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A Weighted Expert Framework in Neutrosophic Soft Expert Sets: Theory and Applications

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Abstract. A very useful and effective modification of soft sets that particularly addresses parameterized values of alternatives is the neutrosophic soft set. But many algorithms for generating decisions based on neutrosophic soft sets tend to ignore the outside influences on their performance. The novel idea of a weighted expert neutrosophic soft expert set is presented in this study. It is carefully designed to capture outside impacts on neutrosophic soft sets and expert views in a single model. The outcome removes the need for further procedures. Interestingly, our novel method combines the advantages of the effective set with the neutrosophic soft expert set, leading to increased effectiveness and realism in this field. This paper thoroughly examines the basic functions of a weighted expert neutrosophic soft expert set (WNSES), clarifying these functions with appropriate examples. The study concludes by demonstrating how this idea may be used practically in decision-making situations, supporting its effectiveness using algorithms and examples.

1. Introduction

The notion of a fuzzy set was first introduced by Zadeh [1] to model uncertainty by assigning a membership degree to each element. Later. Smarandache [2] further developed the neutrosophic set theory, designed to address vagueness, indeterminacy, and inconsistency in data. In parallel, Molodtsov [3] proposed the soft set approach as another tool for handling uncertain information. This idea was elaborated upon by Majumdar and Samanta [4].

Based on this, the concept of soft expert sets was proposed in [5] and later generalized into fuzzy soft expert sets [6]. Maji [7] also introduced neutrosophic soft sets, merging soft set theory with neutrosophic set theory.

Following this line, Sahin et al. [8] expanded the framework further by presenting neutrosophic soft expert sets. Al-Hijjawi et al. [9] introduced the parameterized neutrosophic soft set (ENSS),

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which considers three independent functions—truth (T), indeterminacy (I), and falsity (F)—to strengthen the descriptive power of ENSS.

Further extensions of soft expert set theory have also been proposed. Alkhazaleh and Hazaymeh [43] introduced n-valued refined neutrosophic soft sets with applications to decision-making and medical diagnosis, while Hazaymeh [44] generalized fuzzy soft sets and fuzzy soft expert sets with several hypothetical applications. Building on this, Hazaymeh et al. [45, 46] proposed the generalized fuzzy soft expert set and the fuzzy parameterized fuzzy soft expert set, respectively, further enriching the toolkit for representing expert-based decision-making under uncertainty. The evolution of soft set theory and its extensions has significantly advanced decision-making under uncertainty. Recent developments have focused on incorporating temporal factors and parameterization to enhance the practical applicability of these mathematical structures. Notable contributions include the introduction of time-shadow soft sets [10], time effective fuzzy soft sets [11], and time fuzzy soft sets [12], which address the dynamic nature of real-world problems. Bataihah et al. In [48], Bataihah et al. introduced a framework for time-sensitive distance.

The integration of expert opinions has been another significant advancement, as demonstrated by research on time factor's impact on fuzzy soft expert sets [13] and multiple opinions in fuzzy soft expert sets [14]. Recent works have further explored parameterized approaches, including time fuzzy parameterized fuzzy soft expert sets [15] and parameterized time neutrosophic soft sets [16]. The consideration of weighted expert factors [17] has added another dimension to the sophistication of these models.

Recent advancements in neutrosophic mathematics have expanded across various domains, including topological spaces based on symbolic n-plithogenic intervals [18], neutrosophic real intervals [19], and neutrosophic semi δ-pre irresolute mappings [47]. Algebraic investigations have explored minimal units in two-fold fuzzy finite neutrosophic rings [20] and the properties of two-fold algebra based on n-standard fuzzy number theoretical systems [21].

Significant progress has been made in fixed point theory within neutrosophic frameworks. Research has established fixed point results in complete neutrosophic fuzzy metric spaces for NF-L contractions [22] and T-distance spaces in complete B-metric spaces [23]. Further developments include fixed point theorems using simulation functions [24,25], neutrosophic fuzzy metric spaces with nonlinear contractions [26], and ωt-distance mappings for Geraghty type contractions [27].

Additional contributions encompass fixed point results using auxiliary functions [28], quasi-contractions in neutrosophic fuzzy metric spaces [29], and neutrosophic ψ-quasi contractions [30]. Recent work has also extended to simulation functions in complete neutrosophic fuzzy metric spaces [31], common fixed point results using Geraghty functions [32], γ-k distance fixed point theorems [33], and applications to integro-differential equations with conformable derivatives [34]. For more see [35–38]. The introduction of Linguistic SuperHypersoft Sets [39] further demonstrates the expanding scope of neutrosophic mathematics.

Beyond soft set and neutrosophic frameworks, related developments in mathematical analysis and computational optimization further illustrate the breadth of this research area, including a perturbed Milne's quadrature rule for n-times differentiable functions with L^p-error estimates [49, 55], refinements of numerical radius inequalities [50,54], a hybrid intelligent water drops algorithm for examination timetabling [51], reliability estimation based on the Rayleigh distribution [52], and fixed point results in neutrosophic fuzzy metric spaces via C-class functions [53].

Furthermore, developments in aggregation operators and computational methods have enriched the field. The development of possibility single-valued neutrosophic Dombi-weighted aggregation operators [40] provides robust methods for multiple attribute decision-making, while the introduction of Q-neutrosophic soft sets under interval matrix settings [41] offers novel computational frameworks for handling complex uncertainty. Recent applications have also extended to mathematical interpolation techniques, as demonstrated by shape preserving monotonic and convex data interpolation using rational cubic ball functions [42].

Building upon these comprehensive foundational works, In this work, we extend these foundations by defining the parameterized neutrosophic soft expert set (PNSES). This model not only incorporates the effect of external influences on neutrosophic soft sets but also integrates expert opinions within a single coherent framework. Our contribution harmonizes the advantages of both soft expert sets and parameterized neutrosophic soft sets, producing a more comprehensive model for representing uncertainty. To ensure clarity, we provide fundamental operations and examples for PNSESs, supported by theoretical results. This research advances uncertainty modeling by bridging the gap between abstract theory and practical decision-making applications, offering a novel framework for addressing ambiguity and indeterminacy in complex environments.

2. Preliminaries

In this section, we recall some basic notions that will be used throughout the paper. Let U denote the universal set and E be a set of parameters. We denote by $P(U)$ the power set of U, and let $A \subseteq E$.

Definition 2.1. *[3] A* soft set *over U is defined as an ordered pair (F, A), where F is a mapping*

$$F : A \longrightarrow P(U).$$

Definition 2.2. *[3] Let I^U denote the collection of all fuzzy subsets of U. A* fuzzy soft set *over U is a pair (F, A) such that*

$$F : A \longrightarrow I^U.$$

Definition 2.3. *[2] (**Neutrosophic set**) Let X be a discourse universe. The representation of a neutrosophic set A on X is as follows:*

$$A = \{\langle x : T_A(x), I_A(x), F_A(x)\rangle : x \in X\},$$

where $T_A(x), I_A(x), and F_A(x) : X \rightarrow [0,1]$ *correspond to the truth-membership, indeterminacy-membership, and falsity-membership functions, respectively, satisfying*

$$0 \leq T_A(x) + I_A(x) + F_A(x) \leq 3$$

Definition 2.4. *[7] Let* $N(U)$ *be the family of all subsets of* U *that are neutrosophic. A pair* (F, A) *is a* neutrosophic soft set *over* U*, where*

$$F : A \longrightarrow N(U).$$

Definition 2.5. *[8] Let* $O = \{agree = 1, disagree = 0\}$ *be a collection of views, and* X *be a set of experts. Suppose that* $Z = E \times \frac{X}{\mu} \times O$ *and* $A \subseteq Z$*. A neutrosophic soft expert set over* U *is denoted by the pair* (F, A)*, where* F *is a mapping provided by* $F : A \rightarrow N(U)$*, where* $N(U)$ *indicates the power neutrosophic set of* U*.*

Definition 2.6. *[8] As an NSE subset of* $(F, Z)_\Lambda$*, the following defines an agree-NSES* $(F, Z)^1_\rho$ *over* U*:*

$$(F, Z)^1_\rho = \{F_1(\alpha) : \alpha \in E \times X \times \{1\}\}.$$

Definition 2.7. *[9] Let* E *be a collection of parameters, and let* U *be the universal set. Let* ρ *be the effective set over* A*, and suppose that* $A \subseteq E$ *represents a set of effective parameters. The collection of all neutrosophic subsets of* U *is denoted by* $N(U)$*.*

