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A FUZZY MODEL IN MUSIC SELECTION

A. Uma Maheswari[1], C. Meera[2] and K. Yaseswini[3]
[1]Associate Professor, Department of Mathematics,
Quaid-E-Millath Government College for Women (Autonomous), Chennai–600002
[2]Assistant Professor, Department of Mathematics,
Bharathi Women's College (Autonomous), Chennai–600108
[3]B.Tech (I.T) (III Year), Sri Sai Ram Engineering College, Chennai–600044
E-mail: [1]umashiva2000@yahoo.com, [2]eya65@rediffmail.com, [3]yaseswini@gmail.com

Abstract—*The concept of fuzzy sets was introduced by Zadeh and after the introduction of soft set theory by Molodtsov in 1999 Maji et al. developed it into fuzzy soft theory in 2001. A fuzzy model enables to transform linguistic description into a mathematical model. In this paper a fuzzy model is proposed to select a particular music of listener's choice from the given collection of assorted instrumental music using the techniques of clustering, encoding, fuzzy soft sets and decoding.*

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INTRODUCTION

Zadeh [6] first introduced the concept of a fuzzy set and subsequently went on to extend the notion via the concept of linguistic variables. Fuzzy principles have been applied to a huge and diverse range of problems such as aircraft flight control, robot control, car speed control, power systems, nuclear reactor control etc. Fuzzy sets have been formally designed to mathematically represent uncertainty and vagueness.

In 1999, Molodtsov[5] introduced the soft sets to deal with the uncertainties present in most of our real life situations. The parameterization tools of soft set theory enhance the flexibility of its application to different problems. In 2001, Maji *et al.* [3] expanded soft set theory to fuzzy soft set theory. Fuzzy soft sets combine the strength of both soft sets and fuzzy sets.

Fuzzy logic plays an essential role in human cognition and for any model (system) to accomplish a defined objective, it should have an integrated set of elements in it. This paper deals with the model that integrates the techniques of encoding, fuzzy soft sets and decoding to select a particular music of listener's choice from the given collection of assorted instrumental music. The knowledge about the source set is represented using encoding and fuzzy soft set and retrieval is done using decoding techniques. Based on intuition the information is encoded and fuzzification is done with the help of encoded values so that defuzzification is done automatically by decoding the values.

PRELIMINARIES

This section provides the basic concepts and terminology used in this paper.

Definition 2.1: *Data clustering* is a method in which objects that are somehow similar in characteristics are grouped.

The goal of clustering is to reduce the amount of data by categorizing or grouping similar data items together.

Definition 2.2: A *code* is a rule for converting a piece of information (for example a letter, word, phrase or gesture) into another form or representation not necessarily of the same type.

Definition 2.3: *Encoding* is the process by which information from a source is converted into symbols to be communicated.

One reason for coding is to enable communication in places where ordinary spoken or written language is difficult or impossible

Definition 2.4: *Decoding* is the reverse process converting the code symbols back into information understandable by a receiver.

Definition 2.5: *Knowledge Retrieval* is the process of recalling information that is stored in memory.

The retrieval process relates to encoding and storage. Retrieval failure occurs when the information is not encoded well.

Definition 2.7: [7] If U is a universal set then a *fuzzy subset A* of U is a map (called membership function) μ_A: U → [0,1] such that A = {(x, μ_A(x)) | x ∈ U}. where μ_A(x) is the membership value of x∈U.

Definition 2.8: [4] Let U be a universal set and A be a subset of a set of parameters E. Let I^U (where I = [0, 1]) be the set of fuzzy subsets of U. Then (f, A) is called a *fuzzy soft set* over U where f: A → I^U and f(a) = f_a : U → I is a fuzzy subset of U.

Definition 2.9: *Linguistic variable* is a variable whose values are words in natural languages.

In fuzzy logic, linguistic variables take on linguistic values which are words (linguistic terms) with associated degrees of membership in the set. Linguistic variables are central to fuzzy logic manipulations.

