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Abstract. We introduce the notion of interval-valued intuitionistic neutrosophic vague sets, or IVINVsets. Its fundamental characteristics and outcomes are examined. The IVINV collection is a crucial resource for researching the ambiguity and uncertainty present in decision-making situations. A suggestion is made for an application in career decision. It is suggested to use the IVINV generalized weighted Euclidean distance measure. Every student's and every career's distance from one another is measured. To find the answer, the shortest path between every student and every career is computed.

2020 AMS Classification: 03E72, 08A72

Keywords: Fuzzy sets, Interval-valued fuzzy sets, Intuitionistic fuzzy sets, Interval-valued intuitionistic fuzzy sets, Neutrosophic sets, Interval-valued neutrosophic sets, Intuitionistic neutrosophic sets, Interval-valued intuitionistic neutrosophic sets, IV-INVsets, Career choice

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1. Introduction

Zadeh [1] introduced the idea of fuzzy sets in 1965. It can be used in a wide range of fields. It addresses ambiguity and confusion that the regular set was unable to do so. Atanassov [2] invented intuitionistic fuzzy sets (IF sets) in 1986. It includes the so-called hesitation margin, which is the degree of hesitancy. One less the sum of the degrees of membership and non-membership is how it is defined. Gorzalczany [3] first proposed the idea of an interval-valued fuzzy set in 1987. Atanassov and Gargov [4] introduced the theory of the interval-valued intuitionistic fuzzy set (IVIF set) in 1989. It takes a more applicable, clever, and meaningful approach.

In 1999, Smarandache [5] created neutrosophic sets (Nsets) and neutrosophic logic. An Nset is a collection of elements in the universe with varying degrees of falsehood, indeterminacy, and truth. They are located in the $]0^-, 1^+[$ nonstandard unit interval. The degree of uncertainty is not influenced by the values of truth and falsity. IVN sets and their logic operation rules were developed in 2005 by Wang et al. [6]. 2009 saw the study of the intuitonistic neutrosophic set (INset) by Bhowmik and Pal [7]. They discussed a number of its attributes. The concept of interval valued intuitionistic neutrosophic soft set and its application through similarity measure was first presented by Chinnadurai and Bobin [8] in 2021. In 2019, Hashim et al. [9] introduced the idea of interval-valued neutrosophic vague sets (IVNVset).

An attempt is made to introduce the IVINVSset notions in this work. We present a few fundamental definitions and functions for it. It can be used to make decisions for career selection. It is suggested to use the IVINV generalized weighted Euclidean distance measure. We calculate the separation between every student and every career, in turn. The answer can be found by finding the minimum gap between each student and each career. The following papers ([10, 11, 12]) were also studied by us.

In neutrosophic set, indeterminacy is quantified explicitly and truth-membership, indeterminacy-membership and false-membership are independent. This assumption is very important in information fusion when we try to combine the data from different sensors. The notion of neutrosophic sets was introduced by Smarandache [8] in 1999. It is a branch of philosophy which studies the origin, nature and scope of neutralities, as well as their interactions with different ideational spectra. Neutrosophic set is a powerful general formal framework which generalizes the concept of the classic set, fuzzy set, interval-valued fuzzy set, intuitionistic fuzzy set, interval-valued intuitionistic fuzzy set and others. A neutrosophic set A in E is described by three functions: true membership function $T_A(x)$, indeterminacy membership function $I_A(x)$, false true membership function $F_A(x)$ as $A = \{\langle x, T_A(x), I_A(x), F_A(x)\rangle : x \in E\}$, where $T, I, F \to]0^-, 1^+[$ and $0^- \leq T_A(x) + I_A(x) + F_A(x) \leq 3^+$ The neutrosophic set generalizes the above mentioned sets from philosophical point of view. From scientific or engineering point of view, the neutrosophic set and set-theoretic operators need to be specified. Otherwise, it will be difficult to apply in the real applications. In this paper, we define the set-theoretic operators on an instance of neutrosophic set called *interval intuitionistic neutrosophic vague set*. The notion of interval neutrosophic sets was introduced by Wang et al. [6] in 2005. Bhowmik and Pal [7] introduced the concept of intuitionistic neutrosophic sets in 2009. It is evident that decision-making issues including inherited uncertainties can be resolved with the use of IVINVsets. More over the results of the decision making problem can be obtained more accurately with the help of IVINVsets.

