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Entropy and Correlation Coefficients of Neutrosophic and Interval-Valued Neutrosophic Hypersoft Set with application of Multi-Attributive Problems

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Abstract: In computational intelligence, machine learning, image processing, neural networks, medical diagnostics, and decision analysis, the ideas of correlation coefficients and entropy have practical applications. By applying hypersoft set (HSS) in neutrosophic environment provides a good model for describing and addressing uncertainties. In statistics, the correlation coefficient between two variables is crucial. Furthermore, the accuracy of the correlation assessment is dependent on data from the discourse set. The main focus of this study, is to develop entropy for (NHSS) and generalized correlation coefficient interval-valued neutrosophic hypersoft-set (IVNHSS). We proposed some theorems on entropy along with algorithms based on correlation and weighted correlation coefficients in the context of NHSs and IVNHSS. The validity and superiority are presented along with application and also comparison is made with existing approaches.

Keywords: Entropy, Correlation Coefficients, Fuzziness, Soft Set, Hypersoft Set, Neutrosophic Set, Neutrosophic hypersoft set, Interval-valued neutrosophic hypersoft set, MCDM.

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1. Introduction

The joint connection of two variables may be used to analyses the interdependence of two variables using correlation analysis, which is important in statistics and engineering. Despite the fact that probabilistic approaches have been used to a variety of actual engineering issues, probabilistic solutions still face considerable challenges. The probability of a procedure, for example, is determined by based on the enormous amount of random data obtained However, because huge complex systems contain numerous fuzzy uncertainties, obtaining exact probability events is challenging. As a result, outcomes based on probability theory may not always give relevant information for specialists due to a lack of quantitative data. Furthermore, in real applications, there is sometimes insufficient data to make a decision. Experts do not always have access to results based on probability theory due to the aforementioned limitations. As a result, probabilistic approaches are frequently insufficient to resolve data with inherent uncertainties. Many scholars throughout the world have presented and suggested various ways for resolving situations involving ambiguity. To begin, Zadeh created the notion of a fuzzy set (FS) [1], which he used to handle problems involving uncertainty and ambiguity. It is clear that in some circumstances, FS is unable to resolve the matter. To deal with these problems, Turksen [2] created the concept of interval-valued fuzzy sets (IVFS). In some circumstances, membership as a non-member value must be carefully considered in the right representation of objects that cannot be handled by FS or IVFS under unknown conditions. Atanasov suggested the notion of intuitionistic fuzzy sets (IFSs) to resolve these challenges [3]. Atanassov's theory only deals with inadequate data owing to membership and non-membership values; nevertheless, IFS is unable to cope with incompatible and imprecise data. Soft sets were introduced by Molodtsov [4] as a broad mathematical tool for dealing with uncertain, ambiguous, and indeterminate substances (SS). Maji and colleagues [5] SS's work was expanded, and several enterprises with properties were established. They employ SS theory to make judgments in [6]. Ali and others [7] tweaked the SS Maji technique and created some additional operations utilizing its features. They proved De Morgan's rules [8] in the SS environment by utilizing different operators. Cagman and Enginoglu [9] introduced and studied the notion of soft matrices with operations, as well as their attributes. They also devised a decision-making strategy for dealing with unclear circumstances. They adjusted Molodtsov's SS's suggested operation in [10]. By merging FS and SS, Maji et al. [11] established the notion of fuzzy soft set (FSS). They also suggested the Intuitionistic Fuzzy Soft Set (IFSS) [12], which includes fundamental operations and properties. The idea of IFS was developed by Atanassov and Gargov [13], who introduced a new notion called Interval Valued Intuitionistic Fuzzy Set (IVIFS). For illness diagnosis, Jafar et al. [14] used intuitionistic fuzzy soft matrices. Yang et al. [15] presented the idea of interval-valued fuzzy soft sets with operations (IVFSS) and demonstrated several key findings by merging IVFS and SS, as well as applying the established notions to decision-making. By expanding IVIFS, Jiang et al. [16] developed the notion of interval-valued intuitionistic fuzzy soft sets (IVIFSS). They also offered IVIFSS's need and possible operations, as well as their features. Jafar et.al [17-19] suggested a new technique using neutrosophic soft sets and used it in agriculture sciences, applied sanchez approach for medical diagnosis and proposed an algorithm for neutrosphic soft matrices. Ma and Rani [20] built an algorithm based on IVIFSS and utilized it to make decisions. The aggregation operations for bipolar neutrosophic soft sets were developed by Jafar et.al [21]. Naveed et al [22] developed similarity measures of cosine, tangent and cotangent functions in neutrosophic soft sets environments. Maji [23] proposed a neutrosophic soft set (NSS) with all of the required operations and attributes. Karaaslan [24] proposed the potential NSS, which provided the prospect of a neutrosophic soft decision-making approach to tackle situations with uncertainty based on And-product. Broumi [25] created a generic NSS with certain operations and characteristics and utilized it to make decisions. Deli and Subas [26] introduced the notion of cut sets of SVNNs to handle MCDM issues with single-valued Neutrosophic numbers (SVNNs). The term CC of SVNSs [27] was coined based on the IFS correlation, Simplified NSs were introduced along with various operational rules and aggregation operators including weighted arithmetic and weighted geometric average operators. On the basis of proposed aggregation operators, they developed an MCDM technique. A fuzzy logic controller using neutrosphic soft sets presented by jafar et.al. [28]. Hung and Wu [30] introduced the centroid approach for calculating the CC of IFSs and applied it to IVIFS. The correlation and CC of IVIFS were presented by Bustince and Burillo [31], who also established the decomposition theorems on the correlation of IVIFS. The CCs for IFSs and IVIFSs were also created by Hong [32] and Mitchell [33]. Garg and Arora created the TOPSIS methodology using derived correlation metrics and brought them to the IFSS [34]. With these properties, Huang and Guo [35] enhanced the CC on IFS, as well as establishing the IVIFS coefficient. Singh et al. [36] constructed a one- and two-parameter generalization of CC on IFS and used it to multi-attribute group decision-making situations. Naveed et.al [37] devised a decision-making technique for handling multi-criteria decision-making issues by proposing IVFSS. Experts have been known to evaluate the sub-traits of certain attributes when making decisions. In such cases, none of the aforementioned theories can offer experts with knowledge regarding sub-qualities of the specified attributes. Smarandache [38] expanded the notion of soft sets to hypersoft sets (HSS) by substituting the single-parameter function F with a multi-parameter function based on the Cartesian product of n distinct qualities. The well-established HSS is more adaptable than soft sets and better suited to decision-making situations. Crisp HSS, fuzzy HSS, intuitionistic fuzzy HSS, NHSS, and Plithogenic HSS are some of the other HSS extensions he discussed. Today, the HSS theory and its extensions are quickly progressing, and many academics have produced many operators and characteristics based on the HSS theory and its extensions [39-42]. Abdel-Basset et al. [43] employed Plithogenic set theory to cope with uncertainty and analyses the manufacturing industry's financial performance. To attain this purpose, they employed the VIKOR and TOPSIS techniques to calculate the weight of the financial ratio, followed by the AHP approach. Abdel-Basset et al. [44] proposed a successful combination of Plithogenic aggregate operations and quality feature selection. This combination has the benefit of increasing accuracy, which summarizes the decision-makers. Jafar et al. [45] intuitionistic fuzzy hypersoft matrices and proposed an algorithm for solving MADM problems. To overcome the MADM problem, they also devised a decision-making technique based on created TOPSIS. The type 2 neutrosophic numbers were proposed by Basset et al. [46], along with several operational rules. They also created aggregation operators for type 2 neutrosophic numbers and a decision-making methodology to tackle the MADM issue based on the created operators. Basset et al. [47] developed the AHP and VIKOR techniques for calculating neutrosophic numbers and used them to pick suppliers. Basset et al. [48] proposed a robust ranking methodology for managing green supply chains in a neutrosophic setting. Basset et al. [49] developed a neutrosophic multi-criteria decision-making methodology to assist patients and physicians in determining if a patient has heart failure.

