Analyzing Age Group and Time of the Day Using Interval Valued Neutrosophic Sets

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Abstract: Human psychological behavior is always uncertain in nature with the truth, indeterminacy and falsity of the information and hence neutrosophic logic is able to deal with this kind of real world problems as it resembles human's attitude very closely. In this paper, age group analysis and time (day or night) analysis have been carried out using interval valued neutrosophic sets. Further, the impact of the present work is presented.

Keywords: Neutrosophic Logic; Human Psychological Behavior; Age Group; Day; Interval Valued Neutrosophic Set.

1. Introduction

Uncertainty saturates our daily lives and period the entire range from index fluctuations of stock market to prediction of weather and car parking in a congested area to traffic control management. Hence almost all the area contains ambiguity or impression. For various real world problems, intelligent models with many types of mathematical designs of different logics have been modeled by the researchers. In the area of computational intelligence, fuzzy logic is one of the superior logic that provides appropriate representation of real world information and permits reasoning that are almost accurate in nature [1].

Generally the inputs conquered by the fuzzy logic are determinate and complete. Humans can able to take knowledgeable decisions in those situations, however it is difficult to express in proper terms. But fuzzy models need complete information. Due to basic non-linearity, huge erratic substantial disturbances, time varying nature, difficulties to find precise and predictable measurements, incompleteness and indeterminacy may arise in the data. All these problems can be dealt by neutrosophic logic proposed by Smarandache in the year 1999 [2-10]. Also this logic can able to represent mathematical structure of uncertainty, ambiguity, vagueness, imprecision, inconsistency, incompleteness and contradiction.

Also it is efficient in characterizing various attributes of data such as incompleteness and inaccuracy and hence gives proper estimation about the authenticity of the information. This approach proposes extending the proficiencies of representation of fuzzy logic and system of reasoning by introducing neutrosophic representation of the information and system of neutrosophic reasoning. Neutrosophic logic can exhibit various logical behaviors according to the nature of the problem to be solved and hence it influences its chance to be utilized and experimented for real world performance and simulations in human psychology [15].

Due to computational complexity of the neutrosophic sets, single valued neutrosophic sets have been introduced. It can deal with only exact numerical value of the three components truth, indeterminacy and falsity. While the data in the form of interval, then single valued neutrosophic sets unable to scope up and hence interval valued neutrosophic sets have been introduced. As it has lower and upper membership functions it can deal more uncertainty with less computational complexity than other types [25]. Neutrosophic set has been used in several areas like traffic control management, solving minimum spanning tree problem, analyzing failure modes and effect analysis, blockchain technology, resource leveling problem, medical diagnostic system, evaluating time-cost tradeoffs, analysis of criminal behavior, petal analysis, decision making problem etc. [26-40].

The major advantage of neutrosophic set and its types namely single valued neutrosophic sets and interval valued neutrosophic sets overrule other sets namely conventional set, fuzzy set, type-2 fuzzy, intuitionistic fuzzy and type-2 intuinistic fuzzy by their capability of dealing with indeterminacy which is missing with other types of sets. Since there is a possibility of having interval number than the exact number we consider interval valued neutrosophic set in this study of analyzing age group and time. Prediction of future trend is one of the interesting areas in the research field. Hence, in this paper, age group analysis and time (day or night) analysis have been done using interval valued neutrosophic sets. The remaining part of the paper is organized as follows. In section 2, review of literature is given. In section 3, preliminaries are given for better understanding of the paper. In section 4, age group and day and night time have been analyzed using the concept of interval valued neutrosophic sets. In section 5, impact of the present work is given. In section 6, concluded the present work with the future direction.

2. Review of Literature

The author in, [1] analyzed uncertainty exists in the project schedule using fuzzy logic. And the authors of, [2] analyzed power flow using fuzzy logic. [3] Examined specific seasonal prediction spatially under fuzzy environment for the group of long-term daily rainfall and temperature data spatiotemporally. [4] examined about the prediction of temperature flow of the atmosphere based on fuzzy knowledge–rule base for interior cities in India. [5] proposed a novel approach for intuitionistic fuzzy sets and its applications in the prediction area.

