**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 modifies in one value **anticipate** modify 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. Eventually we presuming (that) an example using 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 entail the degree of membership and degree of non-membership and  the interval range is [0,1]. IFS theory is widely applied with fields such as logic programming, problem-solving in decision-making, medical diagnostics, etc.

In 1995, Florentin Smarandache [11] developed the basic thought of a neutrosphic set, which imparts skill 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 to take part of vital role in many application

 fields. 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 placed 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. In this essay, part 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 part 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 part 4 with some basic definitions and a determined correlation coefficient. Furthermore, we have talked about a part of its characteristics and a strategy for making decisions applying an environment with an interval Fermatean pentapartitioned neutrosophic. In part 5, an illustration likewise -planned correlation method in decision-making with many criteria is provided. The paper is concluded in part 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 like that .

**Definition 2.2. [4]**

Let X be a set that is non-empty. 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 along with a falsity membership function like that x X, and whereupon X is discrete. R is act as

R =.

Definition 2.2. [15]

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

R = {< 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 set that is non-empty. The truth membership function TA (x), the contradiction membership function CA (x), an ignorance membership function KA(x), a unknown membership function along with a falsity membership function like that x X, and

 When X is discrete. A is expressed as

 A =.

**3.2 Definition**

The complement of a FPSVNS is stand for and is expressed as,

**3.3 Definition**

The union of two FPSVNS A and B is stand for and it is expressed as

**3.4 Definition;**

The intersection of two FPSVNS A and B and it is expressed as,

**3.5 Definition:**

Let X be a space that contains 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 every point x in X,

 and

. Thus, an INS A can be described as

 x X}

 ={

Then the conditions can be met by the sum of. . Generally, an INS reduces to the SVNS when the interval values of TA (x), IA (x), and FA (x) are equal upper and lower ends. However, all the positions of neutrosophic sets are SVNSs and INSs.

**3.6. Definition**

The complement of an INS A is stand for and it is expressed as

, and for any x in X.

**3.7. Definition**

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

**3.8. Definition**

If AB and B then two INSs A and B are equal, which is written as A = B

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

Rajashi Chatterjee [4] proposed the concept of correlation coefficient of QSVNSs based on the correlation coefficient of SVNSs, as indicated below:

K (A, B) =

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

The correlation coefficient K (A, B) meets the conditions listed below

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

Equation (1) will have some disadvantages, as described below.

 In the case of two QSVNSs A and B, if and /or

 at all in X (i=1,2,3,…n).

Equation (1) is either undefined or not important. The formula given is not applicable here which is given in

Equation (1). Equation (1) only meets the necessary condition of the property (3)., but not a condition that is sufficient. That is AB. Equation (1) can be equal to 1.

**3.9. Example**

Let’s consider A and B as QSVNSs in X which are chosen by and

 . Here seemingly, AB.

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

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

**4. Improved to Correlation Coefficients**

The strengthened correlation coefficient of FPSVNSs has been defined in the next subsection using the correlation coefficient of FPSVNSs.

**4.1. Definition**

To determine the improved correlation coefficient between A and B, let us assume they are two FPSVNSs in the universe of discussion. X = {

M (A, B) = …..(3)

Where , , ,

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For any and i =1, 2, 3….n.

**Theorem 4.2**

The improved correlation coefficient M (A, B) meets the conditions listed below for any two FPSVNSs A and B in the universe of discourse X = {,

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

PROOF:

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

,,,,

. Consequently, the following in equation delight

 Therefore, we have .

1. If M (A, B) = 1, next we obtain, =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 obtain M (A, B) = 1.

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

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 ,

When AB, let’s consider the same example 2.12. we can obtain M (A, B) = 0.912 by referring 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.

As a result, we generate a weighted correlation coefficient between FPSVNSs and take into account the differences in the elements. By choosing w i to be the weight for each element in X (i = 1, 2, 3... n), the weighted correlation coefficient between the FPSVNSs A and B will be determined. Next, the weighted correlation coefficient between the FPSVNSs A and B is calculated using the parameters &.