The NHSS in Smarandache is incapable of resolving these issues. The object of any sub-truthiness, attribute's indeterminacy, and falsity is supplied in interval form. We know that values change in general; for example, when medical specialists provide a report for a patient, we can see that the HP level of blood ranges between 0 and 17.5; these values are not handled by NHSS. The concept of HSS was extended by Saqlain et. al. [50] he proposed the concept of NHSS with aggregate operators with application to MCDM problems. Then after this concept of NHSS was extended to single and multi-valued neutrosophic hypersoft set with similarity measures and distances [51]. The concept of Interval-valued neutrosophic hypersoft set, m-polar and m-polar neutrosophic hypersoft set was proposed by [52]. The MCDM techniques are also proposed to deal with many daily life issues based on hypersoft set environment theory [53-60]. Jafar et al [61] proposed Trigonometric Similarity measures in NHSs and applied it in Renewable energy source selection. Jafar et.al [62] proposed distance and similarity measures using Max-Min operators and applied it solid waste management system. Many other MCDM techniques used in computer applications by Muslim et al [63] implemented TWOFISH algorithm for data security using activex encryption. Prasetiyo et al [64-65] evaluated about the credit card detection using SMOTE oversampling technique.

To handle the above-discussed environment we need to develop IVNHSS based correlation coefficients and Entropy. The developed IVNHSS Correlations deals with uncertain problems comparative to fuzzy and intuitionistic hypersoft set studies.

The paper is organized as follows: In Section 2, we review some basic definitions used in the following sequels, such as SS, NSS, NHSS, and IVNHSS, etc. In Section 3, Entropy for IVNHSS is proposed along with an algorithm to solve decision-making problem. In Section 4, established the notions of generalized CC and WCC under IVNHSS and discussed their desirable properties with algorithm to solve MCDM. Result Discussion and Comparison are added in section 5. Finally, the current research is concluded with future directions.

2. Preliminaries

In this chapter, some important definitions are listed which will be helpful to understand the thesis and the calculations made.

Definition 2.1: Soft Set [4]

Let $\mathcal{U}$ be the universal set and $\mathcal{E}$ be the set of attributes concerning$\mathcal{U}$. Let $\mathcal{P}(\mathcal{U})$ be the power set of $\mathcal{U}$ and$\mathsf{A} \subseteq \mathcal{E}$. A pair ($\mathcal{F}$, A) is called a **soft set** over $\mathcal{U}$ and its mapping is given as;

$$\mathcal{F}:\mathsf{A} \rightarrow \mathcal{P}(\mathcal{U})$$

It is also defined as:

$$(\mathcal{F},\mathsf{A}) = \{\mathcal{F}(e) \in \mathcal{P}(\mathcal{U}): e \in \mathcal{E}, \mathcal{F}(e) = \emptyset \; if \; e \notin \mathsf{A}\}$$

Definition 2.2 Hypersoft Set [38]

Let $\mathcal{U}$ be a universe of discourse and $\mathcal{P}(\mathcal{U})$ be a power set of $\mathcal{U}$ and k = $\{k_1, k_2, k_3,..., k_n\}$,(n ≥ 1) be a set of attributes and set K_i a set of corresponding sub-attributes of k_i respectively with $K_i \cap K_j$ = φ for $n \geq 1$ for each $i, j \in \{1,2,3 \ldots n\}$ and $i \neq j$. Assume $K_1 \times K_2 \times K_3 \times \ldots \times K_n = \ddot{\mathcal{A}}$ = $\{a_{1h} \times a_{2k} \times \cdots \times a_{nl}\}$ be a collection of multi-attributes, where $1 \leq h \leq \alpha$, $1 \leq k \leq \beta$, and $1 \leq l \leq \gamma$, and α, β, and $\gamma \in \mathbb{N}$. Then the pair ($\mathcal{F}$, $K_1 \times K_2 \times K_3 \times \ldots \times K_n = \ddot{\mathsf{A}}$) is said to be hypersoft set over $\mathcal{U}$ and its mapping is defined as;

$$\mathcal{F}: K_1 \times K_2 \times K_3 \times \ldots \times K_n = \ddot{\mathsf{A}} \rightarrow \mathcal{P}(\mathcal{U}).$$

It is also defined as

$$(\mathcal{F}, \ddot{\mathsf{A}}) = \{\breve{a}, \mathcal{F}_{\ddot{\mathcal{A}}}(\breve{a}): \breve{a} \in \ddot{\mathsf{A}}, \mathcal{F}_{\ddot{\mathcal{A}}}(\breve{a}) \in \mathcal{P}(\mathcal{U})\}$$

Definition 2.3: Neutrosophic Soft Set [23]

Let ξ be the universal set and € be the set of attributes with respect to ξ. Let P(ξ) be the set of Neutrosophic values of ξ and Ą ⊆ € . A pair (F, Ą) is called a Neutrosophic soft set over ξ and its mapping is given as

$$Ꞙ: Ą \rightarrow P(\xi)$$

Definition 2.4: Neutrosophic Hypersoft Set (NHSS) [38]