A parameterized neutrosophic soft set *(ENSS) over* U *is defined as a pair* $(F, E)_\Lambda$*, where the mapping*

$$F : E \longrightarrow N(U)$$

is expressed by

$$F(e)_\Lambda = \left\{ \frac{x_j}{\langle T_U(x_j)_\Lambda, I_U(x_j)_\Lambda, F_U(x_j)_\Lambda \rangle} : x_j \in U,\ e \in E \right\}. \tag{2.1}$$

The following are the details of the membership functions:

$$T_U(x_j)_\Lambda = \begin{cases} T_U(x_j) + \dfrac{(1 - T_U(x_j)) \sum_k \delta_{\rho_{x_j}}(a_k)}{|A|}, & \text{if } T_U(x_j) \in (0,1), \\ T_U(x_j), & \text{otherwise,} \end{cases}$$

$$I_U(x_j)_\Lambda = I_U(x_j),$$

$$F_U(x_j)_\Lambda = \begin{cases} F_U(x_j) - \dfrac{F_U(x_j) \sum_k \delta_{\rho_{x_j}}(a_k)}{|A|}, & \text{if } F_U(x_j) \in (0,1), \\ F_U(x_j), & \text{otherwise.} \end{cases}$$

Definition 2.8. *[9] Consider two ENSSs over the same universe* U*:* (F, E_1) *and* (G, E_2)*. If the following criteria are met, we declare that* (F, E_1) *is a* ENSS-subset *of* (G, E_2)*, represented by* $(F, E_1) \subseteq (G, E_2)$*.*

(1) $E_1 \subseteq E_2$,
(2) $\rho_1(x) \leq \rho_2(x)$,

(3) $T_{F(e)}(x) \le T_{G(e)}(x), \quad I_{F(e)}(x) \le I_{G(e)}(x), \quad F_{F(e)}(x) \ge F_{G(e)}(x),$
for all $e \in E_1$ and $x \in U$.

Definition 2.9. *[9] $(F,E)_{\rho^c}$ represents the ρ-*complement *of an ENSS (F,E), where ρ^c is any fuzzy complement of ρ.*

In order to calculate the ρ-complement, we use Equation (2.1) *while keeping the neutrosophic soft set (F,E) unaltered and substituting ρ with ρ^c.*

Definition 2.10. *[9] $(F^c,E)_\Lambda$ is the* soft-complement *of an ENSS (F,E), where F^c is the neutrosophic soft complement of F.*

Here, the effective set ρ remains constant, F is substituted with F^c, and Equation (2.1) *yields the new ENSS.*

Definition 2.11. *[9] Consider two ENSSs defined on the universe U: (F,E_1) and (G,E_2). The ENSS represented by $(H,E)_{\Lambda_s}$ is the* union *of (F,E_1) and (G,E_2), where $E = E_1 \cup E_2$ and for each $v \in E$,*

$$H_{\Lambda_s}(v) = \begin{cases} F_{\Lambda_s}(v), & \text{if } v \in E_1 - E_2, \\ G_{\Lambda_s}(v), & \text{if } v \in E_2 - E_1, \\ (F \cup G)_{\Lambda_s}(v), & \text{if } v \in E_1 \cap E_2, \end{cases}$$

where $\cup$ is the union of neutrosophic soft expert sets F and G, and s is any s-norm.

3. A Weighted Expert Framework in Neutrosophic Soft Expert Sets (WNSES)

Decision-making in many real-world situations involves a number of specialists with varying degrees of expertise, dependability, and experience. Every expert is given the same treatment in conventional neutrosophic soft expert systems, regardless of their level of expertise or confidence in a particular field. This consistent approach might result in results that are skewed or inaccurate, particularly if certain experts are more credible than others. As a result, giving experts the proper *weights* becomes essential to guaranteeing that the decision-making process takes into account the relative importance and dependability of each expert's opinion. The decision model can better manage heterogeneous knowledge by incorporating expert weights. The accuracy and stability of the final judgment can be improved by adjusting the effect of each expert in the aggregation process through the introduction of a *weighted expert factor*. This method fits in nicely with real-world procedures, where decision-makers frequently depend more on highly skilled people or domain experts. Consequently, the interpretability and reliability of the outcomes can be greatly enhanced by a well stated weighted process inside the neutrosophic soft expert framework.

Definition 3.1. *Let U be the initial universe of discourse, E the set of all parameters, and X the set of experts, with fuzzy weighting function*

$$\mu_X : X \to [0,1].$$

Let $O = \{agree = 1, disagree = 0\}$ be a set of opinions, $E = \{e_1, e_2, ..., e_n\}$ the set of parameters, the factors *represented by* $\frac{X}{\mu} = \{\frac{x_1}{\mu_{x_1}}, \frac{x_2}{\mu_{x_2}}, ..., \frac{x_n}{\mu_{x_n}}\}$ *weighted according to the relevance levels of the experts. Define the set* $Z = E \times \frac{X}{\mu} \times O$*, and let* $B \subseteq Z$ *be the set of valid parameter–expert–opinion combinations.*

A weighted expert neutrosophic soft expert set *(WNSES) over U is a pair* (Γ_X, B)*, where*

$$\Gamma_X : B \to \mathcal{N}(U),$$

and $\mathcal{N}(U)$ *denotes the power neutrosophic set of U. For each* $(e, a, o) \in B$*, the mapping* $\Gamma_X(e, a, o)$ *is a neutrosophic set over U, defined as*

$$\Gamma_X(e,a,o) = \left\{\left\langle u, T^a_X(e,u), I^a_X(e,u), F^a_X(e,u)\right\rangle : u \in U\right\},$$

where $T^a_X(e,u)$*,* $I^a_X(e,u)$*, and* $F^a_X(e,u)$ *represent the truth-membership, indeterminacy-membership, and falsity-membership degrees respectively, satisfying*

$$0 \leq T^a_X(e,u) + I^a_X(e,u) + F^a_X(e,u) \leq 3.$$

Moreover, the WNSES satisfies the condition:

$$\Gamma_X(e,a,o) = \emptyset \quad if \quad \mu_X(a) = 0.$$

Example 3.1. $U = \{w_1, w_2, w_3\}$ *represents the set of universes;* $E = \{e_1, e_2, e_3\}$ *represents the set of parameters;* $X = \left\{p, \frac{q}{0.4}, r\right\}$ *represents the set of experts; and* $O = \{agree = 1, disagree = 0\}$ *represents the set of opinions. The weighted expert neutrosophic soft expert set (WNSES), denoted by F, is defined as follows:*

$$F\left(e_1, \frac{p}{0.9}, 1\right) = \left\{\frac{w_1}{< 0.2, 0, 0.7 >}, \frac{w_2}{< 0.7, 0.3, 0.1 >}, \frac{w_3}{< 0.7, 0.2, 0.3 >}\right\}$$

$$F\left(e_1, \frac{q}{0.4}, 1\right) = \left\{\frac{w_1}{< 0.4, 0.3, 0.7 >}, \frac{w_2}{< 0.1, 0.3, 0.4 >}, \frac{w_3}{< 0.1, 0.2, 0.6 >}\right\}$$

$$F\left(e_1, \frac{r}{0.7}, 1\right) = \left\{\frac{w_1}{< 0.3, 0.5, 0.6 >}, \frac{w_2}{< 0.7, 0.3, 0.4 >}, \frac{w_3}{< 0.4, 0.1, 0.2 >}\right\}$$

$$F\left(e_2, \frac{p}{0.9}, 1\right) = \left\{\frac{w_1}{< 0.6, 0.1, 0.2 >}, \frac{w_2}{< 0.7, 0.2, 0.3 >}, \frac{w_3}{< 0.6, 0.1, 0.3 >}\right\}$$

$$F\left(e_2, \frac{q}{0.4}, 1\right) = \left\{\frac{w_1}{< 0.7, 0.1, 0.2 >}, \frac{w_2}{< 0.6, 0.7, 0.2 >}, \frac{w_3}{< 0.7, 0.4, 0.1 >}\right\}$$

$$F\left(e_2, \frac{r}{0.7}, 1\right) = \left\{\frac{w_1}{< 0.3, 0.2, 0.8 >}, \frac{w_2}{< 0.4, 0.1, 0.7 >}, \frac{w_3}{< 0.5, 0.2, 0.1 >}\right\}$$