 ..(4)

If, Equation (4) becomes equation (3) at that point. The three terms in Theorem 3.1 are also satisfied by .

**Theorem 4.4**

The weighted correlation coefficient between the FPSVNSs A and B, implied by , is expressed by (4) and fits the requirements mentioned below. Let be the weight for each element in X (i=1,2,3,…n), and .

1. ;
2. ;
3. . Theorem 3.1's attributes can be demonstrated similarly.

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

A multiple criteria decision making (MCDM) difficulty is when making decisions in a situation where numerous attributes are present. For instance, one can examine the characteristics that are available in terms of price, style, safety, comfort, etc. before buying a vehicle. In the context of a multiple attribute decision-making problem with Feramatean pentapartitioned single valued neutrosophic information, the following FPSVNS depicts the characteristic of an alternative Ai, (i =1,2,3,...m) on an attribute C j, (j=1,2,3....n).

 ….. (5)

Where and

 , for

and i =1, 2, 3….m.

In order to make things simple, we will discuss the following five functions in terms of a fermatean pentapartitioned single valued neutrosophic value (FPSVNV): . Here, the expert or decision maker will typically determine the values of by evaluating an alternative, in relation to a criterion,. Due to this, we were given the fermatean pentapartitioned single valued neutrosophic decision matrix

 D =.

An ideal FPSVNV can be described by dj in the case of ideal alternative A\*.In the decision-making process,

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In the case of ideal alternative an ideal FPSVNV can be expressed 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 represented 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

. Consequently, an IFPNS can be defined as

 x X}

 ={/ x X}

Next the sum of fulfill the requirements,

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IFPNS decreases to FPSVNS if the lower and higher interval values of are equal. The branches of Fermatean pentapartitioned neutrosophic sets (FPNS) are IFPNS and FPSVNS.

**Definition 5.2** The complement of an IFPNS A is certified as and stands for

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 for any x in X.

**Definition 5.3.** The other IFPNS B contains an IFPNS A, iff.

for every x in X.

**Definition 5.4**

If and, then two IFPNS A and B are equivalent, or A = B**.**

5.5. **Correlation coefficient between IFPNSs**. In this section, we have designed a correlation coefficient between IFPNS as an observation of the improved correlation coefficient of FPSVNSs.

**Definition 5.6.** In the universe of discourse, the correlation coefficient between two IFPNS A and B is written as follows:

N (A, B) = { …..(7)

Where , ,

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Here, we propose a weighted correlation coefficient between IFPNSs A and B by taking the weight of the element

 ( i = 1,2,…n) into consideration for each and i = 1,2,…n.

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

The IFPNS A and B then become the FPSVNSs A and B, respectively, and equations (7) and (8) become equations (3) and (4) when i = 1, 2... n. In addition, N (A, B) and both meet the three requirements of theorems 3.1 and 3.2.

**Theorem 5.7**. The correlation coefficient N (A, B) for any two IFPNSs A and B in the discourse universe

, fits the requirements given below.

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

 Theorem 3.1's attributes can be demonstrated in a similar way.

**Theorem 5.8**

Let w\_i be the weight for each element of x\_i (i=1,2..n), w\_i [0,1] and \_(i=1)nw\_i =1, then the weighted correlation coefficient between the IFPNSs A and B, which is denoted by N\_w (A,B), and is stated in equation (8), also satisfies the requirements listed below.

 Let be the weight for each element and , then the weighted correlation coefficient between the IFPNSs A and B which is stand for and it is stated in equation (8) also satisfies the requirements listed below.

1. ;
2. ;
3.

Theorem 3.1's attributes can be demonstrated in a similar way

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

In this case, the characteristic of an option on an attribute on a multiple choice making issue with interval Fermatean pentapartieioned neutrosophic information is represented by the following IFPNS.

Where and

for and I = 1,2,….m.

