Fuzzy C Means Algorithm A Review

This book presents the workings of major clustering techniques along with their advantages and shortcomings. After introducing the topic, the authors illustrate their modified version that avoids those shortcomings. The book then introduces four modified clustering techniques, namely the Optimized K-Means (OKM), Enhanced Moving K-Means-1(EMKM-1), Enhanced Moving K-Means-2(EMKM-2), and Outlier Rejection Fuzzy C-Means (ORFCM). The authors show how the OKM technique can differentiate the empty and zero variance cluster, and the data assignment procedure of the K-mean clustering technique is redesigned. They then show how the EMKM-1 and EMKM-2 techniques reform the data-transferring concept of the Adaptive Moving K-Means (AMKM) to avoid the centroid trapping problem. And that the ORFCM technique uses the adaptable membership function to moderate the outlier effects on the Fuzzy C-meaning clustering technique. This book also covers the working steps and codings of quantitative analysis methods. The results highlight that the modified clustering techniques generate more homogenous regions in an image with better shape and sharp edge preservation. Showcases major clustering techniques, detailing their advantages and shortcomings; Includes several methods for evaluating the performance of segmentation techniques; Presents several applications including medical diagnosis systems, satellite imaging systems, and biometric systems.

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This book constitutes the refereed proceedings of the Third International Conference on Fuzzy Systems and Knowledge Discovery, FSKD 2006, held in federation with the Second International Conference on Natural Computation ICNC 2006. The book presents 115 revised full papers and 50 revised short papers. Coverage includes neural computation, quantum computation, evolutionary computation, DNA computation, fuzzy computation, granular computation, artificial life, innovative applications to knowledge discovery, finance, operations research, and more.

Fifty years have gone by since the publication of the ?rst paper on clustering based on fuzzy sets theory.

Bioinformatics, a field devoted to the interpretation and analysis of biological data using computational techniques, has evolved tremendously in recent years due to the explosive growth of biological information generated by the scientific community. Soft computing is a consortium of methodologies that work synergistically and provides, in one form or another, flexible information processing capabilities for handling real-life ambiguous situations. Several research articles dealing with the application of soft computing tools to bioinformatics have been published in the recent past; however, they are scattered in different journals, conference proceedings and technical reports, thus causing inconvenience to readers, students and researchers. This book, unique in its nature, is aimed at providing a treatise in a unified framework, with both theoretical and experimental results, describing the basic principles of soft computing and demonstrating the various ways in which they can be used for analyzing biological data in an efficient manner. Interesting research articles from eminent scientists around the world are brought together in a systematic way such that the reader will be able to understand the issues and challenges in this domain, the existing ways of tackling them, recent trends, and future directions. This book is the first of its kind to bring together two important research areas, soft computing and bioinformatics, in order to demonstrate how the tools and techniques in the former can be used for efficiently solving several problems in the latter. Sample Chapter(s). Chapter 1: Bioinformatics: Mining the Massive Data from High Throughput Genomics Experiments (160 KB). Contents: Overview: Bioinformatics: Mining the Massive Data from High Throughput Genomics Experiments (H Tang & S Kim); An Introduction to Soft Computing (A Konar & S Das); Biological Sequence and Structure Analysis: Reconstructing Phylogenies with Memetic Algorithms and Branch-and-Bound (J E Gallardo et al.); Classification of RNA Sequences with Support Vector Machines (J T L Wang & X Wu); Beyond String Algorithms: Protein Sequence Analysis Using Wavelet Transforms (A Krishnan & K-B Li); Filtering Protein Surface Motifs Using Negative Instances of Active Sites Candidates (N L Shrestha & T Ohkawa); Distill: A Machine Learning Approach to Ab Initio Protein Structure Prediction (G Pollastri et al.); In Silico Design of Ligands Using Properties of Target Active Sites (S Bandyopadhyay et al.); Gene Expression and Microarray Data Analysis: Inferring Regulations in a Genomic Network from Gene Expression Profiles (N Noman & H Iba); A Reliable Classification of Gene Clusters for Cancer Samples Using a Hybrid Multi-Objective Evolutionary Procedure (K Deb et al.); Feature Selection for Cancer Classification Using Ant Colony Optimization and Support Vector Machines (A Gupta et al.); Sophisticated Methods for Cancer Classification Using Microarray Data (S-B Cho & H-S Park); Multiobjective Evolutionary Approach to Fuzzy Clustering of Microarray Data (A Mukhopadhyay et al.). Readership: Graduate students and researchers in computer science, bioinformatics, computational and molecular biology, artificial intelligence, data mining, machine learning, electrical engineering, system science; researchers in pharmaceutical industries.

