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A Study of using new Models of Fuzzy analysis method for Human Values

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Abstract - Fuzzy theory gives us a new way to look at the information. Humans use language to communicate with each other, which shows how smart they are. Fuzzy theory makes it easier to write computer code that makes sense. Fuzzy theory also has a human-machine language system. It helps to calm people's emotions and their interactions with computers.It's because of rapid urbanisation and changes, such as the breakup of the family system, the high level of education, job changes, and the migration of young people to cities and abroad, that the elders don't pay attention to them. Elderly people have many personal, social, economic, physical and psychological problems because of these things, as well Adjusting to less strength and less health is also a problem. All of these change the roles they used to play in their home and society. They have a lot of time on their hands, which makes them feel lonely, afraid, and sad. As of right now, this is one of the most important issues in India, which is why we chose this one to work on. If you want to talk about how random things are, you can call it uncertainty. Our lives are full of many unknowns, such as randomness and fuzziness. However, not all of the unknowns have been looked into. Human communication has a lot of unanswered questions. Older people have a hard time communicating with younger people, which makes them unsure about how long they will live. So they think they were rejected, abandoned, and not cared for. When people hear vague words, they can think of them in many different ways. While it may be misunderstood, it leads to new ideas. When something isn't clear there are two sides to it. It does not have any specific rules. So, fuzzy theory is a way to deal with the language of uncertainty. Fuzzy theory gives us a new way to process information. Humans use language that shows how much they know to communicate with other people. Fuzzy theory lets us write computer code that shows how we know things. Thus, fuzzy theory acts as a bridge between humans and machine language. It helps to cut down on the friction between humans and machines.

Keywords - Fuzzy Analysis Method, Human Values, Fuzzy theory, Human communication, Older people, humans and machine language

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INTRODUCTION

The three new fuzzy models Trapezoidal Fuzzy Cognitive Maps (TpFCM), Induced Trapezoidal Fuzzy Cognitive Maps (ITpFCM) and Three Estimates Fuzzy TOPSIS (TEFTOPSIS) are introduced in this chapter and explained. The Fuzzy sets were introduced by L.A.Zadeh in the year 1965 to deal with imprecise and vague information. This fuzzy set has several applications. Several extensions were also proposed by different scientists. One such extension of the fuzzy set theory is the Intuitionistic Fuzzy Sets, proposed by Attanassov in the year 1983. The main advantage of the Intuitionistic fuzzy sets is that they have the characteristic of coping with the hesitancy that may exist due to information imprecision [Papakostas G.A]. Thus it is an advantage to apply them in the problem of study inorder to get precise solutions. Thus in this chapter the intuitionistic fuzzy sets are combined with the FRM model to make an analysis. Fuzzy Relational Maps are constructed corresponding to Fuzzy Cognitive Maps, which promote the correlation between causal associations among concurrently active units. But in FRM the causal associations are divided into two disjoint units, i.e., relation between music and emotions or relation between disease and risk factors. The Fuzzy Relational Maps were introduced by W.B.VasanthaKandasamy and Yasmin Sultana to analyze knowledge processing in the year 2000.

TRAPEZOIDAL FUZZY COGNITIVE MAPS (TpFCM)

Usually Fuzzy Cognitive Maps (FCMs) analyze the causes and effects of the relationships among the concepts to model the behavior of any system. But this new model gives the causes and effects of the

relationships among the concepts to model behavior with ranking of any system. TpFCM are more applicable when the data in the first place is an unsupervised one. The TpFCM works on the expert's opinion. TpFCM models the world as a collection of classes and causal relations between classes. It is a different process when it is compared to FCM. Usually the FCM gives only the ON-OFF position. But this TpFCM is more precise and it gives the ranking for the causes of the problem by using the weightage of the attribute, which is the main advantage of this new model TpFCM.

Trapezoidal fuzzy number and the algebraic operations

Trapezoidal fuzzy number

A Trapezoidal fuzzy number A with four parameters a1 ≤ a2 ≤ a3 ≤ a4 is denoted as A = (a1,a2,a3,a4) in the set of real numbers R.

