Neutrosophic Optimization and Intelligent Systems

SCIENCES FORCE
International Academic Publisher

Journal Homepage: sciencesforce.com/nois

Neutrosophic Opt. Int. Syst. Vol. 3 (2024) 23–31

Paper Type: Original Article

An Entropy Measure for n-Cylindrical Fuzzy Neutrosophic Sets

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Received: 07 Jan 2024 **Revised**: 06 Apr 2024 **Accepted**: 02 May 2024 **Published**: 05 May 2024

Abstract

n-Cylindrical fuzzy neutrosophic set (n-CyFNS) is a new variant of fuzzy neutrosophic sets. In this paper our aim is to introduce an entropy measure for n-CyFNS. Here we explained its properties along with examples. Two real life applications, one on better way of shopping and the second on teacher evaluation, based on this proposed entropy measure are also illustrated.

Keywords: Entropy, n-Cylindrical Fuzzy Neutrosophic Sets, n-Cylindrical Fuzzy Neutrosophic Entropy.

1 | Introduction

Everything is relative to something fuzzy. L.A. Zadeh [22, 23] invented fuzzy sets in 1965. Zadeh only covered the membership function while introducing the fuzzy set notion, which evolved as a new tool for managing uncertainty in real-world problems. As a result of the fuzzy set theory's extensions, Atanassov [7] generalized this idea and created the intuitionistic fuzzy set (IFS) in 1986. IFS is defined as the non-membership grade plus the membership grade of an ambiguous event, with the caveat that the total of the rejection and acceptance degree grades cannot be greater than 1. In certain practical problems, the total of the membership and non-membership degrees to which a decision maker (DM) delivers an adequate satisfactory quality, may be larger than one. IFS was unable to handle the contradictory and unclear information in the belief system. In 1998, F. Smarandache [10-12] embarked on the beginning of the Neutrosophic era –which is characterized by the membership functions for truth (T), indeterminacy (I), and falsity (F). Nowadays, Neutrosophic sets become an effective way to handle insufficient, unpredictable, and incompatible data that exist in this world. F. Smarandache introduced the dependence degree of (also, the independence degree of) the fuzzy components, as well as the neutrosophic components, for the first time. Many extensions of neutrosophic sets were also developed so far, in its journey of success. Recently, Sarannya et.al, [17, 18]defined, n-cylindrical fuzzy neutrosophic sets, which can be considered as one of the greatest extensions of fuzzy neutrosophic

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https://doi.org/10.61356/j.nois.2024.3220

sets, in which I is an independent variable. Here, the degree of positive, neutral, and negative membership functions satisfy the condition, $0 \le \beta_A(\mathbf{x}) \le 1$ and $0 \le \alpha_A{}^n(\mathbf{x}) + \gamma_A{}^n(\mathbf{x}) \le 1$, n>1, is an integer.

Entropy can be viewed as a gauge of the degree of uncertainty present in a set, regardless of how fuzzy, intuitionistic, ambiguous, etc. the set may be. Since the n-CyFNSs in this case can also handle uncertain data, it follows naturally that we are also interested in determining the entropy of an n-CyFNS.In 1965, Zadeh [23] made the first reference to entropy as a fuzziness metric. More recently, De Luca-Termini [4] axiomatized the entropy that is not probabilistic.

The concept of entropy has been studied by a few other writers. A measure of soft entropy based on distance was proposed by Kaufmann [6]; Yager [21] provided an alternative perspective on the degree of fuzziness of any fuzzy set, stating that it lacks differentiation from its complement. Kosko [14] looked at the fuzzy entropy in connection to a subset hood measure. The entropy of intuitionistic fuzzy sets was investigated by Szmidt & Kacprzyk [19]. The entropy of soft sets, etc., was studied by Majumdar and Samanta [15]. Numerous fields, including image processing and optimization, have made extensive use of fuzzy sets' entropy measure.

The rest of the paper is structured as follows: The preliminary section includes some basic definitions, findings, and examples. Later, in section 3, we presented an entropy measure and its characteristics for n-CyFNS. Two real-world scenarios where this entropy metric can be used are mentioned in section 4. The conclusion and potential directions for further research come next.

