Review of Generalized Neutrosophic Soft Set in Solving Multiple Expert Decision Making Problems

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Abstract

To manage issues with incompleteness, indeterminacy, and awareness of inconsistent information, Maji presented the idea of a neutrosophic soft set by merging the ideas of a neutrosophic set and a soft set. The generalized neutrosophic soft set (GNSS) is an extension of this idea, which has now been developed further. At the beginning of this paper, we describe the definition of a generalized neutrosophic soft set. Then, we focus on the concepts of GNSS operations, such as AND, OR, complement, intersection, and union, and provide illustrated examples to describe a number of associated properties. Finally, a description of an algorithm and an application that uses GNSS to address challenges that arise when making decisions that need the experience of more than one specialist is offered here.

Keywords: Soft set; Neutrosophic soft set; Generalized neutrosophic soft set; Multiple expert decision making.

1. Introduction

In the everyday life, there is always a degree of uncertainty, which makes it a research topic in many fields of study. Most engineering, medical research, economics, and environmental issues are inherently uncertain. [1] Molodtsov was the originator of the soft set theory, a revolutionary mathematical method for dealing with uncertainty. This theory differs from more traditional approaches to dealing with uncertainty, since it includes a parameterization tool. It has applications in a wide range of domains, including function smoothing, Riemann integration, measurement, game theory, decision-making, and so on. We must deal with indeterminate and partial knowledge in some real-world challenges in order to properly describe an item in an uncertain and ambiguous setting. With the work of Maji et al. [2], a theoretical study of soft set theory may now go into greater depth. Additionally, it has been used in a variety of algebraic structures, including groups [3, 4], semi-rings [5], rings [6], BCK/BCI algebras [7, 8], d-algebras [9], ordered semi-groups [10], and BL algebras [11].

The proposal of Neutrosophic Logic was made by Florentine Smarandache [12]. The adjective "neutrosophic" comes from the word "neutrosophic," which means "knowledge of neutral thoughts". In French, neutral means "neutral," while in Greek, Sophia means "skill or wisdom". Each neutrosophic set (NS) component is defined by three opposing estimations that correspond to compressed, incorrect, and nonsensical data. Logic Neutrosophic has been established to express the mathematical model of ambiguity and inconsistency, uncertainty, vagueness, imprecision, undefined, redundancy, and contradiction, as well as the lack of completeness in the data it represents. In neutrosophic logic, truth, uncertainty, and falsity are measured in terms of a formal

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framework. True, indeterminate, and falsified members of NS each have their own distinct indeterminacy membership. This presumption is critical in a variety of contexts, including data fusion, which involves combining data from several sensors. The neutrosophic set derives its value from the real standard or non-standard subset of]-0, 1+[from a philosophical perspective. However, it is difficult to employ an NS with values from a real standard or non-standard subset of] -0, 1+ [in real-world scientific and engineering situations. As a consequence, we analyze the fuzzy neutrosophic set, which derives its value from the [0, 1] subset.

Smarandache [13] first proposed a single-valued neutrosophic set (SVNS). Operations and many features of SVNSs were presented by Wang et al. [14]. In [15, 16] the use of correlation coefficient in a single-valued neutrosophic environment for multi-attribute decision-making (MADM) has been discussed. Ye [17, 18] improved the clustering approach and decision-making procedures using SVNS similarity measures. [19] Proposed a new SVNS similarity measure and used it to make decisions. [20] Developed a multi-attribute single-valued neutrosophic decision-making issue using (TOPSIS) technique. [21] Presented and studied the features of single-valued neutrosophic relations. When it came to clustering and MADM, Huang [22] used a new SVNS distance measure he devised. Cross-entropy and prioritized aggregation operators were proposed in [23]. Broumi has developed single and bipolar single-valued neutrosophic graphs [24–26]. To solve the multi-valued neutrosophic MADM issue, Peng et al. [27, 28] presented an ELECTRE technique and a qualitative flexible approach based on probability. A projection-based TODIM technique for the multi-valued neutrosophic MADM issue was developed by Ji et al. [29]. Under a simplified neutrosophic uncertain linguistic environment, Tian et al. [30] suggested a MADM based on generalized prioritized aggregation operators.

Maji [31] presented the SVNSS, by combining neutrosophic set and soft set theory. [32] Using SVNSS various similarity measures were established, which were then applied to real-world difficulties. Deli and Broumi [33] proposed neutrosophic soft matrices (NSM) and NSM decision-making that is now in use. The time-neutrosophic soft set was presented by Alkhazaleh [34], who then went on to study some of its features in depth. The neutrosophic vague soft expert set theory was proposed in [35], and its properties were examined in depth.

Generalized neutrosophic soft set (GNSS) definition and operations have been discussed in this article [36]. This theory has also been applied to a decision-making situation. [37] For neutrosophic soft sets (NSS) and generalized neutrosophic soft sets, similarity measures were given. How GNSS is utilized to aid decision-making was discussed here. [38] In this paper, the GNSES-aggregation operator has been defined to build an algorithm for a GNSES decision-making approach.

In Section 2, we provide the fundamental concepts of neutrosophic set, neutrosophic soft set, and generalized neutrosophic soft set. Section 3 introduces generalized neutrosophic soft set properties, operations, and propositions. Section 4 discusses a multiple expert decision-making method based on generalized neutrosophic soft sets.

2. Preliminaries

2.1. Soft Set

Let Ũ is an initial universe set and Ë is a set of parameters. Let Ṕ(Ũ) denotes the power set of Ũ. Consider a nonempty set □ , where □ ⊂ Ë. A pair (□ , □) is called a soft set over Ũ, where □ is a mapping given by [1], □ : □ → Ṕ(Ũ).

Where □ (□)(ҧ) = ∅ if ҧ ∉ Ũ. Here, □ (□) is called the approximate function of the soft set (□ , □) and the value is a set called the ҧ-element of the soft set for all ҧ ∈ Ũ.

2.2. Neutrosophic Set

A neutrosophic set (NS) Ł on the universe of discourse Ħ is defined as [12],
Ł = {< ҧ, Ӂ(ҧ), Ѥ(ҧ), Ψ(ҧ) >, ҧ ∈ Ħ}, and Ħ ⊂ Ũ
Where; Ӂ, Ѥ, Ψ: Ħ →] $^{-}0, 1^{+}$ [and $^{-}0 \leq$ Ӂ(ҧ) + Ѥ(ҧ) + Ψ(ҧ) $\leq 3^{+}$.