Explore clustering algorithms used with Apache Mahout About This Book Use Mahout for clustering datasets and gain useful insights Explore the different clustering algorithms used in day-to-day work A practical guide to create and evaluate your own clustering models using real world data sets Who This Book Is For This book is for developers who want to try out clustering on large datasets using Mahout. It will also be useful for those users who don't have background in Mahout, but have knowledge of basic programming and are familiar with basics of machine learning and clustering. It will be helpful if you know about clustering techniques with some other tool. What You Will Learn Explore clustering algorithms and cluster evaluation techniques Learn different types of clustering and distance measuring techniques Perform clustering on your data using K-Means clustering Discover how canopy clustering is used as pre-process step for K-Means Use the Fuzzy K-Means algorithm in Apache Mahout Implement Streaming K-Means clustering in Mahout Learn Spectral K-Means clustering implementation of Mahout In Detail As more and more organizations are discovering the use of big data analytics, interest in platforms that provide storage, computation, and analytic capabilities has increased. Apache Mahout caters to this need and paves the way for the implementation of complex algorithms in the field of machine learning to better analyse your data and get useful insights into it. Starting with the introduction of clustering algorithms, this book provides an insight into Apache Mahout and different algorithms it uses for clustering data. It provides a general introduction of the algorithms, such as K-Means, Fuzzy K-Means, StreamingKMeans, and how to use Mahout to cluster your data using a particular algorithm. You will study the different types of clustering and learn how to use Apache Mahout with real world data sets to implement and evaluate your clusters. This book will discuss about cluster improvement and visualization using Mahout APIs and also explore model-based clustering and topic modelling using Dirichlet process. Finally, you will learn how to build and deploy a model for production use. Style and approach This book is a hand's-on guide with examples using real-world datasets. Each chapter begins by explaining the algorithm in detail and follows up with showing how to use mahout for that algorithm using example data-sets.

Nearly everyone knows K-means algorithm in the fields of data mining and business intelligence. But the ever-emerging data with extremely complicated characteristics bring new challenges to this "old" algorithm. This book addresses these challenges and makes novel contributions in establishing theoretical frameworks for K-means distances and K-means based consensus clustering, identifying the "dangerous" uniform effect and zero-value dilemma of K-means, adapting right measures for cluster validity, and integrating K-means with SVMs for rare class analysis. This book not only enriches the clustering and optimization theories, but also provides good guidance for the practical use of K-means, especially for important tasks such as network intrusion detection and credit fraud prediction. The thesis on which this book is based has won the "2010 National Excellent Doctoral Dissertation Award", the highest honor for not more than 100 PhD theses per year in China.

Fuzzy Modeling and Genetic Algorithms for Data Mining and Exploration is a handbook for analysts, engineers, and managers

involved in developing data mining models in business and government. As you'll discover, fuzzy systems are extraordinarily valuable tools for representing and manipulating all kinds of data, and genetic algorithms and evolutionary programming techniques drawn from biology provide the most effective means for designing and tuning these systems. You don't need a background in fuzzy modeling or genetic algorithms to benefit, for this book provides it, along with detailed instruction in methods that you can immediately put to work in your own projects. The author provides many diverse examples and also an extended example in which evolutionary strategies are used to create a complex scheduling system. Written to provide analysts, engineers, and managers with the background and specific instruction needed to develop and implement more effective data mining systems Helps you to understand the trade-offs implicit in various models and model architectures Provides extensive coverage of fuzzy SQL querying, fuzzy clustering, and fuzzy rule induction Lays out a roadmap for exploring data, selecting model system measures, organizing adaptive feedback loops, selecting a model configuration, implementing a working model, and validating the final model In an extended example, applies evolutionary programming techniques to solve a complicated scheduling problem Presents examples in C, C++, Java, and easy-to-understand pseudo-code Extensive online component, including sample code and a complete data mining workbench

