NEUTROSOPHIC LOGIC BASED INCONSISTENT RELATIONAL DATABASE FOR NORMALIZING DATA AND ACCURATE DECISION

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ABSTRACT

In this paper the author propose a new method of search called Neutrosophic search to find the most suitable match for the predicates to answer any imprecise query made by the database users. Neutrosophic search ***is*** *capable of manipulating incomplete as well as inconsistent information. Fuzzy relation or vague relation can only handle incomplete information. Neutrosophic logic is an extension of classical logic.*

Keywords: Neutrosophic Logic, Set, Normal Form, Method.

I. INTRODUCTION

In real world there are vaguely specified data values in many applications, such as medical diagnosis, Robotics, Data Mining etc. Now take an example, when we ask the opinion to a person about certain statement, he or she may say that the possibility that the statement is true is between 0.4 and 0.6, and the statement is false is between 0.2 and 0.3, and the degree that he or she is not sure is between 0.1 and 0.3. Other way, suppose there are 10 voters during a voting process. In time t1, three vote ―yes, two vote ―no and five are undecided, using neutrosophic notation, it can be expressed as x(0.3,0.5,0.2); in time t2, three vote ―yes, two vote ―no, two give up and three are undecided, it then can be expressed as x(0.3,0.3,0.2). That is beyond the scope of the intuitionistic fuzzy set. So, the notion of neutrosophic set is more general and overcomes the fore mentioned issues. In neutrosophic set, indeterminacy is quantified explicitly and truth membership, indeterminacy-membership and falsity membership are independent. This assumption is very important in many applications such as information fusion in which we try to combine the data from different sensors. Neutrosophic set is a powerful general formal framework which generalizes the concept of the classic set, fuzzy set, vague set[1][2] .

The normalization process takes a relational Schema through a series of test to check up whether it satisfies a certain normal form. Consider an instance of a relation schema. In real life situation, the data available are not always precise or crisp, rather it can be in any form like it can be in natural language, and any imprecise data or you can say Neutrosophic data . A wide body of work deals with fuzzy modeling of uncertain neutrosophic data [3] .In this paper a method is suggested for getting more accurate solution using neutrosophic rules.

II. BASIC CONCEPTS

The idea of tripartition (truth, falsehood, indeterminacy) appeared in 1764 when J. H. Lambert[4] investigated the credibility of one witness affected by the contrary testimony of another.

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He generalized the combination of evidence, which was a Non-Bayesian approach to find a probabilistic model. Dempster (1967) gave a rule of combining two arguments[5]. Shafer (1976) extended it to the Dempster-Shafer Theory of Belief Functions by defining the Belief and Plausibility functions and using the rule of inference of Dempster for combining two evidences proceeding from two different sources [6]. Belief function is a connection between fuzzy reasoning and probability. The Dempster-Shafer Theory of Belief Functions is a generalization of the Bayesian Probability. This uses the mathematical probability in a more general way, and is based on probabilistic combination of evidence in artificial intelligence.

Relational data model was proposed by Ted Codd's paper [7]. Since then, relational database systems have been extensively studied and a lot of commercial relational database systems are currently available . This data model usually takes care of only well-defined and unambiguous data. However, when we talk about the imprecise data or imperfect information, it will fail to answer. But our Lay users may or may not be aware of imprecision. In order to represent and manipulate various forms of incomplete information in relational databases, several extensions of the classical relational model have been proposed [8].

2.1 Classical logic

In classical logic, a logical variable is restricted to the values of true (T) and false (F).The logical connectives of **and** (/\), **or** (\/) and **not** (¬) in classical logic have the behaviors that are summarized in the truth values of Table 1.

Table 1

p	q	p/\q	p \/ q	¬ p
T	T	T	T	T
T	F	F	T	F
F	T	F	T	T
F	F	F	F	T

Other names for these connectives are **conjunction** (/\), **disjunction** (\/) and **negation** (¬).

Since each variable in classical logic is restricted to these two values, if an expression has n different variables, the truth table will have 2n rows.

2.2 Neutrosophic logic

It was created by Florentin Smarandache (1999)[9] and is an extension/combination of the fuzzy logic, intuitionistic logic, paraconsistent logic, and the three-valued logics that use an indeterminate value. In neutrosophic logic, in an easy way, every logical variable x is described by an ordered triple.

x= (t, i, f)

where t is the degree of truth, f is the degree of false and i is the level of indeterminacy.

T, I, and F are called *neutrosophic components*, representing the truth, indeterminacy, and falsehood values respectively referring to neutrosophy, neutrosophic logic, neutrosophic components, neutrosophic set.

