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A STUDY ON THE CAUSES FOR FAILURES IN MATHEMATICS BY ENGINEERING STUDENTS OF CHENNAI USING TRIANGULAR EXTENDED FUZZY CLUSTERING MODEL (TREFCLM)

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ABSTRACT

The aim of this paper is to introduce a new Fuzzy Model called Triangular Extended Fuzzy Clustering Model. In this paper the algorithm for this model is derived for the first time. Engineering students mostly keep arrear in engineering mathematics compared to other subjects. Hence Triangular Extended Fuzzy Clustering model is used to analyze the dominant causes for such failure to occur. In our survey, 100 engineering students were interviewed and their reasons for their failure in mathematics were taken as attributes and the above said model was applied to categorize the causes into three clusters namely Low, Medium and High. This paper consists of four sections. Section one gives the introduction of the problem and also the justification for having chosen to use the "Triangular Extended Fuzzy Clustering Model" approach to obtain the dominant causes for the failure. Section two gives the preliminaries and the basics of Triangular Extended Fuzzy Clustering model. Section three deals with the application of the model in determining the cluster of problems, that fall under the three categories viz, 'low', 'moderate' and 'high'. And, the final fourth section gives the conclusion and suggestions based on the result.

Keywords: clustering, fuzzy clustering, triangular model, degrees of membership, failure in maths.

INTRODUCTION

Mathematics plays a vital role in the education field of engineers in all disciplines. It is the subject which has been learnt for both practical oriented and for intrinsic interest. It acts as the root for the study of Engineering. The marks taken from Mathematics to calculate cut- off, shows the importance of learning and scoring high marks in it, in order to enter an engineering field. A loose of one mark makes a huge variation in the calculation of cut- off mark. Mathematics with Engineering yields everything to an engineer. Students failing to realize the importance and seriousness of the subject score low mark in maths compared to other subjects. This problem is a universal growing one. There are various reasons for the students to meet failure in this subject both psychologically and socially. In this paper we analysed the major causes for such failure to happen.

Justification

Fuzzy is the tool which works on unsupervised data. Fuzzy c means clustering gives the degree of membership for the attributes using the algorithm postulated. Extended fuzzy clustering model introduced by Esther Jerlin. J and Dr. A. Praveen Prakash has the advantage of Fuzzy clustering by resulting the major causes in on or off state. The result obtained through the analysis for the failure in Mathematics has been worked out using different fuzzy models like FCM, CFCLM and COFCLM. Now the newly proposed model Triangular Extended Fuzzy Clustering has the basis of Triangular FCM and Extended Fuzzy Clustering Model. This model has been tried out to verify the results to the above said models. TrEFCLM uses three experts opinion to calculate the membership value for the attributes. [3, 7, 2].

PRELIMINARIES

Hard Clustering

In Hard Clustering we make a hard partition of the data set **Z**. In other words, we divide them into c ≥ 2 clusters. With a partition, we mean that

$$\bigcup_{i=1}^{c} A_i = Z$$

and $A_i \cap A_j = \square\ ,\ \square\ i \neq j$ (1)

Also, none of the sets, A_i may be empty. To indicate a partioning, we make use of membership functions $\mu_k(x)$. If $\mu_k(x) = 1$, then object x is in cluster k. Based on the membership functions, we can assemble the Partition Matrix U, of which $\mu_k(x)$ are the elements. Finally there is a rule that □x,

$$\sum_{i=1}^{c} \mu_k \ (x) = 1 \ \forall x \quad \text{...............} \ (2)$$

In other words, every object is only part of one cluster.

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Fuzzy Clustering

Hard clustering has a downside. When an object roughly falls between two clusters Ai and Aj, it has to be put into one of these clusters. Also, outliers have to be put in some cluster. This is undesirable. But it can be fixed by fuzzy clustering.

In Fuzzy clustering, we make a Fuzzy partition of the data. Now, the membership function μk(x) can be any value between 0 and 1. This means that an object zk can be for 0.2 parts in Ai and for 0.8 parts in Aj. However, requirement (2) still applies. So, the sum of the membership functions still has to be 1. The set of all fuzzy partitions that can be formed in this way is denoted by Mfc. Fuzzy partitioning again has a downside. When we have an outlier in the data (being an object that doesn‟t really belong to any cluster), we still have to assign it to clusters. That is, the sum of its membership functions still must equal one.

