**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 coefficients is one of the measurable degree which makes a difference to find the degree of changes to the esteem anticipate alter to the esteem of another. Fermatean Pentapartitioned single valued neutrosophic sets is an act of spontaneity of wang’s single valued neutrosophic sets. In this paper we have examined the Improved Correlation

Coefficients of Fermatean Pentapartitioned single valued neutrosophic sets and interval

Fermatean Pentapartitioned neutrosophic sets and explore its properties. Encourage we have connected this concept in numerous property decision making strategies with Fermatean Pentapartitioned single valued neutrosophic environment and interval Fermatean single valued neutrosophic environment. At last we outlined an case within the over proposed strategy to the numerous property choice making issues.
**Keywords:** Fermatean Pentapartitioned single valued neutrosophic sets, Interval Fermatean Pentapartitioned neutrosophic sets, improved correlation coefficient.

**Introduction:** Fuzzy sets were introduced by Zadeh [21] in 1965 which permits the membership

function valued within the interval [0, 1] additionally it is an expansion of classical set theory. As an expansion of Zadhe’s fuzzy set hypothesis intuitionistic fuzzy set(IFS) was presented by

Atanassov [1] in 1986,which comprises of degree of membership and degree of non-membership and lies within the interim of [0,1]. Uncertainties hypothesis wirely utilized within the areas of rationale programming, decision making problems, medical diagnosis etc.
 Florentin Smarandache [11] present the concept of Neutrosphic set in 1995 which gives the information of impartial thought by presenting the modern figure called indeterminacy within the set. Subsequently neutrosophic set was surrounded and it incorporates the components of truth membership function (T), indeterminacy membership function (I), and falsity membership function (F) separately. Neutrosophic sets deals with non standard interim [0,1]. Since neutrosophic set deal the

Indeterminacy successfully it plays an crucial part in numerous application areas

incorporate data innovation, decision bolster framework, social databse frameworks, medical diagonosis, multicriteria decision making problems etc. Wang[12](2010) presented the concept
of single valued nuetrosophic sets (SVNS) which is additionally known as an expansion of intuitionistic fuzzy sets and it got to be a really unused hot inquire about point presently. Rajashi Chatterjee.,et al [10] proposed the concept of Fermatean Pentapartitioned single valued neutrosophic sets which is based on Belnap’s four rationale and Smarandache’s four numerical esteemed rationale. In (FPSVNS) indeterminacy is splitted into two capacities known as ‘Contradiction’ (both true and wrong) and ‘unknown’ (not one or the other genuine nor untrue) so that (FPSVNS) has five components TA , CA , KA , UA , FA which too lies within the non standard unit interim [0,1]. Correlation coefficient is an
compelling scientific instrument to degree the quality of the relationship between two variables. In 1999 D.A Chiang and N.P. Lin [3] proposed the correlation of fuzzy sets

beneath fuzzy environment. Correlation coefficients plays an critical part in numerous

genuine world issues like numerous quality bunch decision making, clustering examination,

 design acknowledgment, therapeutic conclusion etc., Jun Ye [20] characterized the improved

correlation coefficients of single valued neutrosophic sets and interval nuetrosophic sets for multiple quality choice making to overcome the downsides of the correlation of single valued neutrosophic sets (SVNSs) which is characterized in [16].
In this paper Area 2 gives a few fundamental definitions of Quadripartitioned single esteemed neutrosophic sets and Fermatean Pentapartitioned nuetrosophic sets and its complement, union, intersection, interim neutrosophic sets, correlation coefficient of FPSVNS. In Area 3, we presented the concept of improved correlation coefficient of FPSVNS to overcome the disadvantages of correlation coefficient which is characterized conjointly talked about a few of its properties and decision making strategy utilizing the improved correlation coefficient of FPSVNSs. In Segment 4, we presented the concept of interval Fermatean Pentapartitioned Neutrosophic sets (IFPNS) with a few essential definitions and characterized correlation

 Coefficient of IFPNS. Encourage we have too talked about a few of its properties and choice making strategy utilizing the made strides relationship coefficient with interim Fermatean Pentapartitionedapportioned neutrosophic environment. Area 5 an illustrative illustration is given in over proposed relationship strategy especially in multiple criteria choice making problems. Section 6 concludes the paper.