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2.3. Neutrosophic Soft Set

Let Ũ = Initial universe set
Ë = Set of parameters.
Ṕ(Ũ) = Set of all neutrosophic sets of Ũ.
Neutrosophic soft set (NSS) (□ , □) over Ũ is defined by a mapping [39].
□ : □ → Ṕ(Ũ)
Here, □ = Approximate function of the NSS (□ , □). It can be written as a set of ordered pairs,
(□ , □) = {(□ ⟨ɲ, Ӂ$_□$(ɲ), Ҽ$_□$(ɲ), Ψ$_□$(ɲ) ⟩: ɲ ∈ Ħ): □ ∈ Ë and Ħ ⊂ Ũ}
Where Ӂ$_□$(ɲ), Ҽ$_□$(ɲ), Ψ$_□$(ɲ) ∈ [0, 1], respectively called the truth-membership, indeterminacy-membership, and falsity-membership function. 0 ≤ Ӂ$_□$(ɲ) + Ҽ$_□$(ɲ) + Ψ$_□$(ɲ) ≤ 3. Each of the parameters is either a neutrosophic word or a statement. NSS was first defined by Maji [33], and afterward, Deli and Broumi [38] refined this notion.

2.4. Generalized Neutrosophic Set

Let Ӿ is a non-empty set. Generalized neutrosophic set Ḵ is an object having the form [40],
Ḵ = {< ɲ: Ӂ$_Ḵ$(ɲ), Ҽ$_Ḵ$(ɲ), Ψ$_Ḵ$(ɲ) >, ɲ ∈ Ũ}

3. Generalized Neutrosophic Soft Set (GNSS)

Let Ũ be an initial universe set and □ ⊂ Ë be a set of parameters. Let GNSS(Ũ) denotes the set of all generalized neutrosophic sets of Ũ. (□ , □) is the collection of soft GNS over Ũ, where □ is a mapping given by □ : □ → GNSS(Ũ).

It is a hybrid structure containing both a generalized neutrosophic set (GNS) and a soft set (SS). Each parameter is a generalized neutrosophic word or sentence involving generalized neutrosophic words.

Example 1:
Let Ħ = Set of houses = {ɲ$_1$, ɲ$_2$, ɲ$_3$, ɲ$_4$} and Ħ ⊂ Ũ.
Ë = {close to hospital, close to school, close to bus stand, close to market, strict security, well maintained, close to temple}
□ = Set of selected parameters or qualities = {□$_1$, □$_2$, □$_3$, □$_4$}, □ ⊂ Ë
Where, □$_1$ = Close to hospital
□$_2$ = Close to school
□$_3$ = Strict security
□$_4$ = Well maintained
Let, GNSS(□ , □) = { Close to hospital = {<ɲ$_1$, 0.8, 0.5, 0.2>, <ɲ$_2$, 0.7, 0.4, 0.2>, <ɲ$_3$, 0.5, 0.1, 0.6>, <ɲ$_4$, 0.6, 0.1, 0.5>}, Close to school = {<ɲ$_1$, 0.7, 0.2, 0.3>, <ɲ$_2$, 0.9, 0.3, 0.5>, <ɲ$_3$, 0.8, 0.1, 0.7>, <ɲ$_4$, 0.9, 0.4, 0.5>}, Strict security = {<ɲ$_1$, 0.5, 0.4, 0.7>, <ɲ$_2$, 0.8, 0.5, 0.6>, <ɲ$_3$, 0.6, 0.4, 0.2>, <ɲ$_4$, 0.8, 0.3, 0.4>}, Well maintained = {<ɲ$_1$, 0.7, 0.3, 0.2>, <ɲ$_2$, 0.9, 0.1, 0.5>, <ɲ$_3$, 0.8, 0.5, 0.2>, <ɲ$_4$, 0.3, 0.2, 0.7> }}.
For □ (□$_1$) = 'houses(Close to hospital)', functional value is GNS {<ɲ$_1$, 0.8, 0.5, 0.2>, <ɲ$_2$, 0.7, 0.4, 0.2>, <ɲ$_3$, 0.5, 0.1, 0.6>, <ɲ$_4$, 0.6, 0.1, 0.5>}. Here 'Close to hospital' is the predicate and {<ɲ$_1$, 0.8, 0.5, 0.2>, <ɲ$_2$, 0.7, 0.4, 0.2>, <ɲ$_3$, 0.5, 0.1, 0.6>, <ɲ$_4$, 0.6, 0.1, 0.5>} is the approximate value-set. The tabular representation of GNSS(□ , □) is described in Table 1.

Table 1: GNSS(□ , □)

Ũ	Close to hospital	Close to school	Strict security	Well maintained
ɲ$_1$	0.8, 0.5, 0.2	0.7, 0.2, 0.3	0.5, 0.4, 0.7	0.7, 0.3, 0.2
ɲ$_2$	0.7, 0.4, 0.2	0.9, 0.3, 0.5	0.8, 0.5, 0.6	0.9, 0.1, 0.5
ɲ$_3$	0.5, 0.1, 0.6	0.8, 0.1, 0.7	0.6, 0.4, 0.2	0.8, 0.5, 0.2
ɲ$_4$	0.6, 0.1, 0.5	0.9, 0.4, 0.5	0.8, 0.3, 0.4	0.3, 0.2, 0.7

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3.1. Properties of GNSS [38]

3.1.1. A generalized neutrosophic soft subset

Let (□ , □) and (Ƭ, □) are two GNSS. (□ , □) is a generalized neutrosophic soft subset of (Ƭ, □) if:

(i) □ ⊂ □ .

(ii) □(□) is a generalizedneutrosophic subset of Ƭ(□).

Or, $Ӝ_{□(□)}(ȷъ) \leq Ӝ_{Ƭ(□)}(ȷъ)$, $Ӄ_{□(□)}(ȷъ) \geq Ӄ_{Ƭ(□)}(ȷъ)$, $Ψ_{□(□)}(ȷъ) \geq Ψ_{Ƭ(□)}(ȷъ)$, ∀□∈□, ȷъ ∈ Ũ. Symbolized as (□ , □)⊆ (Ƭ, □). (□ , □) is generalized neutrosophic soft super set of (Ƭ, □) if (Ƭ, □) is a generalized neutrosophic soft subset of (□ , □). Symbolized (□ , □⊇ (Ƭ, □).