2. Preliminaries

In this section, we recall some basic notions for future work.

Definition 2.1 ([1])**.** Let E be an ordinary set. A *fuzzy subset* α in E is the collection of ordered pairs $(x, \mu_\alpha(x))$ with $x \in E$ and a membership function $\mu_\alpha : E \to [0, 1]$. The value $\mu_\alpha(x)$ of x denotes the degree to which an element x may be a member of α. Thus a fuzzy subset α of E is denoted by $\alpha = \{(x, \mu_\alpha(x)) : x \in E\}$, where $\mu_\alpha(x) = 1$, indicates strictly the containment of the element x in α (full membership) and $\mu_\alpha(x) = 0$ denotes that x does not belong to α (non-membership). Thus an ordinary set is a special case of fuzzy set with a membership function which is reduced to a characteristic function. Because of these generalities the fuzzy set theory has a wider scope of applicability than the ordinary set theory in solving real problem.

Definition 2.2 ([2]). Let a set E be fixed. An *intuitionistic fuzzy set* (briefly, IFS) A in E is an object having the form

$$A = \{(x, \mu_A(x), v_A(x)) : x \in E\},$$

where the function $\mu_A : E \to I = [0,1]$ and $v_A : E \to I = [0,1]$ define the degree of membership and non-membership respectively of the element $x \in E$ to the set A and for every $x \in E,\ 0 \leq \mu_A(x) + v_A(x) \leq 1$. An IFS A will be simply denoted by $A = (\mu_A, v_A)$. The rest part $\pi_A(x) = 1 - \mu_A(x) - v_A(x)$ is called the *indeterministic part* of x and $0 \leq \pi_{\mathrm{A}}(\mathrm{x}) \leq 1$.

Definition 2.3 ([3]). An *interval-valued fuzzy set* A over a universe set E is defined as the object of the form

$$A = \{(x, \mu_A(x)) : x \in E\},$$

where $\mu_A : E \to \mathrm{Int}([0,1])$ is a function and $\mathrm{Int}([0,1])$ denotes the set of all closed sub intervals of $[0,1]$. For any $[a,b],\ [c,d] \in Int([0,1])$, let us define $[a,b]+[c,d]$ and $[a,b]-[c,d]$ as follows:

$$[a,b]+[c,d] = [a+c, b+d],\ [a,b]-[c,d] = [a-d, b-c].$$

Definition 2.4 ([6]). An *interval-valued intuitionistic fuzzy set* A over a universe set E is defined as the object of the form

$$A = \{\langle x, (\mu_A(x), \gamma_A(x))\rangle : x \in E\},$$

where $\mu_A : E \to \mathrm{lnt}([0,1])$ and $\gamma_A : E \to \mathrm{lnt}([0,1])$ are functions satisfying the condition: $\forall x \in E,\ \sup \mu_A(x) + \sup \gamma_A(x) \leq 1$. We will simply an interval-valued intuitionistic fuzzy set A as $A = (\mu_A, \gamma_A)$.

The class of all interval valued intuitionistic fuzzy soft sets on E is denoted by $IVIFS(E)$. For an arbitrary set $A \subseteq [0,1]$, we use $\underline{A} = \inf A$ and $\bar{A} = \sup A$.

