Editorial:
Fuzzy Logic and Artificial Intelligence:
A Special Issue on Emerging Techniques
and Their Applications

ARTIFICIAL Intelligence (AI) has become the focus of the day and attracted much attention from researchers, industries, and governments. This special issue serves as a forum to bring together all emerging techniques for fuzzy logic and fuzzy set-based AI and foster new advancements along this important direction. Actually, there have been a number of research pursuits that position themselves at the junction of AI and fuzzy logic. For example, natural language processing, viewed as the jewel in the crown of AI, has been one of the focal points in the domain of fuzzy logic and fuzzy sets. Fuzzy sets can offer an effective paradigm supporting accurate understanding of natural language and build efficient linkages to human intelligence through concepts and computing with membership functions, in particular type-2 fuzzy sets for explainable AI. In addition to type-2 fuzzy sets, there are also some other fuzzy representation schemes that may bridge this gap. Those representations can provide more flexibility to describe the membership information, and hence address the problem of linguistic ambiguity inherently associated with the interpretation and understanding of various data. Besides, the relationship between variation in decision making and how to incorporate them into AI systems are also important for the research in AI and fuzzy systems. Of course, the related applications are also key elements for the research and development. After all, AI and fuzzy logic are predominantly application-driven and many of applications that combine both techniques have demonstrated superior advantages over other intelligent methods. This special issue reflects the timely trends and covers a broad range of topics in the field of fuzzy logic and fuzzy set-based AI, exploring the developments and advances in theoretical studies and its applications.

For this special issue, we have received 96 proposals and accepted 47 manuscripts for regular transactions evaluation. After a thorough review process, 18 papers were selected for publication. We had to make hard decisions: there were some good papers that could not be included because of page limit of the Special Issue. In sum, the accepted papers are a testimony to the wealth of studies stemming from data analysis, learning, control, and contributing to various AI applications. The first and the largest category is about data mining. "Optimize TSK Fuzzy Systems for Big Data Classification Problems: Bag of Tricks"

integrates three novel techniques of uniform regularization, random percentile initialization, and batch normalization into TSK fuzzy systems to speed up the convergence and improve generalization capabilities. In "A Novel Approach for Optimum-Path Forest Classification Using Fuzzy Logic," the authors proposed to use membership grades to identify the most relevant training samples thus making the classification in Fuzzy Optimum-Path Forest more effective. In "Low-Rank Tensor Regularized Fuzzy Clustering for Multiview Data," the authors formulated fuzzy partition matrices of different views as a third-order tensor and a low-rank tensor is introduced as a norm constraint in the KL divergence-based fuzzy clustering to obtain dexterously high-order correlations of different views. In "An Edge-Cloud-Aided High-Order Possibilisticc-Means Algorithm for Big Data Clustering," a high-order possibilistic c-means approach based on the double-layer deep computation model is proposed for big data fuzzy clustering. In "Time Series Prediction Using Sparse Autoencoder and High Order Fuzzy Cognitive Maps," a framework on the basis of sparse autoencoder and high-order FCMs is proposed to address time series prediction problem. In "Modeling of Complex System Phenomena via Computing With Words in Fuzzy Cognitive Maps," general classes of aggregation functions are applied separately to positively and negatively causal antecedents to each node and next combined to form the nodal state to deal with complex systems with singularities occurring in fuzzy cognitive maps. In "Granular Matrix: A New Approach for Granular Intelligence," a new granular structure, named fuzzy approximation space is developed to construct a new granular reduction theory. A new measure, Jaccard consensus of linguistic distribution, is introduced in "Consensus-Based Multicriteria Group Preference Analysis Model with Multigranular Linguistic Distribution Information." On its basis, consensus-based multicriteria group preference analysis model with multigranular linguistic distribution information is established within a unified framework.

There are also various applications concentrating on the use of fuzzy sets and AI techniques. In "Command Filter-Based Finite-Time Adaptive Fuzzy Control for Uncertain Nonlinear Systems With Prescribed Performance," fuzzy systems are employed to approximate completely unknown nonlinear functions and incorporated with prescribed performance control with the

method of command filtered design. In "Membership-Function-Dependent Stabilization of Event Triggered Interval Type-2 Polynomial Fuzzy-Model-Based Networked Control Systems," the IT2 membership functions are utilized to capture the uncertainties present in the plant and then an event-triggered IT2 polynomial fuzzy controller is designed to stabilize the nonlinear model subject to uncertainties. For other applications, in "Fuzzy Neighborhood Learning for Deep 3D Segmentation of Point Cloud," the authors integrated the learning of the fuzzy neighborhood feature of each point into a network architecture, so as to perform operations on high-dimensional features for deep 3D segmentation of point cloud. In "FEPDS: A Proposal for the Extraction of Fuzzy Emerging Patterns in Data Streams," the learning algorithm involves an evolutionary fuzzy system where previous knowledge is employed in order to adapt to concept drift in data streams. In "Hierarchical Fused Model with Deep Learning and Type-2 Fuzzy Learning for Breast Cancer Diagnosis," through the integration of feature extraction aided by domain knowledge and fuzzy learning, the breast cancer diagnosis can achieve favorable performance in a few-shot learning manner and the deterioration of cross-dataset generalization ability is alleviated. Besides, the interpretability is further enhanced. The authors of "Deep Fuzzy Neural Networks for Biomarker Selection for Accurate Cancer Detection" created a new deep fuzzy neural network to handle noise and uncertainty in gene data for specific disease diagnosis and a new algorithm is designed to classify samples for different disease via data preprocessing and the deep fuzzy neural network based gene selection. In "A Fuzzy Adaptive Approach to Decoupled Visual Servoing for a Wheeled Mobile Robot," the authors introduced an improved bagging method based on visibility graph theory to predict the velocity for the WMR. Meanwhile, a fuzzy reinforcement learning mechanism is designed to determine the ratio of the mixture of the current and target Jacobian matrices. In "Adaptive Image-based Visual Servoing using Reinforcement Learning With Fuzzy State Coding," the features captured from ORB are embedded into state vectors through a Fuzzy CMAC for state coding and then a modified reinforcement learning method is proposed to tackle the problem of the semi-Markov process that is raised in the precedent state coding process. In "T2F-LSTM Model for Long-term Traffic Volume Prediction," Type-2 Fuzzy Sets provide more freedom to describe membership information in LSTM to a long-term prediction approach for traffic volume. Finally, in "Solving Fuzzy Job-shop Scheduling Problem Using DE Algorithm Improved by a Selection Mechanism," a novel selection mechanism augmenting the generic DE algorithm to achieve better optimization results for the job-shop scheduling problems with fuzzy execution time and fuzzy completion time.

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