Example 2:

Let, GNSS(Ƭ, □) ={Close to hospital = {<$ȷъ_1$, 0.8, 0.4, 0.3>, <$ȷъ_2$, 0.6, 0.5, 0.1>, <$ȷъ_3$, 0.7, 0.3, 0.5>, <$ȷъ_4$, 0.6, 0.2, 0.6>}, Close to school = {<$ȷъ_1$, 0.8, 0.5, 0.3>, <$ȷъ_2$, 0.6, 0.5, 0.3>, <$ȷъ_3$, 0.9, 0.1, 0.2>, <$ȷъ_4$, 0.7, 0.4, 0.2>}, Strict security = {<$ȷъ_1$, 0.5, 0.2, 0.7>, <$ȷъ_2$, 0.6, 0.5, 0.4>, <$ȷъ_3$, 0.5, 0.4, 0.3>, <$ȷъ_4$, 0.8, 0.4, 0.3>}, Well maintained = {<$ȷъ_1$, 0.8, 0.3, 0.1>, <$ȷъ_2$, 0.9, 0.1, 0.6>, <$ȷъ_3$, 0.5, 0.6, 0.2>, <$ȷъ_4$, 0.5, 0.4, 0.7> }, Close to market = {<$ȷъ_1$, 0.7, 0.4, 0.2>, <$ȷъ_2$, 0.5, 0.5, 0.2>, <$ȷъ_3$, 0.9, 0.5, 0.6>, <$ȷъ_4$, 0.5, 0.7, 0.9>}}

The tabular representation of GNSS (Ƭ, □) is described in Table 2.

Table 2: GNSS (Ƭ, □)

Ũ	Close to hospital	Close to school	Strict security	Well maintained	Close to market
$ȷъ_1$	0.8, 0.4, 0.3	0.8, 0.5, 0.3	0.5, 0.2, 0.7	0.8, 0.3, 0.1	0.7, 0.4, 0.2
$ȷъ_2$	0.6, 0.5, 0.1	0.6, 0.5, 0.3	0.6, 0.5, 0.4	0.9, 0.1, 0.6	0.5, 0.5, 0.2
$ȷъ_3$	0.7, 0.3, 0.5	0.9, 0.1, 0.2	0.5, 0.4, 0.3	0.5, 0.6, 0.2	0.9, 0.5, 0.6
$ȷъ_4$	0.6, 0.2, 0.6	0.7, 0.4, 0.2	0.8, 0.4, 0.3	0.5, 0.4, 0.7	0.5, 0.7, 0.9

Using Example 1, clearly, we have (□ , □)⊑ (Ƭ, □).

3.1.2. Generalized neutrosophic soft equal set

(□ , □) = (Ƭ, □), if (□ , □⊂) (Ƭ, □) and (□ , □ ⊃ (Ƭ, □)

3.1.3. Generalized neutrosophic soft not set

The NOT set of □ = {$□_1$, $□_2$, • • • $□_□$} is denoted by ˥□ .

˥□ = {˥$□_1$, ˥$□_2$, • • • ˥$□_□$}, where ˥$□_φ$ = not $□_φ$, ∀φ.

3.1.4. Complement of GNSS

It is denoted by (□ , □)^c and is defined by (□ , □)^c = ($□^c$, ˥□). Where $□^c$:˥□ → Ұ(Ũ) is a mapping given by $□^c$(ђ) = Generalized neutrosophic soft complement with $Ӝ_□^c(ȷъ) = Ψ_□(ȷъ)$, $Ӄ_□^c(ȷъ) = Ӄ_□(ȷъ)$ and $Ψ_□^c(ȷъ) = Ӝ_□(ȷъ)$.

Example 3:

(□ , □)^c describes the facilities which are not accessible within the house. According to example 1, the tabular representation of GNSS(□ , □)^c is described in Table 3.

Table 3: GNSS(□ , □)^c

Ũ	not close to the hospital	not close to school	no strict security	not well maintained
$ȷъ_1$	0.2, 0.5, 0.8	0.3, 0.2, 0.7	0.7, 0.4, 0.5	0.2, 0.3, 0.7
$ȷъ_2$	0.2, 0.4, 0.7	0.5, 0.3, 0.9	0.6, 0.5, 0.8	0.5, 0.1, 0.9

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$ԉ_3$	0.6, 0.1, 0.5	0.7, 0.1, 0.8	0.2, 0.4, 0.6	0.2, 0.5, 0.8
$ԉ_4$	0.5, 0.1, 0.6	0.5, 0.4, 0.9	0.4, 0.3, 0.8	0.7, 0.2, 0.3

3.1.5. Generalized neutrosophic null soft set

The GNSS(□ , □) is said to be empty or null if $Ӂ_{□(□)}(ԉ) = 0$, $Ψ_{□(□)}(ԉ) = 0$ and $Ҝ_{□(□)}(ԉ) = 0$, ∀ԉ ∈ Ũ, ∀□ ∈ □ .

3.2. Operations on GNSS [36]

3.2.1. Union of two GNSS

Let (□ , □) and (Ƭ, □) be two GNSS. Then the union of (□ , □) and (Ƭ, □) is denoted by,
(□ , □) ∪ (Ƭ, □) = (Ɠ, Ȼ), where Ȼ=□ ∪ □ and

$Ӂ_{Ɠ(□)}(ԉ) = Ӂ_{□(□)}(ԉ)$, if ṽ ∈ □ − □ ,
$= Ӂ_{Ƭ(□)}(ԉ)$, if ṽ ∈ □ − □ ,
$= \max(Ӂ_{□(□)}(ԉ), Ӂ_{Ƭ(□)}(ԉ))$, if ӥ ∈ □ ∩ □ .
$Ҝ_{Ɠ(□)}(ԉ) = Ҝ_{□(□)}(ԉ)$, if ṽ ∈ □ − □ ,
$= Ҝ_{Ƭ(□)}(ԉ)$, if ṽ ∈ □ − □ ,
$= \min(Ҝ_{□(□)}(ԉ), Ҝ_{Ƭ(□)}(ԉ))$, if ӥ ∈ □ ∩ □ .
$Ψ_{Ɠ(□)}(ԉ) = Ψ_{□(□)}(ԉ)$, if ṽ ∈ □ − □ ,
$= Ψ_{Ƭ(□)}(ԉ)$, if ṽ ∈ □ − □ ,
$= \min(Ψ_{□(□)}(ԉ), Ψ_{Ƭ(□)}(ԉ))$, if ӥ ∈ □ ∩ □ .

Example 4:
Let tabular representation of the GNSS(□ , □) be given in Table 4.

Table 4: GNSS(□ , □)

Ũ	Close to hospital	Close to school	Well maintained
$ԉ_1$	0.8, 0.5, 0.2	0.7, 0.2, 0.3	0.7, 0.3, 0.2
$ԉ_2$	0.7, 0.4, 0.2	0.9, 0.3, 0.5	0.9, 0.1, 0.5
$ԉ_3$	0.5, 0.1, 0.6	0.8, 0.1, 0.7	0.8, 0.5, 0.2
$ԉ_4$	0.6, 0.1, 0.5	0.9, 0.4, 0.5	0.3, 0.2, 0.7

A tabular representation of the GNSS(Ƭ, □) is given inTable 5.

