**Improved Correlation Coefficients of Fermatean Pentapartitioned single valued**

**neutrosophic sets and interval Fermatean Pentapartitioned neutrosophic**

**sets for multiple attribute decision making**

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**Abstract**:

 A correlation coefficient is a statistical measure that aids in determining the extent to which changes in one value predict changes in another. Wang's single valued neutrosophic sets were improvised into Fermatean Pentapartitioned single valued neutrosophic sets. We have investigated and looked into the attributes of interval Fermatean Pentapartitioned neutrosophic sets and Fermatean Pentapartitioned single valued neutrosophic sets in this work. Additionally, we have used this idea in many decision-making techniques using interval and Fermatean pentapartitioned single valued neutrosophic environments. Finally, we provided an example using the approach to the problems of many attribute decision making that was previously suggested.

**Keywords:** Improved correlation coefficient, interval Fermatean Pentapartitioned neutrosophic sets, and Fermatean Pentapartitioned single valued neutrosophic sets are other related terms.

**Introduction:**

In 1965, Zadeh [21] developed fuzzy sets, a development of classical set theory that permits the membership function to be valued in the range [0, 1]. In 1986, Atanassov [1] presented the intuitionistic fuzzy set (IFS), a development of Zadhe's fuzzy set theory that consists of degree of membership and degree of non-membership and spans the range [0,1]. IFS theory is widely applied in fields such as logic programming, problem-solving in decision-making, medical diagnostics, etc.

In 1995, Florentin Smarandache [11] developed the idea of a neutrosphic set, which imparts knowledge of neutral thought by introducing a brand-new component known as indeterminacy to the set. The truth membership function (T), indeterminacy membership function (I), and falsity membership

function (F) were therefore included in the framing of the neutrosophic set. The non- standard interval [0,1]

 is dealt with by neutrosophic sets. Neutrophic set plays an essential role in many application fields, including

 information technology, decision support systems, relational database systems, medical diagnosis, multicriteria decision making difficulties, etc. This is because it deals with Indeterminacy well.

Single valued nuetrosophic sets (SVNS), commonly known as an extension of intuitionistic fuzzy sets, were presented by Wang[12](2010), and they have since been a very hot area of research. The notion of Fermatean Pentapartitioned Single Valued Neutosophic Sets, which is based on Belnap's Four Logic and Smarandache's Four Numerical Valued Logic, was proposed by Rajashi Chatterjee, et al. [10]. The indeterminacy in (FPSVNS) is divided into two functions known as "Contradiction" (both true and false) and "unknown" (neither true nor false), resulting in (FPSVNS) having five components: TA, CA, KA, UA, and FA, all of which fall inside the non-standard unit interval [0, 1].

The correlation coefficient is a helpful statistical tool for calculating how closely two variables are related to one another. The correlation of fuzzy sets under a fuzzy environment was proposed in 1999 by D.A. Chiang and N.P. Lin [3]. Many real-world issues, such as multiple attribute group decision making, clustering analysis, pattern recognition, medical diagnosis, etc., heavily rely on correlation coefficients. To address the shortcomings of the correlation of single valued neutrosophic sets (SVNSs), which is introduced in [16], Jun Ye [20] defined the improved correlation coefficients of single valued neutrosophic sets and interval nuetrosophic sets.

In this essay, Section 2 provides some fundamental ideas of Fermatean pentapartitioned neutrosophic sets, quadripartitioned single valued neutrosophic sets, and their complements. It also talk over union, intersection, interval neutrosophic sets, and the correlation coefficient of FPSVNS. To address the control of correlation coefficient as specified, we proposed the idea of enhanced correlation coefficient of FPSVNSs in Section 3. We also enclosed some of its properties and a decision-making approach using the improved correlation coefficient of FPSVNSs. Interval Fermatean Pentapartitioned Neutrosophic sets (IFPNS) were introduced in Section 4 with some basic definitions and a determined correlation coefficient. Furthermore, we have talked about some of its characteristics and a strategy for making decisions applying an environment with an interval Fermatean pentapartitioned neutrosophic. In Section 5, an illustration of the above-planned correlation method in decision-making with many criteria is provided. The paper is concluded in Section 6.

**2. Preliminaries:**

**2.1 Quadripartitioned single valued neutrosophic sets:**

Definition 2.1. [5]

The single valued neutrosophic sets, which are defined over the standard unit interval [0,1], neutrosophic sets are defined over a non-standard unit interval [0,1]. It refers that the definition of a single-valued neutrosophic set A is x X}

 where such that .