Definition 2.10: The *complement* of a fuzzy set A is a new fuzzy set $\bar{A}$ also on X with membership function defined by $\mu_{\bar{A}}$(x) =1 – μ_A (x) for all x∈X.

Definition 2.11: The *concentration* of a fuzzy set A is denoted by con (A) with membership function defined by $\mu_{con(A)}$(x) = $(\mu_A(x))^2$ for all x∈X.

The concentration of a fuzzy set is equivalent to linguistically modifying it by the term *very*. The concentration of *small numbers* is therefore *very* small numbers and can be quantitatively represented by squaring the membership value.

Definition 2.12: The *dilation* of a fuzzy set A is denoted by dil(A) with membership function defined by $\mu_{dil(A)}$(x) = $\sqrt{\mu_A(x)}$ for all x∈X.

The dilation of a fuzzy set is equivalent to linguistically modifying it by the term *more or less.* The dilation of *small numbers* is therefore *more or less* small numbers and can be quantitatively represented by taking the square root of the membership value.

THE FUZZY MODEL

In this section we give a fuzzy model that integrates the techniques of encoding, fuzzy soft sets and decoding using which a listener can select a particular music from the given collection of assorted instrumental music.

Knowledge Representation

The following are the steps involved in the model. In the listing process we first denote the collection of instrumental music which are represented as $x_1,\ldots,x_n$ by U. That is U = { $x_1,\ldots, x_n$ }.We then identify either manually or using neural network techniques the musical instruments used in x_i's and in the clustering process we group the musical instruments as percussion instruments, wind instruments and string instruments. Denote the set of percussion instruments, wind instruments and string instruments respectively as A, B and C. In the encoding process we consider '*m*' to denote the membership value of a variable x_i in which a musical instrument is dominating then m^2 gives the *very domination* of the instrument,$\sqrt{m}$ denotes *slightly dominating*, *not very dominating* is given by 1- m^2 and *not dominating* is given by 1-*m*. We give all the knowledge about the combination and domination of all the musical instruments in each of the x_i's in U using the fuzzy soft sets (f, A) = $\{f_a \mid a\in A\}$, (g, B) = $\{g_b \mid b\in B\}$ and (h, C) = $\{h_c \mid c\in C\}$. For the sake of convenience the information about the x_i's may be tabulated.

Knowledge Retrieval

The final step of the methodology is to retrieve the components from the repository and display the results to the user.

Suppose the query is 'find in which of the x_i's the musical instrument mridang is dominating and violin is very dominating'. On looking at Mridang, search will be done in (f, A) as A denotes the set of all percussion instruments. If a' ∈ A denotes mridang then in $f_{a'}$, those x_i's with membership values *m* will be searched.

Similarly, on looking at Violin, search will be done in (h, C) as C denotes the set of all string instruments. If if c∈C denotes violin then in h_c, those x_i's with membership values m^2 will be searched. The x_i which is common in the above two searches will be declared as the answer for the query.

Note: In case the search results give more than one x_i then the search can be continued by specifying some dominating musical instrument from A, B or C other than Mridang and Violin.

Algorithm (Knowledge Representation)

Begin:

Step 1: Denote by x_i, $1\le i \le 100$, the ith instrumental music.

Step 2: Name the collection of all the x_i's as U.

Step 3: Identify (manually) the instruments used in the x_i's.

Step 4: Cluster the musical instruments as percussion instruments, wind instruments and string instruments

Step 5: Denote the set of percussion instruments, wind instruments and string instruments respectively as A, B and C

Step 6: Encode the linguistic variables 'dominating' as *m*, 'very dominating' as m^2, 'slightly dominating' as $\sqrt{m}$, 'not very dominating' as 1- m^2 and 'not dominating as 1-*m*.

***Step 7*:** Obtain the fuzzy soft set (f, A) using step 5 and Step 6.

Step 8: Obtain the fuzzy soft set (g, B) using step 5 and Step 6.