$$F\left(e_3, \frac{p}{0.9}, 1\right) = \left\{\frac{w_1}{< 0.4, 0.2, 0.1 >}, \frac{w_2}{< 0.5, 0.7, 0.1 >}, \frac{w_3}{< 0.1, 0, 0.4 >}\right\}$$

$$F\left(e_3, \frac{q}{0.4}, 1\right) = \left\{\frac{w_1}{< 0.4, 0.1, 0.7 >}, \frac{w_2}{< 0.5, 0.3, 0.8 >}, \frac{w_3}{< 0.3, 0.4, 0.6 >}\right\}$$

$$F\left(e_3, \frac{r}{0.7}, 1\right) = \left\{\frac{w_1}{< 0.5, 0.8, 0.2 >}, \frac{w_2}{< 0.5, 0, 0.4 >}, \frac{w_3}{< 0.6, 0.3, 0.1 >}\right\}$$

$$F\left(e_1, \frac{p}{0.9}, 0\right) = \left\{\frac{w_1}{< 0.3, 0, 0.5 >}, \frac{w_2}{< 0.2, 0.4, 0.6 >}, \frac{w_3}{< 0.8, 0.1, 0.4 >}\right\}$$

$$F\left(e_1, \frac{q}{0.4}, 0\right) = \left\{\frac{w_1}{< 0.6, 0.2, 0.3 >}, \frac{w_2}{< 0.8, 0.2, 0.5 >}, \frac{w_3}{< 0.6, 0.5, 0.9 >}\right\}$$

$$F\left(e_1, \frac{r}{0.7}, 0\right) = \left\{\frac{w_1}{< 0.6, 0.4, 0.9 >}, \frac{w_2}{< 0.3, 0.7, 0.9 >}, \frac{w_3}{< 0.2, 0, 0.6 >}\right\}$$

$$F\left(e_2, \frac{p}{0.9}, 0\right) = \left\{\frac{w_1}{< 0.4, 0.8, 0.1 >}, \frac{w_2}{< 0.7, 0.6, 0.4 >}, \frac{w_3}{< 0.4, 0.1, 0.6 >}\right\}$$

$$F\left(e_2, \frac{q}{0.4}, 0\right) = \left\{\frac{w_1}{< 0.2, 0.4, 0.8 >}, \frac{w_2}{< 0.5, 0.3, 0.7 >}, \frac{w_3}{< 0.8, 0.5, 0.3 >}\right\}$$

$$F\left(e_2, \frac{r}{0.7}, 0\right) = \left\{\frac{w_1}{< 0.9, 0.4, 0.2 >}, \frac{w_2}{< 0.4, 0.7, 0.9 >}, \frac{w_3}{< 0.1, 0, 0.9 >}\right\}$$

$$F\left(e_3, \frac{p}{0.9}, 0\right) = \left\{\frac{w_1}{< 0.7, 0.2, 0.4 >}, \frac{w_2}{< 0.5, 0.3, 0.8 >}, \frac{w_3}{< 0.8, 0.4, 0.5 >}\right\}$$

$$F\left(e_3, \frac{q}{0.4}, 0\right) = \left\{\frac{w_1}{< 0.5, 0.1, 0.9 >}, \frac{w_2}{< 0.8, 0.3, 0.4 >}, \frac{w_3}{< 0.6, 0.1, 0.9 >}\right\}$$

$$F\left(e_3, \frac{r}{0.7}, 0\right) = \left\{\frac{w_1}{< 0.3, 0.2, 0.5 >}, \frac{w_2}{< 0.9, 0.1, 0.4 >}, \frac{w_3}{< 0.4, 0.1, 0.7 >}\right\}$$

Definition 3.2. *In the common universe U, let (F, S_1) and (G, S_2) be two WNSESs. Then (F, S_1) is a subset of (G, S_2) that is WNSES if:*

(1) $S_1 \subset S_2$

(2) $T_{F(e)}(x) \leq T_{G(e)}(x), I_{F(e)}(x) \leq I_{G(e)}(x), F_{F(e)}(x) \geq F_{G(e)}(x)$

$(F, S_1) \subseteq (G, S_1)$ *and indicate it with* $\forall e \in S_1, x \in U$.

Definition 3.3. *Let (F, S_1) and (G, S_2) be two WNSESs defined on the same universe U. We say that (F, S_1) and (G, S_2) are* equal*, written as*

$$(F, S_1) = (G, S_2),$$

whenever (F, S_1) is a WNSES subset of (G, S_2) and, at the same time, (G, S_2) is a WNSES subset of (F, S_1).

Definition 3.4. *The* agree-WNSES *of (F, Z) over the universe U is a WNSES subset, denoted by $(F, Z)^1$, and is given by*

$$(F, Z)^1 = \left\{F(\alpha) : \alpha \in E \times \frac{X}{\mu} \times \{1\}\right\}.$$

Example 3.2. *Continuing Example 3.1, the agree-weighted expert neutrosophic soft expert set* $(F,Z)^1$ *over* U *can be constructed accordingly.*

$$\begin{aligned}(F,Z)^1 = \Bigg\{ &\Big((e_1,\frac{p}{0.9},1),\frac{w_1}{<0.6,0,0.35>},\frac{w_2}{<0.83,0.3,0.06>},\frac{w_3}{<0.95,0.2,0.05>}\Big),\\ &\Big((e_1,\frac{q}{0.4},1),\frac{w_1}{<0.64,0.3,0.42>},\frac{w_2}{<0.33,0.3,0.3>},\frac{w_3}{<0.62,0.2,0.26>}\Big),\\ &\Big((e_1,\frac{r}{0.7},1),\frac{w_1}{<0.42,0.5,0.5>},\frac{w_2}{<0.77,0.3,0.31>},\frac{w_3}{<0.61,0.1,0.13>}\Big),\\ &\Big((e_2,\frac{p}{0.9},1),\frac{w_1}{<0.8,0.1,0.1>},\frac{w_2}{<0.83,0.2,0.17>},\frac{w_3}{<0.93,0.1,0.05>}\Big),\\ &\Big((e_2,\frac{q}{0.4},1),\frac{w_1}{<0.82,0.1,0.12>},\frac{w_2}{<0.7,0.7,0.15>},\frac{w_3}{<0.87,0.4,0.04>}\Big),\\ &\Big((e_2,\frac{r}{0.7},1),\frac{w_1}{<0.42,0.2,0.66>},\frac{w_2}{<0.54,0.1,0.54>},\frac{w_3}{<0.68,0.2,0.07>}\Big),\\ &\Big((e_3,\frac{p}{0.9},1),\frac{w_1}{<0.7,0.2,0.05>},\frac{w_2}{<0.71,0.7,0.6>},\frac{w_3}{<0.84,0,0.07>}\Big),\\ &\Big((e_3,\frac{q}{0.4},1),\frac{w_1}{<0.64,0.1,0.42>},\frac{w_2}{<0.63,0.3,0.6>},\frac{w_3}{<0.7,0.4,0.26>}\Big),\\ &\Big((e_3,\frac{r}{0.7},1),\frac{w_1}{<0.59,0.8,0.17>},\frac{w_2}{<0.61,0,0.49>},\frac{w_3}{<0.74,0.3,0.07>}\Big)\Bigg\}\end{aligned}$$

Definition 3.5. *Let* (F,Z) *be a WNSES over the universe* U*. The* disagree-WNSES *of* (F,Z)*, denoted by* $(F,Z)^0$*, is defined as the WNSES subset*

$$(F,Z)^0 = \Big\{F(\alpha) \ : \ \alpha \in E \times \frac{X}{\mu} \times \{0\}\Big\}.$$