Definition 2.5 ([5, 13, 14]). A *neutrosophic set* A in a universe E is described by three functions: the *true membership function* $T_A(x)$, the *indeterminacy membership function* $I_A(x)$, the *false true membership function* $F_A(x)$ as

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

where $T, I, F : E \to]\,0^-, 1^+\,[$ and $0^- \leq T_A(x)+I_A(x)+F_A(x) \leq 3^+$. A neutrosophic set A will be simply denoted by $A = \langle T_A, I_A, F_A\rangle$.

Definition 2.6 ([4]). Let E be a universe. An *interval-valued neutrosophic set* (briefly, IVNset) be defined as follows:

$$A = \left\{\left\langle x, \left[T_A^L(x), T_A^U(x)\right], \left[I_A^L(x), I_A^U(x)\right], \left[F_A^L(x), F_A^U(x)\right]\right\rangle : x \in E\right\},$$

where for each element $x \in E,\ T_A(x) \in int[0,1],\ I_A(x) \in int[0,1], F_A(x) \in int[0,1]$ and $0^- \leq \sup T_A(x) + \sup I_A(x) + \sup F_A(x) \leq 3^+$. In fact,

$$T_A(x) = \left[T_A^L(x), T_A^U(x)\right],\ I_A(x) = \left[I_A^L(x), I_A^U(x)\right],\ F_A(x) = \left[F_A^L(x), F_A^U(x)\right].$$

Moreover, we will simply denote an IVNset A as $A = \left\langle \left[T_A^L, T_A^U\right], \left[I_A^L, I_A^U\right], \left[F_A^L, F_A^U\right]\right\rangle$.

Definition 2.7 ([7])**.** An element x of a universe E is called *significant with respect to* a neutrosophic set A of E, if the degree of true-membership, $T_A(x)$ or indeterminacy membership $I_A(x)$ or falsity membership value $F_A(x) \leq 0.5$, otherwise we call it *insignificant*. The truth membership value $T_A(x)$ or the indeterminacy membership value $I_A(x)$ or the falsity membership value $F_A(x)$ will be significant.

An neutrosophic set A is defined by is defined by

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

where for all $x \in U$,

$$\min\{T_A(x), F_A(x)\} \leq 0.5,\ \min\{T_A(x), I_A(x)\} \leq 0.5,\ \min\{F_A(x), I_A(x)\} \leq 0.5.$$

Definition 2.8 ([8])**.** Let E be a universe. An *interval-valued intuitionistic neutrosophic set* (briefly, IVINset) A in E is characterized by the truth membership function $T_A(x)$, the indeterminacy membership function $I_A(x)$ and the falsity membership function $F_A(x)$ as follows: for each $x \in E$, $T_A(x),\ I_A(x),\ F_A(x) \in int[0,1]$,

$$\mathrm{A} = \left\{\left\langle x, \left[T_A^l(x), T_A^r(x)\right], \left[I_A^l(x), I_A^r(x)\right], \left[F_A^l(x), F_A^r(x)\right]\right\rangle : x \in E\right\},$$

$$0 \leq T_A^l(x) + I_A^l(x) + F_A^l(x) \leq 2, \tag{2.1}$$

$$0 \leq T_A^r(x) + I_A^r(x) + F_A^r(x) \leq 2, \tag{2.2}$$

$$\min\left\{\frac{T_A^l(x) + T_A^r(x)}{2}, \frac{F_A^l(x) + F_A^r(x)}{2}\right\} \leq 0.5, \tag{2.3}$$

$$\min\left\{\frac{\{T_A^l(x) + T_A^r(x)}{2}, \frac{I_A^l(x) + I_A^r(x)}{2}\right\} \leq 0.5, \tag{2.4}$$

$$\min\left\{\frac{I_A^l(x) + I_A^r(x)}{2}, \frac{F_A^l(x) + F_A^r(x)}{2}\right\} \leq 0.5. \tag{2.5}$$