Fuzzy C-Means Clustering

In fuzzy clustering, each point has a degree of belonging to clusters, as in fuzzy logic, rather than belonging completely to just one cluster. Thus, points on the edge of a cluster, may be in a cluster to a lesser degree than points in the center of cluster for each point x there is no coefficient giving the degree of belonging in the kth cluster $\mu_k(x) = 1$. Usually, the sum of those coefficients is defined to be 1.

$$\sum_{n=1}^{mm\ cluster} \mu_k = 1 \quad \forall x \tag{3}$$

With fuzzy c-means, the centroid of a cluster is the mean of all points, weighted by their degree of belonging to the cluster

$$\text{Center}_k = \frac{\sum_x \mu_k(x)^m x}{\sum_x \mu_k(x)^m} \tag{4}$$

The degree of belonging is related to the inverse of the distance to the cluster

$$\mu_k(x) = \frac{1}{d(center_k, x)} \tag{5}$$

Then the coefficients are normalized and fuzzy field with a real parameter m > 1 so that their sum is 1. So

$$\mu_k(x) = \frac{1}{\sum_j \left(\frac{d(center_k, x)}{d(center_j, x)}\right)^{2/(m-1)}} \tag{6}$$

For m equal to 2, this is equivalent to normalizing the coefficient linearly to make their sum 1. When m is close to 1, then cluster center closes to the point is given much more weight than the others, and the algorithm is similar to k-means [5].

Triangular Fuzzy Numbers

It is a fuzzy number represented with three points as follows. The membership function defined as

$$\mu_A(x) = \begin{cases} 0, & for\ x < a_1 \\ \dfrac{x-a_1}{a_2-a_1} & for\ a_1 \le x \le a_2 \\ \dfrac{a_3-x}{a_3-a_2} & for\ a_2 \le x \le a_3 \\ 0 & for\ x > a_3 \end{cases}$$

Operation of Triangular Fuzzy Numbers

The following are the four operations that can be performed on triangular fuzzy numbers:

Let $A = (a_1, a_2, a_3)$ and $B = (b_1, b_2, b_3)$ then,

(i) Addition (+): $A + B = (a_1 + b_1, a_2 + b_2, a_3 + b_3)$

(ii) Subtraction (-): $A + B = (a_1 - b_1, a_2 - b_2, a_3 - b_3)$

(iii) Multiplication ($\otimes$) :

(a) $k \otimes A = (ka_1, ka_2, ka_3),\ k \in R,\ k \ge 0$

(b) $A \otimes b = (a_1b_1, a_2b_2, c_1c_2),\ a_1 \ge 0,\ a_2 \ge 0$

(iv) Division ($\varnothing$):

$(A)^{-1} = (a_1, b_1, c_1)^{-1} \cong \left(1/c_1, 1/b_1, 1/a_1\right),\ a_1 > 0$

$A \varnothing B \cong \left(a_1/c_2, b_1/b_2, c_1/a_2\right),\ a_1 \ge 0,\ a_2 > 0$

Degrees of Triangular Fuzzy Numbers

The linguistic values of the triangular fuzzy numbers are [6].

Low	(0, 0.25, 0.50)
Medium	(0.25, 0.50, 0.75)
High	(0.50, 0.75, 1)

Algorithm

Algorithm to find a triangular extended membership values for the attributes.

STEP 1: For the taken attributes give the values on 10-point rating scale in a set *D*.

STEP 2: Categorize the clusters, cluster 1 as Low with beginning value as 2.5(bv1) and ending value as 5.5 (ev1). Cluster 2 as MODERATE ranges with 3.5 (bv2) and

8.5 (ev2). Cluster 3 as HIGH, whose range beginning with 7.5 (**bv3**) end with 10 (ev3).

STEP 3: Select en element *x* in D

STEP 4: If *x* < ev1 and *x* > bv2, then *x* lies in cluster 1 and cluster 2 whose membership value is given as the average of the linguistic values of the corresponding clusters (i.e.) cluster1 and cluster 2 and then the highest membership value among them is threshold and updated as 1 and the lowest membership value as 0. Suppose ***x*** < ev1 condition is not satisfied then x lies in cluster 1 only with the membership value 1.

