

# Review on Fuzzy Classifications Techniques and Applications

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## ABSTRACT

The concept of fuzzy classification has been significantly used in various Purposes. The fuzzy classification area has been increased rapidly in the past few years and it has been successfully adopted. In this work, we propose to develop a means to understand Fuzzy Classification. Particularly, this article tends to present a deep review of the most important topics of Fuzzy classification including new improvements in the field. This article explains the significance of Fuzzy classification, displays the various methods of Fuzzy classification and different applications. The paper ends with a summary and conclusion.

## General Terms

Fuzzy Classification

## Keywords

Fuzzy system, Classification, Fuzzy classification K nearest neighbors classification, Fuzzy K nearest neighbors classification

## 1. INTRODUCTION

Classification is a way for selecting the proper class for each object. A set of classes with specified of properties is given. Any object described by these properties can be determined to which class belongs. Classification can be performed using Decision tree and K-nearestneighbor algorithm. Also A Randomforest and Supportvector machine can be used for classification. From the beginning of Fuzzy Set Theory [1]. It have been utilized in developments of the two topics Classification and Control [2, 3]. Many issues in both areas are solved more efficient by using fuzzy systems. Fuzzy logic have been utilized in the developments of fuzzy classification methods[4-9]. Fuzzy system are widely used for different applications in control [10-19]. The classification can be performed using Fuzzy inference system. In fuzzy classification, a sample can be a member in many classes with different degrees.

Fuzzy concept is widely used in Classification and Control [20] Fuzzy approach offer a useful properties in control problems and used in different applications. Also Fuzzy classification has become popular and has been adopted in many applications, including Data classification. image classification, and medical data classification.

Different methods of fuzzy classification are developed and used in various applications.

The motivation of this review was to present the most significant properties of fuzzy classification including new techniques and applications.

The aim of this article is to view the most significant aspects of fuzzy classification in a single paper for researchers and

students. The article is arranged as :

Fuzzy Classification approaches section, Review section and finally summary and conclusion section.

## 2. FUZZY CLASSIFICATION APPROACHES

Fuzzy classifier can be implemented in several approaches:

### 2.1 Fuzzy k-nearest neighbor classification method

In the k-nearestneighbor classification method, the object is classified to be in one class. The fuzzy k-nearestneighbor (FKNN) method uses the spaces between the examination piece and the nearest neighbor piece. The FKNN model computes a membership of the examination piece for every class and take the decision depending on the largest degree. The membership degree of a given new piece X in a class i that is measured as follows:

$$u_i(y) = \frac{\sum_{j=1}^k u_{ij} (1/\|X-X_j\|^{2/(m-1)})}{\sum_{j=1}^k (1/\|X-X_j\|^{2/(m-1)})} \quad (1)$$

where  $m \in (1, \infty)$  is a fuzzy intensity used to adjust the space  $\|X - X_j\|$  between X and  $X_j$  to weight the effect of each neighbor piece to the magnitude of membership. The variable  $u_{ij}$  is the training piece  $X_j$  membership for class i in the neighbors. The variable  $u_{ij}$  can be measured by two schemes: crisp values and fuzzy memberships[8].

### 2.2 Fuzzy Classification using Inference system

Fuzzy classifier can be implemented using fuzzy inference system (FIS). It relates inputs features to outputs classes using fuzzy relation [10]. The output of FIS is computed by the following steps

1. Selecting fuzzy rules and membership functions.
2. Fuzzification of the input variables
3. Applying rules
4. Finding the consequence of the rule
5. Determine the output
6. Defuzzification of the output.

The classes will be described by fuzzy rules as:

If  $P_1$  is  $A_{11}$  ... and  $P_m$  is  $A_{1m}$ , then class C1.

If  $P_2$  is  $A_{21}$  ... and  $P_m$  is  $A_{2m}$ , then class C2.

.....

.....  
 If  $P_n$  is  $A_{n1}$  ... and  $P_m$  is  $A_{mm}$  then class  $D1$ .

where for  $i = 1, ..n$  ;  $j = 1, ... m$ .

### 2.3 Classification using a Neural Fuzzy Inference system

Adaptive fuzzy neural inference system (ANFIS) consists of fuzzy system and neural network. It is used in various applications.

The ANFIS have five layers:

- Layer of input
- Layer of input membership functions
- Layer of Fuzzy rules;
- Layer of output membership functions
- Layer of output

Figure 2 shows a simplified diagram for ANFIS (two Inputs and one output Network)

### 3. LITERATURE REVIEW OF FUZZY CLASSIFICATION

Qilian et al [20] presented a new method for classification MPEG video with variable rate using fuzzy system. Authors show that a type-2 fuzzy membership function is more suitable. Authors suggested using type-2 fuzzy system to classify a compressed video traffic data. results show the effectiveness of the proposed classifier using type -2 fuzzy which performs better than of the five classifier presented. Uraivan et al [21] presented a classification scheme based on fuzzy inference system for terrorism events. Two classification schemes based on using fuzzy inference

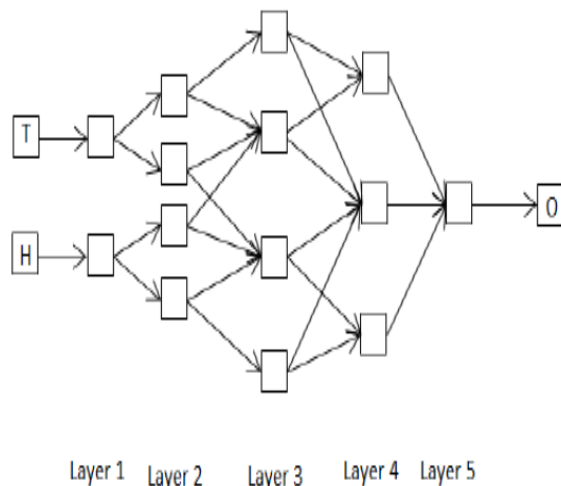


Figure 2. A Simplified Diagram of a Neural Fuzzy Network

system and adaptive neural fuzzy inference system are presented and compared. From the experimental results one can see that the classification using adaptive neural fuzzy inference system show better performance when compared with that of using fuzzy inference system. The root mean square error using fuzzy inference system is 2.16%

while in the case of using the neural fuzzy network the root mean square error is 0.08%. It was concluded that using adaptive neural fuzzy inference system is the best event classification for terrorism event prediction.