The conditions (2.1) and (2.2) can be replaced by

$$0 \leq \sup T_A(x) + \sup I_A(x) + \sup F_A(x) \leq 2.$$

Example 2.9. Let $U = \{u_1, u_2, u_3\}$, where $u_1,\ u_2$ and u_3 are subsets of $[0,1]$ and they are obtained from some question arise of some experts. They impose their opinion in three components. The interval degree of goodness, the interval degree of indeterminacy and the interval degree of poorness explain the characteristics of the object. Consider the IVIN set A in U defined by:

$A = \{\langle u_1, [0.2, 0.4], [0.4, 0.6], [0.3, 0.5]\rangle, \langle u_2, [0.3, 0.5], [0.1, 0.3], [0.4, 0.8]\rangle,$
$\langle u_3, [0.4, 1], [0.2, 0.4], [0.4, 0.6]\rangle\}.$

Then for $u_1 \in U$,

$$\min\left\{\frac{0.2+0.4}{2}, \frac{0.3+0.5}{2}\right\} = \min\{0.3, 0.4\} \leq 0.5,$$

$$\min\left\{\frac{0.2+0.4}{2}, \frac{0.4+0.6}{2}\right\} = \min\{0.3, 0.5\} \leq 0.5,$$

$$\min\left\{\frac{0.3+0.5}{2}, \frac{0.4+0.6}{2}\right\} = \min\{0.4, 0.5\} \leq 0.5.$$

Similarly for $u_2,\ u_3 \in U$.

The maximum [resp. minimum] of an IVN set is $\langle [1,1],[0,0],[0,0]\rangle$

[resp. $\langle [0,0],[0,0],[1,1]\rangle$]. Here the truth membership interval and falsity membership interval are altered while the indeterminacy membership interval is unchanged.

Also $0 \le T_A(x) + I_A(x) + F_A(x) \le 2$.

Definition 2.10 ([15])**.** A *vague set* A in a universe set E is a pair (t_A, f_A), where $t_A, f_A : U \to [0,1]$ such that $t_A(x) + f_A(x) \le 1$ for all $x \in E$. The function t_A and f_A are called the *true membership function* and the *false membership function* respectively. The interval-valued fuzzy set $[t_A, 1 - f_A]$ in E is called the *value* of A and is denoted by $V_A = [t_A, 1 - f_A]$.

Definition 2.11 ([15])**.** Let E be a non-empty set. Let A and B be vague sets in X. Then

(i) $A \subseteq B$ if and only if $V_A \subset V_B$, i.e., $t_A \le t_B$ and $1 - f_A \le 1 - f_B$,

(ii) $A \cup B = V_A \cup V_B$, i.e., for each $x \in E$,

$$(A \cup B)(x) = [\max\{t_A(x), t_B(x)\}, \max\{1 - f_A(x), 1 - f_B(x)\}],$$

(iii) $A \cap B = V_A \cap V_B$, i.e., for each $x \in E$,

$$(A \cap B)(x) = [\min\{t_A(x), t_B(x)\}, \min\{1 - f_A(x), 1 - f_B(x)\}],$$

(iv) $A^c = V_A^c$, i.e., $A^c(x) = [f_A, 1 - t_A]$ for each $x \in E$.

Definition 2.12 ([16])**.** A *neutrosophic vague set* (briefly, NVset) A_{NV} in a universe E is an object of the form

$$A_{NV} = \{\langle x, T_{A_{NV}}(x), I_{A_{NV}}(x), F_{A_{NV}}(x)\rangle : x \in E\},$$

where $T_{A_{NV}}(x) = [T^-(x), T^+(x)],\ I_{A_{NV}}(x) = [I^-(x), I^+(x)],$
$F_{A_{NV}}(x) = [F^-(x), F^+(x)],\ T^+(x) = 1 - F^-(x),\ F^+(x) = 1 - T^-(x),$
$0^- \le T^-(x) + I^-(x) + F^-(x) \le 2^+$.