Table 5: GNSS(Ƭ, □)

Ũ	Strict security	Well maintained
$ԉ_1$	0.5, 0.4, 0.7	0.5, 0.4, 0.6
$ԉ_2$	0.8, 0.5, 0.6	0.7, 0.6, 0.3
$ԉ_3$	0.6, 0.4, 0.2	0.9, 0.8, 0.1
$ԉ_4$	0.8, 0.3, 0.4	0.6, 0.5, 0.4

The result of union operation GNSS(Ɠ, Ȼ) can be represented in Table 6.

Table 6: Result of union operation GNSS(Ɠ, Ȼ)

Ũ	Close to hospital	Close to school	Strict security	Well maintained
$ԉ_1$	0.8, 0.5, 0.2	0.7, 0.2, 0.3	0.5, 0.4, 0.7	0.7, 0.3, 0.2
$ԉ_2$	0.7, 0.4, 0.2	0.9, 0.3, 0.5	0.8, 0.5, 0.6	0.9, 0.1, 0.3
$ԉ_3$	0.5, 0.1, 0.6	0.8, 0.1, 0.7	0.6, 0.4, 0.2	0.9, 0.5, 0.1
$ԉ_4$	0.6, 0.1, 0.5	0.9, 0.4, 0.5	0.8, 0.3, 0.4	0.6, 0.2, 0.4

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3.2.2. *The intersection of two GNSS*

The intersection of (□ , □) and (Ƭ, □) is denoted by (□ , □) ∩ (Ƭ, □) = (Ɠ, Ȼ),
Where Ȼ = □ ∩ □ and $Ӂ_{Ɠ(□)}(ɲ) = \min(Ӂ_{□(□)}(ɲ), Ӂ_{Ƭ(□)}(ɲ))$;
$ІЄ_{Ɠ(□)}(ɲ) = \min(ІЄ_{□(□)}(ɲ), ІЄ_{Ƭ(□)}(ɲ))$;
$Ψ_{Ɠ(□)}(ɲ) = \max(Ψ_{□(□)}(ɲ), Ψ_{Ƭ(□)}(ɲ))$, ∀ й ∈ Ȼ

Example 5:
According to example 4, the intersection result GNSS(Ɠ, Ȼ)) can be represented in Table 7.

Table 7: Result of intersection operation GNSS(Ɠ, Ȼ)

Ũ	Well maintained
$ɲ_1$	0.5, 0.3, 0.6
$ɲ_2$	0.7, 0.1, 0.5
$ɲ_3$	0.8, 0.5, 0.2
$ɲ_4$	0.3, 0.2, 0.7

3.2.3. *AND operation on two GNSS*

The 'AND' operation is denoted by (□ , □)∧ (Ƭ, □) = (Ɠ, □ × □),
Where, $Ӂ_{Ɠ(ȶ, ȡ)}(ɲ) = \min(Ӂ_{□(ȶ)}(ɲ), Ӂ_{Ƭ(ȡ)}(ɲ))$
$ІЄ_{Ɠ(ȶ, ȡ)}(ɲ) = \min(ІЄ_{□(ȶ)}(ɲ), ІЄ_{Ƭ(ȡ)}(ɲ))$
$Ψ_{Ɠ(ȶ, ȡ)}(ɲ) = \max(Ψ_{□(ȶ)}(ɲ), Ψ_{Ƭ(ȡ)}(ɲ))$, ∀ȶ ∈ □ ,∀ȡ ∈ □

Example 6:
According to example 4, the AND result GNSS(Ɠ, □ × □) can be represented in Table 8,

Table 8: Result of AND operation GNSS(Ɠ, □ × □)

Ũ	Close to hospital, Strict security	Close to school, Strict security	Well-maintained, Strict security	Close to hospital, Well maintained	Close to school, Well maintained,	Well maintained, Well maintained
$ɲ_1$	0.5, 0.4, 0.7	0.5, 0.2, 0.7	0.5, 0.3, 0.7	0.5, 0.4, 0.6	0.5, 0.2, 0.6	0.5, 0.3, 0.6
$ɲ_2$	0.7, 0.4, 0.6	0.8, 0.3, 0.6	0.8, 0.1, 0.6	0.7, 0.4, 0.3	0.7, 0.3, 0.5	0.7, 0.1, 0.5
$ɲ_3$	0.5, 0.1, 0.6	0.6, 0.1, 0.7	0.6, 0.4, 0.2	0.5, 0.1, 0.6	0.8, 0.1, 0.7	0.8, 0.5, 0.2
$ɲ_4$	0.6, 0.1, 0.5	0.8, 0.3, 0.5	0.3, 0.2, 0.7	0.6, 0.1, 0.5	0.6, 0.4, 0.5	0.3, 0.2, 0.7

3.2.4. *OR operation on two GNSS*

The 'OR' operation is denoted by (□ , □)∨ (Ƭ, □)= (Ɠ, □ × □).
Where, $Ӂ_{Ɠ(ȶ, ȡ)}(ɲ) = \max(Ӂ_{□(ȶ)}(ɲ), Ӂ_{Ƭ(ȡ)}(ɲ))$;
$ІЄ_{Ɠ(ȶ, ȡ)}(ɲ) = \min(ІЄ_{□(ȶ)}(ɲ), ІЄ_{Ƭ(ȡ)}(ɲ))$;
$Ψ_{Ɠ(ȶ, ȡ)}(ɲ) = \min(Ψ_{□(ȶ)}(ɲ), Ψ_{Ƭ(ȡ)}(ɲ))$, ∀ȶ ∈ □ ,∀ȡ ∈ □

Example 7:
According to example 4, the OR result GNSS(Ɠ, □ × □) can be represented as in Table 9.

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Table 9: Result of OR operation GNSS(Ǥ, □ × □)

Ũ	Close to hospital, Strict security	Close to school, Strict security	Well-maintained, Strict security	Close to hospital, Well maintained	Close to school, Well maintained,	Well maintained, Well maintained
$ɲ_1$	0.8, 0.4, 0.2	0.7, 0.2, 0.3	0.7, 0.3, 0.2	0.8, 0.4, 0.2	0.7, 0.2, 0.3	0.7, 0.3, 0.2
$ɲ_2$	0.8, 0.4, 0.2	0.9, 0.3, 0.5	0.9, 0.1, 0.5	0.7, 0.4, 0.2	0.9, 0.3, 0.3	0.9, 0.1, 0.3
$ɲ_3$	0.6, 0.1, 0.2	0.8, 0.1, 0.2	0.8, 0.4, 0.2	0.9, 0.1, 0.1	0.9, 0.1, 0.1	0.9, 0.5, 0.1
$ɲ_4$	0.8, 0.1, 0.4	0.9, 0.3, 0.4	0.8, 0.2, 0.4	0.6, 0.1, 0.4	0.9, 0.4, 0.4	0.6, 0.2, 0.4

3.3. Proposition on GNSS

If (□ , □), (Ҭ, □) and (□ , □) are three GNSS over Ũ, then;

