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# A Novel Intelligent Hybrid Fuzzy Method for K-Means Algorithm

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## Abstract

In this study, we want to focus on intelligent hybrid fuzzy methods for K-Means algorithm and we want to present a fuzzy model for this algorithm. This method is combined with other methods in order to improve the clustering mechanism. All kinds of hybrid fuzzy methods is helped to improve the performance of K-Means algorithm. We hope that, this paper is useful for the researchers work in machine learning scope.

**Keywords**: Intelligent Hybrid Fuzzy Methods, Machine Learning, Clustering Mechanism, K-Means Algorithm, Fuzzy C-Means Algorithm, Accuracy

## Introduction:

In this part of study, we explain some intelligent fuzzy hybrid methods in different applications. My goal in this part of the paper, is explaining some useful of applications of two important unsupervised learning algorithms, are K-Means algorithm and Fuzzy C-Means algorithm.

In this explanations, First of all we want to focus on combine of multi-objective evolutionary method with fuzzy hidden markov model [1] in order to predict time series clustering. Todays this applications is focused on it. Another application is very important in machine learning scope is [2] dividing the clusters into sub clusters and Using fuzzy threshold to map better data in to it's cluster. In this method we use genetic based algorithm to achieve better answers. In this scope another important item that we want to explain[3],Using Fuzzy Type 2 in clustering Mechanism. This method is helped to cluster, classifications and pattern recognition.

Another application we declare [4], Using genetic programming to search better in association rule mining in sub clusters and our goal here is, finding the best cluster for data that mapped to it s cluster. If some researchers want to focus on Fuzzy-evolutionary systems, we recommend that study this reference [5]. This reference is explained classification and applications and trends in this kind of scenario.The other application we want to talk about it [6],is predicting stock prices. This application is very useful for Economic men. Another application is very useful in machine learning and data mining, is [7] modeling and predicting time series clustering based on co-working and collaborative Fuzzy mapping and do fuzzy C-Means clustering on the Data that we want to cluster. Using fuzzy C-Means clustering [8] is very important. This method is explained in reference [8]. Another method that we want to declare is [9] combine of genetic based algorithm and K-Means algorithm in order to cluster data better than before. This method is used for electing better numeral number for k in this algorithm. Another application of clustering model is very good topic[10] for researchers is explained in reference 10 is used clustering models for using in Cloud scenarios. Another application of fuzzy methods that used FMIG [11] method in reference 11 that help us to cluster, better and the compactness of the cluster is being improved in this method. Another interesting item is very useful[12] is using neuro-fuzzy model that focused on data driven systems. in this type of system we should use fuzzy collaborative methods that help us to achieve suggested model that we want to present it. Another clustering method that we want to talk about it,is using [13] fuzzy K-Modes algorithm that we pattern from this algorithm to cluster better in reference 13.

Another method that we patterned from it to achieve my method is improved Wang-Mendel method [14]. This Method used to generate fuzzy rules. [15], [16] used PID Fuzzy systems in control methods of vessels which can be used for trajectory control and path planning methods. This rule helped us to cluster better and improved the compactness in the Clustering. Last fuzzy method that we want to focus on it is, compound clustering [17, 18] that help us to do better Clustering in the scenario that we have in that paper.

## Main Body :

### Methodology of Suggested Method:

### 1-Using SOFNN* Method in Suggested Method

SOFNN method has 5 layers[11]. The input layer has this equation that showed in equation 1.[11]

$$net - input = f[u_1^{(k)}, u_2^{(k)}, \ldots, u_n^{(k)}; w_1^{(k)}, w_2^{(k)}, \ldots, w_n^{(k)}] \quad (1)$$