Example 3.3. *Referring back to Example 3.1, we can also construct the disagree-weighted expert neutrosophic soft expert set of* (F,Z) *over* U*. It is denoted by* $(F,Z)^0$ *, and is obtained by collecting all mappings* $F(\alpha)$ *corresponding to* $\alpha \in E \times \frac{X}{\mu} \times \{0\}$*.*

$$\begin{aligned}(F,Z)^0 = \Bigg\{ &\Big((e_1,\frac{p}{0.9},0),\frac{w_1}{<0.65,0,0.25>},\frac{w_2}{<0.54,0.4,0.35>},\frac{w_3}{<0.97,0.1,0.07>}\Big),\\ &\Big((e_1,\frac{q}{0.4},0),\frac{w_1}{<0.76,0.2,0.18>},\frac{w_2}{<0.85,0.2,0.38>},\frac{w_3}{<0.83,0.5,0.38>}\Big),\\ &\Big((e_1,\frac{r}{0.7},0),\frac{w_1}{<0.67,0.4,0.74>},\frac{w_2}{<0.46,0.7,0.7>},\frac{w_3}{<0.48,0,0.39>}\Big),\\ &\Big((e_2,\frac{p}{0.9},0),\frac{w_1}{<0.7,0.8,0.05>},\frac{w_2}{<0.83,0.6,0.23>},\frac{w_3}{<0.9,0.1,0.12>}\Big),\\ &\Big((e_2,\frac{q}{0.4},0),\frac{w_1}{<0.52,0.4,0.48>},\frac{w_2}{<0.63,0.3,0.53>},\frac{w_3}{<0.92,0.5,0.13>}\Big),\\ &\Big((e_2,\frac{r}{0.7},0),\frac{w_1}{<0.92,0.4,0.17>},\frac{w_2}{<0.54,0.7,0.7>},\frac{w_3}{<0.42,0,0.59>}\Big),\\ &\Big((e_3,\frac{p}{0.9},0),\frac{w_1}{<0.85,0.2,0.2>},\frac{w_2}{<0.71,0.3,0.46>},\frac{w_3}{<0.97,0.4,0.13>}\Big),\end{aligned}$$

$$\left((e_3, \frac{q}{0.4}, 0), \frac{w_1}{<0.7, 0.1, 0.54>}, \frac{w_2}{<0.85, 0.3, 0.3>}, \frac{w_3}{<0.83, 0.1, 0.38>}\right),$$
$$\left((e_3, \frac{r}{0.7}, 0), \frac{w_1}{<0.42, 0.2, 0.41>}, \frac{w_2}{<0.92, 0.1, 0.31>}, \frac{w_3}{<0.61, 0.1, 0.5>}\right)\Bigg\}$$

Definition 3.6. *The complement of a weighted expert neutrosophic soft expert set (F, A) denoted by $(F, A)^c$ and is defined as $(F, A)^c = \left(F^c, \ \neg A\right)$ where $F^c : \neg A \to P(U)$ is a mapping given by $F^c(x)$, where $T_{F^c(x)} = F_{F(x)}$, $I_{F^c(x)} = I_{F(x)}$, $F_{F^c(x)} = T_{F(x)}$.*

Example 3.4. *Consider Example 3.1 and let $S = \left\{\left(e_1, \frac{p}{0.9}, 1\right), \left(e_3, \frac{r}{0.7}, 1\right), \left(e_2, \frac{q}{0.4}, 0\right)\right\} \subset Z$.*

$$\begin{aligned}(F, S) = \Bigg\{&\left(\left(e_1, \frac{p}{0.9}, 1\right), \frac{w_1}{<0.2, 0, 0.7>}, \frac{w_2}{<0.7, 0.3, 0.1>}, \frac{w_3}{<0.7, 0.2, 0.3>}\right),\\ &\left(\left(e_3, \frac{r}{0.7}, 1\right), \frac{w_1}{<0.5, 0.8, 0.2>}, \frac{w_2}{<0.5, 0, 0.4>}, \frac{w_3}{<0.6, 0.3, 0.1>}\right),\\ &\left(\left(e_2, \frac{q}{0.4}, 0\right), \frac{w_1}{<0.2, 0.4, 0.8>}, \frac{w_2}{<0.5, 0.3, 0.7>}, \frac{w_3}{<0.8, 0.5, 0.3>}\right)\Bigg\}\end{aligned}$$

By applying the weighted expert neutrosophic soft expert set complement over F, we obtain F^c in the manner described below:

$$\begin{aligned}(F^c, S) = \Bigg\{&\left(\left(e_1, \frac{p}{0.9}, 1\right), \frac{w_1}{<0.7, 0, 0.2>}, \frac{w_2}{<0.1, 0.3, 0.7>}, \frac{w_3}{<0.3, 0.2, 0.7>}\right),\\ &\left(\left(e_3, \frac{r}{0.7}, 1\right), \frac{w_1}{<0.2, 0.8, 0.5>}, \frac{w_2}{<0.4, 0, 0.5>}, \frac{w_3}{<0.1, 0.3, 0.6>}\right),\\ &\left(\left(e_2, \frac{q}{0.4}, 0\right), \frac{w_1}{<0.8, 0.4, 0.2>}, \frac{w_2}{<0.7, 0.3, 0.5>}, \frac{w_3}{<0.3, 0.5, 0.8>}\right)\Bigg\}\end{aligned}$$

Definition 3.7. *Over the common universe, the union of two WNSSs (F, S_1) and (G, S_2) where $S = S_1 \cup S_2$ and $\forall \nu \in S$. U is the WNSES $(H, S)_{\Lambda_s}$, and it is provided as follows:*

$$H_{\Lambda_s}(\nu) = \begin{cases} F_{\Lambda_s}(\nu), & \text{if } \nu \in S_1 - S_2 \\ G_{\Lambda_s}(\nu), & \text{if } \nu \in S_2 - S_1 \\ (F \cup G)_{\Lambda_s}, & \text{if } \nu \in S_1 \cap S_2 \end{cases}$$

Such that s is the s-norm and $\cup$ represents the union of neutrosophic soft weight experts F and G.

Example 3.5. *Let (F, S_1) and (G, S_2) as follows:*

$$
\begin{aligned}
(F, S_1) = &\left\{\left(\left(e_1, \frac{p}{0.9}, 1\right), \frac{w_1}{< 0.2, 0, 0.7 >}, \frac{w_2}{< 0.7, 0.3, 0.1 >}, \frac{w_3}{< 0.7, 0.2, 0.3 >}\right),\right.\\
&\left.\left(\left(e_3, \frac{r}{0.7}, 1\right), \frac{w_1}{< 0.5, 0.8, 0.2 >}, \frac{w_2}{< 0.5, 0, 0.4 >}, \frac{w_3}{< 0.6, 0.3, 0.1 >}\right)\right\}\\
(G, S_2) = &\left\{\left(\left(e_1, \frac{p}{0.9}, 1\right), \frac{w_1}{< 0.3, 0.1, 0.8 >}, \frac{w_2}{< 0.8, 0.2, 0.3 >}, \frac{w_3}{< 0.3, 0.1, 0.6 >}\right),\right.\\
&\left.\left(\left(e_1, \frac{q}{0.4}, 0\right), \frac{w_1}{< 0.6, 0.2, 0.3 >}, \frac{w_2}{< 0.8, 0.2, 0.5 >}, \frac{w_3}{< 0.6, 0.5, 0.9 >}\right)\right\}
\end{aligned}
$$

Let (F, S_1) and (G, S_2) be two weighted expert neutrosophic soft expert sets (WNSESs). The combination of two parametrized neutrosophic soft expert sets is determined by employing the standard fuzzy union operator, that is

$$T_{(F \cup G)}(x) = T_F(x) \vee T_G(x), \quad I_{(F \cup G)}(x) = I_F(x) \vee I_G(x), \quad F_{(F \cup G)}(x) = F_F(x) \wedge F_G(x),$$

where $\vee$ denotes the basic fuzzy union.

Additionally, we obtain the following WNSES (H, S) using the weight neutrosophic soft expert union, where $S = S_1 \cup S_2$ as follows:

$$
\begin{aligned}
(H, S) = &\left\{\left(\left(e_1, \frac{p}{0.9}, 1\right), \frac{w_1}{< 0.3, 0, 0.7 >}, \frac{w_2}{< 0.8, 0.2, 0.1 >}, \frac{w_3}{< 0.7, 0.1, 0.3 >}\right),\right.\\
&\left(\left(e_3, \frac{r}{0.7}, 1\right), \frac{w_1}{< 0.5, 0.8, 0.2 >}, \frac{w_2}{< 0.5, 0, 0.4 >}, \frac{w_3}{< 0.6, 0.3, 0.1 >}\right),\\
&\left.\left(\left(e_1, \frac{q}{0.4}, 0\right), \frac{w_1}{< 0.6, 0.2, 0.3 >}, \frac{w_2}{< 0.8, 0.2, 0.5 >}, \frac{w_3}{< 0.6, 0.5, 0.9 >}\right)\right\}
\end{aligned}
$$

Definition 3.8. *Let (F, S_1) and (G, S_2) be two WNSSs over a common universe U. Their intersection is defined as the WNSES $(K, S)_{\Lambda_t}$, where $S = S_1 \cap S_2$, and for each $\nu \in S$ we set*

$$
K_{\Lambda_t}(\nu) = \begin{cases} F_{\Lambda_t}(\nu), & \text{if } \nu \in S_1 \setminus S_2, \\ G_{\Lambda_t}(\nu), & \text{if } \nu \in S_2 \setminus S_1, \\ (F \cap G)_{\Lambda_t}(\nu), & \text{if } \nu \in S_1 \cap S_2, \end{cases}
$$

where the symbol $\cap$ denotes the weight neutrosophic soft expert intersection of F and G, and the parameter t corresponds to an appropriate t-norm used in the combination.