Let $\mathcal{U}$ be a universe of discourse and $\mathcal{P}(\mathcal{U})$ be a power set of $\mathcal{U}$ and k = $\{k_1, k_2, k_3,..., k_n\}$,(n ≥ 1) be a set of attributes and set K_i a set of corresponding sub-attributes of k_i respectively with $K_i \cap K_j$ = φ for $n \geq 1$ for each $i, j \in \{1,2,3 \ldots n\}$ and $i \neq j$. Assume $K_1 \times K_2 \times K_3 \times \ldots \times K_n = \ddot{\mathsf{A}}$ = $\{a_{1h} \times a_{2k} \times \cdots \times a_{nl}\}$ be a collection of sub-attributes, where $1 \leq h \leq \alpha$, $1 \leq k \leq \beta$, and $1 \leq l \leq \gamma$, and α, β, and $\gamma \in \mathbb{N}$ and $NS^{\mathcal{U}}$ be a collection of all neutrosophic subsets over $\mathcal{U}$. Then the pair ($\mathcal{F}$, $K_1 \times K_2 \times K_3 \times \ldots \times K_n = \ddot{\mathsf{A}}$) is said to be Neutrosophic Hypersoft Set over $\mathcal{U}$ and its mapping is defined as

$$\mathcal{F}: K_1 \times K_2 \times K_3 \times \ldots \times K_n = \ddot{\mathsf{A}} \rightarrow NS^{\mathcal{U}}.$$

It is also defined as;

$(\mathcal{F}, \ddot{\mathsf{A}}) = \{(\breve{a}, \mathcal{F}_{\ddot{\mathsf{A}}}(\breve{a})): \breve{a} \in \ddot{\mathsf{A}}, \mathcal{F}_{\ddot{\mathsf{A}}}(\breve{a}) \in NS^{\mathcal{U}}\}$, where $\mathcal{F}_{\ddot{\mathsf{A}}}(\breve{a}) = \{\langle \delta, \sigma_{\mathcal{F}(\breve{a})}(\delta), \tau_{\mathcal{F}(\breve{a})}(\delta), \gamma_{\mathcal{F}(\breve{a})}(\delta) \rangle : \delta \in \mathcal{U}\}$, where $\sigma_{\mathcal{F}(\breve{a})}(\delta)$, $\tau_{\mathcal{F}(\breve{a})}(\delta)$, and $\gamma_{\mathcal{F}(\breve{a})}(\delta)$ represent the truth, indeterminacy, and falsity grades of the attributes such as $\sigma_{\mathcal{F}(\breve{a})}(\delta)$, $\tau_{\mathcal{F}(\breve{a})}(\delta)$, $\gamma_{\mathcal{F}(\breve{a})}(\delta) \in [0, 1]$, and

$0 \leq \sigma_{\mathcal{F}(\breve{a})}(\delta) + \tau_{\mathcal{F}(\breve{a})}(\delta) + \gamma_{\mathcal{F}(\breve{a})}(\delta) \leq 3$.

Definition 2.7: Interval-valued Neutrosophic Hypersoft Number (IVNHSN) [42]

Let $\mathcal{U}$ be a universe of discourse and $\mathcal{P}(\mathcal{U})$ be a power set of $\mathcal{U}$ and k = $\{k_1, k_2, k_3,..., k_n\}$,(n ≥ 1) be a set of attributes and set K_i a set of corresponding sub-attributes of k_i respectively with $K_i \cap K_j$ = φ for $n \geq 1$ for each $i, j \in \{1,2,3 \ldots n\}$ and $i \neq j$. Assume $K_1 \times K_2 \times K_3 \times \ldots \times K_n = \ddot{\mathsf{A}}$ = $\{a_{1h} \times a_{2k} \times \cdots \times a_{nl}\}$ be a collection of sub-attributes, where $1 \leq h \leq \alpha$, $1 \leq k \leq \beta$, and $1 \leq l \leq \gamma$, and α, β, and $\gamma \in \mathbb{N}$ and $IVNS^{\mathcal{U}}$ be a collection of all interval-valued neutrosophic subsets over $\mathcal{U}$. Then the pair ($\mathcal{F}$, $K_1 \times K_2 \times K_3 \times \ldots \times K_n = \ddot{\mathsf{A}}$) is said to be IVNHSS over $\mathcal{U}$ and its mapping is defined as,

$\mathcal{F}: K_1 \times K_2 \times K_3 \times \ldots \times K_n = \ddot{\mathsf{A}} \rightarrow IVNS^{\mathcal{U}}$.

It is also defined as;

$(\mathcal{F},\ddot{A}) = \{(\breve{a}_k, \mathcal{F}_{\ddot{A}}(\breve{a}_k)) : \breve{a}_k \in \ddot{A},\ \mathcal{F}_{\ddot{A}}(\breve{a}_k) \in NS^{\mathcal{U}}\}$,

where $\mathcal{F}_{\ddot{A}}(\breve{a}) = \{\langle \delta, \sigma_{\mathcal{F}(\breve{a}_k)}(\delta), \tau_{\mathcal{F}(\breve{a}_k)}(\delta), \gamma_{\mathcal{F}(\breve{a}_k)}(\delta)\rangle : \delta \in \mathcal{U}\}$, where $\sigma_{\mathcal{F}(\breve{a}_k)}(\delta)$, $\tau_{\mathcal{F}(\breve{a}_k)}(\delta)$, and $\gamma_{\mathcal{F}(\breve{a}_k)}(\delta)$ represent the interval truth, indeterminacy, and falsity grades of the attributes such as

$\sigma_{\mathcal{F}(\breve{a}_k)}(\delta) = [\sigma^{\ell}_{\mathcal{F}(\breve{a}_k)}(\delta), \sigma^{\mathcal{U}}_{\mathcal{F}(\breve{a}_k)}(\delta)]$, $\tau_{\mathcal{F}(\breve{a}_k)}(\delta) = [\tau^{\ell}_{\mathcal{F}(\breve{a}_k)}(\delta), \tau^{\mathcal{U}}_{\mathcal{F}(\breve{a}_k)}(\delta)]$,

$\gamma_{\mathcal{F}(\breve{a}_k)}(\delta) = [\gamma^{\ell}_{\mathcal{F}(\breve{a}_k)}(\delta), \gamma^{\mathcal{U}}_{\mathcal{F}(\breve{a}_k)}(\delta)]$, where $\sigma^{\ell}_{\mathcal{F}(\breve{a}_k)}(\delta), \sigma^{\mathcal{U}}_{\mathcal{F}(\breve{a}_k)}(\delta)$, $\tau^{\ell}_{\mathcal{F}(\breve{a}_k)}(\delta), \tau^{\mathcal{U}}_{\mathcal{F}(\breve{a}_k)}(\delta)$, $\gamma^{\ell}_{\mathcal{F}(\breve{a}_k)}(\delta), \gamma^{\mathcal{U}}_{\mathcal{F}(\breve{a}_k)}(\delta)$ $\subseteq [0,1]$, and $0 \leq \sigma^{\mathcal{U}}_{\mathcal{F}(\breve{a}_k)}(\delta) + \tau^{\mathcal{U}}_{\mathcal{F}(\breve{a}_k)}(\delta) + \gamma^{\mathcal{U}}_{\mathcal{F}(\breve{a}_k)}(\delta) \leq 3$.

