

Editorial Preface

Special Issue on Fuzzy Techniques in Data Clustering, Image Processing and Applications

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Ever since its proposal by L. A. Zadeh in 1965, fuzzy set has proved it to be a very fruitful model for capturing uncertainty in datasets. There are several applications of fuzzy techniques in real life situations. In fact, Zadeh coined the discipline “Soft Computing” in 1994 with Neuro-computing, fuzzy logic and Probabilistic reasoning as its main constituents. The guiding principles being tractability, robustness and low solution cost, Data clustering is a significant component of Data mining, which deals with putting similar items into groups. It has wide applications in the areas of Engineering, Computer Science, life and medical sciences, Astronomy and Earth Sciences, Social Sciences and Economics. Starting with the basic hard c-means, which comes under crisp clustering, several uncertainty models based clustering algorithms like the fuzzy c-means have been proposed in the literature. These algorithms provide greater generality and increase their applicability in real life situations. Image processing is a method to perform some operations on an image, in order to get an enhanced image or to extract some useful information from it. One of the major areas under image processing where clustering techniques are used is image segmentation. Fuzzy techniques are now used in different areas under image processing. Under this background the present issue of IJFSA unfolds recent developments on some areas fuzzy techniques used in data clustering and image processing with applications.

An order to extend the modelling power of fuzzy sets, several models like intuitionistic fuzzy sets, interval valued fuzzy sets, and interval valued intuitionistic fuzzy sets have been introduced. Fuzzy numbers, intuitionistic fuzzy numbers (IFN) and interval valued intuitionistic fuzzy numbers are defined and studied over the years. IFNs have been used in data clustering. Ordering of numbers is an important notion, which facilitates comparison in applications. Possibility measure is used for interval numbers to define an order on IFNs. Similarly, there are three equivalent possibility degree measures for comparing interval numbers. This idea was advanced with a possibility degree measure for comparing two IVIFNs. Decision making is a common problem which we come across on regular basis and Multi Criteria decision Making (MCDM) has been used in several application areas. In the first paper of this issue, the concept of intuitionistic fuzzy possibility degree (IFPD) for ordering several interval-valued intuitionistic fuzzy numbers (IVIFNs) is introduced and based on IFPD measure of IVIFNs, an approach for solving MCDM problems with interval-valued intuitionistic fuzzy parameters is proposed.

A standard clustering algorithms use Euclidean distance for measuring similarity between elements. However, this measure has certain drawbacks like the problem of linear separability. So,

kernels are used now a days to measure similarity, which are linearly separable in higher dimensional spaces. Another drawback of the basic clustering algorithms is the selection of initial centroids of the clusters. Normally, it is random and leads to slow rate of convergence or no convergence. In order to provide optimal selection of the initial centroids metaheuristic algorithms are used and have been observed to generate better results and faster convergence of the algorithms. As mentioned above clustering is one of the fruitful approaches for image segmentation. In the second chapter of the special issue, the author uses both the concepts of kernels and selection of initial centroids by firefly algorithms to develop a better rough set-based clustering algorithm for image segmentation.

Thresholding is one of the important steps in image analysis process and used extensively in different image processing techniques. Medical image segmentation plays a very important role in surgery planning, identification of tumours, diagnosis of organs, etc. In this article, a novel approach for medical image segmentation is proposed using a hybrid technique of genetic algorithm and fuzzy logic. Fuzzy logic can handle uncertain and imprecise information. Genetic algorithm helps in global optimization, gives good result in noisy environments and supports multi-objective optimization. The third paper of this issue describes a technique of finding optimal threshold values for medical MRI images using genetic algorithm and fuzzy logic. Fuzzy entropy-based fitness function used in this paper justifies its selection in obtaining optimal threshold values. Basic fuzzy membership functions such as Gaussian, Trapezoidal and Triangular are used to compare the best segmentation results in terms of sensitivity, specificity, accuracy, CPU time and RMSE. It is quite evident from the comparison of experimental results obtained that the hybrid genetic algorithm with trapezoidal membership function outperforms the others with highest average accuracy. The experimental results obtained prove the effectiveness and efficiency of our proposed method.

Synthetic Aperture Radar (SAR) has been widely used for Earth remote sensing over the past few decades. It provides high-resolution, day-and-night and weather-independent images for a multitude of applications ranging from geoscience and climate change research, environmental and Earth system monitoring. Speckle is a granular ‘noise’ that inherently exists in and degrades the quality of the active radar, synthetic aperture radar, medical ultrasound and optical coherence tomography images. In the fourth article of the issue, a novel fuzzy based filtering approach is proposed for speckle removal from SAR images. The basic structure of existing Mamdani and Sugeno fuzzy inference system is employed to design a proposed approach using Gamma probability density function. The experimental analysis of proposed approach is carried out using Sentinel-1 SAR images. The results thus generated are compared with those of fuzzy filter, Gaussian filter and Gaussian weighted filter. It is derived from the experimental results that the Mamdani system based proposed approach provides better results than the Sugeno-based approach. Also, it is established that the proposed approach is better than the other existing filters.

Algebraic structures have a major component of mathematics and have played an important role in other branches. The role played by Boolean algebra in the development of computers is well known. Also, the ordered structures like lattices are of enough importance. Fuzzification of algebraic structures started as early as 1971, when Rosenfeld introduced the notion of fuzzy subgroups. Since then a lot of important discrete structures have been fuzzified by many authors in various ways. Following this trend, the notion of BCK-algebras was propounded by Imai and Is'eki in 1966. Further, Is'eki extended this notion and proposed BCI-algebra as a super class of BCK-algebras. The study of these type of algebras and their extensions have been carried out in the form of interval-valued fuzzy sub algebras/ideals in BCK-algebras, fuzzy translation, fuzzy multiplication of fuzzy sub-algebras/ideals in BCK/BCI-algebras. An extended the study from fuzzy translation to intuitionistic fuzzy translations in BCK/BCI-algebras. In the recent past was introduced fuzzy translations, fuzzy multiplications of interval-valued doubt fuzzy ideals of BF-algebras. This study established several results on doubt intuitionistic fuzzy sub-algebras and ideals in BCK/BCI algebras. In the fifth article of this issue, the authors have defined interval-valued doubt fuzzy sub algebra in BCK-algebras and investigated its related properties.

The papers in this issue deal with different directions of fuzzy techniques and diverse directions of application. It is expected that the readers will be benefited by the works presented in this issue in order to progress in their research fields.

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Guest Editor

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