

Importance of Fuzzy Logic and Application Areas in Engineering Research

Aruna Bajpai, Virendra Singh Kushwah

Abstract: *The domain of engineering and technology empower us for designing and developing the applications that help us in real world. In this context, the fuzzy logic is a gift for us that is acceptable in a wide range of different industry applications. In this paper, the main aim is to survey about the fuzzy logic applications and finding the recent contributions by using the fuzzy theory and their computational ability. In addition, of that the paper includes the taxonomy and the future research directions. Finally, paper provides a proposal of utilizing the technology in text mining domain as an application for future design and development.*

Index Terms: *Fuzzy Logic, Applications of Fuzzy Systems, Survey, Proposal of Text Mining*

I. INTRODUCTION

Engineering is task of finding solutions for complex real world problems. In engineering, the problem is treated in different manners for obtaining the most feasible and low cost solutions. A number of technology and tools are involved in engineering, among them fuzzy logic is one of the gift for us [1]. The benefits of this technique are, it is more flexibility and generality in the formulation and solution of problems. The fuzzy logic is not only suitable for linear problem solving it is also helpful for exploring the complexities of non-linear problems. Additionally by including all the input facts it helps us to make sharp decisions [2]. In this presented work, the main aim is to provide a detailed study of fuzzy logic. Additionally the efforts are made to provide different areas of applications that are utilizing the services of fuzzy logic. In this context, it is tried to include the recent research efforts and contributions that are fruitful for serving the applications of engineering domain. Not only the computer science applications are getting benefits of fuzzy logic different other domains are also consuming services of fuzzy logic i.e. mechanical engineering, electronics and communication, traffic control and more [3]. Therefore, it is a rich domain of applications and their applicability. The ability of fuzzy system makes it more and more acceptable in our real world problem solving technique [4]. This section provides the overview of the proposed work the next section involve the recent contributions of fuzzy based systems.

II. RELATED WORK

This section involves the different research articles and papers that are usages the techniques of fuzzy logic and improving the existing systems. Feature (gene) choice and grouping of microarray information are the two most fascinating AI challenges. In the present work Rabia Aziz et al [5] two existing element choice/extraction calculations, specifically free segment examination (ICA) and fluffy in reverse component disposal (FBFE) are utilized which is another blend of se-lection/extraction. The principle goal of this paper is to choose the autonomous segments of the DNA microarray information utilizing FBFE to improve the execution of help vector machine (SVM) and Naïve Bayes (NB) classifier, while making the computational costs reasonable. To demonstrate the legitimacy of the proposed technique, it is connected to decrease the quantity of qualities for five DNA microarray datasets specifically; colon malignant growth, intense leukemia, prostate disease, lung malignant growth II, and high-grade glioma. Presently these datasets are then arranged utilizing SVM and NB classifiers. Test results on these five microarray datasets show that quality chosen by proposed approach, viably improve the execution of SVM and NB classifiers as far as grouping precision. We contrast our proposed strategy and vital segment examination (PCA) as a standard extraction calculation and find that the proposed technique can acquire better order exactness, utilizing SVM and NB classifiers with fewer chose qualities than the PCA. The bend between the normal mistake rate and number of qualities with each dataset speaks to the choice of required number of qualities for the most elevated precision with our proposed technique for both the classifiers. ROC demonstrates best subset of qualities for both the classifier of various datasets with propose technique. Mohsen Bakhshi et al [6] proposes a nearby fluffy based damping controller (LFDC) for thyristor controlled arrangement capacitor (TCSC) to improve transient strength of intensity frameworks. To actualize the proposed plan, definite model of TCSC, in view of real conduct of thyristor valves, is received. The LFDC utilizes the recurrence at the TCSC transport as a neighborhood input motion, to control the terminating point. The parameters of fluffy controller are tuned utilizing a disconnected technique through disorderly enhancement calculation (COA).