STEP 5: If ***x*** < ev2 and *x* > bv3, then *x* lies in cluster 2 and cluster 3 whose membership value is given from the average of the linguistic values given of the corresponding clusters (i.e.) cluster2 and cluster 3 and then the highest membership value among them is threshold and updated as 1 and the lowest membership value as 0.

If the above said condition is not satisfied then x lies in cluster 2 only with the membership value 1.

STEP 6: If ***x*** < ev2 condition is not satisfied then x lies in cluster 3 only, the membership value 1.

STEP 7: Repeat the same procedure for all the elements in the set D.

Here 'bv' denotes the beginning value and 'ev' denotes the ending the value [8].

METHODOLOGY

100 Engineering students of Chennai were interviewed for our study. Each one was individually given enough time to express their views for their failure in mathematics. Their opinions are considered as the attributes and TrEFCLM model is used to analyse the major causes among the listed [9].

1. Teachers lack knowledge in teaching methodology
2. Parents admit their wards in Engineering under compulsion
3. Students are not regular to classes
4. Higher secondary schools fail to provide clear knowledge in basics of XI and XII std syllabus
5. Harsh approach and giving rude punishment by teachers
6. Students don't have interest and involvement in maths
7. Teachers are not dedicated to teaching profession
8. Institution fails to provide good atmosphere in nurturing teacher-student relationship
9. Lack of sufficient knowledge in basics by students
10. Lack of sufficient practice by students
11. Just enter the college with the attitude of enjoying college life
12. Problem of English language skill to understand mathematical terminology and the basics
13. Lack of problem solving skill
14. Memory loss for the students
15. Teachers fail to assess the students continuously by keeping test, assignments etc
16. Lack of Logical reasoning and application skill
17. Lack of concentration by students
18. Concentrating more on providing notes as study material rather than teaching the subject
19. Problem of health and nutrition
20. Preconceived notion that Maths is difficult subject and having fear for it
21. Lack of confidence especially for this subject Maths
22. Peer-group pressure
23. Considering keeping arrear as fashion
24. Lack of interest in planning the time
25. Childhood aversion to Maths due to varied environmental conditions

A linguistic questionnaire has been provided to each student and their responses were used to analyse the result. The ratings and the Standard Deviation of the attributes for the causes of failures in mathematics by engineering students have been subjected to triangular extended fuzzy clustering algorithm and the following results are shown in Table-1 according to the expert's opinion. The following Table gives the 3-cluster combination.

The first cluster consists of the attributes with average rating from 2.5 to 5.5 with a mid-value4. The second cluster range is from 3.5 to 8.5 with a mid-value 6 and the third cluster has a range of 7.5- 10 with a mid-value 8.75.

Cluster 1, Cluster 2 and Cluster 3 show the Low, moderate and high level of weightage for the causes of failures in mathematics by engineering students. For the 3-cluster Range of level of Dominant Cause (i.e.) [10].

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Table-1. 3-cluster range of level of dominant cause (i.e.).

	Cluster 1	Cluster 2	Cluster 3
Range	2.5-5.5	3.5-8.5	7.5-10
Mid Value	4	6	8.75
Tr Fuzzy Avg	0.25	0.50	0.75
Classification	LOW	MEDIUM	HIGH

Mean Rating of dominant cause obtained from engineering students.

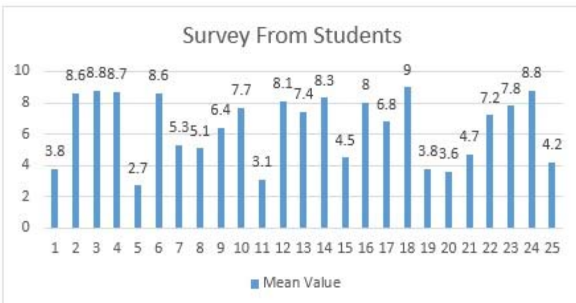

Figure-1. Mean value form students survey.

Table-2. Degree of membership of the attributes - engineering students.