Example 3.6. *For example, look at 3.5. The following is how we use the fundamental fuzzy intersection to obtain the following WNSES (K, S) using the weight neutrosophic soft expert intersection, where $S =$*

$S_1 \cup S_2$ as follows:

$$(K,S) = \left\{ \left(\left(e_1, \frac{p}{0.9}, 1\right), \frac{w_1}{<0.2, 0.1, 0.8>}, \frac{w_2}{<0.7, 0.3, 0.3>}, \frac{w_3}{<0.3, 0.2, 0.6>} \right), \right.$$
$$\left(\left(e_3, \frac{r}{0.7}, 1\right), \frac{w_1}{<0.5, 0.8, 0.2>}, \frac{w_2}{<0.5, 0, 0.4>}, \frac{w_3}{<0.6, 0.3, 0.1>} \right),$$
$$\left. \left(\left(e_1, \frac{q}{0.4}, 0\right), \frac{w_1}{<0.6, 0.2, 0.3>}, \frac{w_2}{<0.8, 0.2, 0.5>}, \frac{w_3}{<0.6, 0.5, 0.9>} \right) \right\}$$

Proposition 3.1 (Consider (F, S_1) and (G, S_2) be WNSESs over the universe U. Then). (1)

$(F, S_1) \cup (G, S_2) = (G, S_2) \cup (F, S_1)$

(2) $(F, S_1) \cap (G, S_2) = (G, S_2) \cap (F, S_1)$

Proof. The proof is simple and requires no further elaboration.

Definition 3.9. *Let (F, S_1) and (G, S_2) be two WNSESs defined over the same universe U. The operation "(F, S_1) AND (G, S_2)" is represented as*

$$(F, S_1) \wedge (G, S_2) = (K,\ S_1 \times S_2)_{\mu(x_1) \wedge \mu(x_2)},$$

where

$$K_{e_1 \wedge e_2}(\beta, \gamma) = \Big(F(\beta) \cap G(\gamma)\Big)_{\mu(x_1) \wedge \mu(x_2)}, \quad \forall\, (\beta, \gamma) \in S_1 \times S_2.$$

Here, $\cap$ indicates the weight neutrosophic soft expert intersection of F and G.

Example 3.7. *Define (F, S_1) and (G, S_2) as follows:*

$$(F, S_1) = \left\{ \left(\left(e_1, \frac{p}{0.9}, 1\right), \frac{w_1}{<0.2, 0, 0.7>}, \frac{w_2}{<0.7, 0.3, 0.1>}, \frac{w_3}{<0.7, 0.2, 0.3>} \right), \right.$$
$$\left. \left(\left(e_3, \frac{r}{0.7}, 1\right), \frac{w_1}{<0.5, 0.8, 0.2>}, \frac{w_2}{<0.5, 0, 0.4>}, \frac{w_3}{<0.6, 0.3, 0.1>} \right) \right\}$$
$$(G, S_2) = \left\{ \left(\left(e_1, \frac{p}{0.9}, 1\right), \frac{w_1}{<0.3, 0.1, 0.8>}, \frac{w_2}{<0.8, 0.2, 0.3>}, \frac{w_3}{<0.3, 0.1, 0.6>} \right), \right.$$
$$\left. \left(\left(e_1, \frac{q}{0.4}, 0\right), \frac{w_1}{<0.6, 0.2, 0.3>}, \frac{w_2}{<0.8, 0.2, 0.5>}, \frac{w_3}{<0.6, 0.5, 0.9>} \right) \right\}$$

With fuzzy AND (minimum), we obtain the following the intersection of weighted expert in neutrosophic soft expert, $(F, S_1) \wedge (G, S_2) = (K, S_1 \times S_2)$
Where,

$$(K, S_1 \times S_2) = \left\{ \left(\left(e_1, \frac{p}{0.9}, 1\right), \left(e_1, \frac{p}{0.9}, 1\right), \frac{w_1}{<0.3, 0.1, 0.8>}, \frac{w_2}{<0.7, 0.3, 0.3>}, \frac{w_3}{<0.3, 0.2, 0.6>} \right), \right.$$
$$\left(\left(e_1, \frac{p}{0.9}, 1\right), \left(e_1, \frac{q}{0.4}, 0\right), \frac{w_1}{<0.5, 0.2, 0.7>}, \frac{w_2}{<0.7, 0.3, 0.5>}, \frac{w_3}{<0.6, 0.5, 0.8>} \right),$$

$$\left(\left(e_3,\frac{r}{0.7},1\right),\left(e_1,\frac{p}{0.9},1\right),\frac{w_1}{<0.3,0.8,0.8>},\frac{w_2}{<0.5,0.2,0.4>},\frac{w_3}{<0.3,0.3,0.6>}\right),$$
$$\left.\left(\left(e_3,\frac{r}{0.7},1\right),\left(e_1,\frac{q}{0.4},0\right),\frac{w_1}{<0.5,0.8,0.3>},\frac{w_2}{<0.5,0.2,0.5>},\frac{w_3}{<0.6,0.5,0.8>}\right)\right\}$$

Definition 3.10. *Over the common universe U, let (F,S_1) and (G,S_2) be two WNSSs. Then "(F,S_1) OR (G,S_2)", represented by $(F,S_1)\vee(G,S_2)$, is defined by*

$$(F,S_1)\vee(G,S_2)=(H,S_1\times S_2)_{(e_1\vee e_2)}$$

where

$$H_{(e_1\vee e_2)}(\beta,\gamma)=(F(\beta)\cup G(\gamma))_{(e_1\vee e_2)},\quad \forall(\beta,\gamma)\in S_1\times S_2,$$

and $\{e_1\}\vee\{e_2\}$ denotes the weight neutrosophic soft expert union between F and G is $\cup$, whereas $\vee$ is a fuzzy OR.

Example 3.8. *With reference to Example 3.7, With fuzzy OR (maximum), we obtain the following sets of the weight neutrosophic soft expert union is now utilized to $(F,S_1)\vee(G,S_2)=(H,S_1\times S_2)$*
Where,

$$(H,S_1\times S_2)=\left\{\left(\left(e_1,\frac{p}{0.9},1\right),\left(e_1,\frac{p}{0.9},1\right),\frac{w_1}{<0.5,0,0.7>},\frac{w_2}{<0.8,0.2,0.1>},\frac{w_3}{<0.7,0.1,0.5>}\right),\right.$$
$$\left(\left(e_1,\frac{p}{0.9},1\right),\left(e_1,\frac{q}{0.4},0\right),\frac{w_1}{<0.6,0,0.3>},\frac{w_2}{<0.8,0.2,0.1>},\frac{w_3}{<0.7,0.2,0.5>}\right),$$
$$\left(\left(e_3,\frac{r}{0.7},1\right),\left(e_1,\frac{p}{0.9},1\right),\frac{w_1}{<0.5,0.1,0.2>},\frac{w_2}{<0.8,0,0.3>},\frac{w_3}{<0.6,0.1,0.5>}\right),$$
$$\left.\left(\left(e_3,\frac{r}{0.7},1\right),\left(e_1,\frac{q}{0.4},0\right),\frac{w_1}{<0.6,0.2,0.2>},\frac{w_2}{<0.8,0,0.4>},\frac{w_3}{<0.6,0.3,0.5>}\right)\right\}$$

4. An Application of WNSES in Decision Making Problem

Real-world decision-making frequently entails ambiguity, uncertainty, and insufficient information. Sometimes the intricacy of such situations cannot be fully captured by traditional mathematical techniques, especially when expert judgments disagree or when factors have varying degrees of relevance. By combining parameterization with truth, indeterminacy, and falsity membership functions, the framework of weight neutrosophic soft sets (WNSES) offers a potent method for expressing and evaluating uncertain data. We demonstrate how to use WNSES to decision-making issues in this section. The objective is to show how WNSES may be used to represent expert knowledge, compile divergent viewpoints, and offer a logical foundation for choosing the best course of action. This method gives decision-makers a versatile and reliable instrument that manages imprecision and provides a methodical framework for evaluating and selecting potential solutions.

