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An Analysis of Fuzzy C Means and Logical Average Distance Measure Algorithms using MRI Brain Images

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Abstract: Now days several clustering algorithm is using in data mining technique. In data mining using distance based clustering algorithms, such as k-Means and Fuzzy C Means (FCM) are used to identify tumor or the origin point of tumor. In this paper pre-processing phase the collected data set are prepared using pre-processing techniques such as region of interest, inverse method and boundary detection for the effective result of clustering. The k-Means and FCM clustering algorithm are used for evaluation and Logical Average Distance Measure Algorithms (LADMA) is designed and implemented. The performances are compared based on accuracy and clustering quality and also measured by time and space parameters.

Keyword: Fuzzy C Means Algorithm, k-Means Algorithm, Medical Image Extraction, Logical Average Distance Measure Algorithms

I. INTRODUCTION

Data mining is the process of extracting meaningful information from large database. In Medical field the problem may arise in the era data mining has vital role to predict and diagnosis the disease in early stage with the use of machine learning tool. Medical images are widely used by the physicians to find abnormalities in human bodies. Medical image normally used by the physicians to detect abnormalities in body system. It is also used for the treatment planning. Various medical images techniques used to sense the irregularities in human bodies such as Magnetic Resonance Imaging (MRI), Computerized tomography (CT), and Ultrasound (US) imaging. In such a case, the radiographer used a tool to make the decision of medical images analysis easier. It also helps radiographer make accurate decision about the corresponding image. Radiologist use medical image to identify the tumors, tissues, and its anatomical structures [1]. But there are many problems faced when performing MRI procedure. The problems are the image generally have non-linear characteristics and sometimes are corrupted with noise These problems make the radiologist faced difficulties in identifying of tumors, tissues and its location as well as difficulties to study the anatomical abnormal growth of glands. Finally, these may lead to inconveniences in making decision. This paper is structured as follows section 2: the concepts of preprocessing, clustering, k-Means, FCM algorithm and LAMDA. Section 3 explains results k-means and our proposed method. Section 4 results are discussed and conclusion part is as section 5.

II. APPROACHES

There are so various approaches are supported by the clustering techniques for data mining these are as this section

A. Pre-processing

This work uses pre-processing to improve quality of raw data for feature enhancement, by removing and reducing the unrelated and surplus details in the contextual of the source data. Preprocessing techniques such as region of interest, inverse method and boundary deduction methods are used to remove noise in an image. The medical domain allows the radiologists to produce the images which give details of internal structure of living tissues which contains noise while capturing raw signals and conversion of digital images.

B. Clustering

Clustering approach used in areas including the analysis of satellite images, medical images, multimedia images and for various information repository data warehouse images. All these are effectively utilized for the ultimate use the images. Clustering is the assignment of an object into groups so that an object from the same group has similar objects and dissimilar from other groups. A look at the clustering methods used in this work is given as follows.

C. The k -Means Algorithm

The k-Means technique is simplest unsupervised algorithms that provide the well-known clustering resolution. Since, k-Mean clustering is normally introduced to group a set of data points x into k clusters. It has high computational efficiency and can support multidimensional vectors. So, it reduces the distortion measurement by minimizing distance measure function [16, 130]. It creates a partition of the objects into groups from which the metric to be minimized can be considered. The k-means is a simple clustering algorithm that has been applied in several problem domains. The distance

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measure for the k-Means algorithm is computed with square means of two pixels points suing the below equation 1.

$$K = \sum_{j=1}^{k} \sum_{i=1}^{n} \left\| x_i^{\,j} - c_j \right\|^2 \quad \text{..... .... 1}$$

Step 1: Place *k* points into the space represented by the objects that are being clustered. These points represent initial group centroids.

Step 2: Assign each object to the group that has the closest centroid.