2 | Preliminaries

Throughout this paper [1-23], U denotes the universe of discourse.

Definition 2.1: [22, 23] A fuzzy set A in U is defined by membership function μ_A: A→ [0, 1] whose membership value μ_A (x) shows the degree to which x∈ U includes in the fuzzy set A, for all x∈ U.

Definition 2.2: [7] An intuitionistic fuzzy set A on U is an object of the form:

A = {(x, α_A (x), γ_A (x) | x ∈ U)} where α_A (x) ∈ [0,1] is called the degree of membership of x in A, γ_A (x) ∈ [0,1] is called the degree of non-membership of x in A, and where α_A and γ_A satisfy (∀x ∈ U) ($\alpha_A(x) + \gamma_A(x) \le 1$) IFS (U) denote the set of all the intuitionistic fuzzy sets (IFSs) on a universe U.

Let X and Y be ordinary non-empty sets.

Definition 2.3: [10, 11] A Neutrosophic set A on U is A = < x, $T_A(x)$, $I_A(x)$, $F_A(x)$ > ; x∈ U , where T_A, , I_A , F_A: A→ $]^-0,1^+[$ and $^-0 < T_A(x) + I_A(x) + F_A(x) < 3^+$

Definition 2.4: [5] A fuzzy Neutrosophic set A on U is A = < x, $T_A(x)$, $I_A(x)$, $F_A(x)$ > ; x∈ U, where T_A, , I_A , F_A: A→ [0,1] and $0 \le T_A(x) + I_A(x) + F_A(x) \le 3$

Definition 2.5: [10-12] A neutrosophic set A on U is an object of the form:

$A = \{(x, u_A(x), \zeta_A(x), v_A(x)): x \in U\}$, where $u_A(x), \zeta_A(x), v_A(x) \in [0,1]$, $0 \le u_A(x) + \zeta_A(x) + v_A(x) \le 3$, for all $x \in U$. $u_A(x)$ is the degree of truth membership, $\zeta_A(x)$ is the degree of indeterminacy, and $v_A(x)$ is the degree of non-membership. Here $u_A(x)$ *and* $v_A(x)$ are dependent components and $\zeta_A(x)$ is an independent component.

Definition 2.6: [17, 18] An n- n-cylindrical fuzzy neutrosophic set (n-CyFNS) A on U is an object of the form:

A= {⟨ x, $\alpha_A(x)$, $\beta_A(x)$, $\gamma_A(x)$⟩ | x ∈ U} where $\alpha_A(x) \in [0, 1]$, called the degree of **positive** membership of x in A, $\beta_A(x) \in [0,1]$, called the degree of **neutral** membership of x in A and $\gamma_A(x) \in [0, 1]$, called the degree of **negative** membership of x in A, which satisfies the condition, (∀x∈ U) ($0 \le \beta_A(\mathbf{x}) \le 1$ and $0 \le \alpha_A{}^n(\mathbf{x}) + \gamma_A{}^n(\mathbf{x}) \le 1$. , n>1, is an integer. Here T and F are dependent Neutrosophic components and I is 100 % independent.

For convenience,⟨ $\alpha_A(x)$, $\beta_A(x)$, $\gamma_A(x)$ ⟩ is called an n-Cylindrical fuzzy Neutrosophic Number (n-CyFNN) and is denoted as A= ⟨ α_A, β_A, γ_A ⟩ and Let **$\mathfrak{C}_N$ (Ʊ)** denote the family of all n- cylindrical fuzzy neutrosophic sets on Ʊ.

Definition 2.7: [17, 18] The height of an n- CyFNS, A is denoted as H (A) and is defined as

H (A) = max {$\beta_A(x)$ | x ∈ Ʊ}.

Thus the height of an element x ∈ Ʊ is h(x) and is equal to the degree of **neutral** membership of x in Ʊ.