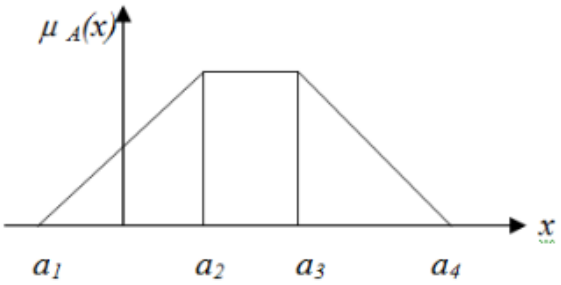

Figure 1: Trapezoidal fuzzy number

Membership function of Trapezoidal fuzzy number is

$$\mu_A(x) = \begin{cases} 0 & ,x < a_1 \\ \frac{x-a_1}{a_2-a_1} & ,a_1 \le x \le a_2 \\ 1 & ,a_2 \le x \le a_3 \\ \frac{x-a_4}{a_3-a_4} & ,a_3 \le x \le a_4 \\ 0 & ,a_4 < x \end{cases}$$

Operations of Trapezoidal fuzzy number

Let A1 = (a11,a12,a13,a14) and A2 = (a21,a22,a23,a24) be two Trapezoidal fuzzy numbers in the set of real numbers R. Then, the following are the operations that can be performed on Trapezoidal fuzzy numbers:

1. *Addition:*

$$A_1 + A_2 = (a_{11}+a_{21}, a_{12}+a_{22}, a_{13}+a_{23}, a_{14}+a_{24})$$

2. *Subtraction:*

$$A_1 - A_2 = (a_{11}-a_{24}, a_{12}-a_{23}, a_{13}-a_{22}, a_{14}-a_{21})$$

Linguistic values of Trapezoidal fuzzy number

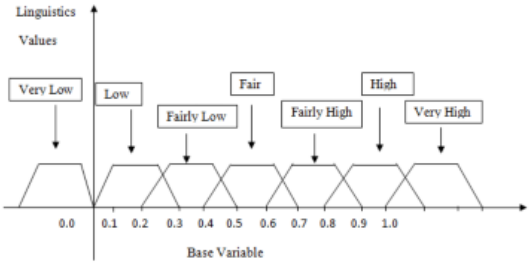

Figure 2: Linguistic values of Trapezoidal fuzzy number

Degrees of the Trapezoidal fuzzy number71

Table1: The linguistic values of the Trapezoidal fuzzy number

Linguistic term	*Linguistic values of Trapezoidal fuzzy number*
Very low	*(0.0, 0.0, 0.0, 0.0)*
Low	*(0.0, 0.1, 0.2, 0.3)*
Fairly low	*(0.2, 0.3, 0.4, 0.5)*
Fair	*(0.4, 0.5, 0.6, 0.7)*
Fairly high	*(0.6, 0.7, 0.8, 0.9)*
High	*(0.8, 0.9, 1, 1)*
Very high	*(1, 1, 1, 1)*

When the nodes of the TpFCM are fuzzy sets then they are called as Fuzzy Trapezoidal nodes.

TpFCMs with edge weights or causalities from the set {−1,0,1} are called simple TpFCMs.

A TpFCM is a directed graph with concepts like policies, events, etc., as nodes and causalities as edges. It represents causal relationships between concepts.

Consider the nodes/concepts T pC1,...,T pCn of the TpFCM. Suppose the directed graph is drawn using edge weight T pei j ∈ {−1,0,1}. The Trapezoidal matrix M be defined by Tp(M) = T pei j where T pei j is the Trapezoidal weight of the directed edge −−−−−−→ T pCiTpCj . Tp(M) is called the adjacency matrix of TpFCMs, also known as the connection matrix of the TpFCM. It is important to note that all

matrices associated with a TpFCM are always square matrices with diagonal entries as zero.