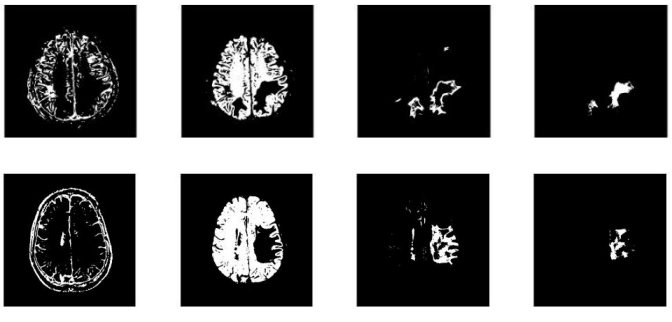
Step 3: When all objects have been assigned, recalculate the positions of the *k* centroids.

Step 4: Repeat steps 2 and 3 until the centroids no longer move.

This produces a separation of the objects into groups from which the metric to be minimized can be calculated. The clustering technique shows their efficiency in various fields, in this technique is expansive in the medical domain, the competence of k-Means was shown in many applications because of its performance.

D. Results of k-Means Algorithm

The k-Means algorithm is applied to dataset based on intensity based clustering to extract the features of tumor. In this algorithm is applied to malignant tumor images. The number of white pixels helps in identifying the tumor affected areas with fewer amounts of pixels. The figure 1 clustered outputs shows the *k*-Means for a tumor identified regions in MRI image, when k value are 1st, 2nd, 3rd and 4th clusters respectively generated by *k*-Means algorithm. Specific refinement process takes place during segmentation of clusters and the 4th cluster has more pixels visibility with huge tumor area.



c=1 *c=2* *c=3* *c=4*

Figure 1: Sample Image Results of k-Means when k=4

E. Fuzzy C-Means Algorithm

The Fuzzy C-Mean is an unsupervised algorithm that has been applied to extensive assortment of difficulties involving feature analysis, clustering and classifier design. Each cluster formed as per the distance of data points in the provided data set [116, 135]. The FCM is a method of clustering which allows one piece of files to belong to more than two clusters. This method is frequently used in pattern recognition. It is based on minimization of average distance measure of centroid function. In this algorithm, data are bound to each cluster by means of a membership function, which represents the fuzzy behavior of the algorithm [17, 118].The fuzzy centroid mean on the distance of pixels with its distance on the centroid point using the given equation 2

$$uij = \frac{1}{\sum_{k=1}^{S} \left[\frac{\| D_i - S_j \|}{\| D_i - S_k \|} \right]^{\frac{2}{m-1}}}, sj = \frac{\sum_{i=1}^{N} I_{ij}^{\,m} . x_i}{\sum_{i=1}^{N} I_{ij}^{\,m}} \text{..... ..... 2}$$

Step 1: Initialize $I = [I_{ij}]$ matrix, I(0)

Step 2: At k-step: calculate the centers vectors S(k)=[sj] with I(k)

Step 3: Update I(k) , I(k+1)

Step 4: If ‖ I(k+1) - I(k)‖< î then STOP; Otherwise return to step 2.

This algorithm, values are assured to every cluster by means of associated with membership function, which embodies the fuzzy behavior. In this research work, it is focused on tumor detection by identifying intensity area in MRI data are taken for analysis. The pre-processing work is done by using the region of interest (RoI), inverse method and edge detection method for the extraction of the input data. After pre-processing the images, they applied to find the clusters by using FCM technique. The number of clusters produced by FCM is 4, 6, and 8.

F. Results of FCM Algorithm

The Fuzzy C Means algorithm (FCM) is also implemented to the MRI to find the intensity value based on cluster via finding tumor region. FCM algorithm is applied to find the clusters of MRI images by dividing the image into 4 cluster groups. To extract the features of tumor from the brain image, for intensity based segmentation FCM algorithm is used. Each image is divided into different number of four clusters group. The input given to the algorithm is the c value 4. It can be easily known that some clusters have less number of pixels. The tumor affected area is easily identified by the number of white pixels present. Since the end clustering is the last refined and tuned image, the affected region is precisely found there as per the suggestions given by the medical practitioners. The figure 2 that shows some visible white pixels which are actually tumor affected area is the final level of cluster. The final level of cluster that shows some difference in the intensity is the most abnormal part of the original image. The images of 4th cluster which are really enormous tumor area have more visible pixels.

