International Journal of Emerging Trends & Technology in Computer Science (IJETTCS)
Web Site: www.ijettcs.org Email: editor@ijettcs.org, editorijettcs@gmail.com
Volume 9, Issue 5, September - October 2020 ISSN 2278-6856

Relevancy of Neutrosophic Logic in Various Domains

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Abstract: ***Neutrosophic Logic has number of applications in different domains. In this paper it is shown how Neutrosophic Logic can be beneficial in different domains of interest. This can be done with help of logical analysis based on Neutrosophic logic. Neutrosophic Logic theory can be applied in many areas of research such as applied economics, mathematics, and physics. The core concept of neutrosophy states that along with certain degree of truth and falsity every concept has a degree of indeterminacy also, which can easily be handled using Neutrosophic logic.***

Keywords: Adaptive learning, Blended learning, Clustering Analysis, Medical Diagnosis

1. INTRODUCTION

In Neutrosophy, we can connect an idea with its neutral and with it's opposite to get common parts, i.e. <non-A> ∧ <A> = nonempty set. This constitutes the common part of the uncommon things! So, neutrosophy means that: <A>, <anti-A> (the opposite of <A>), and < neut-A > (the neutrals between <A> and <anti-A>) interact among themselves. We can always connect the matter with its neutral and opposite and can get an empty set.

It can be also said that neutrosophic logic is (or"Smarandachelogic") a generalization of fuzzy logic based on Neutrosophy. A proposition t, i, f are the real values and are meant as t for true, i for indeterminate, and f for false, with no restriction on the sum n = t + i + f. Thus Neutrosophic logic can be generalized as:

- Intuitionistic logic that supports incomplete theories
- Fuzzy logic that supports probability of truth and falsity
- Boolean logic that is classical logic means either true or false
- Multi-valued logic
- Para consistent logic
- Dialetheism, which says that some contradictions are true

After comparing neutrosophic logic with all other logics, neutrosophic logic introduces a percentage of "indeterminacy"—due to unexpected parameters hidden in some propositions. It also allows t, I, f components to to go above 100 e.g "boil over" or go below 0 e.g "freeze" under 0. To express indeterminate, vague, incomplete and inconsistent information Neutrosophic Set is a powerful structure.

In all neutrosophic logic is the study of dynamics of neutralities and opposites.

2. PRELIMNARIES

Three possible or finite states can be shown with the help of Neutrosophic Logic in this infinite universe.

Fuzzy set theory was first defined by Zadeh. Then Attanasov further extended this to intutionistic Fuzzy sets. This theory can further be applied to clustering analysis and medical diagnosis using similarity and distance measure approaches.

Samarandache introduced the concept of Neutrosophic logic and theory of Neutrosophic sets which is a generalization of Intutionistic fuzzy sets and fuzzy sets. Neutrosophic logic because of its properties is used for decision making problems in real life. Pattern recognition, clustering problems in medical diagnosis are the few areas where similarity measure can be applied using neutrosophic logic for decision making purposes in real life.

By looking at the applications of Neutrosophic set, it can be experienced that there is a prominent difference in application domain of both i.e fuzzy set and neutrosophic set. To convey the inconsistent and uncertain information it is significant to use membership grade i.e truth, falsity and indeterminacy values of neutrosophic components.

3. DECISION MAKING

Mardani et al. (2015) gives a broad review of various fuzzy multi-criteria decision making (MCDM) techniques. To deal with indeterminate and inconsistent information which frequently exists in reality, they are not considered to be suitable. In 1999 Smarandache introduced a new branch of mathematics a powerful framework to deal with scope of neutralities and to resolve with above mentioned issues and termed it as neutrosophs.

For example, consider in a voting system there are ten voters taking part. At one instance, suppose three votes are ''yes'', four votes are ''no'' and three are undecided. In neutrosophy it can be represented as (0.3, 0.4, 0.3). Or at another instance of time three votes are ''yes'', two votes are ''no'', two give up and three are undecided, then it is presented as (0.3, 0.2, 0.2) then this case is out of the reach of IFS. This kind of state is well accomplished by neutrosophic set, where Neutrosophic set generalizes the existing ideas of classical set,

To solve the multi-attribute decision making (MADM) problems the TOPSIS method was developed using the CN of IVIFS. Let's take an example of Flood prediction system, where using experimental observations and statistical analysis, the opinion in this situation can be seen in three different ways: (1) using fuzzy membership grades, (2) using neutrosophic numbers, and (3) using neutrosophic

fuzzy numbers. To express imprecise and incomplete i.e. uncertain information, fuzzy membership grade is used in the first case. Inconsistent and indeterminate information is stated using Neutrosophic numbers in the second case. And fuzzy neutrosophic numbers are used in the last case to express indeterminate, inconsistent and uncertain information.

