Editorial:
Applications of Fuzzy Systems in Data Science and Big Data

IN THE era of big data, intelligent as well as fuzzy tools have become very important to understanding our changing Internet-of-Things-driven data-centric world. Extracting "intelligence" from massive amounts of data has allowed us to support decision making processes in many fields, ranging from common fields like medicine and engineering to more lucrative industries such as vehicular technology and environmental stressors. In line with the shift in many industries to analyzing big data, has added in the fuzzy perspective to allow new ways of reasoning. Examples include interpretability of computing schemes, which have become more and more complex. Yet, successful applications of biomathematical modeling in a fuzzy environment have shown a good alternative to mere common black-box tools. In the call for papers of this special issue, we had devoted our interest in research pertaining to the current state-of-the-art research in the application of fuzzy systems regarding data science and big data analytics. We actively solicited recent results mainly concerned with recent advances and challenges in the theory and applications of fuzzy systems in the fields of data sciences and big data environments. Overall, a total of 90 papers were submitted to the special issue, ranging in topics as well as applicable areas. From these 90 papers, we selected 16 of the strongest papers for this special issue, giving a commemorable acceptance rate of 17%. A total of 60 different reviewers were used to help handle our especially large number of submissions. In the end, authors from 30 different countries spanning most of the globe geographically have contributed to this special issue. The guest editors would like to thank everyone involved for making this special issue a huge success. Next, we summarize some of the notable works that are featured in this issue. In article "Big data driven marine environment information forecasting: A time series prediction network," the authors addressed the poor efficiency of processing large industrial datasets with bias and redundancy in the forecast applications. The main purpose of this article was to effectively solve the time analysis of massive industry data. Specifically, the authors proposed a semisupervised prediction model, which combines the fuzzy partition method and neural network model. Experimental results showed that the proposed method achieved satisfactory prediction effect in various application domains. In article "Feature selection using fuzzy neighborhood entropy-based uncertainty measures for fuzzy neighborhood multigranulation rough sets," the authors presented a fuzzy neighborhood multigranulation rough sets-based feature selection method in neighborhood decision systems. This article investigated fuzzy neighborhood multigranulation rough sets based on fuzzy neighborhood rough sets and neighborhood multigranulation rough sets. The experimental results on 12 datasets showed that the proposed algorithm is effective for selecting important features with higher stability of classification, as compared with representative algorithms. In article "A heuristic neural network structure relying on fuzzy logic for images scoring," the authors proposed a dominant fuzzy fully connected layer (FFCL) for breast imaging reporting and data system scoring. The authors validated the universality of this FFCL structure. This proposed model developed complementary properties of scoring for semantic paradigms, while constructing fuzzy rules based on analyzing human thought patterns, and particularly reduced the influence of semantic conglutination. In article "Hierarchical fuzzy neural networks with privacy preservation on heterogeneous big data," the authors examined a privacy-preserving hierarchical fuzzy neural network to address these challenges while also alleviating privacy concerns. The network itself was trained with a two-stage optimization algorithm, and the parameters at low levels of the hierarchy are learned with a scheme based on the well-known alternating direction method of multipliers, which does not reveal local data to other agents. Coordination at high levels of the hierarchy is handled by the alternating optimization method, which converges very quickly. The entire training procedure is scalable, fast and does not suffer from gradient vanishing problems like the methods based on back propagation. In article "A multiperiod multiobjective portfolio selection model with fuzzy random returns for large scale securities data," the authors developed a multiperiod multiobjective portfolio model with real-world constraints to handle the portfolio selection problem based on large scale securities data in the uncertain market. In this model, the randomness and fuzziness in the financial market are captured by treating future security returns as fuzzy random variables. To improve computational efficiency and cope with large scale securities data, an intelligent parallel hybrid algorithm adopting MPI technology is presented. The experiments certify that the parallel algorithm has a good scalability and could solve the large scale portfolio selection problem consisting of securities up to 402 in a reasonable time. In article "SFCM: A fuzzy clustering algorithm of extracting the shape information of data," the authors proposed a new algorithm, named shape fuzzy C-means (SFCM), with two simultaneous possibilities for mining data: fuzzy clustering as with the fuzzy C-means algorithm, and shape detection as with the Mapper algorithm.