**2. Preliminaries:**

**2.1 Quadripartitioned single valued neutrosophic sets:**

**Definition 2.1. [5]**

Neutrosophic set is characterized over the non-standard unit interval

[0 , 1] though single valued neutrosophic set is characterized over standard unit interval [0,1]. It implies a single valued neutrosophic set A is characterized by

 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 , and each element in X by a truth membership function denoted by , a contradiction membership function is denoted by , an ignorance membership function is denoted by and a falsity membership function denoted by such that x X, and

When X is discrete. Then A can be written as A = .

**Definition 2.2. [15]**

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

A = {< x, TA , CA , KA , UA , FA ,) >: x X } then (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. A Fermatean pentapartitioned 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 KA(x), a unknown membership function and a falsity membership function such that x X, and

When X is discrete, then A is can be written as

A =.

**3.2 Definition**

The complement of a FPSVNS is denoted by and it can be written as

**3.3 Definition**

The union of two FPSVNS A and B is denoted by and it can be written as

**3.4 Definition;**

The intersection of two FPSVNS A and B and it can be written as

**3.5 Definition:**

Let X be a space of points (object) with generic elements in X denoted by x. An INS interval neutrosophic set A in X is characterized by a truth membership function, an indeterminacy membership function, and a falsity function For each point x in X, there are,

 and

. Thus, an INS A can be expressed as

 x X}

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Then the sum of satisfies the condition.

. Obviously, when the upper and lower ends of the interval values of in an INS are equal, the INS reduce to the SVNS. However, SVNSs and INSs are all the subclasses of neutrosophic sets.

**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).

Condition (1) is indistinct or unmeaningful. In this case it isn't conceivable to utilize the

equation which is given in Condition (1). Condition (1) fulfills as it were the essential
condition of the property (3), but not the sufficient condition. That's A≠B. Condition (1) may be break even with to 1.

**3.9. Example**

Let A and B be QSVNSs in X which are given by and

 . Here obviously AB. Then

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

Thus in this case it isn't conceivable to apply in genuine life illustration issues. To overcome these sort of impediments we should characterize an improved correlation coefficient within the taking after area.

**4. Improved Correlation coefficients**

Based on the concept or correlation coefficient of FPSVNSs, we have characterized

the improved correlation coefficient of FPSVNSs within the taking after subsection.

**4.1. Definition**

Let A and B be any two FPSVNSs in the universe of discourse X = {

then the improved correlation coefficient between A and B is defined 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 within the universe of talk X = {x\_1,x\_(2 ,)…..x\_n}, the improved correlation coefficient M (A, B) fulfills the following properties.

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

PROOF:

It is obvious ad straight forward.

Here ,,,,

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. Therefore the following inequation satisfies

Hence we have .

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

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

We get and. This implies, ,

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Hence,, , , ,

 for any , and i = 1,2,3,….n.

 Hence A = B. ,

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Now assume that A=B , implies , , , , for any , and i = 1,2,3,….n.

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

The improved correlation coefficient equation which is characterized in (3) is adjust conjointly fulfill the three properties in Theorem 3.1 when we utilize any constant λ>3 within the taking after expressions.

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When A≠B, consider the same example 2.12 ready to get M (A, B) = 0.912 when we applying Condition (3).

**Example 4.3.**

Let A={〈x,0,0,0,0,0〉} and B={〈x,0.6,0.5,0.4,0.3,0.2〉} be two FPSVNSs in X. At that

point clearly equation (1) is indistinct. Hence by using equation (3) we get M (A, B) = 0.912. It appears that the over characterized improved correlation coefficient overcome the drawback of the correlation coefficient in [10] after that, we characterize a weighted correlation coefficient between FPSVNSs since the contrasts within the components are considered into an account.
Let be the weight for each element in X (i=1, 2, 3, …. n), and , then the weight correlation coefficient between the FPSVNSs A and B

 ..(4)

If , in this point the condition (4) reduced to equation (3).

Mw (A,B) satisfies the three properties in Theorem 3.1.