The goal of traditional clustering is to assign each data point to one and only one cluster. In contrast, fuzzy clustering assigns different degrees of membership to each point. The membership of a point is thus shared among various clusters. This creates the concept of fuzzy boundaries which differs from the traditional concept of well-defined boundaries. In hard clustering, data is divided into distinct clusters, where each data element belongs to exactly one cluster. In fuzzy clustering (also referred to as soft clustering), data elements can belong to more than one cluster, and associated with each element is a set of membership levels. These indicate the strength of the association between that data element and a particular cluster. Fuzzy clustering is a process of assigning these membership levels, and then using them to assign data elements to one or more clusters. This algorithm uses the FCM traditional algorithm to locate the centers of clusters for a bulk of data points. The potential of all data points is being calculated with respect to specified centers. The availability of dividing the data set into large number of clusters will slow the processing time and needs more memory size for the program. Hence traditional clustering should device the data to four clusters and each data point should be located in one specified cluster .Imprecision in data and information gathered from and about our environment is either statistical(e.g., the outcome of a coin toss is a matter of chance) or no statistical (e.g., "apply the brakes pretty soon"). Many algorithms can be implemented to develop clustering of data sets. Fuzzy C-mean clustering (FCM) is efficient and common algorithm. We are tuning this algorithm to get a solution for the rest of data point which omitted because of its farness from all clusters. To develop a high performance algorithm that sort and group data set in variable number of clusters to use this data in control and managing of those clusters.

This thesis is concerned with issues related to clustering. In particular, it addresses the con- vergence speed of fuzzy c-means family of algorithms and cluster validation. The fuzzy c-means clustering algorithm and its objective function is studied along with a literature review of the speed of clustering algorithms. After careful examination, several objective functions are derived by modifying the fuzzy c-means' objective function. In addition, cluster validation is examined and new set distance based cluster validation indexes (CVI) are proposed which are the ratio of separation between clusters to compactness within a cluster. To this end, a new measure of compactness, compactness of a fuzzy partition is presented and fuzzy derivative of Pompeiu-Hausdorff distance is used as separation. The convergence of fuzzy c-means clustering algorithm is tested on real classification and clus- tering datasets. Under classification datasets, Iris, Breast Cancer Wisconsin and Wine Recognition datasets are used. Water Treatment Plant and Libras Movement datasets are used as clustering datasets. In classification datasets, the class labels in the data set are used to measure the per- formance. For clustering datasets, Rand index and Jaccard index are used to evaluate clustering results. The new set distance based validation indexes are tested on both synthetic and real datasets. Datasets with three, four, five and six clusters are generated by using Gaussian distributions. The above mentioned real datasets, Iris, Breast Cancer Wisconsin and Wine Recognition are also used to evaluate the performance of set distance based validation indexes. The result (number of clusters) obtained from the set distance based validation indexes are compared with those obtained from [50] to demonstrate efficiency of set distance based validation indexes and how it considers the structure of underlying data unlike others, [50] in particular.

In this paper, a new clustering algorithm, neutrosophic c-means (NCM), is introduced for uncertain data clustering, which is inspired from fuzzy c-means and the neutrosophic set framework.