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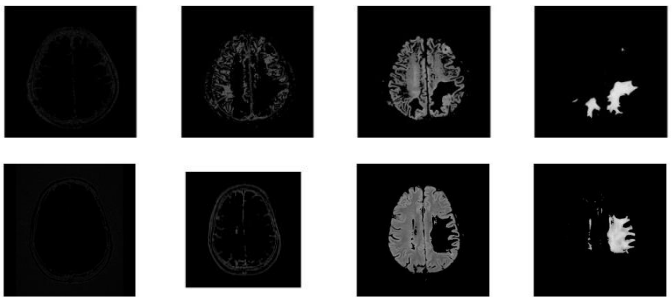


c=1 *c=2* *c=3* *c=4*

Figure 2: Sample Results of FCM Algorithm when c=4

G. Logical Average Distance Measure Algorithm (LADMA)

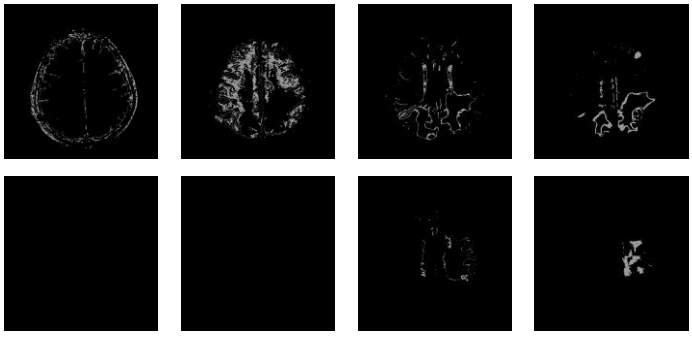
This algorithm is designed with two major types of algebraic operations AND, OR, which are applied into average distance measure computed from k-Means and FCM from clustered image datasets. The corresponding positional pixel distance measures are embedded one with another to apply these operations on clustering results. LADMA method is used for the detection and prediction of significant region in a brain MRI medical data. The clusters are formed using range based density values. The clustered image exhibits high density region which represents in irregular image. The determined common irregular images are unified using logical average distance measure as part of proposed algorithm [137]. Logical Average Distance Measure Algorithm is provided the average distance of the cluster image by using the given equation 3.

$$\text{LCM}I = \sum_{i=0}^{n} \sum_{j=0}^{m} \left| \frac{KI_{ij}\, S_{ij}/F_{ij}}{[KI_{11}\, S_{11}/F_{11} + KI_{12}\, S_{12}/F_{12} + \ldots\ldots\ldots KI_{nmn}\, S_{nmn}/F_{nmn}]} \right|^{1/n_{mn}} \quad \ldots\ldots(3)$$

H. Results of LADMA

The LADMA algorithm is designed using two major types of algebraic operations AND and OR. LADMA method is used for the detection and prediction of significant region in brain MRI medical data to find the tumor affected area of the images. The LADMA method is formed using range based density values. The clustered image exhibits high density region which represents in irregular image. The determined common irregular images are unified using logical average distance measure as part of the algorithm. This method gives the best optimized significant region in various clusters based on LADMA.

The objective of clustering is to divide into set average distance measure of different variation groups for the same source of images. The clustering of items values is based on evaluation of communication between the equivalence of the clustered objects using Average distance measuring function. Thus, output of cluster is equal group of clusters, in a single clustered Average distance supports *d*, similar to each other cluster layers are identified. The LADMA used medical data in malignant image. The results of LADMA methods denoted by the number of clusters *d* as 4, clustering are shown from figures 1. A common more significant region is identified by LADMA algorithm and then it produces an output which is better than the other results.



c=1 *c=2* *c=3* *c=4*

Figure 3: Sample Output of LADMA when d= 4

III. DISCUSSION

The process time and space complexity are calculated for the FCM, *k*-Means and LADMA methods. The LADMA method will predict affected region of different pixels are given as number of significant objects. The results of methods denoted by the number of clusters as 4 are shown from figures. A common more significant region is identified by LADMA algorithm and then it produces an output which is better than the k-means. The process continues until an appropriate affected image is got. The process time and space occupied by the algorithms are tabulated in table 1. In these tables the numbers of white color pixels are given as number of pixels. The table shows results malignant data separately and which contains info such as number of pixels, image file size and run time of the algorithm represents cluster number.