Attributes	Mean	→	Low	Moderate	High
1	3.8	→	0	1	0
2	8.6	→	0	0	1
3	8.8	→	0	0	1
4	8.7	→	0	0	1
5	2.7	→	1	0	0
6	8.6	→	0	0	1
7	5.3	→	0	1	0
8	5.1	→	0	1	0
9	6.4	→	0	1	0
10	7.7	→	0	0	1
11	3.1	→	1	0	0
12	8.1	→	0	0	1
13	7.4	→	0	1	0
14	8.3	→	0	0	1
15	4.5	→	0	1	0
16	8.0	→	0	0	1
17	6.8	→	0	1	0
18	9.0	→	0	0	1
19	3.8	→	1	0	0
20	3.6	→	1	0	0
21	4.7	→	0	1	0
22	7.2	→	0	1	0
23	7.8	→	0	1	0
24	8.8	→	0	0	1
25	4.2	→	0	1	0

CONCLUSIONS

Table-1 shows the threshold and updated values for the attributes that belong to the level low, moderate and high. 1 denotes the on state and 0 denotes the off state for the occurance.

The analysis shows that attributes 5, 11, 19 and 20 with a mean rating 2.7, 3.1, 3.8 and 3.6 come to the 'on state' in cluster 1. (i.e.) LOW level.

Attributes 1, 7, 8, 9, 13, 15, 17, 21, 22, 23 and 25 with mean rating 3.8, 5.3, 5.1, 6.4, 7.4, 4.5,6.8, 4.7, 7.2, 7.8 and 4.2 come to the 'on state' in cluster 2. (i.e.) MODERATE level.

Attributes 2, 3, 4, 6, 10, 12, 14, 16, 18 and 24with a mean rating 8.6, 8.8, 8.7, 8.6, 7.7, 8.1, 8.3, 8.0, 9.0, 8.8 come to the 'on state' in cluster 3. (i.e.) HIGH level.

We arrived to the conclusion that the attributes 2, 3, 4, 6, 10, 12, 14, 16, 18 (i.e.)

- Parents admit their wards in Engineering under compulsion
- Students are not regular to classes
- Higher secondary schools fail to provide clear knowledge in basics of XI and XII std syllabus
- Students don't have interest and involvement in maths
- Lack of sufficient practice by students
- Problem of English language skill to understand mathematical terminology and the basics
- Memory loss for the students
- Lack of Logical reasoning and application skill
- Concentrating more on providing notes as study material rather than teaching the subject

are the dominant reasons for the failures in mathematics by the engineering students .

REFERENCES

[1] Kaufmann, "Introduction to the Theory of Fuzzy Subsets", Academic Press, INC. (LONDON) LTD, 1975.

[2] Kosko, "Neural Networks and Fuzzy systems: A Dynamical System Approach to Machine Intelligence", Prentice Hall of India, 1997.

[3] W.B Vasantha Kandasamy and Smarandache Florentin; 'Fuzzy Cognitive Maps and Neutrosophic Cognitive Maps', Xiquan, Phoenix. (2003).

[4] H.J. Zimmermann, "Fuzzy Set Theory and its application", Fourth Edition Springer 2011.

[5] FuzzyClustering:http://en.wikipedia.org/wiki/Fuzzy clustering.

[6] M. Clement Joe Anand, A. Victor Devadoss, "Using new Triangular Fuzzy Cognitive Maps (TRFCM) to analyze causes of Divorce in Family", International Journal of Communications and networking Systems

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vol 02, pp. 205-213, Integrated Intelligent Research (IIR) 205.

[7] A. Praveen Prakash, J. Esther Jerlin and J. Bennilo Fernandes, “A Study on the causes for aversion to mathematics by engineering students using Fuzzy Cognitive Maps” (FCMs), International Journal of Innovative Research in Science, Engineering and Technology, ISSN: 2319-8753, Vol. 3, Issue 3, March 2014.

[8] Fuzzy Clustering of the Domestic Violence for the Degree of Suicide thought based on Married Women Perception by A. Victor Devadoss, A. Felix, 2012, IJERA. pp. 1770-1773.

[9] A. Praveen Prakash, J.Esther Jerlin and J.Bennilo Fernandes, “A Study on the causes for failures in Mathematics by engineering students using Combined Fuzzy Clustering Model” (CFCLM), International Journal of Computer Applications. ISBN: 973-93-80881-76-7, Vol. 94- No 6, May 2014.

[10] A. Praveen Prakash, J. Esther Jerlin and M.P. Kannan, “An Analysis on causes for failure in Mathematics by engineering students in Tamil Nadu using Combined Overlap Fuzzy Clustering Model” (COFCLM), International Journal of Computer Applications, ISBN: 973-93-80881-76-7, Vol. 94- No 6, May 2014.