The activation function of this network has this

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* On Line Sliding Window Based Self Organizing fuzzy Neural Network

formula that showed in equation 2. [11]

$$output = o_i^{(k)} = a(net - input) = a(f) \tag{2}$$

There is no calculation in this layer, only it transfer the last layer to next layer. [11]

$$f = u_i^{(1)} \text{ and } a^{(1)} = f \tag{3}$$

In this layer, Gaussian formula is used in order to achieve the estimate function. [11]

$$f[u_{ij}^{(2)}] = -\frac{[u_{ij}^{(2)} - \mu_{ij}]^2}{\sigma_{ij}^2} \text{ and } a^{(2)} = e^f \tag{4}$$

In the next layer we use from fuzzy rules to achieve my aim.[11]

$$f[u_i^{(3)}] = \prod_{i=1}^{n} u_i^{(3)} \text{ and } a^{(3)} = f \tag{5}$$

In this layer we use from this estimated function to do the goal that we want [11].

$$f[u_i^{(4)}] = \sum_{i=1}^{r} u_i^{(4)} \text{ and } a^{(4)}(f) = \frac{u_i^{(4)}}{f} \tag{6}$$

In the last layer, we do the defuzzification method to this network. [11]

$$f[u_i^{(5)}] = \sum_i w_i u_i^{(5)},\ a^{(5)}(f) = f \tag{7}$$

**2-Colliborative Fuzzy Clustering in Suggested Method**

In this technique, we use this fuzzy pattern to improve the clustering mechanism. this formula is showed in equation 8.[12]

$$Q[l] = \sum_{i=1}^{N}\sum_{j=1}^{c} u_{ij}^2[l] d_{ij}^2[l] + \sum_{\substack{m=1 \\ m \neq l}}^{p} \beta[l,m] \sum_{i=1}^{N}\sum_{j=1}^{n} \{u_{ij}[l] - u_{ij}[m]\}^2 d_{ij}^2[l] \tag{8}$$

This flow chart contains two phases. First structure learning phase and second parameter learning. 2 phase is
Showed in figure 1.[12]

**3-Improved Wang-Mendel Method for generating Fuzzy rules in Suggested Method**

We use this method [14] to produce fuzzy rules. In fact it used in machine learning, data mining and wireless sensor networks scope. This method is faced to noisy and outlier data very good. Another item is very interesting in that paper [14] is using fuzzy partitioning. all of the formula is showed in next equations.[14]

$$J_m = \min \sum_{i=1}^{N}\sum_{j=1}^{c} (u_{ij})^m d^2(x_i, v_j) \tag{9}$$

$$v_i^{(b)} = \left[\sum_{j=1}^{N} (u_{ij}^{(b)})^m \cdot x_j\right] \Big/ \left[\sum_{j=1}^{N} (u_{ij}^{(b)})^m\right], \quad i = 1, 2, \ldots, c \tag{10}$$

$$u_{ij}^{(b+1)} = \left[\sum_{k=1}^{c} (d_{ij}^{(b+1)} / d_{kj}^{(b+1)})^{2/(m-1)}\right]^{-1}, \quad k = 1, 2, \ldots, c \tag{11}$$

Training model is used in that paper [14] is changed of fuzzy C-Means clustering that named in that paper [14]
AFCM. These models are showed in next equations. [14]

$$aff_i = \frac{1 - E_i}{N - \sum_{i=1}^{N} E_i} \tag{12}$$

$$J_m = \min \sum_{i=1}^{N} \sum_{j=1}^{c} aff_i (u_{ij})^m d^2(x_i, v_j) \tag{13}$$