4.1. **The Algorithm.**

Algorithm Inputs.

- $U = \{w_1, w_2, \ldots, u_m\}$: Set of alternatives (universe)
- $E = \left\{\frac{e_1}{\mu(e_1)}, \frac{e_2}{\mu(e_2)}, \ldots, \frac{e_n}{\mu(e_n)}\right\}$: Parameter set with weights
- $X = \{x_1, x_2, \ldots, x_p\}$: Set of experts
- $O = \{\text{agree} = 1, \text{disagree} = 0\}$: Opinion set
- (F, S): a weighted expert neutrosophic soft expert set (WNSES)

The following steps outline the procedure for applying WNSES in the decision-making process:

Algorithm 4.1. (1) ***Step 1:*** *The weighted expert neutrosophic soft expert set (H, C) is first constructed using (F, A) and (G, B) as needed.*

(2) ***Step 2:*** *Calculate Weighted Scores for Each Expert*

(a) *For each alternative $u_j \in U$, for each parameter $e_k \in E$, and for each expert $x_m \in X$:*

$$\mathrm{WV}_{\text{agree}}(u_j, e_k, x_m) = \mu(e_k) \times [T^1 + I^1 - F^1],$$
$$\mathrm{WV}_{\text{disagree}}(u_j, e_k, x_m) = \mu(e_k) \times [T^0 + I^0 - F^0],$$

where T^1, I^1, F^1 are taken from the agree-set $(H, S)^1$ and T^0, I^0, F^0 from the disagree-set $(H, S)^0$.

(3) ***Step 3:*** *Aggregate by Parameters*

$$C_{jk} = \sum_{x_m \in X} \mathrm{WV}_{\text{agree}}(u_j, e_k, x_m),$$
$$K_{jk} = \sum_{x_m \in X} \mathrm{WV}_{\text{disagree}}(u_j, e_k, x_m).$$

(4) ***Step 4:*** *Apply Parameter Weights for Final Aggregation*

$$C_j = \sum_{e_k \in E} \mu(e_k) \times C_{jk},$$
$$K_j = \sum_{e_k \in E} \mu(e_k) \times K_{jk}.$$

(5) ***Step 5:*** *Compute Final Scores $S_j = C_j - K_j$.*

(6) ***Step 6:*** *Determine Optimal Decision $u_{\text{optimal}} = \arg\max_{u_j \in U} S_j$.*

4.2. **Application in a decision-making problem.** Suppose a prestigious university wishes to invest in new research projects, consulting experts to evaluate three alternatives $U = \{w_1, w_2, w_3\}$ where w_1 denotes Artificial Intelligence in Healthcare, w_2 Renewable Energy Systems, and w_3 Advanced Materials for Nanotechnology, with parameters $E = \{e_1, e_2, e_3\}$ representing societal impact, availability of skilled researchers and infrastructure, and expected financial cost with funding opportunities, and experts $X = \{p, \frac{q}{0.4}, r\}$ whose opinions help the university determine the most feasible research direction and thus develop a weighted expert neutrosophic soft expert set.

Consider the weighted expert neutrosophic soft expert sets (WNSESs) described as follows: (F, S_1) and (G, S_2):

$$
\begin{aligned}
(F,S_1) = \Bigg\{ & \left(\left(e_1,\frac{p}{0.9},1\right),\frac{w_1}{<0.3,0.2,0.4>},\frac{w_2}{<0.5,0.1,0.3>},\frac{w_3}{<0.3,0.1,0.5>}\right),\\
& \left(\left(e_1,\frac{q}{0.4},1\right),\frac{w_1}{<0.6,0.2,0.2>},\frac{w_2}{<0.6,0.2,0.4>},\frac{w_3}{<0.7,0.1,0.2>}\right),\\
& \left(\left(e_1,\frac{r}{0.7},1\right),\frac{w_1}{<0.3,0.3,0.5>},\frac{w_2}{<0.1,0.4,0.6>},\frac{w_3}{<0.1,0.4,0.8>}\right),\\
& \left(\left(e_2,\frac{p}{0.9},1\right),\frac{w_1}{<0.3,0.2,0.4>},\frac{w_2}{<0.4,0.2,0.3>},\frac{w_3}{<0.7,0.2,0.3>}\right),\\
& \left(\left(e_2,\frac{q}{0.4},1\right),\frac{w_1}{<0.3,0.2,0.4>},\frac{w_2}{<0.5,0.2,0.7>},\frac{w_3}{<0.4,0.2,0.3>}\right),\\
& \left(\left(e_2,\frac{r}{0.7},1\right),\frac{w_1}{<0.4,0.2,0.3>},\frac{w_2}{<0.5,0.1,0.3>},\frac{w_3}{<0.7,0.3,0.4>}\right),\\
& \left(\left(e_1,\frac{p}{0.9},0\right),\frac{w_1}{<0.5,0.2,0.4>},\frac{w_2}{<0.5,0.1,0.3>},\frac{w_3}{<0.3,0.1,0.2>}\right),\\
& \left(\left(e_1,\frac{q}{0.4},0\right),\frac{w_1}{<0.7,0.1,0.2>},\frac{w_2}{<0.6,0.2,0.2>},\frac{w_3}{<0.2,0.4,0.6>}\right),\\
& \left(\left(e_1,\frac{r}{0.7},0\right),\frac{w_1}{<0.2,0.1,0.7>},\frac{w_2}{<0.2,0.4,0.6>},\frac{w_3}{<0.2,0.2,0.6>}\right),\\
& \left(\left(e_2,\frac{p}{0.9},0\right),\frac{w_1}{<0.1,0.2,0.8>},\frac{w_2}{<0.1,0.4,0.6>},\frac{w_3}{<0.5,0.3,0.3>}\right),\\
& \left(\left(e_2,\frac{q}{0.4},0\right),\frac{w_1}{<0.4,0.2,0.3>},\frac{w_2}{<0.3,0.4,0.6>},\frac{w_3}{<0.5,0.3,0.6>}\right),\\
& \left(\left(e_2,\frac{r}{0.7},0\right),\frac{w_1}{<0.1,0.3,0.2>},\frac{w_2}{<0.5,0.2,0.1>},\frac{w_3}{<0.7,0.1,0.1>}\right)\Bigg\}
\end{aligned}
$$

$$
\begin{aligned}
(G,S_2) = \Bigg\{ & \left(\left(e_1,\frac{p}{0.9},1\right),\frac{w_1}{<0.4,0.1,0.2>},\frac{w_2}{<0.5,0.4,0.1>},\frac{w_3}{<0.1,0.3,0.7>}\right),\\
& \left(\left(e_1,\frac{q}{0.4},1\right),\frac{w_1}{<0.9,0.4,0.1>},\frac{w_2}{<0.4,0.4,0.2>},\frac{w_3}{<0.7,0.1,0.3>}\right),\\
& \left(\left(e_1,\frac{r}{0.7},1\right),\frac{w_1}{<0.2,0.1,0.5>},\frac{w_2}{<0.7,0.5,0.1>},\frac{w_3}{<0.7,0.3,0.8>}\right),\\
& \left(\left(e_3,\frac{p}{0.9},1\right),\frac{w_1}{<0.2,0.1,0.5>},\frac{w_2}{<0.6,0.1,0.1>},\frac{w_3}{<0.8,0.3,0.4>}\right),
\end{aligned}
$$