For disaster forecasting, experts often rely on a number of attributes/criteria, whose values are often uncertain, inconsistent and indeterminate
Some well-known distance measures in the context of SVNFS and using the distance measures we compute similarity measures. Finally we apply SVNFS in decision making applications using similarity measures.

Ye (2014a) firstly defined Hamming and Euclidean distances between INSs and then using the distance measures the author proposed similarity measures between two INSs.

Using trapezoidal NS, a cosine similarity measure based decision making approach was presented by Biswas et al. (2014). To propose a decision making problem, Tan and Zhang (2017) applied TOPSIS method in the context of trapezoidal fuzzy set. Inspired by the correlation measure of IFSs, For decision making problems, the correlation measure was explored by Ye(2013) for single valued neutrosophic sets. Majumdar (2015) gives a comprehensive discussion on the distance, similarity measures, and entropy on NSs. Deli et al. (2015) defined bipolar NS and defined few of its operations. Extending the cross entropy of FSs, Ye (2014b) studied cross entropy of SVNSs. As mentioned in (Abdel-Basset et al. 2018; Garg and Nancy 2018; Jana et al. 2019; Maiti et al. 2019; Meng et al. 2019; Wei and Zhang 2019; Karaaslan and Hunu 2020) a number of new ideas on neutrosophic set have been evolving.

For engineering and scientific applications similarity measures are effective. It would be a significant research contribution by embedding NFS in various promising research fields, such as multi granular linguistic modelling, consensus measures, managing preference relations, information aggregation, entropy computation, etc.

4. E LEARNING

One of the ways to support personalized eLearning is Adaptive eLearning that is supported by intelligent techniques and methods.

E learning has adaptive, appropriate and intelligent features for a better learning model.

Learning methods include Face to face learning termed as traditional learning, both place and time independent learning may be termed as distance learning or Online learning distance which is termed as asynchronous learning and then last type is the combination of online learning with instruction-led learning that leads to reduced classroom concept.

Blended learning basically increases student learning as compared to fully online learning. It optimizes both distance learning and traditional learning while lowering the challenges. Blended learning has proven very beneficial and potential to enhance efficiency and affectivity of learning experiences.

4.1 Learning management systems

The software that automates the administration of education is an LMS (Learning Management System). Register students, track courses in a catalog, record data from learners, and provide reports to management are the tasks of an LMS.

It actually focuses on other learning resources instead of including its own capabilities.

4.2 Pedagogical eLearning challenges

Pedagogically, educational psychologists agree that very few teachers can adapt learning to each student in typical large classes and students differ in the ways they learn. So pedagogically, best, trained novices using are produced different technologies and training methods. This type of learning provides students with opportunities to practice exercises using this knowledge.

4.3 Adaptive eLearning

For students with different learning styles, interests and with varying backgrounds Adaptive learning is virtually a must.

For better eLearning Adaptive eLearning systems would be a good solution. LMSs are powerful integrated systems that support a number of teachers' and students' needs because of which vast majority of web-enhanced courses rely on it.

By adapting learning some parameters like identifying, analyzing, and monitoring relevant aspects of instructions, such as different velocities, paths, or strategies of learning, Adaptive eLearning enables personalizing the learning process to individual learners.

Adaptive learning integrates neutrosophic theory and different intelligent natures to empower the learning model. To improve instructor and student performance innovative enhanced features are used to enhance adaptive learning. To present intelligent features in different aspects neutrosophic theory is used.

4.4 Intelligent eLearning systems

For Intelligent learning systems i.e behavior similar to humans to produce Artificial Intelligence can be utilized for programming to simulate reasoning and the thought processes. The potential of creating realistic

environments with which students can interact can be produced with the applications of AI within eLearning.

