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On Pythagorean Vague Distance Measure Using Python

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Abstract : *The focus of our article is to a new concept of Pythagorean vague sets and to examine about the vague distance measures using python. In this paper, the main features of Pythagorean vague set is to characterized the relationship between these measures vizualise Manhattan distance, Normalized Manhattan distance and Minkowski distance for Pythagorean vague set using python.*

Keywords : *Pythagorean vague sets , distance measures , relationship between distance measures for PVS using python.*

1. INTRODUCTION:

The Theory of fuzzy set proposed by Zudeh in 1965 has achieved a great success in various field due to its potentiality in handling uncertainly. Fuzzy set is a characterized by a membership function,μ which taken value from crisp set to a unit interval I=[0,1].In 1986,Atanassor proposed the concept of Intuitionistic Fuzzy Sets(IFSs).The main advantage of IFS is to cope with the hesitancy that may exist due to imprecise information. This is achieved by incorportating a second function called a non-membership function v, along with membership function, μ of the conventional fuzzy set. A lot of attention towards the introduction and fundamentals of IFS have been paid on developing distance and similarity measures between IFS, as they apply them to solving many problems of decision making, pattern recognition, among others. As a result, several measures were proposed, each one presenting specific properties of similarity measures. The theory of vague set was introduced by the Gau and Buehrer , as an extension of fuzzy set theory and vague sets are regarded as a special care of context-dependent fuzzy sets.
The vague set is defined by a idea of true membership (t_u) and false membership (f_u). The value of $t_u(x)$ and $f_u(x)$ are defined by closed interval [0,1] with each point in a base set x , where $t_u(x)+f_u(x)=1$.However the robust notion of IFS is there are cases where $\mu+v\geq 1$ unlike the situation captured in IFSs where $\mu+v\leq 1$ only. This limitation in IFS construct the motivation for the introduction of Pythagorean fuzzy set.

In 2013 Yagar proposed the model of Pythagorean fuzzy sets (PFS) is a new arm to ded with vagueness considering the membership grad (μ) and non-membership grade (v) satisfying the condition $\mu+v\geq 1$. The concept of PFSs can be used to characterized certain information more sufficiently and accurately than IFS. After that, yagar and Abbasor presented the concept of Pythagorean grades and conception related to PFS and also introduced the relationship between the Pythagorean membership grades and complex numbers.

Yagar initiated Pythagoras membership grades operations for Pythagorean Fuzzy numbers. The purpose of this paper is to introduce the concept of Pythagorean Vague sets and obtain some of the Pythagorean vague properties and similarity measures, also obtain the measuring distance for Pythagorean vague set using Python. Python has features like analyzing data. In 1989,python has been created by Guido and Rossum . Finally , provided to illustrate the various measures in Pythagorean vague sets and python programming language.

2. PRELIMINARIES:

Definition-1:
A Vague set V on the universe of discourse as $A = \{ < x, t_A(x), 1-f_A(x)> | x \in X\}$ is characterized by a true membership function $t_u(x)$ and false membership function $f_u(x)$ as follows t_u: U->[0,1], f_u: U->[0,1] and $t_u + f_u \leq 1$.

Definition-2:
Let X and Y be vague sets of the form
$X= \{< x, t_X(x),1-f_X(x) >| x £ X\}$ and $Y= \{<x\, t_Y(x), 1-f_Y(x)>| x \in X\}$. Then
1. X ⊆= iff and only if $t_X(x) \leq t_Y(x)$ and $1 – f_X(x) \leq 1-f_Y(x)$
2. X=Y if and only if X ⊆ Y and Y ⊆ X.
3. $X^c= \{ < x, 1-f_X(x), t_X(x) >| x \in X\}$.
4. $X \cup Y= \{ < x, \max ((t_X(x), t_Y(x)), \max (1-f_X(x), 1-f_Y(x)) > | x £ X\}$.
5. $X \cap Y= \{ < x, \min ((t_X(x), t_Y(x)), \min (1-f_X(x), 1-f_Y(x)) > | x £ X\}$