The SFCM can generate similar outputs from the topological standpoint as the previous two methods, Mapper and F-Mapper. The clustering stability and internal index of the SFCM are better than those produced by the Mapper and F-Mapper in most experimental cases. Finally, the SFCM can visualize highly complex data in a simple, meaningful and informative form with potential of applicability to big data. In article "Fuzzy detection aided real-time and robust visual tracking under complex environments," the authors focused on solving the problem of fast and accurate tracking of targets in complex environments. Their article proposed a fuzzy detection strategy. This strategy detects whether the current tracking is good by adding a fuzzy-based detection module; At the same time, it combines the human memory mechanism to store the target features in memory. When a tracking error in the current frame is detected, the stored feature information is used to perform feature matching to avoid template contamination, thereby achieving target relocation. Tested on the OTB platform, the experimental results show that the auxiliary detection strategy proposed in this article can ensure the tracking speed and overall success rate of the algorithm, and effectively improve the tracking robustness of the complex environment. In article "CoMHisP: A novel feature extractor for histopathological image classification based on fuzzy SVM with within-class relative density," the authors present a novel integrated framework of interdisciplinary concepts such as center of mass, machine learning, fuzzy theory to deal with the challenging problem of canine mammary tumor histopathological image analysis. The framework provides an illumination invariant feature extraction approach based on the center of mass by utilizing a new technique of optimizing block size that acts similar to the concept of filter for extracting sophisticated features. This article also used fuzzy SVM with within-class density information (FSVM-WD) because the robustness and fault tolerance of machine learning can be enhanced by using fuzzy modeling to capture the uncertainty in the image data. This framework proves its potential for binary classification of canine mammary tumor images by achieving 97% accuracy with limited datasets and works perfectly with fewer computation resources as compared to DL based approaches. This article presented a novel idea to deal with complex histopathology data effectively in comparatively less time. In article "A fuzzy adaptive dynamic NSGA-ii with fuzzy-based Borda ranking method and its application to multimedia data analysis," the authors introduce a novel fuzzy-based dynamic multiobjective evolutionary algorithm. The basic idea is to randomly remove some solutions and replace by newly created solutions. However, the random selection detours the algorithm's trajectory and deteriorates the performance of the optimization algorithm. In this article, we propose an improved Borda count method incorporated with fuzzy tuned parameters so that its parameters are adjusted by Mamdani fuzzy rules. Our new Borda method can distinguish the information before and after change with different fuzzy weights. In addition to the fuzzy-based Borda, we employ an improved evolutionary algorithm based on fuzzy logic. Experiments are conducted on standard benchmarks and the results are compared with recent algorithms. Then, multimedia data analysis, such as segmentation of moving objects, is experimented as a dynamic multiobjective problem and solved by the proposed algorithm. In article "Least-squares fuzzy transforms and autoencoders: some remarks and application," the author discussed formally the analogies and the differences between a type of fuzzy transform and a type of autoencoder, both based on a least-squares optimization. The author shows that the least-squares fuzzy transform can be regarded as a kind of autoencoder with a lower computational cost, without losing accuracy. Some properties are presented and the numerical experiments, for the application cases concerning big data compression, show the good performance of the fuzzy-based approach against existing results retrieved from the literature. Other interesting articles included in the special issue included "Fuzzy-based trustworthiness evaluation scheme for privilege management in vehicular ad hoc networks," where the authors focuses on a fuzzy scheme in relation to vehicular networks. In article "A cloudedge-aided incremental high-order possibilistic c-means algorithm for medical data clustering," the authors presented a variation of the c-means algorithm for edge computation. In article "Load forecasting through estimated parametrized based fuzzy inference system in smart grids," the authors explored fuzzy systems in load forecasting for smart grids. In article "Deep fuzzy hashing network for efficient image retrieval," the authors applied fuzzy hashing to efficient image processing and retrieval. In article "FDM: Fuzzy optimized data management technique for improving big data analytics," the authors improved big data analytics using a fuzzy model in data management. Finally, in "A novel conflict measurement in decision making and its application in fault diagnosis," the authors applied fuzzy systems to conflict resolution in decision making for fault diagnosis. Overall, with a highly respected and well-known journal like IEEE TRANSACTIONS ON FUZZY SYSTEMS, the quality of submissions were exceptional. Combining the concepts of data science, big data, and fuzzy systems has only just begun and this Special Issue as a whole can pave the way for future research avenues in this highly important interdisciplinary area of study.

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