- (i) (□ , □) ∪ (□ , □) = (□ , □)
- (ii) (□ , □) ∩ (□ , □) = (□ , □)
- (iii) (□ , □) ∪ (Ҭ, □) = (Ҭ, □) ∪ (□ , □)
- (iv) (□ , □) ∩ (Ҭ, □) = (Ҭ, □) ∩ (□ , □)
- (v) (□ , □) ∪ Φ = (□ , □)
- (vi) (□ , □) ∩ Φ = Φ
- (vii) [(□ , □)^c]^c = (□ , □)
- (viii) (□ , □) ∩ [(Ҭ, □) ∩ (□ , □)] = [(□ , □) ∩ (Ҭ, □)] ∩ (□ , □)
- (ix) (□ , □) ∪ [(Ҭ, □) ∪ (□ , □)] = [(□ , □) ∪ (Ҭ, □)] ∪ (□ , □)
- (x) (□ , □) ∪ [(Ҭ, □) ∩ (□ , □)] = [(□ , □) ∪ (Ҭ, □)] ∩ [(□ , □) ∪ (□ , □)]
- (xi) (□ , □) ∩ [(Ҭ, □) ∪ (□ , □)] = [(□ , □) ∩ (Ҭ, □)] ∪ [(□ , □) ∩ (□ , □)]
- (xii) [(□ , □) ∧ (Ҭ, □)]^c = (□ , □)^c ∨ (Ҭ, □)^c
- (xiii) [(□ , □) ∨ (Ҭ, □)]^c = (□ , □)^c ∧ (Ҭ, □)^c

4. Algorithm for GNSS

Here, we provided an explanation of an algorithm that makes use of GNSS to address the difficulties that arise when making judgments that require more than one specialist.

Step-1:
Assume that Ũ will represent the universal set, while Ë will stand for the set of parameters.
Step-2:
Input k, the choice parameter that selects more preferred parameters from a collection of parameters.
Step-3:
Determine GNSS(□ , □) based on the recommendations of several specialists, and will provide the outcomes in separate tables.
Step-4:
The aggregate table should be computed for each of the experts. Where,

- Truth-membership; $\breve{Ж}_{agg}(\tilde{U}_{\varphi}, □) = \frac{1}{□}\sum_{ʒ=1}^{□} Ж_{ʒ}(\tilde{U}_{\varphi}, □)$ (1)
- Indeterminacy-membership; $Ꞓ_{agg}(\tilde{U}_{\varphi}, □) = \frac{1}{□}\sum_{ʒ=1}^{□} Ꞓ_{ʒ}(\tilde{U}_{\varphi}, □)$ (2)
- Falsity-membership; $\Psi_{agg}(\tilde{U}_{\varphi}, □) = \frac{1}{□}\sum_{ʒ=1}^{□} \Psi_{ʒ}(\tilde{U}_{\varphi}, □)$ (3)

Step-5:
Compute the table of scores for each of the experts.
Score $(Ƨ_{\varphi}) = \left| \breve{Ж}_{agg}(\tilde{U}_{\varphi}) - Ꞓ_{agg}(\tilde{U}_{\varphi}) - \Psi_{agg}(\tilde{U}_{\varphi}) \right|$, where φ = {1, 2,. . .ɯ}.
Step-6:
Compute the choice value $Ḉ_{\varphi}$ of $\tilde{U}_{\varphi}$ for any $\tilde{U}_{\varphi} \in$ Ũ, by adding the score value of each expert for that particular $\tilde{U}_{\varphi}$.
Step-7:
The optimal decision is to select $\tilde{U}_{ɖ}$ if $Ḉ_{ɖ} = \max Ḉ_{\varphi}$ for all $\tilde{U}_{\varphi} \in$ Ũ.

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Step-8:
If ƌ has more than one value, then any one of the options in Ḉ will be the better option.

5. Application of GNSS in Multiple Expert Decision-Making Problem

Let's say there is a group of universities, Ň = {Œ$_1$, Œ$_2$, Œ$_3$, Œ$_4$, Œ$_5$}, where Ň ⊂ Ũ. Suppose a student wants to enroll at the finest university for him. As a result, he enlisted the help of various experts to determine which university is the greatest. The set of experts, Ҳ = {Ḇ, Ḏ, Ṉ, Ẕ}. Assume that, there are seven factors or parameters to consider while selecting a university, Ë = {□$_1$, □$_2$, □$_3$, □$_4$, □$_5$, □$_6$, □$_7$}.

Where □$_1$ = Discipline
□$_2$ = Placement
□$_3$ = Teaching Facility
□$_4$ = Fees
□$_5$ = Research opportunities
□$_6$ = Health and wellness facilities
□$_7$ = Campus Safety

The parameters will be different for each student and the outcome will vary depending on the parameters.

Step-1:
According to this illustration, Ũ stands for the whole universe of universities, and Ë denotes the characteristics or qualities of universities upon which a student might make his or her decision to enroll in a particular university.

Step-2:
Let us take into consideration the criteria or parameters selected by a student which are significant or vital in order to choose a university for higher education that is most appropriate for him.
□ = Selected parameters by a student = {□$_1$, □$_2$, □$_3$, □$_4$} = {Discipline, Placement, Teaching facility, Fees}, where □ ⊂ Ë.

Step-3:
The responses of each of the expert Ḇ, Ḏ, Ṉ, and Ẕ about the various universities have been organized into tables 10, 11, 12, and 13 respectively.

GNSS of Expert Ḇ

Table 10: GNSS$_{Ḇ}$(Ƭ, □)

Ň	□$_1$	□$_2$	□$_3$	□$_4$
Œ$_1$	0.6, 0.3, 0.4	0.5, 0.1, 0.5	0.8, 0.7, 0.1	0.7, 0.3, 0.4
Œ$_2$	0.4, 0.2, 0.1	0.4, 0.8, 0.1	0.2, 0.3, 0.7	0.6, 0.2, 0.1
Œ$_3$	0.8, 0.7, 0.2	0.6, 0.7, 0.4	0.4, 0.3, 0.8	0.4, 0.3, 0.6
Œ$_4$	0.3, 0.5, 0.6	0.5, 0.2, 0.3	0.5, 0.6, 0.7	0.8, 0.1, 0.5
Œ$_5$	0.7, 0.3, 0.4	0.3, 0.5, 0.6	0.3, 0.2, 0.5	0.7, 0.4, 0.2