Authors in[22] present the proposed fuzzy classification of land / cover using satellite image and features of the histograms for each area. It suggest an appropriate method that includes selecting the parameters of the membership functions and classification of the satellite image. The proposed fuzzy classification method show good performance. It is better than classical known methods.

The work in [23] consider and present an interval type-2 fuzzy rule-based classification systems. A compressed reduced rule interval type-2fuzzy rule base is constructed. The performance of this system is presented experimentally using many data sets.

Authors in[24] are proposed an adaptive fuzzy classifier for bankruptcy prediction based on the k- nearestneighbor method. The particle swarm optimization algorithm is used in the design of the parameters of this classifier. The proposed prediction model is studied and compared other classification methods. Results show the goodness of the developed model when compared with other methods.

The work in [25] proposed a method for gender classification using collected shape information to formulate a decision creating system based on fuzzy logic. The face information together with image texture properties and Zernike moments information were collected to form inputs of the fuzzy inference system which make decision and classification.

The study in [26] is related to the classification problem of coronary artery disease. The quality of classification is related to the number of input variables and on fuzzy rules. A medical suitable membership functions which give good accuracy are chosen for the variables. The fuzzy inference method is adopted with weighted rules to obtain good results.

The work in [27] study different method of classification using fuzzy inference system and fuzzy cognitive map.

The conclusion is that in the case of uncertain or missing values then the recommendation is to use Neutrosophic logic.

The work in [28] developed a multiple stage system for the detection of EEG signals utilizing fuzzy system. The system is examined using rats EEG recorded data. The proposed fuzzy inference system is tested based on features extracted accurately in terms of three stages and results showed that the proposed system is good.

Authors in [29] considered the classification the real world data using fuzzy rules. The proposed algorithm is used to classify students into three groups - admitted, rejected and those who might get the admission. The system is designed for handling admission of students to various universities. The prediction for getting admission fuzzy rules generated from the data and gives suitable output. The developed algorithm is more efficient when compared with other known algorithms.

The work in [30] proposed an approach to design neuro-fuzzy classifiers with new interpretation standard. The proposed system uses hybrid algorithm (genetic and the imperialist algorithm) for the optimization of the parameters and the structure of the neuro-fuzzy system used for classification.

The work in [31] introduced an online fault detection in transmission line using fuzzy system. The developed method is used to detect and classify the fault. Results demonstrated the goodness of the developed method. The proposed fuzzy based fault detection is simple and can be utilized for fault detection efficiently.

The work in [32] presented a system to differentiate a student on the basis of performance in larger organization with high number of student. The new developed fuzzy inference system is adopted to classify the student. The system is useful to many educational organizations. A fuzzy Inference system is utilized to predict student performance and may improve it.

Authors in [33] Consider the design of a fuzzy neural network for detection of liver. Authors here used data extracted from a common known data base. The proposed system is better when compared to other systems.

Authors in [34] presented a new modified fuzzy system for cyber hate classification. Authors conducted experiments to examine the validity of the presented system. The performance of the presented fuzzy system is compared with the other approaches to cyber hate classification.

Results demonstrated that the proposed system was good in doing the classification.

Authors in [35] presented the subject of Text classification using Fuzzy Neural Networks. The text to be classified is divided into tokens and then the features are extracted to select a subset of key words best represent the text document and used to classify the document.

Authors in [36] presented a proposed classification scheme based on using fuzzy inference and radial basis network for the analysis of time dependent signal. Experimental test was performed for classification diagnoses of cardiovascular diseases using ECG signals. Results showed the proposed method strongly improve classification ability when compared with other methods.

Authors in [37] presented an information system based on type-1 fuzzy and transformed into interval type-2 fuzzy. In the experiments different fuzzification procedures were investigated using Mamdani type inference. The developed method was tested on benchmark data.

The work in [38] explained the subject of using neural fuzzy system in classification. Finally it was concluded that the neural fuzzy system can be used for classification and there is a big chance for using it in different applications.

In the work of [39] diagnosis of diabetes was considered. Fuzzy system was used to design a system for early detection by two fuzzy classifiers. The proposed system

has been tested using diabetes dataset. Results indicated good performance for the proposed system. It gives better accuracy when compared with other techniques.

The work of [40] presented a modified fuzzy k-nearest neighbor system. The Minkowski distance is used and the nearest neighbors are weighted by fuzzy weights in the modified system to improve the performance. The system is tested on real-world data and results show good performance. It was concluded that the new presented system is better than other known techniques.

## 4. CONCLUSION

The objective of this article is to present a review of methods and applications of fuzzy classifications. The study of scientific publications demonstrates that the research area of fuzzy classifications is still growing. One can notice an increasing efforts in the subject of entering fuzzy theory in conventional classifications methods using solutions based on fuzzification of the classical algorithms. Also hybrid approach using fuzzy logic with metaheuristic algorithms have been adopted to obtain an efficient algorithm. It is noticed that there is an increase in medical applications.

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