Definition 2.8: [17, 18] The **peak of an element, x**∈A, where A={⟨ x, $\alpha_A(x)$, $\beta_A(x)$, $\gamma_A(x)$⟩ | x∈ Ʊ} is

$\wp_A$**(x)** =max {$\alpha_A(x)$, $\beta_A(x)$, $\gamma_A(x)$/ **x**∈A}

Now we define the Peak of an n- CyFNS set.

Definition 2.9: [17, 18] Let A={⟨ x, $\alpha_A(x)$, $\beta_A(x)$, $\gamma_A(x)$⟩ | x∈ Ʊ}, then peak of A is defined as $\wp(A)$ =max { $\wp_A$(x)/ **x**∈A}.

Definition 2.10: [17,18]

- **Inclusion** For every two A, B ∈ $\mathfrak{C}_N$ (Ʊ), A ⊆ B iff (∀x ∈ Ʊ, $\alpha_A(x) \leq \alpha_B(x)$ and $\beta_A(x) \leq \beta_B(x)$ and $\gamma_A(x) \geq \gamma_B(x)$) and A = B iff (A ⊆ B and B ⊆ A).
- **Union** For every two A, B ∈ $\mathfrak{C}_N$ (Ʊ), the union of two n-CyFNSs A and B is A⋃B(x) = {⟨ x, max ($\alpha_A(x)$, $\alpha_B(x)$), max ($\beta_A(x)$, $\beta_B(x)$), min ($\gamma_A(x)$, $\gamma_B(x)$) ⟩ |x ∈ Ʊ}.
- **Intersection** For every two A, B ∈ $\mathfrak{C}_N$ (Ʊ), the intersection of two n- CyFNSs A and B is A⋂B(x) = {⟨ x, min ($\alpha_A(x)$, $\alpha_B(x)$), min ($\beta_A(x)$, $\beta_B(x)$), max ($\gamma_A(x)$, $\gamma_B(x)$) ⟩ |x ∈ Ʊ}.
- **Complementation** For every A ∈ $\mathfrak{C}_N$ (Ʊ), the complement of an n-CyFNS A is A^c = {⟨ x, $\gamma_A(x)$, $\beta_A(x)$, $\alpha_A(x)$ ⟩ |x ∈ Ʊ}.

3 |n-Cylindrical Fuzzy Neutrosophic Entropy

Entropy as a measure of fuzziness was first proposed by Zadeh [23]. Later many mathematicians defined several entropy measures. In this section, we focus on defining an entropy measure for n-CyFNSs that connects the degree of membership, non-membership, and neutral membership. As an example, we have applied the proposed entropy measure in the field of shopping and evaluation criteria of teacher educators.

Definition 3.1: Let A= ⟨ α_A, β_A, γ_A⟩ be an n-CyFNS in **Ʊ**. The new entropy measure for A denoted by $\mathcal{E}_{CyN}$(A), is a function, $\mathcal{E}_{CyN}$: **$\mathfrak{C}_N$ (Ʊ)⟶[0,1] and is defined as** $\mathcal{E}_{CyN}(A) = 1 - \frac{1}{n}\sum_{i=1}^{n}(\alpha_A - \gamma_A)^2\,(1 - \beta_A)$**; for every x_i** ∈A

Proposition 3.2: The entropy measure $\mathcal{E}_{CyN}$ satisfies the following properties

$\mathcal{E}_{CyN}$(A)=0 ⟺ A is a crisp set

$\mathcal{E}_{CyN}$(A)=1 ⟺ $\alpha_A(x_i) = \gamma_A(x_i)$ **or** $\beta_A = 1$ **for all i**

$\mathcal{E}_{CyN}(A) = \mathcal{E}_{CyN}(A^c)$

$\mathcal{E}_{CyN}(A) \leq \mathcal{E}_{CyN}(B)$, if A is less fuzzy than B or B is more uncertain than A

ie, if $(\alpha_A - \gamma_A)^2 \geq (\alpha_B - \gamma_B)^2$ and $\beta_A \leq \beta_B$

Proof:

$\mathcal{E}_{CyN}$(A)=0 $\Leftrightarrow$ A is a crisp set with β_A=0

$\Leftrightarrow \alpha_A$=1, γ_A=0 and β_A=0 or α_A=0, γ_A=1 and β_A=0

$\mathcal{E}_{CyN}$(A)=1 $\Leftrightarrow \alpha_A(\boldsymbol{x_i}) = \gamma_A(\boldsymbol{x_i})$ **or** β_A= 1 **for all i**

$\mathcal{E}_{CyN}$(A)=1

$\Leftrightarrow 1 - \frac{1}{n}\sum_{i=1}^{n}(\alpha_A - \gamma_A)^2\,(1 - \beta_A) \;\mathbf{= 1}$

$\Leftrightarrow \frac{1}{n}\sum_{i=1}^{n}(\alpha_A - \gamma_A)^2\,(1 - \beta_A) \;\mathbf{=0}$

$\Leftrightarrow \sum_{i=1}^{n}(\alpha_A - \gamma_A)^2\,(1 - \beta_A)$=0

$\Leftrightarrow (\alpha_A - \gamma_A)^2(1 - \beta_A)$=0

$\Leftrightarrow (\alpha_A - \gamma_A) = \mathbf{0}$ or $(1 - \beta_A)$=0 or both terms equal to 0

$\Leftrightarrow \alpha_A = \gamma_A$ or β_A= 1

$\Leftrightarrow \alpha_A(\boldsymbol{x_i}) = \gamma_A(\boldsymbol{x_i})$ **or** β_A= 1 **for all i**

$\mathcal{E}_{CyN}$(A) = $\mathcal{E}_{CyN}$(A^c)

From the definition of A^c, the result follows.

$\mathcal{E}_{CyN}$(A) $\leq \mathcal{E}_{CyN}$(B) ,

if A is less fuzzy than B or B is more uncertain than A

ie, if $(\alpha_A - \gamma_A)^2 \geq (\alpha_B - \gamma_B)^2$ and $\beta_A \;\leq \beta_B$

Proof

$\mathcal{E}_{CyN}$(A) $\leq \mathcal{E}_{CyN}$(B)

$\Rightarrow 1 - \frac{1}{n}\sum_{i=1}^{n}(\alpha_A - \gamma_A)^2\,(1 - \beta_A) \;\leq 1 - \frac{1}{n}\sum_{i=1}^{n}(\alpha_B - \gamma_B)^2\,(1 - \beta_B)$

$\Rightarrow - \frac{1}{n}\sum_{i=1}^{n}(\alpha_A - \gamma_A)^2\,(1 - \beta_A) \leq - \frac{1}{n}\sum_{i=1}^{n}(\alpha_B - \gamma_B)^2\,(1 - \beta_B)$

$$\Rightarrow \sum_{i=1}^{n}(\alpha_A - \gamma_A)^2\,(1 - \beta_A) \geq \sum_{i=1}^{n}(\alpha_B - \gamma_B)^2\,(1 - \beta_B)$$

$\Rightarrow (\alpha_A - \gamma_A)^2 \geq (\alpha_B - \gamma_B)^2$ and $(1 - \beta_A) \geq (1 - \beta_B)$

$\Rightarrow (\alpha_A - \gamma_A)^2 \geq (\alpha_B - \gamma_B)^2$ and $\beta_A \;\leq \beta_B$

Thus $\mathcal{E}_{CyN}$ is an entropy function defined on $\boldsymbol{\tau}_N$

Example 3.3: Let X= {a, b} and let A= {<a; 0.5, 0.5, 0.7>, <b; 0.2,05, 0.4>} and B= {<a; 0.6, 0.5, 0.5>, <b; 0.5, 0.5, 0.5>} are two n-CyFNS on X then, $\mathcal{E}_{CyN}$(A)= 0.98 and $\mathcal{E}_{CyN}$(B)= 0.9975

Here $\mathcal{E}_{CyN}$(A) < $\mathcal{E}_{CyN}$(B).

Hence we can say

A is less fuzzy than B.