Simply an interval-valued neutrosophic hypersoft number (IVNHSN) can be expressed as

$\mathcal{F} = \{[\sigma^{\ell}_{\mathcal{F}(\breve{a}_k)}(\delta), \sigma^{\mathcal{U}}_{\mathcal{F}(\breve{a}_k)}(\delta)], [\tau^{\ell}_{\mathcal{F}(\breve{a}_k)}(\delta), \tau^{\mathcal{U}}_{\mathcal{F}(\breve{a}_k)}(\delta)], [\gamma^{\ell}_{\mathcal{F}(\breve{a}_k)}(\delta), \gamma^{\mathcal{U}}_{\mathcal{F}(\breve{a}_k)}(\delta)]\}$,

$$\text{Where} 0 \leq \sigma^{\mathcal{U}}_{\mathcal{F}(\breve{a}_k)}(\delta) + \tau^{\mathcal{U}}_{\mathcal{F}(\breve{a}_k)}(\delta) + \gamma^{\mathcal{U}}_{\mathcal{F}(\breve{a}_k)}(\delta) \leq 3.$$

3. Entropy of NHSS and IVNHSS

In this section, we propose the entropy of neutrosophic hypersoft set (NHSS) and interval-valued neutrosophic hypersoft set (IVNHSS).

- Entropy for NHSS and theorems.
- Entropy for IVNHSS and theorems.

In decision making measure of fuzziness is an important factor. The measurement of fuzziness in neutrosophic environment plays a vital role, since neutrosophic numbers and its decision-making approaches are used in many daily life issues like HR personnel selection, equipment selection, shortest path selection, engineering and medical etc. The validity and superiority can be measure by considering the value of fuzziness, when this value of fuzziness is less, then it can be considered as the best modelling and more accurate.

Definition 3.1: Entropy for NHSS

Let $\mathcal{H}$ *and* $\mathbb{E}$ be defined as;

$\mathcal{H} : \mathcal{H}^1 \times \mathcal{H}^2 \times \mathcal{H}^3 \times \dots \times \mathcal{H}^n \longrightarrow P(U)$ be neutrosophic hypersoft set, $\mathbb{E} : \mathcal{H} \longrightarrow [0,1]$ such that $\omega \in \mathcal{H}$ *and* $\omega := ([p : p \in [0,1]], [q : q \in [0,1]], [r : r \in [0,1]])$. Then $\mathbb{E}(\omega)$ is said to be an entropy of neutrosophic hypersoft set if, $\mathbb{E}$ satisfies the following axioms.

(1) $\mathbb{E}(\omega) = 0 \iff (p = q = r = 0)$

(2) $\mathbb{E}(\omega) = 3 \iff (p = q = r = 1)$

(3) $\mathbb{E}(\omega) = \mathbb{E}(\omega^c) \iff (p = q = r = 0.5)$

(4) Let $\omega, \mu \in \mathcal{H}$ then $\mathbb{E}(\omega) \leq \mathbb{E}(\mu)$ if $\omega \leq_{\mathcal{H}} \mu$.

Where $\mathbb{E}(\omega)$ is defined as;

$$\mathbb{E}(\omega) = \begin{cases} 3 - (P^c + q^c + r^c) & when \quad p,q,r \in [0,1] \\ 0 & otherwise \end{cases} \quad (1)$$

Theorem 3.2 $\mathbb{E}(\omega)$ introduced as (1) is entropy for ω.

Proof: It is easy to see that,

(1) $\mathbb{E}(\omega) = 0 \iff 3 - (P^c + q^c + r^c)$

$$= 3 - (0^c + 0^c + 0^c)$$

$$= 3 - (1 + 1 + 1) = 3 - 3 = 0$$

(2) $\mathbb{E}(\omega) = 3 \Leftrightarrow\ 3 - (P^c + q^c + r^c)$

$$= 3 - (1^c + 1^c + 1^c)$$

$$= 3 - (0 + 0 + 0) = 3 - 0 = 3$$

(3) $\mathbb{E}(\omega) = \mathbb{E}(\omega^c) \ \Leftrightarrow\ 3 - (P^c + q^c + r^c)\ clearly\ satisfied.$

(4) Let $\omega, \mu \in \mathcal{H}$ and $\omega^c = 1 - \omega$ also $\mu^c = 1 - \mu$. If $\omega \leq_{\mathcal{H}} \mu$ when $\omega \leq_{\mathcal{H}} \omega^c\ or\ \omega \leq_{\mathcal{H}} \mu$ when $\mu^c \leq_{\mathcal{H}} \mu$ then $\mathbb{E}(\omega) \leq \mathbb{E}(\mu)$. ■

Definition 3.3: Entropy for IVNHSS

Let $\mathcal{H}\ and\ \mathbb{E}$ be defined as;

$\mathcal{H} : \mathcal{H}^1 \times \mathcal{H}^2 \times \mathcal{H}^3 \times \ldots \times \mathcal{H}^n \longrightarrow P(U)$ be interval-valued neutrosophic hypersoft set, $\mathbb{E} : \mathcal{H} \longrightarrow [0,1]$ such that $\omega \in \mathcal{H}\ and\ \omega := ([p^l, p^u] \in [0,1], [q^l, q^u] \in [0,1], [r^l, r^u] \in [0,1])$. Then $\mathbb{E}(\omega)$ is said to be an entropy of neutrosophic hypersoft set if, $\mathbb{E}$ satisfies the following axioms.