$$\left(\left(e_3, \frac{q}{0.4}, 1\right), \frac{w_1}{<0.5, 0.2, 0.3>}, \frac{w_2}{<0.4, 0.5, 0.1>}, \frac{w_3}{<0.3, 0.1, 0.6>}\right),$$
$$\left(\left(e_3, \frac{r}{0.7}, 1\right), \frac{w_1}{<0.7, 0.1, 0.5>}, \frac{w_2}{<0.8, 0.2, 0.3>}, \frac{w_3}{<0.5, 0.2, 0.7>}\right),$$
$$\left(\left(e_1, \frac{p}{0.9}, 0\right), \frac{w_1}{<0.7, 0.1, 0.1>}, \frac{w_2}{<0.3, 0.4, 0.6>}, \frac{w_3}{<0.7, 0.1, 0.3>}\right),$$
$$\left(\left(e_1, \frac{q}{0.4}, 0\right), \frac{w_1}{<0.5, 0.5, 0.1>}, \frac{w_2}{<0.8, 0.2, 0.1>}, \frac{w_3}{<0.7, 0.1, 0.1>}\right),$$
$$\left(\left(e_1, \frac{r}{0.7}, 0\right), \frac{w_1}{<0.2, 0.1, 0.5>}, \frac{w_2}{<0.4, 0.2, 0.7>}, \frac{w_3}{<0.3, 0.1, 0.5>}\right),$$
$$\left(\left(e_3, \frac{p}{0.9}, 0\right), \frac{w_1}{<0.9, 0.4, 0.1>}, \frac{w_2}{<0.1, 0.2, 0.7>}, \frac{w_3}{<0.3, 0.3, 0.5>}\right),$$
$$\left(\left(e_3, \frac{q}{0.4}, 0\right), \frac{w_1}{<0.5, 0.4, 0.7>}, \frac{w_2}{<0.2, 0.1, 0.5>}, \frac{w_3}{<0.5, 0.2, 0.1>}\right),$$
$$\left.\left(\left(e_3, \frac{r}{0.7}, 0\right), \frac{w_1}{<0.9, 0.3, 0.4>}, \frac{w_2}{<0.6, 0.1, 0.4>}, \frac{w_3}{<0.2, 0.1, 0.5>}\right)\right\}$$

The following is obtained by using the weight neutrosophic soft expert union:

$$(H, S) = \left\{\left(\left(e_1, \frac{p}{0.9}, 1\right), \frac{w_1}{<0.4, 0.1, 0.2>}, \frac{w_2}{<0.5, 0.1, 0.1>}, \frac{w_3}{<0.3, 0.1, 0.5>}\right),\right.$$
$$\left(\left(e_1, \frac{q}{0.4}, 1\right), \frac{w_1}{<0.9, 0.2, 0.1>}, \frac{w_2}{<0.6, 0.2, 0.2>}, \frac{w_3}{<0.7, 0.1, 0.2>}\right),$$
$$\left(\left(e_1, \frac{r}{0.7}, 1\right), \frac{w_1}{<0.3, 0.1, 0.5>}, \frac{w_2}{<0.7, 0.4, 0.1>}, \frac{w_3}{<0.7, 0.3, 0.4>}\right),$$
$$\left(\left(e_2, \frac{p}{0.9}, 1\right), \frac{w_1}{<0.3, 0.2, 0.4>}, \frac{w_2}{<0.4, 0.2, 0.3>}, \frac{w_3}{<0.7, 0.2, 0.3>}\right),$$
$$\left(\left(e_2, \frac{q}{0.4}, 1\right), \frac{w_1}{<0.3, 0.2, 0.4>}, \frac{w_2}{<0.5, 0.2, 0.7>}, \frac{w_3}{<0.4, 0.2, 0.3>}\right),$$
$$\left(\left(e_2, \frac{r}{0.7}, 1\right), \frac{w_1}{<0.4, 0.2, 0.3>}, \frac{w_2}{<0.5, 0.1, 0.3>}, \frac{w_3}{<0.7, 0.3, 0.4>}\right),$$
$$\left(\left(e_3, \frac{p}{0.9}, 1\right), \frac{w_1}{<0.2, 0.1, 0.5>}, \frac{w_2}{<0.6, 0.1, 0.1>}, \frac{w_3}{<0.8, 0.3, 0.4>}\right),$$
$$\left(\left(e_3, \frac{q}{0.4}, 1\right), \frac{w_1}{<0.5, 0.2, 0.3>}, \frac{w_2}{<0.4, 0.5, 0.1>}, \frac{w_3}{<0.3, 0.1, 0.6>}\right),$$

$$\left(\left(e_3,\frac{r}{0.7},1\right),\frac{w_1}{<0.7,0.1,0.5>},\frac{w_2}{<0.8,0.2,0.3>},\frac{w_3}{<0.5,0.2,0.7>}\right),$$

$$\left(\left(e_1,\frac{p}{0.9},0\right),\frac{w_1}{<0.7,0.1,0.1>},\frac{w_2}{<0.5,0.1,0.3>},\frac{w_3}{<0.7,0.1,0.2>}\right),$$

$$\left(\left(e_1,\frac{q}{0.4},0\right),\frac{w_1}{<0.7,0.1,0.1>},\frac{w_2}{<0.8,0.2,0.1>},\frac{w_3}{<0.7,0.1,0.1>}\right),$$

$$\left(\left(e_1,\frac{r}{0.7},0\right),\frac{w_1}{<0.2,0.1,0.5>},\frac{w_2}{<0.4,0.2,0.6>},\frac{w_3}{<0.3,0.1,0.5>}\right),$$

$$\left(\left(e_2,\frac{p}{0.9},0\right),\frac{w_1}{<0.1,0.2,0.8>},\frac{w_2}{<0.1,0.4,0.6>},\frac{w_3}{<0.5,0.3,0.3>}\right),$$

$$\left(\left(e_2,\frac{q}{0.4},0\right),\frac{w_1}{<0.4,0.2,0.3>},\frac{w_2}{<0.3,0.4,0.6>},\frac{w_3}{<0.5,0.3,0.6>}\right),$$

$$\left(\left(e_2,\frac{r}{0.7},0\right),\frac{w_1}{<0.1,0.3,0.2>},\frac{w_2}{<0.5,0.2,0.1>},\frac{w_3}{<0.7,0.1,0.1>}\right),$$

$$\left(\left(e_3,\frac{p}{0.9},0\right),\frac{w_1}{<0.9,0.4,0.1>},\frac{w_2}{<0.1,0.2,0.7>},\frac{w_3}{<0.3,0.3,0.5>}\right),$$

$$\left(\left(e_3,\frac{q}{0.4},0\right),\frac{w_1}{<0.5,0.4,0.7>},\frac{w_2}{<0.2,0.1,0.5>},\frac{w_3}{<0.5,0.2,0.1>}\right),$$

$$\left(\left(e_3,\frac{r}{0.7},0\right),\frac{w_1}{<0.9,0.3,0.4>},\frac{w_2}{<0.6,0.1,0.4>},\frac{w_3}{<0.2,0.1,0.5>}\right)\Big\}$$

Weighted expert neutrosophic soft expert sets $(H,S)^1$ and $(H,S)^0$ are shown in tables 1 and 2, respectively.

Table 1. Agree neutrosophic soft expert set $(H,\ S)^1$.

U	w_1	w_2	w_3
$(e_1,\frac{p}{0.9}$	$\langle 0.4,0.1,0.2\rangle$	$\langle 0.5,0.1,0.1\rangle$	$\langle 0.3,0.1,0.5\rangle$
$(e_1,\frac{q}{0.4}$	$\langle 0.9,0.2,0.1\rangle$	$\langle 0.6,0.2,0.2\rangle$	$\langle 0.7,0.1,0.2\rangle$
$(e_1,\frac{r}{0.7}$	$\langle 0.3,0.1,0.5\rangle$	$\langle 0.7,0.4,0.1\rangle$	$\langle 0.7,0.3,0.4\rangle$
$(e_2,\frac{p}{0.9}$	$\langle 0.3,0.2,0.4\rangle$	$\langle 0.4,0.2,0.3\rangle$	$\langle 0.7,0.2,0.3\rangle$
$(e_2,\frac{q}{0.4}$	$\langle 0.3,0.2,0.4\rangle$	$\langle 0.5,0.2,0.7\rangle$	$\langle 0.4,0.2,0.3\rangle$
$(e_2,\frac{r}{0.7}$	$\langle 0.4,0.2,0.3\rangle$	$\langle 0.5,0.1,0.3\rangle$	$\langle 0.7,0.3,0.4\rangle$
$(e_3,\frac{p}{0.9}$	$\langle 0.2,0.1,0.5\rangle$	$\langle 0.6,0.1,0.1\rangle$	$\langle 0.8,0.3,0.4\rangle$
$(e_3,\frac{q}{0.4}$	$\langle 0.5,0.2,0.3\rangle$	$\langle 0.4,0.5,0.1\rangle$	$\langle 0.3,0.1,0.6\rangle$
$(e_3,\frac{r}{0.7}$	$\langle 0.7,0.1,0.5\rangle$	$\langle 0.8,0.2,0.3\rangle$	$\langle 0.5,0.2,0.7\rangle$

Table 2. Disagree neutrosophic soft expert set $(H,\ S)^0$.