3. PYTHAGOREAN VAGUE SET:

Definition-3:

Let A be the universe of discourse. A Pythagorean vague set (PVS), X in A is given by X= { < x, $t_X(x)$, 1-f_X (x) | x £ X } where $t_X(x)$: X ->[0,1] denotes the truth value and 1- $f_X(x)$: x -> [0,1] denotes the false value of the element x £ X to the set X , respectively, with the condition of $0 \leq t_X(x)$^2 + 1-$f_X(x)$^2 ≤ 1.

Definition-4:

Let A_{PV} and B_{PV} be two PVSs of the universe U. if ∀ (xi) ∈ U, t_{APV} (xi)= t_{BPV} (xi), 1-F_{APV}(xi)=1-f_{BPV}(xi),then the Pythagorean Vague Set A_{PV} and B_{PV} , are equal , where $1 \leq i \leq n$

4. DISTANCE FOR PYTHAGOREAN VAGUE SETS:

Definition -5:

Let A_{PV} = { < x; t_{APV} (x) , 1-f_{APV} (x) > ; x £ X } and B_{PV} = { < x ;t_{BPV} (x) , 1-f_{BPV} (x) > ; x £ X } Pythagorean vague sets in X.

- **MANHATTAN DISTANCE :**

M (A_{PV},B_{PV}) =

$$\sum_{i=1}^{n} |tAPV(xi) - tBPV(xi)| + \left|\left(1 - fAPV(xi)\right) - \left(1 - fBPV(xi)\right)\right| + |\pi APV(xi) - \pi BPV(xi)|$$

- **NORMALIZED MANHATTAN DISTANCE :**

NM (A_{PV} , B_{PV}) =

$$\sum_{i=1}^{n} |tAPV(xi) - tBPV(xi)| + \left|\left(1 - fAPV(xi)\right) - \left(1 - fBPV(xi)\right)\right| + |\pi APV(xi) - \pi BPV(xi)|$$

- **MINKOWSKI DISTANCE :**

K (A_{PV} ,B_{PV}) =

$$\sum_{i=1}^{n} |tAPV(xi) - tBPV(xi)|^{P} + \left|\left(1 - fAPV(xi)\right) - \left(1 - fBPV(xi)\right)\right|^{P} + |\pi APV(xi) - \pi BPV(xi)|^{P}$$

- **NORMALIZED MINKOWSKI DISTANCE :**

N_k (A_{PV},B_{PV}) =

$$\sum \frac{1}{n} \{ \, | \, tApv(xi) - tBpv(xi)|^{p} + |(1 - fApv(xi - (1 - fBpv(xi))|^{p} + |\pi Apv(xi) - \pi Bpv(xi)|^{p} \}$$

- **EUCLIDEAN DISTANCE :**

E_{PV} (A_{PV}, B_{PV}) =

$$\sqrt{\sum_{i=1}^{n} (tAPV(xi) - tBPV(xi))^2 + ([1 - fAPV(xi)] - [1 - fBPV(xi)])^2 + (\pi APV(xi) - \pi BPV(xi))^2}$$

Where

$\pi APV(xi) = 1 - tAPV(xi) - \left(1 - fAPV(xi)\right)$; $\pi BPV(xi) - (1 - tBPV(xi) - (1 - fBPV(xi))$be the degree of indeterminancy of x in X and Y.