(5) $\mathbb{E}(\omega) = 0 \ \Leftrightarrow\ [p^l, p^u] = [0, 0]\ or\ [1, 1]\ and\ [r^l, r^u] = [0, 0]\ or\ [1, 1]$

(6) $\mathbb{E}(\omega) = 1 \ \Leftrightarrow\ [p^l, p^u] = [q^l, q^u] = [r^l, r^u] = [0.5, 0.5]$

(7) $\mathbb{E}(\omega) = \mathbb{E}(\omega^c)$

(8) Let $\omega, \mu \in \mathcal{H}$ then $\mathbb{E}(\omega) \leq \mathbb{E}(\mu)$ if $\omega \leq_{\mathcal{H}} \mu$.

Where $\mathbb{E}(\omega)$ is defined as;

$$\mathbb{E}(\omega) = \begin{cases} 1 - \frac{|q^l + q^u - 1|}{2}, [p^l, p^u] = [r^l, r^u] = [0.5, 0.5] \\ \frac{1}{2} - \frac{1}{2}\{\max\{|p^l - r^l|, |p^u - r^u|\}\} \qquad otherwise \end{cases} \tag{2}$$

Theorem 3.4

$\mathbb{E}(\omega)$ Introduced as (2) is entropy for ω.

Proof: It is easy to see that,

(5) $\mathbb{E}(\omega) = 0 \Leftrightarrow \frac{1}{2} - \frac{1}{2}\{\max\{|p^l - r^l|, |p^u - r^u|\}\}$

$\Leftrightarrow\ [p^l, p^u] = [0, 0]\ or\ [1, 1]\ , [r^l, r^u] = [0, 0]\ or\ [1, 1].$

(6) $\mathbb{E}(\omega) = 1 \Leftrightarrow\ [p^l, p^u] = [q^l, q^u] = [r^l, r^u] = [0.5, 0.5]$

(7) $\mathbb{E}(\omega) = \mathbb{E}(\omega^c)\ clearly\ satisfied.$

(8) Let $\omega := ([p^l, p^u] \in [0,1], [q^l, q^u] \in [0,1], [r^l, r^u] \in [0,1]), \mu := ([p^{2l}, p^{2u}] \in [0,1], [q^{2l}, q^{2u}] \in [0,1], [r^{2l}, r^{2u}] \in [0,1]) \in \mathcal{H}$

then $\mu^c = ([r^{2l}, r^{2u}], [1 - r^{2u}, 1 - r^{2l}], [p^{2l}, p^{2u}])$

If $\omega \leq_{\mathcal{H}} \mu$ when $\mu \leq_{\mathcal{H}} \mu^c\ or\ \omega \leq_{\mathcal{H}} \mu$ when $\mu^c \leq_{\mathcal{H}} \mu$ then $\mathbb{E}(\omega) \leq \mathbb{E}(\mu)$.

■

4. Generalized Correlation Coefficients of IVNHSS

In this section we propose the generalized correlation coefficients of IVNHSS.

4.1: Calculations

Assume that there are two interval valued neutrosophic hypersoft Set A and B in the universe of discourse U = {u¹, u², u³… uⁿ}

$$A = \sum_{1}^{n} \langle \begin{Bmatrix} \{A_{1^a}[\inf T_A(x_i), \sup T_A(x_i)], [\inf I_A(x_i), \sup I_A(x_i)], [\inf F_A(x_i), \sup F_A(x_i)]\} \\ \{A_{2^b}[\inf T_A(x_i), \sup T_A(x_i)], [\inf I_A(x_i), \sup I_A(x_i)], [\inf F_A(x_i), \sup F_A(x_i)]\} \\ \vdots \\ \{A_{n^z}[\inf T_A(x_i), \sup T_A(x_i)], [\inf I_A(x_i), \sup I_A(x_i)], [\inf F_A(x_i), \sup F_A(x_i)]\} \end{Bmatrix} \rangle$$

$$B = \sum_{1}^{n} \langle \begin{Bmatrix} \{B_{1^a}[\inf T_B(x_i), \sup T_B(x_i)], [\inf I_B(x_i), \sup I_B(x_i)], [\inf F_B(x_i), \sup F_B(x_i)]\} \\ \{B_{2^b}[\inf T_B(x_i), \sup T_B(x_i)], [\inf I_B(x_i), \sup I_B(x_i)], [\inf F_B(x_i), \sup F_B(x_i)]\} \\ \vdots \\ \{B_{n^z}[\inf T_B(x_i), \sup T_B(x_i)], [\inf I_B(x_i), \sup I_B(x_i)], [\inf F_B(x_i), \sup F_B(x_i)]\} \end{Bmatrix} \rangle$$

Where

E = set of attributes

$A \subseteq E$ and $A_{1^a}, A_{2^b}, A_{3^c}, \dots, A_{n^z}$ are bifurcated attributes of A

B⊆ E and $B_{1^a}, B_{2^b}, B_{3^c}, \dots, B_{n^z}$ are bifurcated attributes of B.

Correlation of IVNHSS ($\boldsymbol{C_{IVNHSS}}$)

$$\boldsymbol{C_{IVNHSS}} = \sum_{1}^{n} \begin{Bmatrix} \begin{bmatrix} \{(A_{1^a} \inf T_A(x_i) . B_{1^a} \inf T_B(x_i) + A_{1^a} \sup T_A(x_i) . B_{1^a} \sup T_B(x_i))\} \\ \{(A_{2^a} \inf T_A(x_i) . B_{2^a} \inf T_B(x_i) + A_{2^a} \sup T_A(x_i) . B_{2^a} \sup T_B(x_i))\} \\ \vdots \\ \{(A_{n^z} \inf T_A(x_i) . B_{n^z} \inf T_B(x_i) + A_{n^z} \sup T_A(x_i) . B_{n^z} \sup T_B(x_i))\} \end{bmatrix} \\ + \\ \begin{bmatrix} \{(A_{1^a} \inf I_A(x_i) . B_{1^a} \inf I_B(x_i) + A_{1^a} \sup I_A(x_i) . B_{1^a} \sup I_B(x_i))\} \\ \{(A_{2^a} \inf I_A(x_i) . B_{2^a} \inf I_B(x_i) + A_{2^a} \sup I_A(x_i) . B_{2^a} \sup I_B(x_i))\} \\ \vdots \\ \{(A_{n^z} \inf I_A(x_i) . B_{n^z} \inf I_B(x_i) + A_{n^z} \sup I_A(x_i) . B_{n^z} \sup I_B(x_i))\} \end{bmatrix} \\ + \\ \begin{bmatrix} \{(A_{1^a} \inf F_A(x_i) . B_{1^a} \inf F_B(x_i) + A_{1^a} \sup F_A(x_i) . B_{1^a} \sup F_B(x_i))\} \\ \{(A_{2^a} \inf F_A(x_i) . B_{2^a} \inf F_B(x_i) + A_{2^a} \sup F_A(x_i) . B_{2^a} \sup F_B(x_i))\} \\ \vdots \\ \{(A_{n^z} \inf F_A(x_i) . B_{n^z} \inf F_B(x_i) + A_{n^z} \sup F_A(x_i) . B_{n^z} \sup F_B(x_i))\} \end{bmatrix} \end{Bmatrix}$$