Let T pC1,...,TpCn be the nodes of a TpFCM. A = (a1,a2,a3,a4) where T pei j ∈ {−1,0,1}. A is called the instantaneous state vector and it denotes the ON - OFF position of the node at an instant.

$$Tpa_i = \begin{cases} 1 & ,Maximum(weight) \\ 0 & ,otherwise \end{cases}$$

Let T pC1,...,TpCn be the nodes of a TpFCM. Let −−−−−−−→ T pC1T pC2,..., −−−−−−→ T pCiTpCj be the edges of the TpFCM (i 6= j). Then, the edges form a directed cycle. A TpFCM is said to be cyclic if it possesses a directed cycle. A TpFCM is said to be acyclic if it does not possess any directed cycle.

A TpFCM with cycles is said to have a feedback.

Definition 3.2.12 When there is a feedback in a TpFCM, i.e., when the causal relations flow through a cycle in a revolutionary way, the TpFCM is called a dynamical system.

Let −−−−−−−→ T pC1T pC2,..., −−−−−−→ T pCiTpCj be a cycle. When T pCi is switched on and if the causality flows through the edges of a cycle and if it again causes T pCi , we say that the dynamical system goes round and round. This is true for any node T pCi , for i = 1,...,n. The equilibrium state for this dynamical system is called the hidden pattern.

If the equilibrium state of a dynamical system is a unique state vector, then it is called a fixed point. Consider a TpFCM with T pC1,...,TpCn as nodes. For example let us start the dynamical system by switching on T pC1. Let us assume that the TpFCM settles down with T pC1 and T pCn i.e., the state vector remains as (1,0,0,...,0,1). This state vector is called the fixed point.

If the TpFCM settles down with a state vector repeating in the form A1 → A2 → ··· → Ai → A1, then this equilibrium is called limit cycle.

INDUCED TRAPEZOIDAL FUZZY COGNITIVE MAPS (ITpFCMs)

There exist many models for ranking like Dematel72–74 , AHP75, 76 ,TOPSIS75–80 , etc. This model deals with the ON-OFF position of the attributes, Triggering pattern and ranking. When compared to other models, it is observed that the algorithm used in this model is easier.

The proposed Algorithm

To get the triggering pattern of each attribute and ranking of the attributes, these steps are to be followed: Step 1: Let T pC1,...,TpCn be the nodes of a TpFCM with feedback. Find the adjacency matrix T p(M). Step 2: Find the hidden pattern when T pC1 is switched ON,

(i) Let A = (1 0 0 0 0 0 0 0 0 0).

(ii) Find A∗T p(M) and denote it as AT p(M)weight.

(iii) Find average of each linguistic value and denote it as AT p(M)weight(Avg) .

(iv) Threshold the vector by replacing ai by 1 if ai is the maximum weight of the trapezoidal node, otherwise replace ai by 0.

(v) Form different vectors for all 1's in which the previous value at the position of 1 should be reset for that 1, and find the product of each with the given matrix.

(vi) The vector which has maximum number of maximum weight is considered as A2

(v) Repeat the same process till Ai = Ai+1 which is the fixed point.

Step 3: Find the Hidden pattern for all Trapezoidal nodes.

Step 4: Taking average of the corresponding node of the experts opinion, we call it as AiTp(M)Average.

Step 5: Find the Total Average weight of each attribute.

THREE ESTIMATES FUZZY TOPSIS (TEFTOPSIS)

Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) is one of the well-known methods in Multiple Attribute Decision-Making (MADM). Hwang and Yoon81 have introduced TOPSIS in 1981. An algorithmic procedure is used to rank the alternatives in TOPSIS. Wang and Chang developed an evaluation approach based on TOPSIS82 in a fuzzy environment where the vagueness and subjectivity were handled with linguistic terms parameterized by triangular fuzzy numbers. A fuzzy multi-criteria decision analysis method based on the concepts of ideal and anti-ideal points83 was introduced by M.S.Kuo, G.H.Tzeng and W.C.Huang. A fuzzy number is a quantity whose value is imprecise, not exact as in "ordinary" numbers. Any fuzzy number can be defined as a function whose domain is a specified set. In many situations, fuzzy numbers depict the physical world more realistically than any single valued numbers. Fuzzy numbers enable us to create the mathematical model of linguistic variable. Fuzzy numbers are used in statistic, computer related techniques. In 1978 Dubios and Prade defined fuzzy numbers as the fuzzy subset of the real line86. If a fuzzy set is convex and normalized, and its

membership function is defined in R and piecewise continuous, it is called as fuzzy number. So fuzzy number (fuzzy set) represents a real number interval whose boundary is fuzzy. Fuzzy number is expressed as a fuzzy set defining a fuzzy interval in the real number R. Since the boundary of this interval is ambiguous, the interval is also a fuzzy set.

