on low quality imbalanced data sets and proposes the generalization of several pre-processing methods for these data sets. The performances of a GFS together with different pre-processing methods are analyzed for low quality imbalanced data sets.

The next two papers are related to regression problems. Both papers try to improve the interpretability or transparency of the fuzzy regression model by using multiobjective optimization algorithms. The paper “A mechanism to improve the interpretability of linguistic fuzzy systems with adaptive defuzzification based on the use of a multiobjective evolutionary algorithm” by A. A. Márquez et al. incorporates an adaptive thresholds model into the optimization of rule weights by evolutionary multiobjective optimization. The proposed method can remove weights from highly important rules and remove unnecessary rules from the rule set, while optimizing the rule weights.

The paper “Improving transparency in approximate fuzzy modeling using multi-objective immune-inspired optimisation” by J. Chen et al. proposes a population adaptive immune algorithm within a multi-objective optimization framework and a variable length coding scheme for regression problems. The proposed method is applied to the mechanical property prediction of hot rolled steels. The results indicate that the proposed method can successfully improve the complexity and the accuracy of the fuzzy models.

The next two papers are related to fuzzy association rule mining. The paper “Finding Pareto-front membership functions in fuzzy data mining” by C-H. Chen et al. applies SPEA2 to fuzzy association rule mining. The authors use two objective functions: One is to maximize the shape suitability of the

membership functions composed of the overlap factor and the coverage factor of the membership functions. The other is to maximize the total number of large 1-itemsets. The experimental results show the superiority of SPEA2 to the previous algorithm.

The paper “Genetic lateral tuning for subgroup discovery with fuzzy rules using the algorithm NMEEF-SD” by C. J. Carmona et al. incorporates 2-tuple linguistic representation and genetic lateral tuning into CHC algorithm-based support discovery. The objective function is the weighted sum of the sensitivity, unusualness, and confidence. Through the experiments, it is shown that the genetic lateral tuning can improve the performance of the proposed method at the small risk of interpretability.

The last two papers are real-world applications. The paper “Automatic laser pointer detection algorithm for environment control device systems based on template matching and genetic tuning of fuzzy rule-based systems” F. Chávez et al. proposes a user-friendly and less expensive home device control device system with a laser pointer. A fuzzy-rule based system is used to detect a laser pointer spot. The performance of the system was improved by means of the color information and genetic tuning of fuzzy membership functions.

The paper “Genetic learning of fuzzy parameters in predictive and decision support modelling” by A. Nebot et al. applies a genetic fuzzy system to an e-learning system which predicts students’ performance and understands students’ learning behavior. The results show that better predictive and decision support models were obtained when the discretization parameters were optimized by GAs.

The guest editors hope that these ten contributions become triggers for further advances of EFSs and GFSs in the field of computational intelligence and machine learning. Finally, the guest editors wish to deeply thank all the authors for their contributions and the reviewers for their careful checks and valuable comments.

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