A comprehensive, coherent, and in depth presentation of the state of the art in fuzzy clustering. Fuzzy clustering is now a mature and vibrant area of research with highly innovative advanced applications. Encapsulating this through presenting a careful selection of research contributions, this book addresses timely and relevant concepts and methods, whilst identifying major challenges and recent developments in the area. Split into five clear sections, Fundamentals, Visualization, Algorithms and Computational Aspects, Real-Time and Dynamic Clustering, and Applications and Case Studies, the book covers a wealth of novel, original and fully updated material, and in particular offers: a focus on the algorithmic and computational augmentations of fuzzy clustering and its effectiveness in handling high dimensional problems, distributed problem solving and uncertainty management. presentations of the important and relevant phases of cluster design, including the role of information granules, fuzzy sets in the realization of human-centricity facet of data analysis, as well as system modelling demonstrations of how the results facilitate further detailed development of models, and enhance interpretation aspects a carefully organized illustrative series of applications and case studies in which fuzzy clustering plays a pivotal role This book will be of key interest to engineers associated with fuzzy control, bioinformatics, data mining, image processing, and pattern recognition, while computer engineers, students and researchers, in most engineering disciplines, will find this an invaluable resource and research tool.

This Special Edited Volume is a unique approach towards Computational solution for the upcoming field of study called Vision Science. From a scientific firmament Optics, Ophthalmology, and Optical Science has surpassed an Odyssey of optimizing configurations of Optical systems, Surveillance Cameras and other Nano optical devices with the metaphor of Nano Science and Technology. Still these systems are falling short of its computational aspect to achieve the pinnacle of human vision system. In this edited volume much attention has been given to address the coupling issues Computational Science and Vision Studies. It is a comprehensive collection of research works addressing various related areas of Vision Science like Visual Perception and Visual system, Cognitive Psychology, Neuroscience, Psychophysics and Ophthalmology, linguistic relativity, color vision etc. This issue carries some latest developments in the form of research articles and presentations. The volume is rich of contents with technical tools for convenient experimentation in Vision Science. There are 18 research

papers having significance in an array of application areas. The volume claims to be an effective compendium of computing developments like Frequent Pattern Mining, Genetic Algorithm, Gabor Filter, Support Vector Machine, Region Based Mask Filter, 4D stereo camera systems, Principal Component Analysis etc. The detailed analysis of the papers can immensely benefit to the researchers of this domain. It can be an Endeavour in the pursuit of adding value in the existing stock of knowledge in Vision Science.

By clustering one seeks to partition a given set of points into a number of clusters such that points in the same cluster are similar and are dissimilar to points in other clusters. In the virtue of this goal, data of relational nature become typical for clustering. The similarity and dissimilarity relations between the data points are supposed to be the nuts and bolts for cluster formation. Thus, the task is driven by the notion of similarity between the data points. In practice, the similarity is usually measured by the pairwise distances between the data points. Indeed, the objective function of the two widely used clustering algorithms, namely, k-means and fuzzy c-means, appears in terms of the pairwise distances between the data points. The clustering task is complicated by the choice of the distance measure and estimating the number of clusters. Fuzzy c-means is convenient when there are uncertainties in allocating points, in overlapping areas, to clusters. The k-means algorithm allocates the points unequivocally to clusters; overlooking the similarities between those points in overlapping areas. The fuzzy approach allows a point to be a member in as many clusters as necessary; thus it provides better insight into the relations between the points in overlapping areas. In this thesis we develop a relational framework that is inspired by the silhouette measure of clustering quality. The framework asserts the relations between the data points by means of logical reasoning with the cluster membership values. The original description of computing the silhouettes is limited to crisp partitions. A natural generalization of silhouettes, to fuzzy partitions is given within our framework. Moreover, two notions of silhouettes emerge within the framework at different levels of granularity, namely, point-wise silhouette and center-wise silhouette. Now by the generalization, each silhouette is capable of measuring the extent to which a crisp, or fuzzy, partition has fulfilled the clustering goal at the level of the individual points, or cluster centers. The partitions are evaluated by the silhouette measure in conjunction with point-to-point or center-to-point distances. By the generalization, the average silhouette value becomes a reasonable device for selecting between crisp and fuzzy partitions of the same data set. Accordingly, one can find about which partition is better in representing the relations between the data points, in accordance with their pairwise distances. Such powerful feature of the generalized silhouettes has exposed a problem with the partitions generated by fuzzy c-means. We have observed that defuzzifying the fuzzy c-means partitions always improves the overall representation of the relations between the data points. This is due to the inconsistency between some of the membership values and the distances between the data points. This inconsistency was reported, by others, in a couple of occasions in real life applications. Finally, we present an experiment that demonstrates a successful application of the generalized silhouette measure in feature selection for highly imbalanced classification. A significant improvement in the classification for a real data set has resulted from a significant reduction in the number of features.