E (A) → Informational energy of A

$$E(A) = \sum_{1}^{n} \begin{Bmatrix} \left[\left(A_{1^a}T_{AL}^2(x_i) + A_{1^a}T_{AU}^2(x_i)\right) + \left(A_{2^a}T_{AL}^2(x_i) + A_{2^a}T_{AU}^2(x_i)\right) + \cdots \left(A_{n^z}T_{AL}^2(x_i) + A_{n^z}T_{AU}^2(x_i)\right)\right] \\ + \\ \left[\left(A_{1^a}I_{AL}^2(x_i) + A_{1^a}I_{AU}^2(x_i)\right) + \left(A_{2^a}I_{AL}^2(x_i) + A_{2^a}I_{AU}^2(x_i)\right) + \dots \left(A_{n^z}I_{AL}^2(x_i) + A_{n^z}I_{AU}^2(x_i)\right)\right] \\ + \\ \left[\left(A_{1^a}F_{AL}^2(x_i) + A_{1^a}F_{AU}^2(x_i)\right) + \left(A_{2^a}F_{AL}^2(x_i) + A_{2^a}F_{AU}^2(x_i)\right) + \cdots \left(A_{n^z}F_{AL}^2(x_i) + A_{n^z}F_{AU}^2(x_i)\right)\right] \end{Bmatrix}$$

E (B) → Informational energy of B

$$E(B) = \sum_{1}^{n} \begin{Bmatrix} \left[\left(B_{1^a}T_{AL}^2(x_i) + B_{1^a}T_{AU}^2(x_i)\right) + \left(B_{2^a}T_{AL}^2(x_i) + B_{2^a}T_{AU}^2(x_i)\right) + \cdots \left(B_{n^z}T_{AL}^2(x_i) + B_{n^z}T_{AU}^2(x_i)\right)\right] \\ + \\ \left[\left(B_{1^a}I_{AL}^2(x_i) + B_{1^a}I_{AU}^2(x_i)\right) + \left(B_{2^a}I_{AL}^2(x_i) + B_{2^a}I_{AU}^2(x_i)\right) + \dots \left(B_{n^z}I_{AL}^2(x_i) + B_{n^z}I_{AU}^2(x_i)\right)\right] \\ + \\ \left[\left(B_{1^a}F_{AL}^2(x_i) + B_{1^a}F_{AU}^2(x_i)\right) + \left(B_{2^a}F_{AL}^2(x_i) + B_{2^a}F_{AU}^2(x_i)\right) + \cdots \left(B_{n^z}F_{AL}^2(x_i) + B_{n^z}F_{AU}^2(x_i)\right)\right] \end{Bmatrix}$$

Where

T_{AL} = infimum (lower bound) of truthness value of A

I_{AL} = infimum (lower bound) of indeterminacy value of A

I_{AU} = supremum (upper bound) of indeterminacy value of A

F_{AL}= infimum (lower bound) of Falsity value of A

F_{AU} = supremum (upper bound) of Falsity value of B

And

T_{BL} = infimum (lower bound) of truthiness value of B

T_{BU} = supremum (upper bound) of truthiness value of B

I_{BL}= infimum (lower bound) of indeterminacy value of B

I_{BU} = supremum (upper bound) of indeterminacy value of B

F_{BL}= infimum (lower bound) of Falsity value of B

U = supremum (upper bound) of Falsity value of B

Correlation coefficient of IVNHSS

Let A and B be the two IVNHSS then the correlation coefficient of A and B is denoted by $\mathcal{R}$(A, B) and defined as

$$R(A,B) = \frac{CIVNHSS}{(E(A))^{\frac{1}{2}}.(E(B))^{\frac{1}{2}}} \in [0, 1^{+}[$$

$\mathcal{R}$(A, B) Satisfies the following properties

(1) $0 \leq \mathcal{R}(A, B) \leq 1$

(2) $\mathcal{R}(A, B) = \mathcal{R}(B, A)$

(3) $\mathcal{R}(A, B) = 1$ if A = B

Also the value of T, I, F should be independent of each other, i.e

$$0 \leq \sup T_A(x_i) + \sup I_A(x_i) + \sup F_A(x_i) \leq 3$$

Information about IVNHSS (A)	Information about IVNHSS (B)
$\inf T_A(x_i) \leq \sup T_A(x_i)$	$\inf T_B(x_i) \leq \sup T_B(x_i)$
$\inf I_A(x_i) \leq \sup I_A(x_i)$	$\inf I_B(x_i) \leq \sup I_B(x_i)$
$\inf F_A(x_i) \leq \sup F_A(x_i)$	$\inf F_B(x_i) \leq \sup F_B(x_i)$
$\inf T_A(x_i), \inf I_A(x_i), \inf F_A(x_i) \in [0,1]$	$\inf T_B(x_i), \inf I_B(x_i), \inf F_B(x_i) \in [0,1]$
$\sup T_A(x_i), \sup I_A(x_i), \sup F_A(x_i) \in [0,1]$	$\sup T_B(x_i), \sup I_B(x_i), \sup F_B(x_i) \in [0,1]$

4.2: Case Study

To discuss the

- Validity
- Applicability

of the proposed algorithm, best school selection is considered as a MCDM problem.