Pentagonal Fuzzy Number

A Pentagonal fuzzy number A with five parameters a ≤ b ≤ c ≤ d ≤ e is denoted as A = (a,b, c,d, e) in the set of real numbers in R.

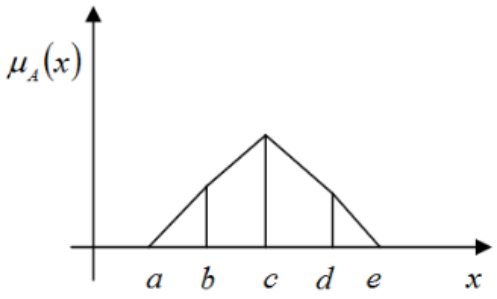

Figure 3: Pentagonal fuzzy number

Membership function of a Pentagonal fuzzy number

$$\mu_A(x) = \begin{cases} \frac{(x-a)\theta}{b-a} & ,a \le x \le b \\ \frac{(x-b)\theta}{c-b} & ,b \le x \le c \\ \frac{(d-x)\theta}{d-c} & ,c \le x \le d \\ \frac{(e-x)\theta}{e-d} & ,d \le x \le e \\ 0 & ,otherwise \end{cases}$$

The operational Laws of PFN Ae1 = (a1,b1, c1,d1, e1) and Ae2 = (a2,b2, c2,d2, e2) are shown below.

1. *Addition of the fuzzy number* $\oplus$:

$$\tilde{A}_1 \oplus \tilde{A}_2 = (a_1,b_1,c_1,d_1,e_1) \oplus (a_2,b_2,c_2,d_2,e_2)$$
$$= (a_1+a_2, b_1+b_2, c_1+c_2, d_1+d_2, e_1+e_2)$$

2. *Subtraction of the fuzzy number* $\ominus$:

$$\tilde{A}_1 \ominus \tilde{A}_2 = (a_1,b_1,c_1,d_1,e_1) \ominus (a_2,b_2,c_2,d_2,e_2)$$
$$= (a_1-e_2, b_1-d_2, c_1-c_2, d_1-b_2, e_1-a_2)$$

Five-point linguistic scale of the Pentagonal fuzzy number

The five-point scales are not only easy to be used by the respondents but are also widely used in Triangular fuzzy number and Trapezoidal fuzzy number. Therefore, here we define a new five-point linguistic scale of the Pentagonal fuzzy number.

Linguistic values of Pentagonal fuzzy number

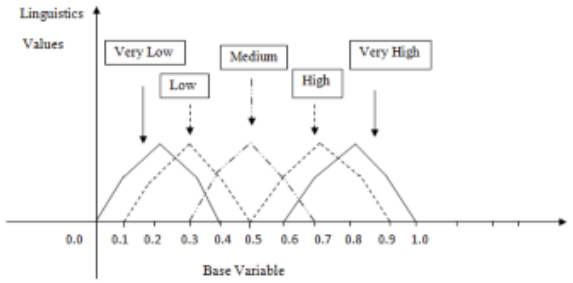

Figure 4: Linguistic values of Pentagonal fuzzy number

Table 2: Linguistic scale of Pentagonal fuzzy number

Linguistic Variable	Linguistic scale of Pentagonal fuzzy number
Very low(VL)	(0.0, 0.1, 0.2, 0.3, 0.4)
Low(L)	(0.1, 0.2, 0.3, 0.4, 0.5)
Medium(M)	(0.3, 0.4, 0.5, 0.6, 0.7)
High(H)	(0.5, 0.6, 0.7, 0.8, 0.9)
Very high	(0.6, 0.7, 0.8, 0.9, 1)

Three Time Estimates

This technique, takes the uncertainty of activities into account.