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To check the proposed LFDC, numerical reproductions are done in Matlab/Simpower tool compartment for the accompanying contextual investigations: two-territory two-machine (TATM), WSCC three-machine nine-transport and Kundur's two-region fourmachine (TAFM) frameworks under different issues types. In such manner, to more assess the viability of the proposed technique, the reenactment results are contrasted and the wide-territory fluffy based damping controller (WFDC). In addition, the transient conduct of the itemized and phasor models of the TCSC is talked about in the TATM control framework. The reenactment results affirm that the proposed LFDC is a productive instrument for transient strength improvement since it uses just neighborhood signals, which are effectively accessible.

Recognizable proof, elucidation and reaction to client prerequisites are the key achievement factors for organizations, paying little heed to their industry. Neglecting to fulfill client necessities can harm an organization's notoriety and cause substantial misfortunes. In this investigation, Celestine Aguwa et al [7] have built up another methodology for appropriately deciphering and dissecting the fluffy voice of the client utilizing affiliation rule learning and content mining. This extraordinary procedure changes over printed and subjective information into a typical quantitative configuration, which is then used to build up a mapped Integrated Customer Satisfaction Index (ICSI). ICSI is a structure for estimating consumer loyalty. Past proportions of consumer loyalty proportion neglected to fuse the cost ramifications of settling client objections/issues and the fluffy effect of those grievances/issues on the framework. Notwithstanding including these vital and one of a kind factors in the present examination, they have likewise acquainted a dynamic Critical with Quality (CTQ) idea, a novel strategy that gives a continuous framework to screen the CTQ list through a refreshed CTQ library. Finally, a method for client input mining and notion examination is recommended that handles typographical blunders, which are unavoidable in each genuine database. The aftereffects of this investigation recommend that consolidating the fluffy dimension of antagonism and energy of remarks into the model as opposed to regarding negative and positive remarks as twofold factors prompt progressively sensible results. In addition, this examination gives an increasingly organized system to understanding client necessities.

As per Padmalaya Nayak et al [8] Wireless sensor organize (WSN) brings another worldview of constant implanted frameworks with constrained calculation, correspondence, memory, and vitality assets that are being utilized for immense scope of utilizations where the conventional foundation based system is for the most part infeasible. The sensor hubs are thickly conveyed in an unfriendly domain to screen, identify, and investigate the physical wonder and devour significant measure of vitality while transmitting the data. It is unrealistic and at times difficult to supplant the battery and to keep up longer system lifetime. Thus, there is an impediment on the lifetime of the battery power and vitality protection is a testing issue. Fitting bunch head (CH) decision is one such issue, which can diminish the vitality utilization drastically. Low vitality versatile bunching

pecking order (LEACH) is the most popular various leveled steering convention, where the CH is chosen in pivot premise dependent on a probabilistic limit esteem and just CHs are permitted to send the data to the base station (BS). Be that as it may, in this methodology, a super-CH (SCH) is chosen among the CHs who can just send the data to the portable BS by picking reasonable fluffy descriptors, for example, remaining battery control, portability of BS, and centrality of the bunches. Fluffy surmising motor (Mamdani's standard) is utilized to choose the opportunity to be the SCH. The outcomes have been gotten from NS-2 test system and demonstrate that the proposed convention performs superior to anything the LEACH convention regarding the main hub kicks the bucket, half hub alive, better dependability, and better lifetime.

With the blast of Social media, Opinion mining has been utilized quickly lately. In any case, a couple of concentrates concentrated on the exactness rate of highlight audit's and assessment word's extraction. These examinations don't accompany any ideal component of providing required exactness rate for powerful feeling mining. The majority of these examinations depend on Naïve Bayes, Support Vector Machine (SVM), K-Nearest Neighbors (KNN), and traditional philosophy. These frameworks are yet defective for grouping the component surveys into more degrees of extremity terms (solid negative, negative, impartial, positive and solid positive). Further, the current established philosophy based frameworks cannot remove obscured data from surveys; therefore, it gives poor outcomes. In such manner, Farman Ali et al [9] proposes a vigorous order strategy for highlight survey's ID and semantic learning for conclusion mining dependent on SVM and Fuzzy Domain Ontology (FDO). The proposed framework recovers a gathering of audits about lodging and inn highlights. The SVM recognizes inn include audits and channel external pertinent surveys (clamors) and the FDO is then used to process the extremity term of each element. The amalgamation of FDO and SVM altogether builds the exactness rate of audit's and supposition word's extraction and precision of conclusion mining. The FDO and wise model are created utilizing Protégé OWL-2 (Ontology Web Language) instrument and JAVA, individually. The exploratory outcome indicates impressive execution improvement in highlight survey's grouping and conclusion mining.