GNSS$_{Ḇ}$(Ƭ, □) = [(□$_1$, {<Œ$_1$, 0.6, 0.3, 0.4>, <Œ$_2$, 0.4, 0.2, 0.1>, <Œ$_3$, 0.8, 0.7, 0.2>, <Œ$_4$, 0.3, 0.5, 0.6>, <Œ$_5$, 0.7, 0.3, 0.4>}), (□$_2$, {<Œ$_1$, 0.5, 0.1, 0.5>, <Œ$_2$, 0.4, 0.8, 0.1>, <Œ$_3$, 0.6, 0.7, 0.4>, <Œ$_4$, 0.5, 0.2, 0.3>, <Œ$_5$, 0.3, 0.5, 0.6>}), (□$_3$, {<Œ$_1$, 0.8, 0.7, 0.1>, <Œ$_2$, 0.2, 0.3, 0.7>, <Œ$_3$, 0.4, 0.3, 0.8>, <Œ$_4$, 0.5, 0.6, 0.7>, <Œ$_5$, 0.3, 0.2, 0.5>}), (□$_4$, {<Œ$_1$, 0.7, 0.3, 0.4>, <Œ$_2$, 0.6, 0.2, 0.1>, <Œ$_3$, 0.4, 0.3, 0.6>, <Œ$_4$, 0.8, 0.1, 0.5>, <Œ$_5$, 0.7, 0.4, 0.2>})]

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GNSS of Expert Ḏ

Table 11: GNSS$_{Ḏ}$(Ŧ, □)

Ň	□$_1$	□$_2$	□$_3$	□$_4$
Œ$_1$	0.6, 0.4, 0.5	0.4, 0.5, 0.7	0.8, 0.1, 0.2	0.7, 0.1, 0.2
Œ$_2$	0.3, 0.2, 0.7	0.8, 0.2, 0.3	0.6, 0.4, 0.3	0.5, 0.3, 0.6
Œ$_3$	0.8, 0.4, 0.6	0.7, 0.1, 0.8	0.5, 0.6, 0.2	0.6, 0.1, 0.8
Œ$_4$	0.7, 0.1, 0.8	0.4, 0.5, 0.1	0.3, 0.4, 0.5	0.4, 0.6, 0.2

GNSS$_{Ḏ}$(Ŧ, □)= [(□$_1$, {<Œ$_1$, 0.6, 0.4, 0.5>, <Œ$_2$, 0.3, 0.2, 0.7>, <Œ$_3$, 0.8, 0.4, 0.6>, <Œ$_4$, 0.7, 0.1, 0.8>, <Œ$_5$, 0.6, 0.3, 0.2>}), (□$_2$, {<Œ$_1$, 0.4, 0.5, 0.7>, <Œ$_2$, 0.8, 0.2, 0.3>, <Œ$_3$, 0.7, 0.1, 0.8>, <Œ$_4$, 0.4, 0.5, 0.1>, <Œ$_5$, 0.6, 0.7, 0.3>}), (□$_3$, {<Œ$_1$, 0.8, 0.1, 0.2>, <Œ$_2$, 0.6, 0.4, 0.3>, <Œ$_3$, 0.5, 0.6, 0.2>, <Œ$_4$, 0.3, 0.4, 0.5>, <Œ$_5$, 0.6, 0.3, 0.8>}), (□$_4$, {<Œ$_1$, 0.7, 0.1, 0.2>, <Œ$_2$, 0.5, 0.3, 0.6>, <Œ$_3$, 0.6, 0.1, 0.8>, <Œ$_4$, 0.4, 0.6, 0.2>, <Œ$_5$, 0.4, 0.1, 0.7>})]

GNSS of Expert Ṉ

Table 12: GNSS$_{Ṉ}$(Ŧ, □)

Ň	□$_1$	□$_2$	□$_3$	□$_4$
Œ$_1$	0.5, 0.3, 0.4	0.7, 0.8, 0.1	0.4, 0.1, 0.6	0.8, 0.7, 0.4
Œ$_2$	0.7, 0.8, 0.2	0.6, 0.2, 0.3	0.5, 0.3, 0.8	0.7, 0.5, 0.3
Œ$_3$	0.3, 0.6, 0.8	0.4, 0.7, 0.5	0.7, 0.2, 0.5	0.4, 0.6, 0.2
Œ$_4$	0.2, 0.5, 0.4	0.5, 0.2, 0.4	0.8, 0.7, 0.2	0.3, 0.8, 0.1
Œ$_5$	0.6, 0.4, 0.8	0.8, 0.7, 0.2	0.6, 0.4, 0.3	0.5, 0.7, 0.5

GNSS$_{Ṉ}$(Ŧ, □)= [(□$_1$, {<Œ$_1$, 0.5, 0.3, 0.4>, <Œ$_2$, 0.7, 0.8, 0.2>, <Œ$_3$, 0.3, 0.6, 0.8>, <Œ$_4$, 0.2, 0.5, 0.4>, <Œ$_5$, 0.6, 0.4, 0.8>}), (□$_2$, {<Œ$_1$, 0.7, 0.8, 0.1>, <Œ$_2$, 0.6, 0.2, 0.3>, <Œ$_3$, 0.4, 0.7, 0.5>, <Œ$_4$, 0.5, 0.2, 0.4>, <Œ$_5$, 0.8, 0.7, 0.2>}), (□$_3$, {<Œ$_1$, 0.4, 0.1, 0.6>, <Œ$_2$, 0.5, 0.3, 0.8>, <Œ$_3$, 0.7, 0.2, 0.5>, <Œ$_4$, 0.8, 0.7, 0.2>, <Œ$_5$, 0.6, 0.4, 0.3>}), (□$_4$, {<Œ$_1$, 0.8, 0.7, 0.4>, <Œ$_2$, 0.7, 0.5, 0.3>, <Œ$_3$, 0.4, 0.6, 0.2>, <Œ$_4$, 0.3, 0.8, 0.1>, <Œ$_5$, 0.5, 0.7, 0.5>})]

GNSS of Expert Ẕ

Table 13: GNSS$_{Ẕ}$(Ŧ, □)

Ň	□$_1$	□$_2$	□$_3$	□$_4$
Œ$_1$	0.8, 0.3, 0.2	0.2, 0.3, 0.5	0.4, 0.5, 0.4	0.8, 0.5, 0.2
Œ$_2$	0.7, 0.4, 0.5	0.4, 0.1, 0.7	0.6, 0.7, 0.8	0.4, 0.3, 0.5
Œ$_3$	0.6, 0.3, 0.4	0.5, 0.7, 0.3	0.1, 0.4, 0.6	0.2, 0.1, 0.6
Œ$_4$	0.5, 0.8, 0.7	0.8, 0.5, 0.4	0.3, 0.5, 0.4	0.3, 0.2, 0.7
Œ$_5$	0.6, 0.4, 0.5	0.7, 0.6, 0.1	0.2, 0.6, 0.5	0.5, 0.4, 0.4