4 | Application

4.1 | Example 1

Consider an example of a shopping experience with different items. The pandemic situation of COVID-19 has broadened the doors of our shopping experience more than the direct one, before. Nowadays we depend on different methods of shopping like e-commerce, and e-business other than direct purchases. Based on the reviews and ratings, we will find out the most reliable method of shopping for a specific item using the n-CyFN entropy measure.

Table 1. Ratings of products based on the different shopping ways.

	Precious Ornaments(a)	Electronic Gadgets(b)	Grocery(c)	Textiles(d)
Direct (1)	⟨ a,1;0.8,0.3,0.03 ⟩	⟨ b,1;0.4,0.7,0.6 ⟩	⟨ c,1;0.6,0.3,0.5 ⟩	⟨ d,1;0.8,0.3,0.4 ⟩
e-business(2)	⟨ a,2;0.7,0.7,0.4 ⟩	⟨ b,2;0.5,0.2,0.02 ⟩	⟨ c,2;0.8,0.3,0.2 ⟩	⟨ d,2;0.9,0.4,0.2 ⟩
e-commerce(3)	⟨ a,3;0.6,0.3,0.5 ⟩	⟨ b,3;0.9,0.5,0.5 ⟩	⟨ c,3;0.6,0.4,0.5 ⟩	⟨ d,3;0.6,0.3,0.4 ⟩

Clearly, all values in the Table 1 are n-CyFNSs. Now we calculate the $\mathcal{E}_{CyN}$ of each value.

Table 2. Entropy measure of each item through different shopping ways.

	Precious Ornaments	Electronic Gadgets	Grocery	Textiles
Direct (1)	**0.825**	0.988	0.993	0.888
e-business(2)	0.973	0.928	**0.748**	**0.706**
e-commerce(3)	0.993	**0.92**	0.994	0.972

From Table 2, it is clear that $\mathcal{E}_{CyN}(a,1) < \mathcal{E}_{CyN}(a,2) < \mathcal{E}_{CyN}(a,3)$. Hence purchasing precious ornaments through direct method is more recommended. Similarly$\mathcal{E}_{CyN}(b,3) < \mathcal{E}_{CyN}(b,2) < \mathcal{E}_{CyN}(b,1)$. Thus purchasing electronic gadgets through the e-commerce method is more reliable. Also, $\mathcal{E}_{CyN}(c,2) < \mathcal{E}_{CyN}(c,1) < \mathcal{E}_{CyN}(c,3)$& $\mathcal{E}_{CyN}(d,2) < \mathcal{E}_{CyN}(d,1) < \mathcal{E}_{CyN}(d,3)$. E-business is the best option for purchasing groceries and textiles.

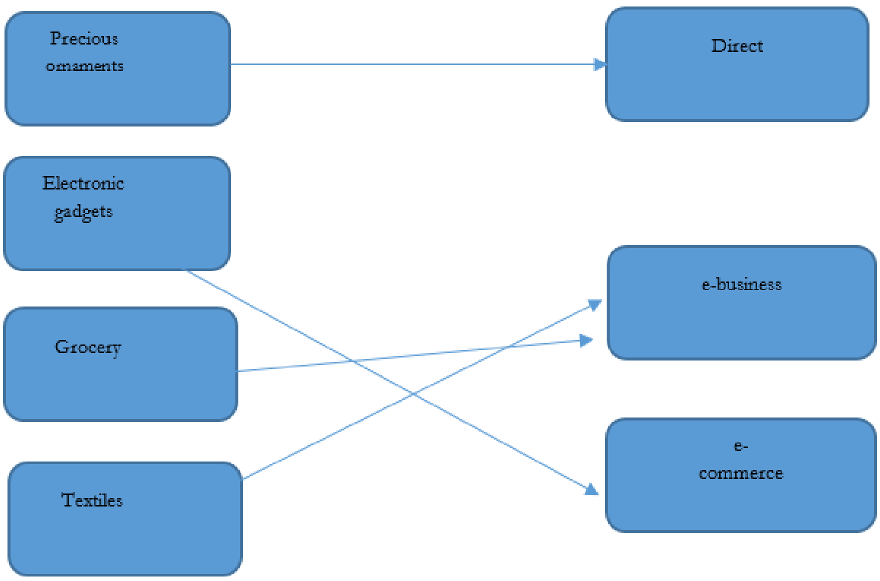

Figure 1. Showing the best option for buying items.