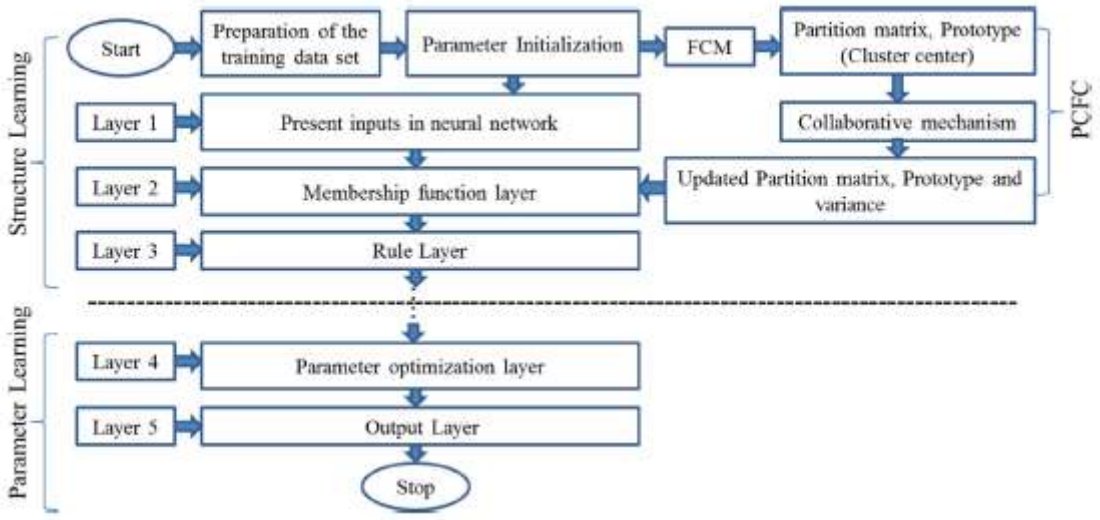



Figure1[12]

$$v_i^{(b)} = \left[\sum_{j=1}^{N} aff_i(u_{ij}^{(b)})^m \cdot x_j\right] \Big/ \left[\sum_{j=1}^{N} aff_i(u_{ij}^{(b)})^m\right], \quad i = 1, 2, \ldots, c \tag{14}$$

**4-Improved Wang-Mendel Methods in Suggested Method**

This method is used in order to improve the clustering mechanism [14]. This method is focused to generate sub clusters and with using fuzzy rules, this improving is happened. Another factor is occurred in this method, is deleting noisy data. This formula is showed in next equations.

$$MAC_{\phi,\varphi} = \frac{(\phi^T \varphi)^2}{(\phi^T \phi)(\varphi^T \varphi)} \tag{15}$$

The flow chart of this method is showed in figure 2 [14].

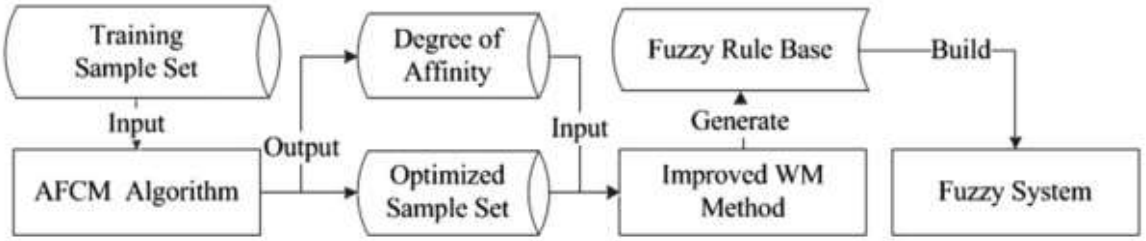



Figure 2 [14]

**5-Using HRBFNN† Method By uses Fuzzy Clustering Method and PNN‡ Method in Suggested Method**

The writers of this study suggested that using this two kind of neural network in suggested method, can helped
To improve clustering mechanism and improved the compactness in clusters.

## Conclusion:

In this paper first of all we explain some hybrid intelligent fuzzy methods and after that we recommend a method to improve the performance of clustering mechanism and this method can improved the compactness in the clustering**.** This method has five parts and the writers of this paper believe that if five parts is done sequentially, the improving of clustering and compactness is occurred.

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† Hybrid Radial Based Fuzzy Neural Network
‡ Poly Nominal Neural Network

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