Numerical Example:

Let U be the set of different schools nominated for best school given as U = {s^1, s^2, s^3, s^4, s^5} and consider the set of attributes as E = {Teaching standard, organization, ongoing evaluation, Goals}, consider the subset of attributive set A ⊆ E which is $A = \{A_1, A_2, A_3, A_4\}$ where

$$A = \begin{cases} A_1 = \text{teaching standard} \\ A_2 = \text{organization} \\ A_3 = \text{ongoing evaluation} \\ A_4 = \text{goals} \end{cases}$$

These attributes are further bifurcated as

$$A=\begin{cases}A_1^a = A_1 = \text{teaching standard} = \langle \text{High, mediocre, low}\rangle\\ A_1^b = A_2 = \text{organization} = \langle \text{good, average, poor}\rangle\\ A_1^c = A_3 = \text{ongoing evaluation} = \langle \text{yes, no}\rangle\\ A_1^d = A_4 = \text{goals} = \langle \text{effective, committed, up to date}\rangle\end{cases}$$

For discussion we suppose a **SIVNHSS** F (high, average, yes, effective) $= \{s^1, s^5\}$ then

$$A=\sum_1^n\left\langle \begin{matrix}\begin{Bmatrix}s^1\,\{\textbf{high}\,([0.6,0.8],[0.2,0.3],[0.1,0.2])\}+\{\textbf{average}([0.7,0.8],[0.2,0.4],[0.1,0.3])\}\\ +\{\textbf{yes}([0.4,0.6],[0.3,0.5],[0.1,0.3])\}+\{(\textbf{effective}[0.5,0.7],[0.2,0.4],[0.2,0.3])\}\end{Bmatrix}\\ \begin{Bmatrix}s^5\,\{\textbf{high}\,([0.6,0.8],[0.4,0.5],[0.2,0.4])\}+\{\textbf{average}([0.8,0.9],[0.4,0.6],[0.2,0.3])\}\\ +\{\textbf{yes}([0.5,0.7],[0.1,0.3],[0.1,0.4])\}+\{(\textbf{effective}[0.6,0.8],[0.2,0.5],[0.2,0.4])\}\end{Bmatrix}\end{matrix}\right\rangle$$

Let B ⊆ E, B = {B_1, B_2, B_3, B_4} and

$$B=\begin{cases}B_1 = \text{teaching standard}\\ B_2 = \text{organization}\\ B_3 = \text{ongoing evaluation}\\ B_4 = \text{goals}\end{cases}$$

Further bifurcated attributes of B are

$$A=\begin{cases}B_1^a = A_1 = \text{teaching standard} = \langle \text{High, mediocre, low}\rangle\\ B_1^b = A_2 = \text{organization} = \langle \text{good, average, poor}\rangle\\ B_1^c = A_3 = \text{ongoing evaluation} = \langle \text{yes, no}\rangle\\ B_1^d = A_4 = \text{goals} = \langle \text{effective, committed, up to date}\rangle\end{cases}$$

For discussion we suppose a **SIVNHSS** F (high, good, yes, up − to date) $= \{s^2, s^3\}$ then

$$B=\sum_1^n\left\langle \begin{matrix}\begin{Bmatrix}s^2\,\{\textbf{high}\,([0.7,0.9],[0.2,0.4],[0.1,0.3])\}+\{\textbf{good}([0.6,0.8],[0.4,0.5],[0.2,0.3])\}\\ +\{\textbf{yes}([0.7,0.9],[0.4,0.5],[0.2,0.3])\}+\{(\textbf{up}-\textbf{to date}[0.8,0.9],[0.5,0.6],[0.3,0.4])\}\end{Bmatrix}\\ \begin{Bmatrix}s^3\,\{\textbf{high}\,([0.6,0.8],[0.2,0.4],[0.1,0.3])\}+\{\textbf{good}([0.7,0.9],[0.3,0.5],[0.1,0.3])\}\\ +\{\textbf{yes}([0.8,0.9],[0.1,0.3],[0.2,0.4])\}+\{(\textbf{up}-\textbf{to date}[0.6,0.8],[0.3,0.4],[0.3,0.5])\}\end{Bmatrix}\end{matrix}\right\rangle$$

$$C_{VNHSS}$$

$$=\sum_1^n\left\{\begin{bmatrix}((0.6)(0.7)+(0.8)(0.9)\}+\{(0.7)(0.6)+(0.8)(0.8)\}+\{(0.4)(0.7)+(0.6)(0.9)\})\\ +\{(0.5)(0.8)+((0.7)(0.9))\}]+[\{(0.2)(0.2))+(0.3)(0.4))\}+\{((0.2)(0.4))+((0.4)(0.5)\}\\ +\{(0.3)(0.4))+(0.5)(0.6))\}+\{(0.2)(0.5)+(0.4)(0.6)\}]+[\{(0.1)(0.1)+(0.2)(0.3)\}\\ +\{(0.1)(0.2)+(0.3)(0.3)\}+\{(0.1)(0.4)+(0.3)(0.5)\}+\{(0.2)(0.3)+(0.3)(0.4)\}]\\ +\{[[\{(0.6)(0.6)+(0.8)(0.8)\}+\{(0.8)(0.7)+(0.9)(0.9)\}+\{(0.5)(0.8)+(0.7)(0.9)\}+\\ +\{(0.6)(0.6)+(0.8)(0.8)\}]+[\{(0.4)(0.2)+(0.5)(0.4)\}+\{(0.4)(0.3)+(0.6)(0.5)\}\\ +\{(0.1)(0.1)+(0.3)(0.3)\}+\{(0.2)(0.3)+(0.5)(0.4)\}]+[\{(0.2)(0.1)+(0.4)(0.3)\}\\ +\{(0.2)(0.1)+(0.3)(0.3)\}+\{(0.1)(0.2)+(0.4)(0.4)\}+\{(0.2)(0.3)+(0.4)(0.5)\}\end{bmatrix}\right\}$$

$$C_{VNHSS}$$

$$=\sum_1^n\left\{\begin{bmatrix}\{0.42+0.72\}+\{0.42+0.64\}+\{0.28+0.54\}+\{0.4+0.63\}]+[\{0.04+0.12\}\\ +\{0.08+0.2\}+\{0.12+0.3\}+\{0.7+0.24\}]+[\{0.01+0.06\}+\{0.02+0.09\}\\ +\{0.04+0.15\}+\{0.06+0.12\}]\}+\{[[\{0.36+0.64\}+\{0.56+0.8\}+\{0.4+0.63\}\\ +\{0.36+0.64\}]+[\{0.08+0.2\}+\{0.12+0.3\}+\{0.01+0.09\}+\{0.06+0.2\}]\\ +[\{0.02+0.12\}+\{0.02+0.09\}+\{0.02+0.16\}+\{0.06+0.2\}\end{bmatrix}\right\}$$

$$C_{VNHSS}=\sum_1^n\left\{\begin{bmatrix}[\{1.14+1.06+0.82+0.252\}+\{0.16+0.28+0.42+1.36\}\\ +\{0.07+0.11+0.19+0.18\}]+[\{1+1.36+0.252+1\}\\ +\{0.28+0.42+0.1+0.26\}+\{0.14+0.11+0.18+0.26\}\end{bmatrix}\right\}$$

$$C_{VNHSS} = \sum_{1}^{n}\{[3.72 + 2.22 + 0.55] + [3.162 + 1.06 + 0.69]\} = 11.404$$