4.2 | Example 2

Educational evaluation plays a vital role in the teaching-learning process because it accomplishes a shared objective. Assessment is a comprehensive, continuous procedure. It helps educators recognize issues and work with pupils to find solutions to those issues. An effective teacher is a keen observer and a good evaluator.

In a teacher interview, the recruiters give five answer scripts to the 3 teacher candidates to evaluate the student's learning outcome (LO) and are asked to fill in the rubrics. The evaluation done by the teacher candidates is in the form of n-CyFN linguistic terms as in Tables 4-9. To find which teacher candidate is the best evaluator, we use the n-CyFN entropy measure.

Table 3. Linguistic terms [18].

Linguistic Terms	$< \alpha , \beta , \gamma >$
Outstanding (O)	< 0.9, 0.7,0.1>
Excellent(E)	<0.8,0.6,0.1>
Very good (V)	<0.7,0.5,0.2>
Good (G)	<0.6,0.5,0.2>
Average (Av)	<0.5,0.5,0.5>
Satisfactory (S)	<0.4,0.4,0.6>
Poor (P)	<0.2,0.3,0.7>
Pathetic (Pa)	<0.1,0.2,0.9>

Teacher 1:

Table 4. Evaluation made by Teacher1.

Students	LO-1(I)	LO-2(II)	LO-3(III)	LO-4(IV)
Student-1	V	V	E	V
Student-2	G	G	G	Av
Student-3	S	S	S	P
Student-4	E	E	E	V
Student-5	S	S	P	P

Teacher 2:

Table 5. Evaluation made by Teacher2.

Students	LO-1(I)	LO-2(II)	LO-3(III)	LO-4(IV)
Student-1	G	G	G	G
Student-2	Av	G	Av	Av
Student-3	Av	Av	S	Av
Student-4	E	G	G	V
Student-5	P	S	P	P

Teacher 3:

Table 6. Evaluation made by Teacher3.

Students	LO-1(I)	LO-2(II)	LO-3(III)	LO-4(IV)
Student-1	V	G	G	V
Student-2	G	G	G	V
Student-3	Av	S	Av	S
Student-4	E	E	E	V
Student-5	p	S	P	P

Teacher 1:

Table 7. n-CyFN values of evaluation made by Teacher1.

Students	LO-1(I)	LO-2(II)	LO-3(III)	LO-4(IV)
Student-1	<1I;0.7,0.5,0.2>	<2,II;0.7,0.5,0.2>	<3,III;0.8,0.6,0.1>	<4,IV;0.7,0.5,0.2>
Student-2	<2,I;0.6,0.5,0.2>	<2,II;0.6,0.5,0.2>	<3,III;0.6,0.5,0.2>	<4,IV;0.5,0.5,0.5>
Student-3	<3,I;0.4,0.4,0.6>	<3,II;0.4,0.4,0.6>	<3,III;0.4,0.4,0.6>	<4,IV;0.2,0.3,0.7>
Student-4	<4,I;0.8,0.6,0.1>	<4,II;0.8,0.6,0.1>	<3,III;0.8,0.6,0.1>	<4,IV;0.7,0.5,0.2>
Student-5	<5,I;0.4,0.4,0.6>	<5,II;0.4,0.4,0.6>	<3,III;0.2,0.3,0.7>	<4,IV;0.2,0.3,0.7>

Teacher 2:

Table 8. n-CyFN values of evaluation made by Teacher2.