**Theorem 4.4**Let be the weight for each element in X (i=1,2,3,…n), and , then the weight correlation coefficient between the FPSVNSs A and B which is denoted 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.**

Different criteria decision making (MCDM) issues alludes to create decisions when a few properties are included in genuine – life issue. For case one may purchase a car by analyzing the traits which is given in terms of cost, fashion, security, consolation etc.
Here we consider a numerous property decision making issue with Feramatean pentapartitioned single valued neutrosophic data, and the characteristic of an elective Ai,(i=1,2,3,…m) on an attribute Cj,(j=1,2,3….n) is spoken to by the taking after FPSVNS.

….. (5)

Where and

 , for and i =1, 2, 3….m.

For our convenient, let us consider 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. Therefore the weight correlation coefficient between an alternative and the ideal alternative is becomes

 ..(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 get the ranking order of all alternatives and we can select the best one among those.

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

**Definition 5.1**

An IFPNS A in x is consider a truth membership function, an 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}

Then the sum of satisfies the following 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 subclasses of Fermatean pentapartitioned neutrosophic sets (FPNS).

**Definition 5.2** The complement of an IFPNS A is denoted by and is defined 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.**

Herewe proposed a correlation coefficient between IFPNS as a generalization of the improved correlation coefficient of FPSVNSs.

**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 take 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 as the equation (8).

…….(8)

If , then equation (8) becomes the equation (7). When

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 in the IFPNS A and , , ,

, 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. .

Similarly 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.**

Let us consider a multiple attribute decision making problem with interval Fermatean Pentapartieioned neutrosophic information, and the characteristic of an alternative on an attribute is written as 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)

Now 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 can get an interval Fermatean pentapartitioned neutrosophic decision maker . Here IFPNV can be write it as

In the ideal alternative, so the equation (8) the weighted correlation coefficient between an alternative and the ideal alternative becomes

 = …..(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 find the ranking order of all alternatives and we can select the best one among those.

**6. Illustrative example**

In this section we can see the example for the multiple attribute decision making problem with the given alternative corresponds to the criteria allotted 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 which will discussing about the best mobile phone among all available alternatives based on various criteria. The alternatives are denoted by the mobile1, mobile2, mobile3. The customer must take a decision according to the following four attributes that is (1) is the cost (2) is the average space (3) is the camera quality (1) is the looks. According to this attributes we will derive the ranking order of all altenatives and based on this order and customer will select the best one.

 The weight vector of the above attributes is given by . In this alternatives it will be evaluated by the above five attributes by the form of FPSVNSs. In general the evaluation of an alternative with respect to an attribute

Will be done by the questionnaire of a domain expert. In particularly, while asking the opinion about an alternative with respect to an attribute , the possibility he (or) she say that the statement true is 0.5 the statement both true and false is 0.4, the statement neither true nor false is 0.3 and the statement false is 0.2. It can be denoted in the neutrosophic notation as. Continuing the same process for all the three alternatives with respect to four attributes we will get the following fermatean pentapartitioned single valued neutrosophic decision matrix.

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

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

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

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

Consider the same example here for the three possible alternatives are to be evaluated by the above four attributes by the form of IFPNSs. In general the evaluation of an alternative with respect to an attribute (i=1,2,3;j=1,2,3,4) will be done by the fermatean pentapartitioned of a domain expert. Hence we get the following interval fermatean pentapartitioned nuetrosophic decision matrix R.

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

Therefore ,,

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

**7 conclusion**

Here we have defined the improved correlation coefficient of FPSVNSs, IFPNSs and this is applicable for some cases when the correlation coefficient of FPSVNSs defined in [ ] is undefined (or) unmeaningful and also studied its properties. Decision making is a process which plays a vital role in real life problems. The main process in decision making is recognizing the problem (or) opportunity and deciding to address it. Here we have discussed the decision making method using the improved correlation coefficient of FPSVNSs, IFPNSs and in particularly an illustrative example is given in multiple attribute decision making problems which involves the several alternatives based on various criteria. Hence our proposed improved correlation coefficient of FPSVNss, IFPNSs helps to identify the most suitable alternative to the customer based on the given criteria.

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