Definition 2.13 ([9])**.** An *interval-valued neutrosophic vague set* (briefly, IVNVset) A_{INV} in a universe E is denoted by

$$A_{INV} = \{\langle x, \left[T_A^L(x), T_A^U(x)\right], \left[I_A^L(x), I_A^U(x)\right], \left[F_A^L(x), F_A^U(x)\right]\rangle : x \in E\}$$

and is characterized by the true membership, the indeterminacy membership, the false true membership function,
where $T_A^L(x) = \left[T^{L^-}(x), T^{L^+}(x)\right],\ T_A^U(x) = \left[T^{U^-}(x), T^{U^+}(x)\right],$
$F_A^L(x) = \left[F^{L^-}(x), F^{L^+}(x)\right],\ F_A^U(x) = \left[F^{U^-}(x), F^{U^+}(x)\right],$
$I_A^L(x) = \left[I^{L^-}(x), I^{L^+}(x)\right],\ I_A^U(x) = \left[I^{U^-}(x), I^{U^+}(x)\right],$
$T^{L^+}(x) = 1 - F^{L^-}(x),\ F^{L^+} = 1 - T^{L^-}(x),$
$T^{U^+}(x) = 1 - F^{U^-}(x),\ F^{U^+} = 1 - T^{U^-}(x),$
$0^- \le T^{L^+}(x) + T^{U^+}(x) + I^{L^+}(x) + I^{U^+}(x) + F^{L^+}(x) + F^{U^+}(x) \le 4^+$.

3. Interval-valued intuitionistic neutrosophic vague sets

In this section we introduce the concept of interval-valued intuitionistic neutrosophic vague sets (briefly, IVINVset). We study their operations and observe that the family of all IVINVsets does not form the topology.

Definition 3.1. An *interval-valued intuitionistic neutrosophic vague set* (briefly, IVINVset) or a *significant interval-valued neutrosophic vague set* (briefly, SIVNVset) in a nonempty set E, denoted by A_{IVINV}, is an IVNVset in E satisfying the following conditions:

(i) $\min\left\{\frac{T_A^L(x)+T_A^U(x)}{2}, \frac{F_A^L(x)+F_A^U(x)}{2}\right\} \leq 0.5$, i.e.,

$$\min\left\{\frac{\left[T^{L^-},T^{L^+}\right]+\left[T^{U^-},T^{U^+}\right]}{2}, \frac{\left[F^{L^-},F^{L^+}\right]+\left[F^{U^-},F^{U^+}\right]}{2}\right\} \leq 0.5, \tag{3.1}$$

(ii) $\min\left\{\frac{T_A^L(x)+T_A^U(x)}{2}, \frac{I_A^L(x)+I_A^U(x)}{2}\right\} \leq 0.5\Big\}$, i.e.,

$$\min\left\{\frac{\left[T^{L^-},T^{L^+}\right]+\left[T^{U^-},T^{U^+}\right]}{2}, \frac{\left[I^{L^-},I^{L^+}\right]+\left[I^{U^-},I^{U^+}\right]}{2}\right\} \leq 0.5, \tag{3.2}$$

(iii) $\min\left\{\frac{A_A^L(x)+I_A^U(x)}{2}, \frac{F_A^L(x)+F_A^U(x)}{2}\right\} \leq 0.5\Big\}$, i.e.,

$$\min\left\{\frac{\left[I^{L^-},I^{L^+}\right]+\left[I^{U^-},I^{U^+}\right]}{2}, \frac{\left[F^{L^-},F^{L^+}\right]+\left[F^{U^-},F^{U^+}\right]}{2}\right\} \leq 0.5, \tag{3.3}$$