[6] proposed single-valued neutrosophic minimum spanning tree and its aggregation method. [7] proposed a new approach for the advisory of weather using fuzzy logic. [8] Proposed a method for prediction of weather under fuzzy neural network environment and Hierarchy particle swarm optimization algorithm. [9] Proposed various types of neutrosophic graphs and algebraic model and applied in the field of technology. [10] proposed single valued neutrosophic graphs (SVNGs).

[11] examined bipolar single valued neutrosophic graphs. [12] Proposed interval valued neutrosophic graphs. [13] proposed isolated SVNGs. [14] provided an introduction to the theory bipolar SVNG. [15] proposed the degree, size and order of SVNGs. 16] applied Dijkstra algorithm to solve shortest path problem under IVN environment. [17] solved minimum spanning tree problem under trapezoidal fuzzy neutrosophic environment.

[18] applied minimum spanning tree algorithm for shortest path (SP) problem using bipolar neutrosophic numbers. [19] proposed a novel matrix algorithm for solving MST for undirected interval value NG. [20] solved a spanning tree problem with neutrosophic edge weights. [21] proposed a new algorithm to solve MST problem with undirected NGs. [22] analyzed the role of SVNSs and rough sets with imperfect and incomplete information systems.

[23] Studied about neutrosophic set and its development . [24] studied about the prediction of long-term weather elements using adaptive neuro-fuzzy system using GIS approach in Jordan. [25] have done overview of neutrosophic sets. [26] proposed a methodology of traffic control management using triangular interval type-2 fuzzy sets and interval neutrosophic sets. [27] Solved MST problem using single valued trapezoidal neutrosophic numbers.

[28] estimated risk priority number in design failure modes and effect analysis using factor analysis. [29] have done edge detection on DICOM image using type-2 fuzzy logic. [30] made a review on the applications of type-2 fuzzy in the field of biomedicine. [31] have done image extraction on DICOM image usingtype-2 fuzzy. [32] made a review on application of type-2 fuzzy in control system. [33] proposed single and interval valued neutrosophic graphs using blockchain technology. [34] introduced interval valued neutrosophic graphs using Dombi triangular norms. [35] solved resource leveling problem under neutrosophic environment.

[36] introduced cosine similarity measures of bipolar neutrosophic sets and applied in diagnosis of disorder diseases. [37] introduced a methodology for petal analysis using neutrosophic cognitive maps. [38] analyzed criminal behavior using neutrosophic model. [39] presented assessments of linear time-cost tradeoffs using neutrosophic sets. [40] solved sustainable supply chain risk management problem using plithogenic TOPSIS-CRITIC methodology. In view of the literature, prediction of age group and day or night time under interval neutrosophic set are yet to be studied and which is the reason of the present study.

3. Preliminaries

In this section, preliminaries of the proposed concept are given

3. 1. Neutrosophic Set (NS) [25]

Consider the space X consists of universal elements characterized by e. The NS A is a phenomenon which has the structure $A=\left\{\left(T_A(e), I_A(e), F_A(e)\right)/e\in X\right\}$ where the three grades of

memberships are from X to]−0,1+[of the element $e \in X$ to the set A, with the criterion:
$^{-}0 \le T_A(e) + I_A(e) + F_A(e) \le 3^{+}$ (1)

The functions $T_A(e)$, $I_A(e)$ and $F_A(e)$ are the truth, indeterminate and falsity grades lies in real standard/non-standard subsets of] −0, 1+ [.

Since there is a complication of applying NSs to real issues, Samarandache and Wang et al. [11-12] proposed the notion of SVNS, which is a specimen of NS and it is useful for realistic applications of all the fields.

3.2. Single Valued Neutrosophic Set (SVNS) [25]

For the space X of objects contains global elements e. A SVNS is represented by degrees of bership grades mentioned in Def. 2.8. For all e in X, $T_A(e)$, $I_A(e)$, $F_A(e) \in [0, 1]$. A SVNS can be written as

$$A = \{\langle e : T_A(e), I_A(e), F_A(e)\rangle / e \in X\} \quad (2)$$

3.3. Interval Valued Neutrosophic Set [12]

Let X be a space of objects with generic elements in X denoted by e. An interval valued neutrosophic set (IVNS) A in X is characterized by truth-membership function, $T_A(e)$, indeterminacy-membership function $I_A(e)$ and falsity membership function $F_A(e)$. For each point e in X, $T_A(e)$, $I_A(e), F_A(e) \in [0,1]$, and an IVNS A is defined by

$$A = \{\langle [T_A^L(e), T_A^U(e)], [I_A^L(e), I_A^U(e)], [F_A^L(e), F_A^U(e)]\rangle \mid e \in X\} \quad (3)$$