2.3 Definition of Neutrosophic Components

Let T, I, F be standard or non-standard real subsets of] -0, 1+ [,

with sup T = t_sup, inf T = t_inf,

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sup I = i_sup, inf I = i_inf,

sup F = fsup, inf F = finf.

2.4 Neutrosophic Set

Let X be a space of points (objects), with a generic element in X denoted by x. A neutrosophic set A in X is characterized by a truth membership function TA, an indeterminacy-membership function IA and a falsity-membership function FA. $TA(x)$, $IA(x)$ and $FA(x)$ are real standard or non-standard subsets.

To maintain consistency with the classical and fuzzy logics and with probability, there is the special case where t + i + f = 1.

But to refer to intuitionistic logic, which means incomplete information on a variable, proposition or event one has t + i + f < 1.

Analogically, referring to paraconsistent logic, which means contradictory sources of information about a same logical variable, proposition, or event one has t + i + f > 1.

2.4.1 Example

If i is always zero and t and f must be zero or one, then the variables are restricted to the forms (1,0,0) and (0,0,1). The behavior of the connectives in CS for these values can be defined using the following truth Table 2.

Table 2

p	q	p/\q	p \/ q	¬ p
(1,0,0)	(1,0,0)	(1,0,0)	(1,0,0)	(0,0,1)
(1,0,0)	(0,0,1)	(0,0,1)	(1,0,0)	(0,0,1)
(0,0,1)	(1,0,0)	(0,0,1)	(1,0,0)	(1,0,0)
(0,0,1)	(0,0,1)	(0,0,1)	(0,0,1)	(1,0,0)

2.5 Differences Between Neutrosophic Set (NS) and Intuitionistic Fuzzy Set (IFS)

Neutrosophic Set can distinguish between absolute membership (i.e. membership in all possible worlds; we have extended Leibniz's absolute truth to absolute membership) and relative membership (membership in at least one world but not in all), because NS(absolute membership element)=1+ while NS(relative membership element)=1. This has application in philosophy (see the neutrosophy). That's why the unitary standard interval [0, 1] used in IFS has been extended to the unitary non-standard interval]-0, 1+[in NS.

Similar distinctions for absolute or relative non-membership and absolute or relative indeterminant appurtenances are allowed in NS.

In NS there is no restriction on T, I, F other than they are subsets of]-0, 1+[, thus: -0 [inf T + inf I + inf F [sup T + sup I + sup F [3+.

This non-restriction allows paraconsistent, dialetheist, and incomplete information to be characterized in NS (i.e. the sum of all three components if they are defined as points, or sum of superior limits of all three components if they are defined as subsets can be >1 (for paraconsistent information coming from different sources), or < 1 for incomplete information), while that information cannot be described in IFS because in IFS the components T (membership), I (indeterminacy), F (non-membership) are restricted to t+i+f=1 , if T, I, F are all reduced to the points t, i, f respectively, or to sup T + sup I + sup F = 1 if T, I, F are subsets of [0, 1]. Of course, there are cases when paraconsistent and incomplete informations can be normalized to 1, but this procedure is not always suitable.

2.5.1 Example

The proposition "Tomorrow it will be raining" does not mean a fixed-valued components structure; this proposition may be say 40% true, 50% indeterminate, and 45% false at time t_1; but at time t_2 may change at 50% true, 49% indeterminate, and 30% false (according with new evidences, sources, etc.); and tomorrow at say time t_1 45% the same proposition may be 100%, 0% indeterminate, and 0% false (if tomorrow it will indeed rain). This is the dynamics: the truth value changes from one time to another.

The subsets are not necessary intervals, but any sets (discrete, continuous, open or closed or half-open/half-closed interval, intersections or unions of the previous sets, etc.) in accordance with the given proposition. A subset may have one element only in special cases of this logic.

2.6 Advantages

The advantage of using neutrosophic logic is that this logic distinguishes between relative truth, that is a truth in one or a few worlds only, noted by 1, and absolute truth, that is a truth in all possible worlds, noted by 1+. And similarly, neutrosophic logic distinguishes between relative falsehood, noted by 0, and absolute falsehood, noted by –0.

In neutrosophic logic the sum of components is not necessarily 1 as in classical and fuzzy logic, but any number between –0 and 3+, and this allows the neutrosophic logic to be able to deal with paradoxes, propositions which are true and false in the same time: thus NL(paradox)=(1, I, 1); fuzzy logic cannot do this because in fuzzy logic the sum of components should be 1.

When the sum of components $t + i + f = 1$ (classical and fuzzy logic);

When the sum of components is $t + i + f < 1$ (intuitionistic logic);

When the sum of components is $t + i + f \geq 1$ (paraconsistent logic).