GNSS$_{Ẕ}$ (Ŧ, □) = [(□$_1$, {<Œ$_1$, 0.8, 0.3, 0.2>, <Œ$_2$, 0.7, 0.4, 0.5>, <Œ$_3$, 0.6, 0.3, 0.4>, <Œ$_4$, 0.5, 0.8, 0.7>, <Œ$_5$, 0.6, 0.4, 0.5>}), (□$_2$, {<Œ$_1$, 0.2, 0.3, 0.5>, <Œ$_2$, 0.4, 0.1, 0.7>, <Œ$_3$, 0.5, 0.7, 0.3>, <Œ$_4$, 0.8, 0.5, 0.4>, <Œ$_5$, 0.7, 0.6, 0.1>}), (□$_3$, {<Œ$_1$, 0.4, 0.5, 0.4>, <Œ$_2$, 0.6, 0.7, 0.8>, <Œ$_3$, 0.1, 0.4, 0.6>, <Œ$_4$, 0.3, 0.5, 0.4>, <Œ$_5$, 0.2, 0.6, 0.5>}), (□$_4$, {<Œ$_1$, 0.8, 0.5, 0.2>, <Œ$_2$, 0.4, 0.3, 0.5>, <Œ$_3$, 0.2, 0.1, 0.6>, <Œ$_4$, 0.3, 0.2, 0.7>, <Œ$_5$, 0.5, 0.4, 0.4>})]

Step-4:

The aggregation tables for each of the experts have been shown here, beginning with table 14 and continuing through table 17.

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Table 14: Aggregation table of Expert Ḇ

Ň	**T_{agg}**	**I_{agg}**	**F_{agg}**
$Œ_1$	0.65	0.35	0.35
$Œ_2$	0.4	0.375	0.25
$Œ_3$	0.55	0.5	0.5
$Œ_4$	0.525	0.350	0.525
$Œ_5$	0.5	0.35	0.425

Table 15: Aggregation table of Expert Ḏ

Ň	**T_{agg}**	**I_{agg}**	**F_{agg}**
$Œ_1$	0.625	0.275	0.4
$Œ_2$	0.55	0.275	0.475
$Œ_3$	0.65	0.3	0.6
$Œ_4$	0.45	0.4	0.4
$Œ_5$	0.55	0.35	0.5

Table 16: Aggregation table of Expert Ṉ

Ň	**T_{agg}**	**I_{agg}**	**F_{agg}**
$Œ_1$	0.6	0.475	0.375
$Œ_2$	0.625	0.45	0.4
$Œ_3$	0.45	0.525	0.5
$Œ_4$	0.45	0.55	0.275
$Œ_5$	0.625	0.55	0.45

Table 17: Aggregation table of Expert Ẕ

Ň	**T_{agg}**	**I_{agg}**	**F_{agg}**
$Œ_1$	0.55	0.4	0.325
$Œ_2$	0.525	0.375	0.625
$Œ_3$	0.35	0.375	0.475
$Œ_4$	0.475	0.5	0.55
$Œ_5$	0.5	0.5	0.375

Step-5:
The score table of each expert was given in Table 18.

Table 18: Score Table

Ň	**Ḇ**	**Ḏ**	**Ṉ**	**Ẕ**
$Œ_1$	0.05	0.05	0.25	0.175
$Œ_2$	0.225	0.2	0.225	0.475
$Œ_3$	0.45	0.25	0.575	0.5
$Œ_4$	0.35	0.35	0.375	0.575
$Œ_5$	0.275	0.3	0.375	0.375

Step-6:
The choice value of each university is equivalent to the sum of the score values gathered from all of the experts.

$Ḉ_1 = (Ƨ_1)_{Ḇ} + (Ƨ_1)_{Ḏ} + (Ƨ_1)_{Ṉ} + (Ƨ_1)_{Ẕ} = 0.05 + 0.05 + 0.25 + 0.175 = 0.525$
$Ḉ_2 = (Ƨ_2)_{Ḇ} + (Ƨ_2)_{Ḏ} + (Ƨ_2)_{Ṉ} + (Ƨ_2)_{Ẕ} = 0.225 + 0.2 + 0.225 + 0.475 = 1.125$
$Ḉ_3 = (Ƨ_3)_{Ḇ} + (Ƨ_3)_{Ḏ} + (Ƨ_3)_{Ṉ} + (Ƨ_3)_{Ẕ} = 0.45 + 0.25 + 0.575 + 0.5 = 1.775$
$Ḉ_4 = (Ƨ_4)_{Ḇ} + (Ƨ_4)_{Ḏ} + (Ƨ_4)_{Ṉ} + (Ƨ_4)_{Ẕ} = 0.35 + 0.35 + 0.375 + 0.575 = 1.65$
$Ḉ_5 = (Ƨ_5)_{Ḇ} + (Ƨ_5)_{Ḏ} + (Ƨ_5)_{Ṉ} + (Ƨ_5)_{Ẕ} = 0.275 + 0.3 + 0.375 + 0.375 = 1.325$

Step-7:
Optimal decision = maximum value = $Ḉ_3$ = 1.775. Indicates that, the third university $Œ_3$ will be chosen by experts as the one that is best for the student in question to enroll. Here is a preference of universities in Table 19, based on the decisions of different experts. If a student is unable to get admission to his or her institution of the first choice, he or she may apply to universities of the second choice.

Table 19: Preference table of the Universities

Serial Number	**1**	**2**	**3**	**4**	**5**
University	$Œ_3$	$Œ_4$	$Œ_5$	$Œ_2$	$Œ_1$
Choice Value	1.775	1.65	1.325	1.125	0.525

6. Conclusion

In this article, we presented an overview of the fundamental ideas behind NSS and GNSS, as well as some fundamental operations that are performed on these theories. The complement, union,

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intersection, AND, and OR operations were defined for use with GNSS. After that, the fundamental properties relating to the idea of a GNSS are defined. An example of how the newly developed algorithm may be used to tackle an issue involving decision-making has now been presented. This article provides a description of both an algorithm and an application that make use of GNSS in order to overcome difficulties that frequently occur when making judgments that require the expertise of more than one professional. This new extension will make a substantial contribution to the existing theories for handling indeterminacy, and it will also encourage further advancements in further study and relevant application development.

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References

[1] Molodtsov, D. (1999). Soft set theory—first results. Computers & mathematics with applications, 37(4-5), 19-31.

[2] Maji, P. K. (2003). R, Biswas and AR Roy, Soft set theory. Comp. Math. Appl, 45, 555-562.

[3] Aygünoğlu, A., & Aygün, H. (2009). Introduction to fuzzy soft groups. Computers & Mathematics with Applications, 58(6), 1279-1286.

[4] Aktaş, H., & Çağman, N. (2007). Soft sets and soft groups. Information sciences, 177(13), 2726-2735.

[5] Feng, F., Jun, Y. B., & Zhao, X. (2008). Soft semirings. Computers & Mathematics with Applications, 56(10), 2621-2628.