Where, $T_A(e) = [T_A^L(e), T_A^U(e)]$, $I_A(e) = [I_A^L(e), I_A^U(e)]$ and $F_A(e) = [F_A^L(e), F_A^U(e)]$

Fig 1 shows the Pictorial Representation of the neutrosophic set [5]

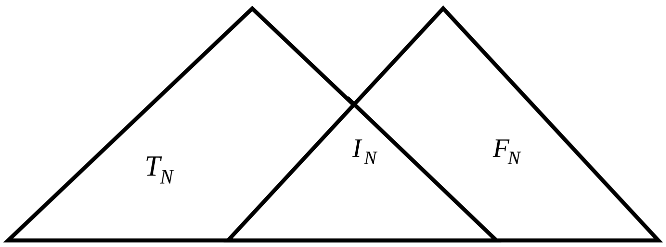

Fig.1. Neutrosophic set

4. Proposed Methodology

In this section, age group and time (day or night) have been analyzed using interval valued neutrosophic set.

4.1 Application of Interval Valued Neutrosophic Set in Age Group Analysis

As per our convenience, the age group is divided into three groups: young people, middle aged people and old people. Assume young people are a truth membership function, middle aged people are indeterminate membership function and old people are a falsity membership function. Here, the degree of middle aged people may provide either degree of old people or young people or both. Let us consider the age group is definitely young at and below 18-40, it is definitely old at and beyond 51-100 and in between the age group is middle. i.e., the level of the young age people decreases and the level of old age people increases. The age group is represented pictorially for young people, middle aged people and old people as in Fig. 2.

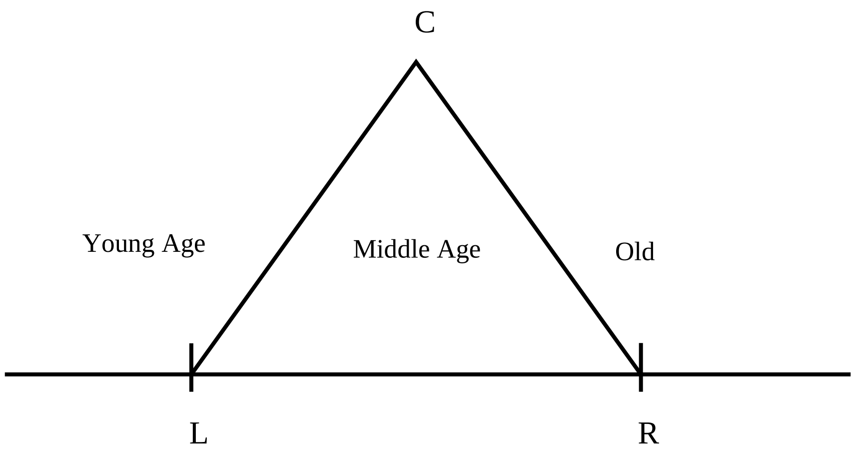

Fig.2. The degrees of 'young age', 'middle age' and 'old age' people.

Let A be the different age groups of the people and N be an interval valued neutrosophic set defined in the set A. Let $T_N(a)$ be the membership degree of the age group 'young age people' at a, here a denotes a numerical value. For example, $a = 20$. Similarly, indeterminate degree of 'middle age people' can be denoted by $I_N(a)$ and the falsity degree of 'old age people' denoted by $F_N(a)$ at a.

Consider $A = \{\langle [18,40],[41,50],[51,100] \rangle\}$ and

$$N = \{\langle T_N([18,40]), I_N([18,40]), F_N([18,40]) \rangle,$$

$$\langle T_N([41,50]), I_N([41,50]), F_N([41,50]) \rangle, \langle T_N([51,100]), I_N([51,100]), F_N([51,100]) \rangle\}.$$

Case (i). At and below [18, 40], there is no middle age people and old age people but there exist only young age people. Therefore the following values are obtained.