Contents:Introduction:Basic Concepts of Fuzzy SetsFuzzy RelationsFuzzy Models for Image Processing and Pattern RecognitionMembership Functions:IntroductionHeuristic SelectionsClustering ApproachesTuning of Membership FunctionsConcluding RemarksOptimal Image Thresholding:IntroductionThreshold Selection Based on Statistical Decision TheoryNon-fuzzy Thresholding AlgorithmsFuzzy Thresholding AlgorithmUnified Formulation of Three Thresholding AlgorithmsMultilevel ThresholdingApplicationsConcluding RemarksFuzzy Clustering:IntroductionC-Means AlgorithmFuzzy C-Means AlgorithmComparison between Hard and Fuzzy Clustering AlgorithmsCluster ValidityApplicationsConcluding RemarksLine Pattern Matching:IntroductionSimilarity Measures between Line SegmentsBasic Matching AlgorithmDealing with Noisy PatternsDealing with Rotated PatternsApplicationsConcluding RemarksFuzzy Rule-based Systems:IntroductionLearning from ExamplesDecision Tree ApproachFuzzy Aggregation Network ApproachMinimization of Fuzzy RulesDefuzzification and OptimizationApplicationsConcluding RemarksCombined Classifiers:IntroductionVoting SchemesMaximum Posteriori ProbabilityMultilayer Perceptron ApproachFuzzy Measures and Fuzzy IntegralsApplicationsConcluding Remarks Readership: Engineers and computer scientists. keywords:

The Second International Conference on Fuzzy Information and Engineering (ICFIE2007) is a major symposium for scientists, engineers and practitioners in China as well as the world to present their latest results, ideas, developments and applications in all areas of fuzzy information and knowledge engineering. It aims to strengthen relations between industry research laboratories and universities, and to create a primary symposium for world scientists.

Provides a timely and important introduction to fuzzy cluster analysis, its methods and areas of application, systematically describing different fuzzy clustering techniques so the user may choose methods appropriate for his problem. It provides a very thorough overview of the subject and covers classification, image recognition, data analysis and rule generation. The application examples are highly relevant and illustrative, and the use of the techniques are justified and well thought-out. Features include: * Sections on inducing fuzzy if-then rules by fuzzy clustering and non-alternating optimization fuzzy clustering algorithms * Discussion of solid fuzzy clustering techniques like the fuzzy c-means, the Gustafson-Kessel and the Gath-and-Geva algorithm for classification problems * Focus on linear and shell clustering techniques used for detecting contours in image analysis * Accompanying software and data sets pertaining to the examples presented, enabling the reader to learn through experimentation * Examination of the difficulties involved in evaluating the results of fuzzy cluster analysis and of determining the number of clusters with analysis of global and local validity measures This is one of the most comprehensive books on fuzzy clustering and will be welcomed by computer scientists, engineers and mathematicians in industry and research who are concerned with different methods, data analysis, pattern recognition or image processing. It will also give graduate students in computer science, mathematics or statistics a valuable overview.

It is really important to diagnose jaw tumor in its early stages to improve its prognosis. A differential diagnosis could be performed using X-ray images; therefore, accurate and fully automatic jaw lesions image segmentation is a challenging and essential task. The aim of this work was to develop a novel, fully automatic and effective method for jaw lesions in panoramic X-ray image segmentation.

Fuzzy logic refers to a set of methods used to characterize and quantify uncertainty in engineering systems. This edition covers major advances that have been made with regard to both theory and applications.

This report introduces two robust statistics -- the fuzzy median and the fuzzy median absolute deviation from the median -- that have been developed for use with fuzzy data sets. The two statistics were applied to the fuzzy c- Means algorithm, a powerful clustering algorithm that normally employs linear statistics. The modified algorithm showed improved performance, being able to cluster data sets generated by heavy-tailed distributions like the Cauchy and Slash distributions.