III. APPLICATIONS OF FUZZY SYSTEM

As reported in above section the different contributions are reported. In this section, some of the real world application areas are listed which are consuming the services of fuzzy computation.

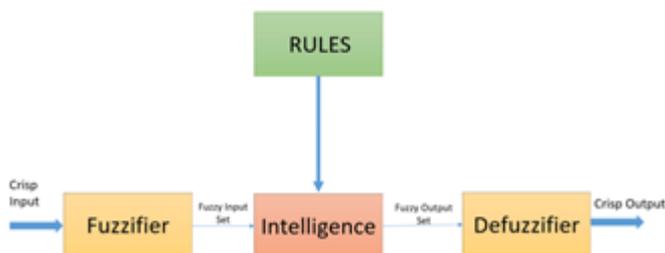


Figure 1 fuzzy system

Defense: now in these days in various defense and security agencies are implementing intelligent systems. Among some of them are implemented for underwater target recognition, interceptor missiles development, target tracking and others. In addition of some complex decisions are also made using the fuzzy based decision and support systems [10].

Finance and banking: as we described the fuzzy systems are helping us for decision-making. Therefore, now in these days banking and finance sector is also working with the fuzzy based data models. These models are help to make decisions during fund management, loan and credit card, fraud detection and stock market predictions [11].

Manufacturing and production: in a number of production units where the quality control and process management is taken place in automatic mode. Then an intelligent system is required to handle and make instant decisions. In this context the fuzzy based decision making system are help to regulate the processes of production and manufacturing [12].

Machine learning and pattern recognition: the machine learning techniques are supporting a number of tasks. Such as classification, clustering, optimization, rule development and others, in such conditions the data is need to be evaluated and the similar patterns are captured and extracted from raw data. Therefore, that is also suitable for machine learning and pattern recognition task i.e. image recognition, text classification, and others [13].

Transportation industry: In transport industry, the fuzzy based systems are employed for various applications such as, traffic scheduling, air traffic control, braking and signaling and others [14].

Medical science: the medical science and their research are closely dependent on the engineering and its applications. In their regular use of applications is also the invention of engineering among some of them is frequently usages the fuzzy logic based systems such as Medical diagnostic, Radiology, control of anesthesia, pressure and temperature control and others [15].

Industrial sector: industrial sector where the process control is required for managing the heat, pressure and composition of elements the fuzzy based systems are required such as waste management, water treatment plants, cement manufacturing units and others [16].

In this section different applications of fuzzy based system is provided additionally how these systems are used are reported. The next section involves some essential terminology of the fuzzy systems.

IV. ADVANTAGES & DISADVANTAGES

The potential of fuzzy logic make it more valuable for their applicability. In this section, some advantages and disadvantages are listed for fuzzy based systems.

Advantages

1. High precision on outcomes
2. Much similar as human reasoning
3. Usages simple mathematical models for solving real world complexities linear or non-linear
4. Used for rapid operations and decision control
5. Very useful for rule based modeling and membership measurements

Disadvantages

1. Low speed and long running time required
2. Lack of real time response
3. For precise results need to involve a significant amount of data, that also increases rules for reasoning
4. Not usages the feedback of system

This section introduces the advantages and disadvantages of the fuzzy based systems. In next section the different research directions in computer science is provided.

V. RESEARCH DIRECTIONS

This section includes the different domain of computer science applications and the research domains where the fuzzy logic can be helpful for improving the existing models.