- **NORMALIZED EUCLIDEAN DISTANCE :**

N E_{pv} (A_{PV}, B_{PV}) =

$$\sqrt{\frac{1}{n}\sum_{i=1}^{n} (tAPV(xi) - tBPV(xi))^2 + ([1 - fAPV(xi)] - [1 - fBPV(xi)])^2 + (\pi APV(xi) - \pi BPV(xi))^2}$$

Distance Measure satisfies the following conditions

$0 \leq M(A_{PV}, B_{PV}) \leq 2n$

$0 \leq NM(A_{PV}, B_{PV}) \leq 2$

$0 \leq K(A_{PV}, B_{PV}) \leq (2n)^{\frac{1}{p}}$

$0 \leq NK(A_{PV}, B_{PV}) \leq 2^{\frac{1}{p}}$

$0 \leq E_{PV}(A_{PV}, B_{PV}) \leq \sqrt{2}n$

$0 \leq NE_{PV}(A_{PV}, B_{PV}) \leq \sqrt{2}$

EXAMPLE :

Let A = { 1,2 } and let X and Y are the Pythagorean vague set in A defined by X = { < x , (0.5,0.7),(0.3,0.5)>} Y = { < x ,(0.5,0.3),(0.4,0.2)>}

- **MANHATTAN DISTANCE**

M (Apv , Bpv) =

$$\sum_{i=}^{n} |tAPV(xi) - tBPV(xi)| + |(1 - fAPV(xi)) - (1 - fBPV(xi))| + \pi APV(xi) - \pi BPV(xi)$$

= 0.6

- **NORMALIZED MANHATTAN DISTANCE :**

NM (Apv , Bpv) =

$$\sum_{i=1}^{n} |tAPV(xi) - tBPV(xi)| + |(1 - fAPV(xi) - (1 - fBPV(xi))| + |\pi APV(xi) - \pi BPV(xi)|$$

= 0.2

- **MINKOWSKI DISTANCE :**

K (Apv , Bpv) =

$$\sum_{i=1}^{n} [|tApv(xi) - tBpv(xi)|^p [+|1 - fpv(xi) - (1 - fpv(xi))|^p + |\pi Apv(xi) - \pi Bpv(xi)|^p]$$

=0.2

- **NORMALIZED MINKOWSKI DISTANCE :**

N k (Apv , Bpv) =

$$\sum_{n}^{1} \{|tApv(xi) - tBpv(xi)|^p + |(1 - fApv(xi)) - (1 - fBpv(xi))|^p + |\pi Apv(xi) - \pi Bpv(xi)^p\}^{\frac{1}{p}}$$

=0.6

- **EUCLIDEAN DISTANCE :**

$E_{PV}(A_{PV}, B_{PV}) =$

$$\sqrt{\sum_{i=1}^{n} (tAPV(xi) - tBPV(xi))^2 + ([1 - fAPV(xi)] - [1 - fBPV(xi)])^2 + (\pi APV(xi) - \pi BPV(xi))^2}$$

=0.27

- **NORMALIZED EUCLIDEAN DISTANCE :**

$N E_{pv}(A_{PV}, B_{PV}) =$

$$\sqrt{\frac{1}{n}\sum_{i=1}^{n} (tAPV(xi) - tBPV(xi))^2 + ([1 - fAPV(xi)] - [1 - fBPV(xi)])^2 + (\pi APV(xi) - \pi BPV(xi))^2}$$

=0.17

Distance in Pythagorean vague sets should be calculated by taking truth membership, Indeterminancy membership and false membership function and it also satisfies the following conditions.

$0 \leq 0.6 \leq 4$
$0 \leq 0.2 \leq 2$
$0 \leq 0.2 \leq 4$
$0 \leq 0.6 \leq 2$
$0 \leq 0.27 \leq 4$
$0 \leq 0.17 \leq \sqrt{2}$

5. DISTANCE FOR PYTHAGOREAN VAGUE SETS USING PYTHON:

5.1 .Manhattan Distance:

Here we use the Manhattan Distance formula in the python software and get the solution as follows

Output of Manhattan distance has been verified

5.2. Normalized Manhattan Distance:

Here we use the Normalized Manhattan Distance formula in the python software and get the solution as follows

```
*mannewe.py - C:\Python34\mannewe.py (3.4.4)*
File Edit Format Run Options Window Help
# Python3 code to find sum of
# Normalized Manhattan distance between all
# the pairs of given points
# Return the sum of distance
# between all the pair of points.
def distancesum (x, y, n):
    sum = 0
        for i in range(n):
        for j in range(i+1,n):
        sum += (1/n)*(abs(x[i] - x[j]) +
                 abs(y[i] - y[j]))
         return sum
```