Example 3.2. Let $E = \{x_1, x_2, x_3\}$ and consider the IVINVset A_{IVINV} in E defined by

$$A_{IVINV}(x_1) = \langle [[0.2, 0.4], [0.1, 0.3]], [[0.1, 0.2], [0.2, 0.3]], [[0.6, 0.8], [0.7, 0.9]] \rangle,$$
$$A_{IVINV}(x_2) = \langle [[0.2, 0.4], [0.1, 0.2]], [[0.1, 0.2], [0.3, 0.4]], [[0.6, 0.8], [0.8, 0.9]] \rangle,$$
$$A_{IVINV}(x_3) = \langle [[0.6, 0.9], [0.7, 0.8]], [0.1, 0.2], [0.2, 0.3]], [[0.1, 0.4], [0.2, 0.3]] \rangle.$$

Then we calculate the IVINVset A_{IVINV} for x_1:

$$T^{L^+}(x_1) = 0.4 = 1 - F^{L^-}(x_1),\ F^{L^+}(x_1) = 0.8 = 1 - T^{L^-}(x_1),$$
$$T^{U^+}(x_1) = 0.3 = 1 - F^{U^-}(x_1),\ F^{U^+}(x_1) = 0.9 = 1 - T^{U^-}(x_1).$$

Thus we have

$$T^{L^-}(x_1) + T^{U^-}(x_1) + I^{L^-}(x_1) + I^{U^-}(x_1) + F^{L^-}(x_1) + F^{U^-}(x_1) = 1.9,$$
$$T^{L^+}(x_1) + T^{U^+}(x_1) + I^{L^+}(x_1) + I^{U^+}(x_1) + F^{L^+}(x_1) + F^{U^+}(x_1) = 2.9.$$

So we get

$$0 \leq T^{L^-}(x_1) + T^{U^-}(x_1) + I^{L^-}(x_1) + I^{U^-}(x_1) + F^{L^-}(x_1) + F^{U^-}(x_1) \leq 4^+,$$
$$0^- \leq T^{L^+}(x_1) + T^{U^+}(x_1) + I^{L^+}(x_1) + I^{U^+}(x_1) + F^{L^+}(x_1) + F^{U^+}(x_1) \leq 4^+.$$

On the other hand, we have

$\min\left\{\frac{[0.2,0.4]+[0.1,0.3]}{2}, \frac{[0.6,0.8]+[0.7,0.9]}{2}\right\}$

$= \min\left\{\frac{[0.3,0.7]}{2}, \frac{[1.3,1.7]}{2}\right\}$
$= \min\{\text{mean of the interval } [0.3, 0.7], \text{ mean of the interval } [1.3, 1.7]\}$
$= \min[0.5, 1.5] = 0.5 \leq 0.5$
Hence A_{IVINV} satisfies the condition (3.1). Similarly, we can check that A_{IVINV} satisfies the conditions (3.2) and (3.3). Therefore A_{IVINV} is an IVINVset in E.

Now consider the IVINVset B in E given by

$$B(x_1) = \langle [[0.2, 0.5], [0.2, 0.3]], [[0.1, 0.6], [0.3, 0.6]], [[0.5, 0.8], [0.7, 0.8]] \rangle,$$

$$B(x_2) = \langle [[0.4, 0.5], [0.1, 0.7]], [[0.5, 0.6], [0.1, 0.3]], [[0.5, 0.6], [0.3, 0.9]] \rangle,$$

$$B(x_3) = \langle [[0.6, 0.9], [0.2, 0.5]], [[0.3, 0.7], [0.4, 0.6]], [[0.1, 0.4], [0.5, 0.8]] \rangle.$$

Then we can easily check that B does not satisfy the conditions (3.1), (3.2) and (3.3). Thus B is not an IVINVset in E.