**Definition 2.2. [4]**

Let X be a non-empty set. A quadripartitioned single valued neutrosophic set (QSVNS) A over X characterizes each element in X by a truth membership function , a contradiction membership function , an ignorance membership function and a falsity membership function such that x X, and when X is discrete. A is act as

A =.

Definition 2.2. [15]

Let X be a universe. A Fermatean pentapartitioned neutrosophic set (FPN) A on X is

 A = {< x, TA , CA , KA , UA , FA ,) >: x X } such that (TA)3 + (CA)3 + (KA)3+ (UA)3 + (FA)3 ≤ 3

Here, TA(x) is the truth membership,

CA(x) is contradiction membership,

KA(x) is ignorance membership,

UA (x) is unknown membership,

FA(x) is the false membership.

**3. Fermatean pentapartioned single valued neutrosophic sets**

**3.1 Definition:**

Let X be a non-empty set. The truth membership function TA (x), the contradiction membership function CA (x), an ignorance membership function KA(x), a unknown membership function and a falsity membership function such that x X, and

 When X is discrete. A is expressed as

 A =.

**3.2 Definition**

The complement of a FPSVNS is denoted by and is expressed as,

**3.3 Definition**

The union of two FPSVNS A and B is denoted by and is defined as

**3.4 Definition;**

The intersection of two FPSVNS A and B and is defined as,

**3.5 Definition:**

Let X be a space of points (an object), where x represents a common element. A truth membership function TA (x), an indeterminacy membership function IA (x), and a falsity function FA (x) define an INS interval neutrosophic set A in X. There exists, for each point x in X,

 and

. Thus, an INS A can be expressed as

 x X}

 ={

Then the sum of satisfies the condition.

. Generally, an INS reduces to the SVNS when the upper and lower ends of the interval values of TA (x), IA (x), and FA (x) are equal. However, all of the position of neutrosophic sets are SVNSs and INSs.

**3.6. Definition**

The complement of an INS A is denoted by and is defined as

, and for any x in X.

**3.7. Definition**

An INS A is contained in the other INS B, AB if and only if and .

**3.8. Definition**

Two INSs A and B are equal, written as A = B, if and only if AB and B.

**3.8. Definition: Correlation coefficient of QSVNSs**

Rajashi Chatterjee [4] defined the concept of the correlation coefficient of QSVNSs which is based on the correlation coefficient of SVNSs and is defined as follows:

K (A, B) =

= --------- (1)

The correlation coefficient K (A, B) satisfies the following properties.

1. K(A,B) = K(B,A);
2. 0
3. K (A, B) = 1, iff A = B.

There will be some drawbacks in using Equation (1) which is given below.

 For any two QSVNSs A and B, if and /or

 for any in X (i=1,2,3,…n).

Equation (1) is undefined or not important. Here it is not possible to use the formula which is given in

Equation (1). Equation (1) satisfies only the necessary condition of the property (3), but not the sufficient condition. That is AB. Equation (1) may be equal to 1.

**3.9. Example**

Let us consider A and B be QSVNSs in X which are chosen by and

 . Here seemingly, AB.

 Then K (A, B) = = 1\_\_\_\_\_\_\_\_\_\_\_ (2)

Therefore, it is not possible to apply in real world example problems in this event. So, we will define a better correlation coefficient as address these types of drawbacks.

**4. Improved to Correlation Coefficients**

We have defined the strengthened correlation coefficient of FPSVNSs in the next subdivision based on the idea of correlation coefficient of FPSVNSs.

**4.1. Definition**

Let A and B be any two FPSVNSs in the universe of discussion X = { then the improved correlation coefficient between A and B is determined as follows:

M (A, B) = …..(3)

Where , , ,

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For any and i =1, 2, 3….n.

**Theorem 4.2**

 For any two FPSVNSs A and B in the universe of discourse X = {, the improved correlation coefficient M (A, B) satisfies the following attributes

1. M(A,B) = M(B,A);
2. ;
3. .

PROOF:

1. It is obvious and forthright.
2. Here ,,,,

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. Consequently, the following in equation delight

Accordingly, we have .

1. If M (A, B) = 1, then we get, =5. Since,,,

,, there are =1. And also since ,,,

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We get and. This implies, ,

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Accordingly,, , , ,

 for any , and i = 1,2,3,….n.

So A = B. ,

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Now in case that A= B, implies

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for any, and i = 1,2,3,….n.

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So we get M (A, B) = 1.

The improved correlation coefficient formula which is defined in (3) is correct and also satisfy the three properties in Theorem 3.1 when we use any constant in the following terms.