$\left[T_N^L, T_N^U\right]([18,40]) = [1,1]$, $\left[I_N^L, I_N^U\right]([18,40]) = [0,0]$ and

$\left[F_N^L, F_N^U\right]([18,40]) = [0,0]$

i.e., the membership function of the interval valued neutrosophic set is $([1,1],[0,0],[0,0])$

Case (ii). At age [41, 50] (at the point C)

$\left[T_N^L, T_N^U\right]([41,50]) = [0,0]$, $\left[I_N^L, I_N^U\right]([41,50]) = [1,1]$ and

$\left[F_N^L, F_N^U\right]([41,50]) = [0,0]$

i.e., the membership function of the interval valued neutrosophic set is $([0,0],[1,1],[0,0])$

Case (iii). At and above [51,100], there are no young age people and middle age people, but there exist only old age people.

$\left[T_N^L, T_N^U\right]([51,100]) = [0,0]$, $\left[I_N^L, I_N^U\right]([51,100]) = [0,0]$ and $\left[F_N^L, F_N^U\right]([51,100]) = [1,1]$

i.e., the membership function of the interval valued neutrosophic set is $([0,0],[0,0],[1,1])$

Hence, $N = \left\{\langle[1,1],[0,0],[0,0]\rangle, \langle[0,0],[1,1],[0,0]\rangle, \langle[0,0],[0,0],[1,1]\rangle\right\}$

Also, young age people decreases and middle age people increases in between L and C.

i.e., $[1,1] > \left[T_N^L, T_N^U\right] > [0,0]$ and $[0,0] < \left[I_N^L, I_N^U\right] < [1,1]$

Further, middle age people decreases and old age people increases in between C and R.

i.e., $[1,1] > \left[I_N^L, I_N^U\right] > [0,0]$ and $[0,0] < \left[F_N^L, F_N^U\right] < [1,1]$

4.2 Application of Interval Valued Neutrosophic Set in Day and Night Time Analysis

As per our convenience, time of the day is divided into three groups: day, day or night (or both) and night. Assume day time is a truth membership function, day or night (or both) is an indeterminate membership function and night time is a falsity membership function. Here, the degree of day or night time may provide either degree of day time or night time or both. Let us consider the time of the day is definitely day time at and below 7 AM to 6 PM, it is definitely night at and beyond 7 PM and 5 AM and in between time is day or night. i.e., the level of the day time decreases and the level of night time increases. The time of the day is represented pictorially for day, day or night people and night as in Fig. 3.

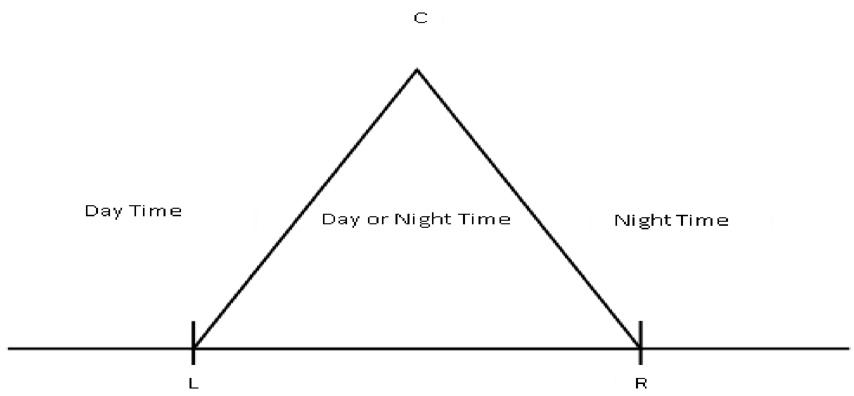

Fig.3. The degrees of time for 'day', 'day or night' and 'night'

Let B be the different times of the day, M an interval valued neutrosophic set defined in the set B. Let $T_M(b)$ be the membership degree of the time 'day' at b, here, b denotes a numerical value.

For example $b = 8$ AM or PM. Similarly, the indeterminate degree of the time $I_N(b)$ and the falsity degree of the time $F_M(b)$ can be represented by b.

Consider two cases.