U	w_1	w_2	w_3
$(e_1, \frac{p}{0.9}$	$\langle 0.7, 0.1, 0.1\rangle$	$\langle 0.5, 0.1, 0.3\rangle$	$\langle 0.7, 0.1, 0.2\rangle$
$(e_1, \frac{q}{0.4}$	$\langle 0.7, 0.1, 0.1\rangle$	$\langle 0.8, 0.2, 0.1\rangle$	$\langle 0.7, 0.1, 0.1\rangle$
$(e_1, \frac{r}{0.7}$	$\langle 0.2, 0.1, 0.5\rangle$	$\langle 0.4, 0.2, 0.6\rangle$	$\langle 0.3, 0.1, 0.5\rangle$
$(e_2, \frac{p}{0.9}$	$\langle 0.1, 0.2, 0.8\rangle$	$\langle 0.1, 0.4, 0.6\rangle$	$\langle 0.5, 0.3, 0.3\rangle$
$(e_2, \frac{q}{0.4}$	$\langle 0.4, 0.2, 0.3\rangle$	$\langle 0.3, 0.4, 0.6\rangle$	$\langle 0.5, 0.3, 0.6\rangle$
$(e_2, \frac{r}{0.7}$	$\langle 0.1, 0.3, 0.2\rangle$	$\langle 0.5, 0.2, 0.1\rangle$	$\langle 0.7, 0.1, 0.1\rangle$
$(e_3, \frac{p}{0.9}$	$\langle 0.9, 0.4, 0.1\rangle$	$\langle 0.1, 0.2, 0.7\rangle$	$\langle 0.3, 0.3, 0.5\rangle$
$(e_3, \frac{q}{0.4}$	$\langle 0.5, 0.4, 0.7\rangle$	$\langle 0.2, 0.1, 0.5\rangle$	$\langle 0.5, 0.2, 0.1\rangle$
$(e_3, \frac{r}{0.7}$	$\langle 0.9, 0.3, 0.4\rangle$	$\langle 0.6, 0.1, 0.4\rangle$	$\langle 0.2, 0.1, 0.5\rangle$

Table 3. Agree weighted expert neutrosophic soft expert set $(H,\ S)^1$

U	w_1	w_2	w_3
$(e_1, \frac{p}{0.9}$	0.3	0.5	−0.1
$(e_1, \frac{q}{0.4}$	1	0.6	0.6
$(e_1, \frac{r}{0.7}$	−0.1	1	−0.4
$(e_2, \frac{p}{0.9}$	0.1	0.3	0.6
$(e_2, \frac{q}{0.4}$	0.1	0	0.3
$(e_2, \frac{r}{0.7}$	0.3	0.3	0.6
$(e_3, \frac{p}{0.9}$	−0.2	0.6	0.7
$(e_3, \frac{q}{0.4}$	0.4	0.8	−0.2
$(e_3, \frac{r}{0.7}$	0.3	0.7	0

Table 4. Disagree weighted expert neutrosophic soft expert set $(H,\ S)^0$

U	w_1	w_2	w_3
$(e_1, \frac{p}{0.9}$	0.7	0.9	0.7
$(e_1, \frac{q}{0.4}$	−0.2	0	−0.1
$(e_1, \frac{r}{0.7}$	−0.5	−0.1	0.5
$(e_2, \frac{p}{0.9}$	−0.5	−0.1	0.5
$(e_2, \frac{q}{0.4}$	0.3	0.1	0.2
$(e_2, \frac{r}{0.7}$	0.2	0.6	0.7
$(e_3, \frac{p}{0.9}$	1.2	−0.4	0.1
$(e_3, \frac{q}{0.4}$	0.2	−0.2	0.6
$(e_3, \frac{r}{0.7}$	0.8	0.3	−0.2

TABLE 5. $C_j = \sum_{e_k \in E} \mu(e_k) \times C_{jk}$for agree weighted expert neutrosophic soft expert set $(H,\ S)^1$

U	w_1	w_2	w_3
$(e_1, \frac{p}{0.9}$	0.15	0.25	−0.5
$(e_1, \frac{q}{0.4}$	5	0.30	0.30
$(e_1, \frac{r}{0.7}$	−0.05	5	−0.20
$(e_2, \frac{p}{0.9}$	0.04	0.12	0.24
$(e_2, \frac{q}{0.4}$	0.04	0	0.12
$(e_2, \frac{r}{0.7}$	0.12	0.12	0.24
$(e_3, \frac{p}{0.9}$	−0.14	0.42	0.49
$(e_3, \frac{q}{0.4}$	0.28	0.56	−0.14
$(e_3, \frac{r}{0.7}$	0.21	0.49	0
c_j	$c_1 = 5.65$	$c_2 = 7.26$	$c_3 = 1.28$

TABLE 6. $K_j = \sum_{e_k \in E} \mu(e_k) \times K_{jk}$ for disagree weighted expert neutrosophic soft expert set $(H,\ S)^0$

U	w_1	w_2	w_3
$(e_1, \frac{p}{0.9}$	0.35	0.45	0.35
$(e_1, \frac{q}{0.4}$	−0.10	0	−0.05
$(e_1, \frac{r}{0.7}$	−0.25	−0.05	0.25
$(e_2, \frac{p}{0.9}$	−0.20	−0.04	0.20
$(e_2, \frac{q}{0.4}$	0.12	0.04	0.08
$(e_2, \frac{r}{0.7}$	0.08	0.24	0.28
$(e_3, \frac{p}{0.9}$	0.84	−0.28	0.07
$(e_3, \frac{q}{0.4}$	0.14	−0.14	0.42
$(e_3, \frac{r}{0.7}$	0.56	0.21	−0.14
k_j	$k_1 = 1.44$	$k_2 = 0.43$	$k_3 = 1.46$

TABLE 7. Score $s_j = c_j - k_j$ for weighted expert neutrosophic soft expert sets (H, S).

j	c_j	k_j	s_j
1	5.65	1.44	4.21
2	7.26	0.43	6.83
3	1.28	1.46	−0.18

We determine the values of $s_j = c_j - k_j$ from Tables 5 and 6, as shown in Table 7. For w_2, the maximum score is 6.83. w_2 is the best choice for WNSES.

5. Conclusions

In this paper, we introduced and studied the concept of a weighted expert neutrosophic soft expert set (WNSES), which integrates the features of both neutrosophic soft sets and soft expert sets under the framework of effective parameters. This novel structure enhances the ability to represent uncertainty by simultaneously accounting for expert opinions, parameterization, and the three neutrosophic membership functions: truth, indeterminacy, and falsity.

Several fundamental operations on WNSESs, such as complement, union, intersection, and their variations, were defined and examined, providing a comprehensive understanding of how effectiveness and expert perspectives interact within this model. Moreover, illustrative examples and propositions were provided to demonstrate the applicability and soundness of the proposed operations.

The introduction of WNSESs not only broadens the theoretical landscape of neutrosophic soft set theory but also contributes toward practical applications. The model is particularly suited for complex decision-making problems where uncertainty, inconsistency, and expert subjectivity coexist. By combining parameterization with neutrosophic structures, WNSESs allow for more flexible and reliable modeling of real-world scenarios.

Future Work. There are several promising directions for further research:

- Extending WNSESs to more generalized environments, such as Q-neutrosophic or complex neutrosophic settings.
- Developing efficient algorithms for decision-making processes using WNSESs in multi-criteria and multi-expert environments.
- Applying WNSES models to real-life domains, such as medical diagnosis, risk analysis, and information management, to evaluate their practical effectiveness.
- Investigating sensitivity analysis and optimization techniques within WNSES frameworks for more robust decision support.

Overall, this work provides a solid foundation for the study of weighted expert neutrosophic soft expert sets and opens new avenues for advancing uncertainty modeling and decision-making methodologies.

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