[6] Acar, U., Koyuncu, F., & Tanay, B. (2010). Soft sets and soft rings. Computers & Mathematics with Applications, 59(11), 3458-3463.

[7] Jun, Y. B. (2008). Soft bck/bci-algebras. Computers & Mathematics with Applications, 56(5), 1408-1413.

[8] Jun, Y. B., Lee, K. J., & Zhan, J. (2009). Soft p-ideals of soft BCI-algebras. Computers & Mathematics with Applications, 58(10), 2060-2068.

[9] Jun, Y. B., Lee, K. J., & Park, C. H. (2009). Soft set theory applied to ideals in d-algebras. Computers & Mathematics with Applications, 57(3), 367-378.

[10] Jun, Y. B., Lee, K. J., & Khan, A. (2010). Softly ordered semigroups. Mathematical Logic Quarterly, 56(1), 42-50.

[11] Zhan, J., & Jun, Y. B. (2010). Soft BL-algebras based on fuzzy sets. Computers & Mathematics with Applications, 59(6), 2037-2046.

[12] Smarandache, F. (2020). NeutroAlgebra is a Generalization of Partial Algebra, International Journal of Neutrosophic Science, Vol. 2 , No. 1: 08-17

[13] Smarandache, F. (1998). Neutrosophy: neutrosophic probability, set, and logic: analytic synthesis & synthetic analysis.

[14] Wang, H., Smarandache, F., Zhang, Y., & Sunderraman, R. (2010). Single valued neutrosophic sets. Infinite study.

[15] Ye, J. (2013). Multicriteria decision-making method using the correlation coefficient under a single-valued neutrosophic environment. International Journal of General Systems, 42(4), 386-394.

[16] Ye, J. (2014). Improved correlation coefficients of single-valued neutrosophic sets and interval neutrosophic sets for multiple attribute decision making. Journal of Intelligent & Fuzzy Systems, 27(5), 2453-2462.

[17] Ye, J. (2014). Clustering methods using distance-based similarity measures of single-valued neutrosophic sets. Journal of Intelligent Systems, 23(4), 379-389.

[18] Ye, J. (2014). Multiple attribute group decision-making method with completely unknown weights based on similarity measures under a single-valued neutrosophic environment. Journal of Intelligent & Fuzzy Systems, 27(6), 2927-2935.

Doi: https://doi.org/10.54216/IJNS.190103
Received: March 18, 2022 Accepted: August 26, 2022

[19] Peng, X., & Dai, J. (2018). Approaches to single-valued neutrosophic MADM based on MABAC, TOPSIS, and new similarity measure with score function. Neural Computing and Applications, 29(10), 939-954.
[20] Biswas, P., Pramanik, S., & Giri, B. C. (2016). TOPSIS method for multi-attribute group decision-making under a single-valued neutrosophic environment. Neural Computing and Applications, 27(3), 727-737.
[21] Al-Tahan, M. (2020). Some Results on Single Valued Neutrosophic (Weak) Polygroups, International Journal of Neutrosophic Science, 2 (1): 38-46
[22] Huang, H. L. (2016). New distance measure of single- valued neutrosophic sets and their application. International Journal of Intelligent Systems, 31(10), 1021-1032.
[23] Wu, X. H., Wang, J. Q., Peng, J. J., & Chen, X. H. (2016). Cross-entropy and prioritized aggregation operator with simplified neutrosophic sets and their application in multi-criteria decision-making problems. International Journal of Fuzzy Systems, 18(6), 1104-1116.
[24] Broumi, S., Talea, M., Bakali, A., & Smarandache, F. (2016). Single valued neutrosophic graphs. Journal of New theory, (10), 86-101.
[25] Broumi, S., Bakali, A., Talea, M., & Smarandache, F. (2016). Isolated single-valued neutrosophic graphs. Infinite Study.
[26] Broumi, S., Smarandache, F., Talea, M., & Bakali, A. (2016, July). Single valued neutrosophic graphs: degree, order, and size. In 2016 IEEE international conference on fuzzy systems (FUZZ-IEEE) (pp. 2444-2451). IEEE.
[27] Peng, J.J., Wang, J.Q., & Yang, W.E. (2017). A multi-valued neutrosophic qualitative flexible approach based on the likelihood for multi-criteria decision-making problems. International Journal of Systems Science. doi: 10.1080/00207721.2016.1218975.
[28] Peng, J. J., Wang, J. Q., & Wu, X. H. (2017). An extension of the ELECTRE approach with multi-valued neutrosophic information. Neural Computing and Applications, 28(1), 1011-1022.
[29] Ji, P., Zhang, H. Y., & Wang, J. Q. (2018). A projection-based TODIM method under multi-valued neutrosophic environments and its application in personnel selection. Neural Computing and Applications, 29(1), 221-234.
[30] Tian, Z. P., Wang, J., Zhang, H. Y., & Wang, J. Q. (2018). Multi-criteria decision-making is based on generalized prioritized aggregation operators under a simplified neutrosophic uncertain linguistic environment. International Journal of Machine Learning and Cybernetics, 9(3), 523-539.
[31] Maji, P. K. (2013). Neutrosophic soft set. Infinite Study.
[32] Mukherjee, A., & Sarkar, S. (2014). Several similarity measures of neutrosophic soft sets and their application in real-life problems. Annals of Pure and Applied Mathematics, 7(1), 1-6.
[33] Deli, I., & Broumi, S. (2015). Neutrosophic soft matrices and NSM-decision making. Journal of Intelligent & Fuzzy Systems, 28(5), 2233-2241.
[34] Alkhazaleh, S. (2016). Time-neutrosophic soft set and its applications. Journal of Intelligent & Fuzzy Systems, 30(2), 1087-1098.
[35] Al-Quran, A., & Hassan, N. (2016). Neutrosophic vague soft expert set theory. Journal of Intelligent & Fuzzy Systems, 30(6), 3691-3702.
[36] Bal M., Ahmad, K. & Ali R. (2022). A Review On Recent Developments In Neutrosophic Linear Diophantine Equations, Journal of Neutrosophic and Fuzzy Systems, 2(1): 61-75
[37] Sahin, R., & Küçük, A. (2014). Generalized Neutrosophic Soft Set and its Integration to Decision Making Problem. Applied Mathematics & Information Sciences, 8(6).
[38] Uluçay, V., Şahin, M., & Hassan, N. (2018). Generalized neutrosophic soft expert set for multiple-criteria decision-making. Symmetry, 10(10), 437.
[39] Deli, I., & Broumi, S. (2015). Neutrosophic soft relations and some properties. Annals of fuzzy mathematics and informatics, 9(1), 169-182.
[40] Salama, A. A., & Alblowi, S. A. (2012). Generalized neutrosophic set and generalized neutrosophic topological spaces. Infinite Study.

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