Optimistic estimate (to)

It is a opinion of the expert when everything goes on very well during the activity.

Pessimistic estimate (tp)

It is a opinion of the expert when almost everything goes against our will and a lot of difficulties is faced.

Most likely estimate(tm)

It is an opinion of the expert when sometimes things go on very well and sometimes things goes on very bad.

INTUITIONISTIC FUZZY RELATIONAL MAPS

Intuitionistic Fuzzy Set

An intuitionistic fuzzy set

A in X is given by [K.Atanassov, 1986]

$$A = \{< x, \mu_A(x), \nu_A(x) | x \in X >\}$$

$$\text{where, } \mu_A(x) : X \to [0,1] \text{ and } \nu_A(x) : X \to [0,1]$$

$$\text{with the condition } 0 \leq \mu_A(x) + \nu_A(x) \leq 1; \forall x \in X$$

with the condition 0 ≤ μA(x) + νA(x) ≤ 1; ∀x ∈ X

The numbers μA(x), νA(x) ∈ [0; 1] denote the degree of membership and non-membership of x to A, respectively.

Intuitionistic Index

For each intuitionistic fuzzy set in X ,the intuitionistic index of x in A is defined as follows, πA(x) = 1 − μA(x) − νA(x); πA(x) ∈ [0, 1]; ∀x ∈ X.[K.Atanassov,1994]

Methods of determining the hidden pattern

- Let R1, R2...Rm and D1, D2...Dn be the nodes of a FRM with feedback.
- Let M be the relational matrix formulated according to the experts opinion using the intuitionistic fuzzy sets.
- Calculate the distance between two intuitionistic fuzzy sets using the normalized euclidean distance formula given by

$$q^1_{IFS}(A,B) = \sqrt{\frac{1}{2n}\sum(\mu_A(x_i) - \mu_B(x_i))^2 + (\nu_A(x_i) - \nu_B(x_i))^2 + (\pi_A(x_i) - \pi_B(x_i))^2}$$

EulaliaSzmidt, JanuszKacprzyk, 2000]

- Let's find a hidden pattern when D1 is switched on i.e. When an input is given as A1 = (1, 0...0) in D1, the data should pass through the relational matrix. This is done by multiplying A1 with the relational matrix E.
- Let A1M = (r1, r2...rm) be considered.
- After thresholding and updating, A1M ∈ R is the resultant vector obtained.
- Now let B = A1M. • Pass on B into MT and obtain BMT .
- The vector BMT is updated and threshold so that BMT ∈ D. This procedure is repeated till a limit cycle or a fixed point is obtained.

DESCRIPTION OF THE PROBLEM

Human beings live in a world surrounded by so many beautiful things. One among Gods beautiful creation is the nature that a person lives in. This nature teaches one how to live one's life in a disciplined manner. Nature follows certain values and it comprises of different values. Every individual has to learn the art of discipline and values from this nature. The nature is basically made up of the panchaboothangal that is the five elements of nature. They are water, air, earth, fire and space. Each of these five elements possesses certain qualities which induces certain human values. The virtues of humility, serenity, simplicity, frugality and independence can be learnt from the wide spread nature in which one survives [Holmes Rolston].