Step 9: Obtain the fuzzy soft set (h, C) using step 5 and Step 6.

Step 10: Represent the information from Step 7, Step 8 and Step 9 in tabular form.

End

Algorithm (Knowledge Retrieval)

Query **-**Find the x_i in which a percussion instrument say *a*' is dominating and a string instrument *c* is very dominating.

Begin:

Step 11: Search for $f_{a'}$ given in step10 and return those x_i's with membership value m.

Step 12: Denote this set by S_1.

Step 13: Search for h_c given in step7 and return those x_i's with membership value m^2

Step 14: Denote this set by S_2.

Step 15: Find the common music from Step12 and Step14 using $S_1 \cap S_2$.

Step 16: Declare $S_1 \cap S_2$ as the answer for the query if it is a singleton set.

Step 17: If in Step 16, $S_1 \cap S_2$ is not a singleton set then repeat the above steps to $S_1 \cap S_2$ by specifying some dominating musical instrument from A, B or C other than *a*' and *c*.

End

AN APPLICATION OF THE MODEL

In this section we apply the model to a set consisting of eight instrumental music which are composed of Tabla, Mridang, Flute, Saxophone, Violin and Guitar.

Encoding Information

Human beings may provide valuable facts based on their knowledge. Hence if dominating is intuitively encoded as 0.9, then very dominating is encoded as 0.81, slightly dominating is encoded as 0.95, not very dominating is encoded as 0.19 and not dominating is encoded as 0.1.

Knowledge Representation

Let $U = \{ x_1, x_2, x_3, x_4, x_5, x_6, x_7, x_8 \}$ be the given set of eight instrumental music.

Let A = { Tabla, Mridang}, B = { Flute, Saxophone} and C = { Violin, Guitar}.Then the fuzzy soft sets (f, A), (g, B) and (h, C) are given as follows.

(f, A) =$\{f_a, f_{a'}\}$ where *a*-Tabla,*a*'-Mridang

(g, B) =$\{g_b, g_{b'}\}$ where *b*-Flute,*b*'-Saxophone

(h, C) =$\{h_c, h_{c'}\}$ where *c*-Violin,*c*'-Guitar

Let after identifying manually the musical instruments used in x_i's the membership values of x_i's (Using Encoding Information) be as given in the following Table 1.

Table 1

	f_a	$f_{a'}$	g_b	$g_{b'}$	h_c	$h_{c'}$
x_1	0.1	0.9	0.19	0.1	0.9	0.1
x_2	0.95	0.81	0.1	0.1	0.1	0.81
x_3	0.9	0.81	0.1	0.1	0.1	0.9
x_4	0.81	0.1	0.1	0.9	0.95	0.81
x_5	0.1	0.9	0.9	0.19	0.81	0.1
x_6	0.81	0.19	0.1	0.1	0.81	0.1
x_7	0.1	0.95	0.81	0.1	0.81	0.1
x_8	0.81	0.81	0.81	0.1	0.81	0.1

Music Selection (Retrieval)

Suppose we wish to select the x_i in which Mridang is dominating and Violin is very dominating.

On looking at Mridang, search will be done in $f_{a'}$. In $f_{a'}$, those x_i's with membership values 0.9 will be searched.

In this case, the search 1 result will be x_1 and x_5.

Similarly, on looking at Violin, search will be done in h_c. In h_c, those x_i's with membership values 0.81 will be searched.

In this case, the search 2 result will be x_5, x_6, x_7 and x_8.

From search 1 and search 2 results, x_5 is the common music and hence it is concluded that $\mathbf{x_5}$ is the required music in which Mridang is dominating and Violin is very dominating.

CONCLUSION

In this paper a model has been proposed to select a particular music of listener's choice from the given collection of assorted instrumental music using the techniques of clustering, encoding and fuzzy soft sets and decoding. This work gives a further scope for developing a software that selects a specified music from any collection of instrumental music.

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