Personalized, adaptive, and intelligent services to both students and educators can be brought by employing state-of-the-art AI technology in current eLearning systems.

5. MEDICAL DIAGNOSIS, TAXONOMY AND CLUSTERING ANALYSIS

In a universe full of uncertainties Clustering analysis and medical diagnosis are among the most important research topics. Conventional tools are inadequate for processing uncertain information because of complexity of information or data related to the problem area.

Smarandache proposed philosophically the theory of neutrosophic sets (NSs), which is a generalization of FSs [1] and IFSs [2] so as to more accurately deal with inconsistent and indeterminate information.

For representing information that is inconsistent and indeterminate, INS and SVNS are used reasonably which are involved in clustering analysis, decision-making, machine learning, and pattern recognition and medical diagnosis. [3-9].

Two important tools used to determine the similarity/different relationship between objects in an uncertainty environment are Similarity/distance measure. Therefore, more and more researchers have started to study the As SVNSs and SNSs has the capability of handling uncertainty, so more research has started in this area based on similarity/distance measures.

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5.1 Cluster analysis

Medical diagnosis and many other applications belonging to this are a common practice area using the concept of Pattern recognition. [10,11,12].

The classified set of objects can be put together into appropriate groups using Cluster analysis. Under a neutrosophic environment, clustering algorithm can be taken based on the proposed similarity measure between SVNSs and can be applied to a clustering problem. Therefore, we basically generalize the intuitionistic fuzzy clustering algorithm proposed by Zhang et al. [13] and Xu et al. [14] to SVNSs.

Example 5.1. (Clustering approach)

In this section, based on similarity matrices under single-valued neutrosophic data environment, a real example adapted from Ye [15] is utilized to demonstrate the application and effectiveness of the proposed clustering algorithms.

A car market is going to classify five different cars of A_i (i ¼ 1, 2,…, 5). Every car has six evaluation attributes:

(1) u_1: fuel consumption;
(2) u_2: coefficient of friction;
(3) u_3: price;
(4) u_4: comfortable degree;
(5) u_5: design;
(6) u_6: security coefficient.

By the form of SVNSs, the characteristics of each car under the six attributes are represented and then the single-valued neutrosophic data.

Then, under the single valued neutrosophic similarity measure, the developed algorithm is used to classify the five different cars of A_i (i 1, 2,…, 5).

By analyzing the results obtained, we can note that not only are the proposed similarity measures able to offer different final options to decision-makers by different fuzzy implications but also handle the single valued neutrosophic information.

Neutrosophic logic can be applied with new similarity measures of SNSs to other areas such as image processing, decision-making, and clustering analysis.

In Medical diagnosis field let's assume a few samples from a patient with all the symptoms represented by Neutrosophic values. Considering the similarity measure a proper diagnosis can be conducted. And proper diagnosis results can be obtained by looking at the maximum similarity degree measure.

Neutrosophic theory is also beneficial in bacteria detection in microbiology. Bacteria can be classified broadly according to their shapes. Indeterminate information cannot be handled by Intutionistic logic. On the other side neutrosophic logic can be applied without any restriction for decision purposes in medical diagnosis. For capturing uncertain, imprecise and inconsistent information it's more effective and suitable.

6. CONCLUSION

On being analysed by NL theory, some fields of science are improved. So, it is clear that Neutrosophic theory can be applied in many areas like economics, applied mathematics, and also physics. It can also be used in gravitation theories to reconcile the "push" and "pull".

It would be a significant research contribution of Embedding NFS in various promising research fields, such as information aggregation, multi granular linguistic modelling, managing preference relations, consensus measures, etc.

ELearning which is facing challenges right now is an important part of the future. The absence of current eLearning systems that adaptively and intelligently invoke students' capabilities is one of the eLearning challenges. To exploit unlimited eLearning advantages, Adaptive eLearning is the solution. Adaptive eLearning that is supported by intelligent methods and techniques, such as Neutrosophic Sets and Theory is a need. The solution to present efficient and effective learning is Adaptive eLearning which is supported by intelligent techniques.

To overcome difficult situations, mainly incomplete, inconsistent, and missing data all intelligent Micro services utilized Neutrosophic Sets and Theory.

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