III. NEUTROSOPHIC RELATIONAL DATABASE

In this section I have presented a method of decomposing a relational schema with Neutrosophic attributes into basic relational form. This Method is called as Neutrosophic-First Normal Form -1NF(NFNF) a revision of First normal Form in Relational database.

3.1 Algorithm

Let us present Sequence of steps for Rank Neutrosophic normalization of relation schema into 1NF.

Step1 Remove all the Neutrosophic-attributes from the relation.

Step2 For each Neutrosophic-attribute create one separate table with the following attributes:

Step2.1 All attributes in the primary key

Step2.2 MV (z) (membership value)

Step2.3 NMV (Z) (non-membership value)

Step3 For every precise value of the Neutrosophic attribute put MV=1 and NMV=0.

Thus, if there is m number of attributes in the relation schema then, after normalization there will be in total (m + l) number of relations .In special case, when the hesitation or in deterministic parts are nil for every element of the universe of discourse the Neutrosophic number reduces to fuzzy number. In such cases, the attribute non membership value i.e. NMV (Z) will not be required in any reduced tables of 1NF.

The method of normalizing a relational schema (with Neutrosophic attributes) into 1NF is explained in this section. For the sake of simplicity, consider a relation schema R as given in Table 3 with only one Neutrosophic attribute and all other three attributes being crisp. Neutrosophic attribute means that at least one attribute value in a relation instance is Neutrosophic.

3.1.1 Example

Table 3

NAME	**ID**	**Monthly_Sal (in thousands of Rupees)**
Amal	E11	5637
Kamal	E12	7289
Nilay	E13	Approximately 32
Bikram	E14	2987

In this instance NAME and ID are crisp attribute whereas Monthly_Sal is neutrosophic attribute, all the attribute values for NAME are atomic; all the attribute values for the attribute ID are atomic. But all the attribute values for the attribute Monthly Sal are not atomic. The data approximately 32 is an Neutrosophic number 32. Suppose that for this relation, a database expert proposes the Neutrosophic number 32 as an NS given by **={(32,.6,.4),(32,.9,.01),(32.7,.8,.10)}.**

Now remove the Neutrosophic attribute Monthly_ Sal (MS) for this instance and divide it into two relations Table 4 and Table 5.

Table 4

FNAME	**ID**
Amal	E11
Kamal	E12
Nilay	E13
Bikram	E14

Table 5

ID	**MS**	**MV(MS)**	**NMV(MS)**
E11	5637	1	0
E12	7289	1	0
E13	32	.6	.4
E13	32	.9	.01
E13	32.7	.8	.10
E14	2987	1	0

Clearly, it is now in 1NF. For Table 3, the Primary Key is ID, for Table 4 the Primary Key is {FID, MS}.

3.2 New Decision Making Method in Neutrosophic

In the new method rows of a matrix is labeled by the object names h_1, h_2, ...h_n and the columns are labeled by the parameters c_1, c_2,......c_m. The formula is considered for taking the decision is a+b-c, where 'a' is the value which is measure how many times truth value of one row is greater or equal to other rows truth values, 'b' is the value which is measure how many times in deterministic value of one row is greater or equal to other rows in deterministic values, 'c' is the value which is measure how many times false value of one row is greater or equal to other rows false values.

Now solve to the given problem in Table 6 as per the new method for taking proper decision.

3.2.1 Problem

Table 6

House	Decoration(as per Beauty) with(T,I,F)
H_1	(0.6,0.2,0.7)
H_2	(0.5,0.3,0.6)
H_3	(0.7,0.5,0.2)
H_4	(0.6,0.2,0.7)
H_5	(0.7,0.1,0.5)

Which one house will be selected by the person who is interested for house decoration?

3.2.2 Solution

First of all make a table with the help of given formula for comparison the status which is shown in Table 7.

Table 7

House	a	b	c	Sum(a+b-c)
H_1	3	2	4	1
H_2	0	3	2	1
H_3	4	4	0	8
H_4	2	2	4	0
H_5	4	0	1	3

3.2.3 Decision

Person will select the H_3 for decoration as per the new methods. If she does not want to choose H_3 due to some reason, her second choice will be H_5.

This kind of distinct decision can not be taken either fuzzy or vague relational database. But neutrosophic logic based new method will allow taking appropriate decision.

IV. CONCLUSION

In this paper I have adopted Neutrosophic set, logic and apply in new methods to solve the problem with appropriate decisions either for searching or selecting exact option from the table with the help of truth-membership, indeterminacy-membership and falsity-membership. The neutrosophic framework has found practical applications in a variety of different fields with comprising of relational database. I have applied an algorithm for normalization of table with 1NF and implemented the method for taking accurate decision. The data model can be used to represent relational information which is incomplete and inconsistent.

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