E(A) = {{[(0.6)^2 + (0.8)^2 + (0.7)^2 + (0.8)^2 + (0.4)^2 + (0.6)^2 + (0.5)2+(0.7)^2] + [(0.2)^2 + (0.3)^2 + (0.2)^2 + (0.4)^2 + (0.3)^2 + (0.5)^2 + (0.2)^2 + (0.4)^2] + [(0.1)^2 + (0.2)^2 + (0.1)^2 + (0.3)^2 + (0.1)^2 + (0.3)^2 + (0.2)^2 + (0.3)^2]} + {[(0.6)^2+ (0.8)^2 + (0.8)^2 + (0.9)^2 + (0.5)^2 + (0.7)^2 + (0.6)^2 + (0.8)^2] + [(0.4)^2 + (0.5)^2 + (0.4)^2 + (0.6)^2 + (0.1)^2 + (0.3)^2 + (0.2)^2 + (0.5)^2] + [(0.2)^2 + (0.4)^2 + (0.2)^2 + (0.3)^2 + (0.1)^2 + (0.4)^2 + (0.2)^2 + (0.4)^{2}Type equation here.]}

$$\mathbf{E\ (A)} = \textstyle\sum_{1}^{n}\{\{\ 3.64 + 0.87 + 0.38\} + \{4.19 + 1.32 + 0.7\}\}$$

$$\mathbf{E\ (A)} = \textstyle\sum_{1}^{n}\{\{\ 4.89 + 6.21\}$$

$$\mathbf{E\ (A)} = 11.1$$

E(B) = $\sum_{1}^{n}${{[(0.7)^2 + (0.9)^2 + (0.6)^2 + (0.8)^2 + (0.7)^2 + (0.9)^2 + (0.8)2+(0.9)^2] + [(0.2)^2 + (0.4)^2 + (0.4)^2 + (0.5)^2 + (0.4)^2 + (0.6)^2 + (0.5)^2 + (0.6)^2] + [(0.1)^2 + (0.3)^2 + (0.2)^2 + (0.3)^2 + (0.4)^2 + (0.5)^2 + (0.3)^2 + (0.4)^2]} + {[(0.6)^2+ (0.8)^2 + (0.7)^2 + (0.9)^2 + (0.8)^2 + (0.9)^2 + (0.6)^2 + (0.8)^2] + [(0.2)^2 + (0.4)^2 + (0.3)^2 + (0.5)^2 + (0.1)^2 + (0.3)^2 + (0.3)^2 + (0.4)^2] + [(0.1)^2 + (0.3)^2 + (0.1)^2 + (0.3)^2 + (0.2)^2 + (0.4)^2 + (0.3)^2 + (0.5^2]}

$$\mathbf{E\ (B)} = \textstyle\sum_{1}^{n}\{\{5.05 + 1.74 + 0.89\} + \{4.75 + 0.89 + 0.74\}\}$$

$$\mathbf{E\ (B)} = \textstyle\sum_{1}^{n}\{7.68 + 6.38\}$$

$$\mathbf{E\ (B)} = 14.06$$

$$\mathcal{R}(A, B) = \frac{CIVNHSS}{(E(A))^{\frac{1}{2}}.(E(B))^{\frac{1}{2}}} \quad \in \quad [0, 1^+ [$$

$$\mathcal{R}(A, B) = \frac{11.404}{(11.1)^{\frac{1}{2}}.(14.06)^{\frac{1}{2}}}$$

$$\mathcal{R}(A, B) = 0.912 \quad \in \quad [0, 1^+ [$$

It shows that the IVNHSS A and B have a good positive relation.

4. Result Discussion

In this section, we discuss the results obtained by using the proposed algorithms. We have proposed generalized-CC for interval-valued neutrosophic hypersoft set, in which we merged two existing theories i.e. interval-valued neutrosophic set theory (IVNSS) and hypersoft set theory (HSS). As we know interval-valued neutrosophic set theories are more accurate, superior and valid. Whereas, the hypersoft set structure is valid in the environment where attributes are further divided into n-terms. Thus, by merging these theories our new decision-making and optimization environment IVNHSS becomes more efficient and faster. Hence, the correlation coefficients-CC's and weighted correlation coefficients-WCC's are used to design an algorithm which can be utilized to solve decision-making problems which have more than one attribute and are further-bifurcated in interval-valued neutrosophic hypersoft environment.

Comparison of Results

It can be concluded from the current investigation, as well as the comparison analysis in Table 1 below, that the results obtained by the suggested technique overlap with those obtained by other approaches. The fundamental benefit of the suggested method in relation to accessible decision-making strategies, however, is that it includes more information. The information about the thing can be evaluated more properly and objectively among them. In the DM process, it's also a great tool for resolving erroneous and imprecise data. In addition, the created method's calculating methodology differs from existing methodologies. As a result, the motivation for the score value corresponding to each parameter will have no effect on other values, resulting in predictable information loss.

As a result, it's a good technique for combining erroneous and ambiguous data in the DM process. As a result, our proposed methodologies are effective, adaptable, and simple.

	Set	**Truthness**	**Indeterminacy**	**Falsity**	**Parameterization**	**Attributes**	**Sub-attributes**
Zadeh [1]	FS	✓	×	×	×	✓	×
Atanassov [2]	IFS	✓	×	✓	×	✓	×
Maji [21]	FSS	✓	×	×	✓	✓	×
Maji [22]	IFSS	✓	×	✓	✓	✓	×
Proposed	IVNHSS	✓	✓	✓	✓	✓	✓

Table: 1 The Comparison of proposed techniques with existing-ones

Based on the findings, it is reasonable to conclude that the suggested technique provides greater stability and usability for decision-makers in the DM procedure.

5. Conclusions

In decision making measure of fuzziness (entropy) is an important factor. The measurement of fuzziness in neutrosophic environment plays a vital role, since neutrosophic numbers and its decision-making approaches are used in many daily life issues like HR personnel selection, equipment selection, shortest path selection, engineering and medical etc. The validity and superiority can be measure by considering the value of fuzziness, when this value of fuzziness is less, then it can be considered as the best modelling and more accurate. Under the IVNHSS context, we introduced entropy, and generalized correlation coefficients. Based on the established correlation coefficient, a decision-making strategy has been constructed. Finally, a numerical example of best school selection is solved. In future, this concept of entropy and correlation coefficients can be extended to m-polar NHSS.

Conflicts of Interest

The authors declare no conflict of interest.

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