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When AB, consider the same example 2.12 we can get M (A, B) = 0.912 by refer Equation (3)

**Example 4.3.**

Give us two FPSVNSs in X, and . Then it is clear that equation (1) is determined. So we obtain M (A, B) = 0.912 by applying equation (3). It convention that the drawback of the correlation coefficient in [10] is appropriately by the improved correlation coefficient as exposed above. Therefore the variations in the elements are consider in the following, we create a weighted correlation coefficient between FPSVNSs. The weighted correlation coefficient between the FPSVNSs A and B will be decide by setting w i to be the weight for each element in X ( i = 1, 2, 3... n). and, then the weighted correlation coefficient between the FPSVNSs A and B

 ..(4)

If, then equation (4) reduces to equation (3). also satisfies the three terms in Theorem 3.1.

**Theorem 4.4**

 Let be the weight for each element in X (i=1,2,3,…n), and , then the weighted correlation coefficient between the FPSVNSs A and B which is implied by, defined by (4) also satisfies the following properties.

1. ;
2. ;
3. it is similar to prove the properties in Theorem 3.1.

**4.5**. **Decision making method using the improved correlation coefficient of FPSVNSs**.

 Making judgments when multiple qualities are present in a real-world scenario is referred to as a multiple criteria decision making (MCDM) problem. For instance, one might purchase an automobile by researching the features that are offered in terms of cost, fashion, safety, comfort, etc. The following FPSVNS represents the characteristic of an alternative Ai,(i =1,2,3,...m) on an attribute C j,(j=1,2,3....n) in the context of a multiple attribute decision-making issue with Feramatean pentapartitioned single valued neutrosophic information.

….. (5)

Where and

 , for

and i =1, 2, 3….m. To make it convenient, we are considering the following five functions in terms of a fermatean pentapartitioned single valued neutrosophic value (FPSVNV). Here the values of are usually derived from the evaluation of an alternative with respect to a criterion by the expert or decision maker. Therefore we got a fermatean pentapartitioned single valued neutrosophic decision matrix D =.

In the case of ideal alternative an ideal FPSVNV can be defined by

 in the decision making method.

 Hence the weight correlation coefficient between an alternative and the ideal alternative is given by, ..(6)

Where , , ,

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, for I = 1,2,….m and j = 1,2,…n

By using the above weighted correlation coefficient (i=1, 2…m), we can derive the ranking order of all alternatives and we can choose the best one among those.

1. **Interval Fermatean Pentapartitioned Neutrosophic sets (IFPNS)**

**Definition 5.1**

An IFPNS A in x is denoted by a truth membership function, a contradiction membership function, an ignorance membership function , an unknown membership function and a falsity membership function. For each point x in X, there are

 and

. Therefore an IFPNS a can be denote as

 x X}

 ={/ x X}

Next the sum of fulfil the condition,

. If the lower and upper ends of the interval values of in an IFPNS are equal then IFPNS reduces to the FPSVNS. Both IFPNS and FPSVNS are all the branches of Fermatean pentapartitioned neutrosophic sets (FPNS).

**Definition 5.2** The complement of an IFPNS A is denoted by and is authenticated as

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 for any x in X.

**Definition 5.3.** An IFPNS A is contained in the other IFPNS B, iff

For any x in X.

**Definition 5.4**

Two IFPNS A and B are equal i.e., A =B, iff and.

5.5. **Correlation coefficient between IFPNSs**. As a observation of the improved correlation coefficient of FPSVNSs, we have planned a correlation coefficient between IFPNS in this section.

**Definition 5.6.** The correlation coefficient between two IFPNS A and B in the universe of discourse

 is defined as follows:

N (A, B) = { …..(7)

Where , ,

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Here we introduce a weighted a correlation coefficient between IFPNSs A and B by consider the weight of the element (I = 1,2,…n) into an account for any and I = 1,2,…n.

 Let be the weight for each element (i=1, 2…n), and, then the weighted correlation coefficient between the IFPNSs A and B which is denoted by defined

In following equation (8).

…….(8)

If , then equation (8) becomes like to equation (7). When

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 in the IFPNS A and ,

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, in the IFPNS B for any in X

 and i =1,2,…..n, then the IFPNS A and B reduces to the FPSVNSs A and B respectively, and also the equation (7) and (8) reduce to equations (3) and (4). Both N (A, B) and also satisfies the three properties of theorem 3.1 and theorem 3.2.

**Theorem 5.7**. For any two IFPNSs A and B in the universe of discourse, the correlation coefficient N (A, B) satisfies the following properties

1. N(A,B) = N(B,A);
2. ;
3. .

It is similar to prove the properties in Theorem 3.1.