1. **Humility:** Humility is the quality of being humble and modest. Humility comes from the Latin word humilis, which literally means low. It can be seen as the act of lowering oneself in relation to others. It is the lack of ego. Humility is the lack of self-pride.
2. **Simplicity:** Simplicity is the state or quality of being simple. Simplicity is all about finding the greatest value in our lives and then staying right there in that sweet spot. Simplicity is not necessarily about less amounts but the right amount. It can be seen as the absence of luxury or showiness. It refers to being ordinary, unassuming and without artificiality.
3. **Frugality:** Frugality literally means the prudence in avoiding waste. It is the conscious awareness of how one utilizes or spends the resources around oneself. One should have the knowledge and right understanding about the utilization of the resources in order to reduce wasting of it.
4. **Serenity:** Serenity is the absence of mental stress or anxiety. It is the quality of oneself being calm and composed. Generally, life is full of ups and downs. In the midst of such complex uncertain situations, staying calm and composed is helpful to maintain the pace with life. 5. Independence For a human to be fully developed from a child to an accomplished adult he needs to become independent. To be fully independent is to be self-reliant onto one's self, trusting one and believing in oneself not being doubtful of one's own thoughts and beliefs. The only true way to be independent is to make decisions based on oneself and not based on what society thinks.
5. **Self-Identity:** Self-identity is what one perceives oneself to be. It is the perception about ones abilities, disabilities, worth and status. It arises from the subconscious mind. It refers to the mental picture of the knowledge of one's strengths and weakness. It largely determines ones performance, attitudes and actions.
6. **Self-Actualization:** Self-actualization is the desire to become what one is capable of becoming. It can be seen as the desire to realize ones capabilities. It is the realization of one's own potential and true self.
7. **Unity:** Unity is the quality of being together not really taking into account the mutual differences and mental conflicts. One should respect others differences and accept them as they are. It is essential for an effective life. Brotherhood recognizes human rights and is aware of its obligations. The sense of

brotherhood provides unity and understanding among people.

The FRM is a Directed Graph or Map from Domain Space to a Range Space. Here the rows correspond to the domain space and the columns correspond to range space. Thus to define a FRM a domain space and a range space which are disjoint in concepts are needed. So it is assumed that there is no intermediate relation existing within the domain and the attributes in the range space. Human live in a beautiful world which is surrounded and governed by the nature. People are a part of this nature. The nature is a carrier of values. The five great elements namely the water, air, earth, fire and space teach us how to live according to human values. Since the panchaboothangal and the human values are distinct in nature, the fuzzy relational maps can be applied to these two different domains. The relationship between the human values and the five elements of nature using Fuzzy Relational Maps by taking the human values as domain space and the five great elements of nature as the range space are discussed. Later the Intuitionistic Fuzzy Relational Maps are applied to the problem of study and analyses are made.

CONCLUSION

The ranking of the problems of elderly was found by the new fuzzy model Trapezoidal Fuzzy Cognitive Maps (TpFCM) and Induced Trapezoidal Fuzzy Cognitive Maps (ITpFCM). The ranking obtained by TpFCM was T pC9, T pC8, T pC7, T pC10, T pC6, T pC4, T pC5&1 and T pC2&3. It was concluded that the attribute T pC9 which accounts for “Lack of emotional support” was the major problem, next T pC8 for “Isolation”, followed by T pC7 for “Depression”. T pC2 and T pC3 for “Treating as Burden”, “Forced to sell their property” has got negligible value. This shows that not all Adolescent people are facing these problem. The ranking obtained by ITpFCM was T pC8 > T pC9 > T pC7 > T pC6 > T pC10 > T pC4 > T pC1 > T pC5 > T pC2 > T pC3. So, it was concluded that the major causes of the Adolescent age people are T pC8 - Isolation and T pC9 - Lack of emotional support. The attributes T pC2 - Treating as Burden and T pC3 - Forced to sell their property are not affecting Adolescent age people to a large extent. The Triggering pattern was also derived from this model. From this Triggering pattern, it was concluded that all attributes induce the attributes T pC7 and T pC6. Lack of reasons to live and Depression and trauma are induced by all attributes. That is Whatever problem they have, it will finally end with these 2 attributes. The problems of elderly are analyzed and ranked using the above models. Now factors for preferring Adolescent age home were found by Bidirectional Associative Memory (BAM) and extended bidirectional associative memory (EBAM). By BAM model, When the factor A1 is in ON state, the other factors A2,A3,A4,A5,A6 becomes ON and also the family status B1,B2,B3,B4,B5 becomes ON. This shows that A1 is one of the important factors. Similarly for all the other factors A2,A3,A4,A5,A6 every other factors for each case becomes ON and also the family status B1,B2,B3,B4,B5.Regarding EBAM for survival data, Daughter-InLaw plays an important role. The other factors also contribute to preferring Adolescent age home.

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