 Let's examine the following five functions for the sake of convenience.

, ,

 , ,

, based on an interval fermatean pentapartitioned neutrosophic value (IFPNV)

The decision maker or wizard in this case normally determines the values of by evaluating an alternative in light of a criterion As a result, is an interval Fermatean pentapartitioned neutrosophic decision maker. Here, an ideal IFPNV is one that:

The weighted correlation coefficient between an alternative and the ideal alternative A\* is therefore provided by applying equation (8).

 = …..(9)

Where , ,

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For i =1, 2…m and j = 1, 2, 3….n.

The ranking order of all options can be determined using the weighted correlation coefficient

 and then the best option can be chosen.

1. **Illustrative example**

In this section, a multiple attribute decision-making dilemma is illustrated using an alternative that complies with the rules set forth in the fermatean pentapartitioned single valued neutrosophic environment and the interval fermatean pentapartitioned neutrosophic environment.

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

The high-phone example that will be discussed in this location is about quality mobile devices with all applicable options set up various testing. The mobile1, mobile2, and mobile3 are each independently designated by the options A1, A2, A3 . The customer must reach a decision based on the following four criteria, specifically: (1) C1 is the cost; (2) C2 is the average scope. (1) C4 is the looks, (3) C3 is the character of the camera. According to the characteristics described in this sentence, we will draw the conclusion that the client will choose the best candidate according to the stabled order of all choices. The weight vector for the aforementioned characteristics is probably given by  . Here, the chances for evaluation will be evaluated in accordance with the five FPSVNS qualities listed above.

A rule expert will often evaluate an alternative Ai in relation to an attribute C j , (i = 1,2,3; j = 1,2,3,4,5) for each question. To be more exact, when asking someone their opinion on an alternative A1 in relation to an attribute C1, the likelihood that they will say the proposition is true is 0.5, that they will say it is both true and false is 0.4, that they will say it is neither true nor false is 0.3, and that they will say it is false is 0.2.

It may have been intended to read d11=〈0.5, 0.4, 0.3, 0.2〉 in the neutrosophic documentation. The following fermatean pentapartitioned single valued neutrosophic decision model will be obtained by repeating this approach for all three alternate about four characteristics.

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| --- | --- | --- | --- | --- |
|  / |  |  |  |  |
|  | [ | [ | [ | [ |
|  | [ | [ | [ | [ |
|  | [ | [ | [ | [ |

Next, we will get the cutest alternative by applying the suggested strategy. Equation (6) can be used to determine the correlation coefficient.

,,

As a result, the ranking is . The most advantageous option out of the three is alternative (Mobile 1).

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

Consider the current similar model, where the four qualities are to be evaluated using IFPNSs to rank the three attainable options. Each fermatean pentapartitioned of a rule expert will complete the assessment of an alternative Ai regarding an attribute Cj (i=1,2,3;j=1,2,3,4) . The resulting interval fermatean pentapartitioned nuetrosophic decision matrix M is thus captured.

The best option will then be obtained by applying the suggested procedure. Equation (9) allows us to obtain the values of the correlation coefficient .

Hence ,, As a result, the ranking is . With accordance to the specified requirements in an environment with interval fermatean pentapartitioning, alternative (Mobile 2) is the best option out of the three.

1. **Conclusion**

When the correlation coefficient of FPSVNSs defined in [] is unclear or meaningless, we have defined the improved correlation coefficient of FPSVNSs, or IFPNSs, and we have also researched its features. Making decisions is a process that is essential to solving challenges in everyday life. Identifying the issue (or opportunity) and making the decision to take action are the major steps in the decision-making process. Specifically, an instructive example is likely in multiple attribute choice making problems that contains the many alternatives based on various criteria. In this article, we explored the decision making pattern using the increased correlation coefficient of FPSVNSs and IFPNSs. Therefore, our anticipated increased correlation coefficient of FPSVNss and IFPNSs aids in labeling the most appropriate alternative to the client and likely.

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