Clustering has emerged as one of the more fertile fields within data analytics, widely adopted by companies, research institutions, and educational entities as a tool to describe similar/different groups. The book Recent Applications in Data Clustering aims to provide an outlook of recent contributions to the vast clustering literature that offers useful insights within the context of modern applications for professionals, academics, and students. The book spans the domains of clustering in image analysis, lexical analysis of texts, replacement of missing values in data, temporal clustering in smart cities, comparison of artificial neural network variations, graph theoretical approaches, spectral clustering, multiview clustering, and model-based clustering in an R package. Applications of image, text, face recognition, speech (synthetic and simulated), and smart city datasets are presented.

Recently many researchers are working on cluster analysis as a main tool for exploratory data analysis and data mining. A notable feature is that specialists in di?erent ?elds of sciences are considering the tool of data clustering to be useful. A major reason is that clustering

algorithms and software are ?exible in thesensethatdi?erentmathematicalframeworksareemployedinthealgorithms and a user can select a suitable method according to his application. Moreover clusteringalgorithmshavedi?erentoutputsrangingfromtheolddendrogramsof agglomerativeclustering to more recent self-organizingmaps. Thus, a researcher or user can choose an appropriate output suited to his purpose,which is another ?exibility of the methods of clustering. An old and still most popular method is the K-means which use K cluster centers. A group of data is gathered around a cluster center and thus forms a cluster. The main subject of this book is the fuzzy c-means proposed by Dunn and Bezdek and their variations including recent studies. A main reasonwhy we concentrate on fuzzy c-means is that most methodology and application studies infuzzy clusteringusefuzzy c-means,andfuzzy c-meansshouldbe consideredto beamajortechniqueofclusteringingeneral,regardlesswhetheroneisinterested in fuzzy methods or not. Moreover recent advances in clustering techniques are rapid and we requirea new textbook that includes recent algorithms.We should also note that several books have recently been published but the contents do not include some methods studied herein.

Development of models with explicit mechanisms for data generation from cluster structures is of major interest in order to provide a theoretical framework for cluster structures found in data. Especially appealing in this regard are the so-called typological structures in which observed entities relate in various degrees to one or several prototypes. Such structures are relevant in many areas such as medicine or marketing, where any entity (patient / consumer) may adhere, with different degrees, to one or several prototypes (clinical scenario / consumer behavior), modelling a typological classification. In fuzzy clustering, the fuzzy c-means (FCM) method has become one of the most popular techniques. As a fuzzy analogue of c-means crisp clustering, FCM models a typological classification, much the same way as c-means. However, FCM does not adhere to the statistical paradigm at which the data are considered generated by a cluster structure, while crisp c-means does. The present work proposes a framework for typological classification based on a fuzzy clustering model of data generation.

Clustering algorithms are widely used in pattern recognition and data mining applications. Due to their computational efficiency, partitional clustering algorithms are better suited for applications with large datasets than hierarchical clustering algorithms. K-means is among the most popular partitional clustering algorithm, but has a major shortcoming: it is extremely sensitive to the choice of initial centers used to seed the algorithm. Unless k-means is carefully initialized, it converges to an inferior local optimum and results in poor quality partitions. Developing improved method for selecting initial centers for k-means is an active area of research. Genetic algorithms (GAs) have been successfully used to evolve a good set of initial centers. Among the most promising GA-based methods are those that exchange neighboring centers between candidate partitions in their crossover operations. K-means is best suited to work when datasets have well-separated non-overlapping clusters. Fuzzy c-means (FCM) is a popular variant of k-means that is designed for applications when clusters are less well-defined. Rather than assigning each point to a unique cluster, FCM determines the degree to which each point belongs to a cluster. Like k-means, FCM is also extremely sensitive to the choice of initial centers. Building on GA-based methods for initial center selection for k-means, this dissertation developed an evolutionary program for center selection in FCM called FCMGA. The proposed algorithm utilized region-based crossover and other mechanisms to improve the GA. To evaluate the effectiveness of FCMGA, three independent experiments were conducted using real and simulated datasets. The results from the experiments demonstrate the effectiveness and consistency of the proposed algorithm in identifying better quality solutions than extant methods. Moreover, the results confirmed the effectiveness of region-based crossover in enhancing the search process for the GA and the convergence speed of FCM. Taken together, findings in these experiments illustrate that FCMGA was successful in solving the problem of initial center selection in partitional clustering algorithms.