**Theorem 5.8**

 Let be the weight for each element and , then the weighted correlation coefficient between the IFPNSs A and B which is denoted by defined in equation (8) also satisfies the following properties.

1. ;
2. ;
3.

It is similar to prove the properties in Theorem 3.1.

**5.9. Decision making method using the improved correlation coefficient of IFPNSs.**

Here we consider a multiple decision making problem with interval Fermatean Pentapartieioned neutrosophic information, and the characteristic of an alternative on an attribute is represented by the following IFPNS.

Where and

for and I = 1,2,….m.

 For our convenient, let us consider the following five functions

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, in terms of a interval fermatean pentapartitioned neutrosophic value (IFPNV)

* Here the values of are usually derived from assesses of an alternative  in relation to a criterion by the wizard or decision maker. Hence we got an interval Fermatean pentapartitioned neutrosophic decision maker . Here an ideal IFPNV can be defined as

In the ideal alternative, Hence by applying equation (8) the weighted correlation coefficient between an alternative and the ideal alternative is given by,

 = …..(9)

Where , ,

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For i =1, 2…m and j = 1, 2, 3….n.

By using the above weighted correlation coefficient, we can derive the ranking order of all alternatives and we can select the best one among those.

1. **Illustrative example**

This part deals the example for the multiple attribute decision making problem with the given alternative concur to the convention assigned under fermatean pentapartitioned single valued neutrosophic environment and interval feramatean pentapartitioned neutrosophic environment.

**6.1. Decision making under feramatean pentapartitioned single valued neutrosophic environment**.

The example that will confer in this place is about high- phone between quality mobile all

applicable options established miscellaneous tests. The alternatives A1, A2, A3 individually designates the

 mobile1, mobile2, mobile3. The customer must conclude in accordance with the following four attributes that is to say (1) C1is the cost (2) C2is the average scope (3) C3 is the camcorder character (1) C4 is the looks. As mentioned in to this attributes we will conclude that the order of all alternatives and stabled this order

customer will select best choice individual. The weight vector of the above attributes is likely by

   . Here the opportunities search out be judged under the above five attributes apiece form of FPSVNSs.

In general the evaluation of an alternative Ai regarding an attribute C j , (i = 1,2,3; j = 1,2,3,4,5) Will be accomplished apiece inquiry of a rule expert. In specifically, while querying the opinion about an

alternative A1 in regard to an attribute C1, the likelihood he (or) she suggest that the statement true is 0.5

the report both true and false is 0.4, the assertion neither true nor false is 0.3 and the statement false is 0.2.

It maybe meant in neutrosophic documentation as d11=〈0.5, 0.4, 0.3, 0.2〉. Continuing this process for all three

alternate regarding four attributes we will catch the following fermatean pentapartitioned single

valued neutrosophic decision model.

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|  | [ | [ | [ | [ |
|  | [ | [ | [ | [ |

Next by using the proposed method we will obtain the most adorable alternative. We can get the values of the correlation coefficient by using equation (6).

,,

Hence the ranking order is . The alternative (Mobile 1) is the best choice between all the three alternatives.

**6.3. Decision making under interval Fermatean pentapartitioned nuetrosophic environment.**

Consider the similar model present the three obtainable alternatives are to be assessed under the same four attributes by the form of IFPNSs. In common the assessment of an alternative Ai

regarding an attribute  Cj (i=1,2,3;j=1,2,3,4) will be completed apiece fermatean pentapartitioned of a

 rule expert. Hence we catch the ensuing an interval fermatean pentapartitioned nuetrosophic

decision matrix M.

Then by using the proposed method we will obtain the most desirable alternative. We can catch the values of the correlation coefficient by using equation (9).

Hence ,,

Hence the ranking order is . The alternative (Mobile 2) is the best choice among all the three alternatives with regard to the given criteria under interval fermatean pentapartitioned neutrosophic environment.

**7. Conclusion**

Here we have defined the improved correlation coefficient of FPSVNSs, IFPNSs

and this appropriate for few samples when the correlation coefficient of FPSVNSs defined in

 [ ] is undefined (or) unmeaningful and likewise studied its properties. Decision making is a process

 that plays a vital role in real existence problems. The main process in decision making is

recognizing the problem (or) opportunity and determining to address it. Here we have discussed the decision making pattern utilizing the improved correlation coefficient of FPSVNSs, IFPNSs and in

specifically an explanatory example is likely in multiple attribute decision making problems which includes the various alternatives based on miscellaneous criteria. Hence our projected improved correlation

coefficient of FPSVNss, IFPNSs helps to label ultimate appropriate alternative to the customer

established the likely criteria.

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