This paper explains clustering methods which are widely used in medical image analysis. The techniques and their applications in medical image analysis are been presented. Some are applied in MRI images, like brain images.

Table 1: Result of algorithm

	k-Means	**FCM**	**LAMDA**
Run Time in Sections	0.977995	27.44898	0.201566
Number of pixels	4397	8946	5739
Original Memory KB	55.6	55.6	55.6
Pre-process Memory KB	20.2	20.2	20.2
After Cluster Memory	6.40	6.71	11.2

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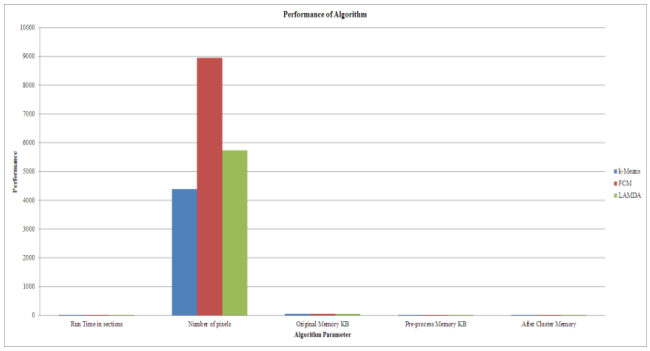

Figure 4: Overall Performance of algorithm

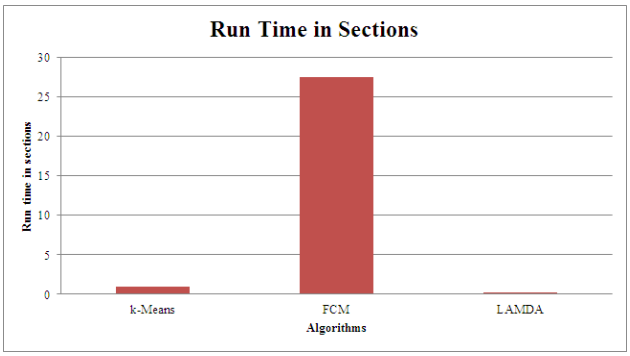

Figure 5: Performance of algorithm based on run time

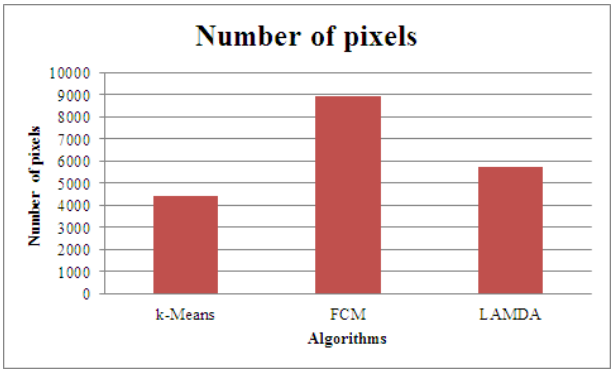

Figure 56: Performance of algorithm based on pixels

IV. CONCLUSION

The process of clustering methods is similar to clustering and classification technique which do not require any training data. These techniques are known as unsupervised learning methods. The unsupervised learning algorithm tries to summarize and present their data by applying main features. Many data mining algorithms have been used in clustering. The clustering approach is the combination of k-means and FCM clustering methods which is being for segmentation of brain tumor images. A new method is implemented and applied on several image and results are compared and analyzed, has more performance with truth image. Comparative analysis of performance metrics has been obtained. This research work compares the performance of clustering algorithm such as k-Means, FCM and LAMDA. Algorithm provides more accuracy and the computation is done in a less time. The tumor image is identified accurately by novel segmentation algorithm and it shows the exact result with higher correctness.

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