Hard C-means (HCM) and fuzzy C-means (FCM) algorithms are among the most popular ones for data clustering including image data. The HCM algorithm offers each data entity with a cluster membership of 0 or 1. This implies that the entity will be assigned to only one cluster. On the contrary, the FCM algorithm provides an entity with a membership value between 0 and 1, which means that the entity may belong to all clusters but with different membership values. The main disadvantage of both HCM and FCM algorithms is that they cluster an entity based on only its self-features and do not incorporate the influence of the entity's neighborhoods, which makes clustering prone to additive noise. In this chapter, Kullback-Leibler (KL) membership divergence is incorporated into the HCM for image data clustering. This HCM-KL-based clustering algorithm provides twofold advantage. The first one is that it offers a fuzzification approach to the HCM clustering algorithm. The second one is that by incorporating a local spatial membership function into the HCM objective function, additive noise can be tolerated. Also spatial data is incorporated for more noise-robust clustering.

The fuzzy set was conceived as a result of an attempt to come to grips with the problem of pattern recognition in the context of imprecisely defined categories. In such cases, the belonging of an object to a class is a matter of degree, as is the question of whether or not a group of objects form a cluster. A pioneering application of the theory of fuzzy sets to cluster analysis was made in 1969 by Ruspini. It was not until 1973, however, when the appearance of the work by Dunn and Bezdek on the Fuzzy ISODATA (or fuzzy c-means) algorithms became a landmark in the theory of cluster analysis, that the relevance of the theory of fuzzy sets to cluster analysis and pattern recognition became clearly established. Since then, the theory of fuzzy clustering has developed rapidly and fruitfully, with the author of the present monograph contributing a major share of what we know today. In their seminal work, Bezdek and Dunn have introduced the basic idea of determining the fuzzy clusters by minimizing an appropriately defined functional, and have derived iterative algorithms for computing the membership functions for the clusters in question. The important issue of convergence of such algorithms has become much better understood as a result of recent work which is described in the monograph.

This article presents a New Neutrosophic C-Means (NNCMs) method for clustering. It uses the neutrosophic logic (NL), to generalize the Fuzzy C-Means (FCM) clustering system.

This book presents the proceedings of the 13th International Conference on Application of Fuzzy Systems and Soft Computing (ICAFS 2018), held in Warsaw, Poland on August 27–28, 2018. It includes contributions from diverse areas of soft computing such as uncertain computation, Z-information processing, neuro-fuzzy approaches, evolutionary computing and others. The topics of the papers include theory of uncertainty computation; theory and application of soft computing; decision theory with imperfect information; neuro-fuzzy technology; image processing with soft computing; intelligent control; machine learning; fuzzy logic in data analytics and data mining; evolutionary computing; chaotic systems; soft computing in business, economics and finance; fuzzy logic and soft computing in the earth sciences; fuzzy logic and soft computing in engineering; soft computing in medicine, biomedical engineering and the pharmaceutical sciences; and probabilistic and statistical reasoning in the social and educational sciences. The book covers new ideas from theoretical and practical perspectives in economics, business, industry, education, medicine, the earth sciences and other fields. In addition to promoting the development and application of soft computing methods in various real-life fields, it offers a useful guide for academics, practitioners, and graduates in fuzzy logic and soft computing fields.

For decades practitioners have been using the center-based partitional clustering algorithms like Fuzzy C Means (FCM), which rely on minimizing an objective function, comprising of an appropriately weighted sum of distances of each data point from the cluster representatives.