1. **Text mining:** in real world there are a number of applications exist where the classification and clustering is required with the text data. the application of text mining in a number of places are available now in these days such as opinion mining, feedback management and others
2. **Object recognition:** In different applications such as monitoring and surveillance, it is required to track or monitor the objects in video frames. Here for finding the objects in these frames the fuzzy system can be a suitable and effective option.
3. **Image classification:** image classification is a complex task, additionally identification of valuable and target features are needed to be recognized. Therefore, the medical image processing and their applications are also required precise classification of images where similar kinds of images are needed to be classified.
4. **Image retrieval:** the content based image retrieval techniques are also needs the complex computations and extraction of similar object based images. Therefore,

5. the fuzzy based systems are also best-fit solution.
6. **Optimization:** the ability of selecting appropriate features form different kinds of data make it valuable for finding solution in optimization problems.

VI. RESEARCH PROPOSAL

During the survey of different article and research papers, it is recognized the fuzzy logic is one of the most essential technique for processing data and obtaining the fruitful patterns. Therefore, in this presented work a proposal on text mining for discovering the orientations of the user is proposed for design and implementation.

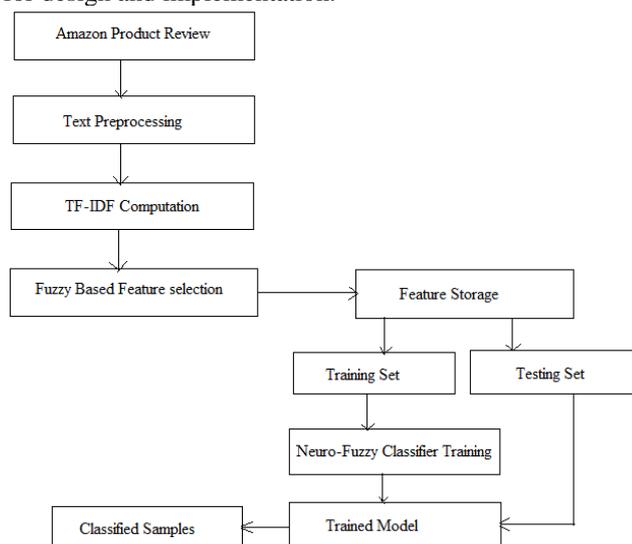


Figure 2 proposed model

The figure 2 includes the proposed system model for feedback processing system and obtaining users orientations according to their text reviews. In this context, the Amazon product review dataset is used as input to the system. This dataset is preprocessed in first phase to reduce the unwanted text and additional characters. In this context stop word removal and special character, removal is adopted. In next process, the data is preprocessed for obtaining the valuable features. Therefore, first the TF-IDF concept is implemented. That technique reduces the content of the entire reviews of product, in addition of that it is helping us to find the significant tokens among all the text keywords. However, the length of the computed valuable features is not regular in size. Therefore, the proposed work is intended to propose a fuzzy logic based feature selection technique. That help in two contexts first find more suitable features for classification increases the classify-ability of the selected features. After selection of the features the list of features is sub-divided into two parts first contains the ratio of 70% of entire input samples, which is used training of the supervised learning model. Here for optimizing the classification outcomes the Neuro-fuzzy model is used. After training of the system, the system is able to classify the unclassified test samples, which are remaining 30% of the entire samples. Using the classified test samples, the performance of the system is computed. This section provides a data model which usages the fuzzy based technique for selecting the classification features and used for learning the features using the supervised learning algorithms. In next section, the conclusion and future work is suggested

for design and development. As reported in above section the different contributions are reported. In this section, some of the real world application areas are listed which are consuming

VII. CONCLUSION & FUTURE WORK

The fuzzy logic is an essential part of technology. That offers services not only to the core engineering that is also applicable to solve various real world complexities. The problem solving technique is much transparent and flexible to scale and minimize the requirements according to the application needs. In this context, the paper provides the detailed understanding about the applications and acceptability of the fuzzy based systems in various industries and organizations. In addition, of that paper is also providing the advantages and the disadvantages of the existing fuzzy based data models. For future design and development based on the gained experience a data model is introduced for text mining application where the key aim is to categorize the text according to user sentiments and their orientations according to the product review. In near future the given model is implemented and their performance is simulated.

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