Figure1

Output of Normalized Manhatttan distance has been verified

5.3. Minkowski Distance:

Here we use the Minkowski Distance formula in the python software and get the solution as follows

```
*mink.py - C:/Python34/mink.py (3.4.4)*
File Edit Format Run Options Window Help
# Python3 code to find sum of
# Minkowski distance between all
# the pairs of given points

# Return the sum of distance
# between all the pair of points.
def distancesum (x, y, n):
        sum = 0

        # for each point, finding distance
        # to rest of the point
        for i in range(n):
                for j in range(i+1,n):
                        sum += ((abs(x[i] - x[j])**4 +
                                                abs(y[i] - y[j]))**4)**0.25

        return sum
```

Figure 2

Output of Minkowski distance has been verified

5.4. Normalized Minkowski Distance:

Here we use the Normalized Minkowski Distance formula in the python software and get the solution as follows

```
*mink.py - C:\Python34\mink.py (3.4.4)*
File Edit Format Run Options Window Help
# Python3 code to find sum of
# Normalized Minkowski distance between all
# the pairs of given points
# Return the sum of distance
# between all the pair of points.
def distancesum (x, y, n):
   sum = 0
      for i in range(n):
      for j in range(i+1,n):
        sum += (1/n)*(abs(x[i] - x[j])**4 +
          abs(y[i] - y[j]))**4)**0.25
          return sum
```

Figure 3

Output of Normalized Minkowski distance has been verified

5.5. Euclidean Distance:

Here we use the Normalized Euclidean Distance formula in the python software and get the solution as follows

```
euclideanm.py - C:\Python34\euclideanm.py (3.4.4)
File Edit Format Run Options Window Help
# Python3 code to find sum of
# Euclidean distance between all
# the pairs of given points

# Return the sum of distance
# between all the pair of points.
def distancesum (x, y, n):
        sum = 0

        # for each point, finding distance
        # to rest of the point
        for i in range(n):
                for j in range(i+1,n):
                        sum += ((abs(x[i] - x[j])**2 +
                                                abs(y[i] - y[j]))**2 )**0.5

        return sum
```

Figure 4

Output of Normalized Euclidean distance has been verified

5. 6. Normalized Euclidean Distance:

Here we use the Normalized Euclidean Distance formula in the python software and get the solution as follows

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euclideanm.py - C:\Python34\euclideanm.py (3.4.4)

File Edit Format Run Options Window Help

```
# Python3 code to find sum of
# Normalized Euclidean distance between all
# the pairs of given points
# Return the sum of distance
# between all the pair of points.
def distancesum (x, y, n):
 sum = 0
   for i in range(n):
   for j in range(i+1,n):
        sum += (1/n)*(abs(x[i] - x[j])**2 +
                    abs(y[i] - y[j]))**2 )**0.5
        return sum
```

Figure 5

Output of Normalized Euclidean Distance has verified.

6. RESULT AND DISCUSSION:

In 21st century, Technology plays a major role in every Human Being 's life . Likewise the fundamentals of technology are build through some codings or programming languages. Although Python is High Programming language. Python is free and simple to learn . its primary features are that it is high level, dynamically typed and interpreted. This makes debugging of errors easy and encourages the rapid development of application prototypes, marking itself as the language to code with. In this paper we use the Manhattan Distance and Normalized Manhattan Distance and Euclidean Distance and Normalized Euclidean Distance formula in the python software and get the solution as follows.

7. CONCLUSION :

In this paper we discuss about various distance measure in Pythagorean vague set and also it is verified by using examples. And also we compare Pythagorean vague set in Python an through this outcome we get python is increasingly viable and it is progressively compelling.

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