Students	LO-1(I)	LO-2(II)	LO-3(III)	LO-4(IV)
Student-1	<0.6,0.5,0.2>	<0.6,0.5,0.2>	<0.6,0.5,0.2>	<0.6,0.5,0.2>
Student-2	<0.5,0.5,0.5>	<0.6,0.5,0.2>	<0.5,0.5,0.5>	<0.5,0.5,0.5>
Student-3	<0.5,0.5,0.5>	<0.5,0.5,0.5>	<0.4,0.4,0.6>	<0.5,0.5,0.5>
Student-4	<0.8,0.6,0.1>	<0.6,0.5,0.2>	<0.6,0.5,0.2>	<0.7,0.5,0.2>
Student-5	<0.2,0.3,0.7>	<0.4,0.4,0.6>	<0.2,0.3,0.7>	<0.2,0.3,0.7>

Teacher 3:

Table 9. n-CyFN values of evaluation made by Teacher3.

Students	LO-1(I)	LO-2(II)	LO-3(III)	LO-4(IV)
Student-1	<0.7,0.5,0.2>	<0.7,0.5,0.2>	<0.8,0.6,0.1>	<0.7,0.5,0.2>
Student-2	<0.6,0.5,0.2>	<0.6,0.5,0.2>	<0.6,0.5,0.2>	<0.7,0.5,0.2>
Student-3	<0.5,0.5,0.5>	<0.4,0.4,0.6>	<0.5,0.5,0.5>	<0.4,0.4,0.6>
Student-4	<0.8,0.6,0.1>	<0.8,0.6,0.1>	<0.8,0.6,0.1>	<0.7,0.5,0.2>
Student-5	<0.2,0.3,0.7>	<0.4,0.4,0.6>	<0.2,0.3,0.7>	<0.2,0.3,0.7>

Clearly, all values in the table are n-CyFNSs. Now we calculate the $\mathcal{E}_{CyN}$of each value as in Tables 10-12.

Teacher 1:

Table 10. $\mathcal{E}_{CyN}$ values of Teacher 1.

Students	$\mathcal{E}_{CyN}$
Student-1	0.857
Student-2	0.94
Student-3	0.896
Student-4	0.82
Student-5	0.90

Teacher 2:

Table 11. $\mathcal{E}_{CyN}$ values of Teacher 2.

Students	$\mathcal{E}_{CyN}$
Student-1	0.92
Student-2	0.98
Student-3	0.994
Student-4	0.879
Student-5	0.944

Teacher 3:

Table 12. $\mathcal{E}_{CyN}$ values of Teacher 3.

Students	$\mathcal{E}_{CyN}$
Student-1	0.8975
Student-2	0.98
Student-3	0.994
Student-4	0.822
Student-5	0.92

Here we can see that all the $\mathcal{E}_{CyN}$ values of Teacher 1 are less than that of other teachers. Thus evaluation done by Teacher 1 is more certain.

Hence the ranking given to the values selection process is given below as in Table 13:

Table 13. Ranking based on $\mathcal{E}_{CyN}$.

Teacher	Rank
Teacher-1	I
Teacher-3	II
Teacher-2	III

5 | Conclusions

Neutrosophic sets are a general formal framework that has been suggested to explore uncertainty resulting from "indeterminacy" issues. It has been demonstrated from a philosophical perspective that a neutrosophic set generalizes an interval-valued fuzzy set, fuzzy set, classical set, fuzzy set with intuition, etc. One type of neutrosophic set that has practical uses in science and engineering is the n-cylindrical fuzzy neutrosophic set. Consequently, the study of n-cylindrical fuzzy neutrosophic sets and their attributes is important for both understanding the principles of uncertainty and for applications. We present a new measure of entropy and two applications related to it. This measure is consistent with similar considerations for other sets like fuzzy sets and intuitionistic fuzzy sets etc. Hence the proposed entropy measure can be used to measure the uncertainty factor in related problems.

Acknowledgments

The author is grateful to the editorial and reviewers, as well as the correspondent author, who offered assistance in the form of advice, assessment, and checking during the study period.

Author Contribution

All authors contributed equally to this work.

Funding

This research received no external funding.

Data Availability

The datasets generated during and/or analyzed during the current study are not publicly available due to the privacy-preserving nature of the data but are available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare that there is no conflict of interest in the research.

Ethical Approval

This article does not contain any studies with human participants or animals performed by any of the authors.

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