$B = \{\langle [7AM, 6PM], [5AM, 6AM], [7PM, 5AM] \rangle\}$ and

$$M = \{\langle T_N([7AM, 6PM]), I_N([7AM, 6PM]), F_N([7AM, 6PM]) \rangle,$$
$$\langle T_N([5AM, 6AM]), I_N([5AM, 6AM]), F_N([5AM, 6AM]) \rangle,$$
$$\langle T_N([7PM, 5AM]), I_N([7PM, 5AM]), F_N([7PM, 5AM]) \rangle\}.$$

Also we can consider, $B = \{\langle [7AM, 6PM], [6PM, 7PM], [7PM, 5AM] \rangle\}$ and

$$M = \{\langle T_N([7AM, 6PM]), I_N([7AM, 6PM]), F_N([7AM, 6PM]) \rangle,$$
$$\langle T_N([6PM, 7PM]), I_N([6PM, 7PM]), F_N([6PM, 7PM]) \rangle,$$
$$\langle T_N([7PM, 5AM]), I_N([7PM, 5AM]), F_N([7PM, 5AM]) \rangle\}.$$

Case (i). At and below [7AM, 6 PM], there is no hesitation of day or night time and no night time but there exist only day time. Therefore the following values are obtained.

$[T_N^L, T_N^U]([7AM, 6PM]) = [1,1]$

$[I_N^L, I_N^U]([7AM, 6PM]) = [0,0]$ and

$\left[F_N^L, F_N^U\right]([7AM, 6PM]) = [0,0]$

i.e., the membership function of the interval valued neutrosophic set is $([1,1],[0,0],[0,0])$

Case (ii). At [5AM, 6AM] (at the point C) and at [6 PM, 7PM]

$\left[T_N^L, T_N^U\right]([5AM, 6AM]) = [0,0]$ and $\left[T_N^L, T_N^U\right]([6PM, 7PM]) = [0,0]$

$\left[I_N^L, I_N^U\right]([5AM, 6AM]) = [1,1]$ and $\left[I_N^L, I_N^U\right]([6PM, 7PM]) = [1,1]$

$\left[F_N^L, F_N^U\right]([5AM, 6AM]) = [0,0]$ and $\left[F_N^L, F_N^U\right]([6PM, 7PM]) = [0,0]$

i.e., the membership function of the interval valued neutrosophic set is $([0,0],[1,1],[0,0])$

Case (iii). At and above [7 PM, 5 PM], there is no day time and no hesitation of day or night time, but there exist only night time.

$\left[T_N^L, T_N^U\right]([7PM, 5AM]) = [0,0]$

$\left[I_N^L, I_N^U\right]([7PM, 5AM]) = [0,0]$ and

$\left[F_N^L, F_N^U\right]([7PM, 5AM]) = [1,1]$

i.e., the membership function of the interval valued neutrosophic set is $([0,0],[0,0],[1,1])$

Hence, $M = \left\{\langle[1,1],[0,0],[0,0]\rangle, \langle[0,0],[1,1],[0,0]\rangle, \langle[0,0],[0,0],[1,1]\rangle\right\}$

Also, day time decreases and day or night time increases in between L and C.

i.e., $[1,1] > \left[T_N^L, T_N^U\right] > [0,0]$ and $[0,0] < \left[I_N^L, I_N^U\right] < [1,1]$

Further, day or night time decreases and night time increases in between C and R.

i.e., $[1,1] > \left[I_N^L, I_N^U\right] > [0,0]$ and $[0,0] < \left[F_N^L, F_N^U\right] < [1,1]$

5. Impacts of the work

i). The proposed approach is the effective one in determining age group forecasting while the data is in the form of interval data with indeterminate information too.

ii). Time (day or night) analysis under interval neutrosophic environment will be very useful as it is the major scientific and technical problems.

iii). Analysing any future trend can be done easily by inferring the existing information into the future using interval neutrosophic sets as it has the capacity of addressing with the set of numbers in the real unit interval which is not just a determined number, it is efficient to deal with real world problems with various possible interval values

iv). The proposed methodology of age group analysis can be used in facial image analysis as age detection system.
v). The proposed methodology of time analysis can be utilized in time series analysis.

6. Conclusion

Since neutrosophic logic resembles human behavior for predicting age and time (day or night), it is suitable for this study. According to the knowledge of human, membership values of the truth, indeterminacy and falsity may be exact numbers or interval numbers. In this paper, analysis of age group and time(day or night) have been done using interval valued neutrosophic set with the detailed description and pictorial representation. Also the impact of the present work has been given. In future, the proposed concept can be done based on the concept of neutrosophic rough and soft sets.

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