Definition 3.3. Let E be a universe. Then A is called:

(i) a *unit IVINVset* in E, denoted by 1_{IVINV} or $\varnothing_{IVINV}$, if for each $x \in E$,

$$T_A^L(x) = [1, 1],\ T_A^U(x) = [1, 1],$$

$$F_A^L(x) = [0, 0],\ F_A^U(x) = [0, 0],$$

$$I_A^L(x) = [0, 0],\ I_A^U(x) = [0, 0].$$

(ii) a *zero IVINVset* in E, denoted by 0_{IVINV} or δ_{IVINV}, if for each $x \in E$,

$$T_{\delta_{IVINV}}^L(x) = [0, 0],\ T_{\delta_{IVINV}}^U(x) = [0, 0],$$

$$F_{\delta_{IVINV}}^L(x) = [0, 0],\ F_{\delta_{IVINV}}^U(x) = [0, 0],$$

$$I_{\delta_{IVINV}}^L(x) = [1, 1],\ I_{\delta_{IVINV}}^U(x) = [1, 1].$$

It is obvious that 1_{IVINV} and 0_{IVINV} satisfy the conditions (3.1), (3.2) and (3.3).

Definition 3.4. Let A_{IVINV} be an IVINVset in a universe E. Then the *complement* of A_{IVINV}, denoted by A_{IVINV}^c, is an IVINVset in E defined as follows:

$$\mathrm{A}_{IVINV}^c = \left\langle \left[\left(T_A^L\right)^c, \left(T_A^U\right)^c\right], \left[\left(I_A^L\right)^c, \left(I_A^U\right)^c\right], \left[\left(F_A^L\right)^c, \left(F_A^U\right)^c\right] \right\rangle,$$

$$\left(T_A^L\right)^c = \left[1 - T^{L^+}, 1 - T^{L^-}\right],\ \left(T_A^u\right)^c = \left[1 - T^{U^+}, 1 - T^{U^-}\right],$$

$$\left(F_A^L\right)^c = \left[1 - F^{L^+}, 1 - F^{L^-}\right],\ \left(F_A^u\right)^c = \left[1 - F^{U^+}, 1 - F^{U^-}\right],$$

$$\left(I_A^L\right)^c = \left[I^{L^-}, I^{L^+}\right],\ \left(I_A^u\right)^c = \left[I^{U^-}, I^{U^+}\right].$$

It is clear that A_{IVINV}^c satisfy the conditions (3.1), (3.2) and (3.3).

Example 3.5. Let A_{IVINV} be the IVINVset in E defined in Example 3.2. Then A_{IVINV}^c is an IVINVset in E given by:

$$A_{IVINV}(x_1) = \langle [[0.6, 0.8], [0.7, 0.9]], [[0.1, 0.2], [0.2, 0.3]], [[0.2, 0.4], [0.1, 0.3]] \rangle,$$

$$A_{IVINV}(x_1) = \langle [[0.6, 0.8], [0.8, 0.9]], [[0.1, 0.2], [0.3, 0.4]], [[0.2, 0.4], [0.1, 0.2]] \rangle,$$

$$A_{IVINV}(x_1) = \langle [[0.1, 0.4], [0.2, 0.3]], [[0.1, 0.2], [0.2, 0.3]], [[0.6, 0.9], [0.7, 0.8]] \rangle.$$

Definition 3.6. Let A_{IVINV} and B_{IVINV} be IVINVsets in a universe E. Then

(i) we say that A_{IVINV} *is a subset of* B_{IVINV}, denoted by $A_{IVINV} \subset B_{IVINV}$, if for each $x \in E$,

$$T_A^L(x) \leq T_B^L(x),\ T_A^U(x) \leq T_B^U(x),$$
$$I_A^L(x) \geq I_B^L(x),\ I_A^U(x) \geq I_B^U(x),$$
$$F_A^L(x) \geq F_B^L(x), F_A^U(x) \geq F_B^U(x),$$

(ii) we say that A_{IVINV} *and* B_{IVINV} *are equal*, denoted by $A_{IVINV} = B_{IVINV}$, if $A_{IVINV} \subset B_{IVINV}$ and $B_{IVINV} \subset A_{IVINV}$,

(iii) the *union* of A_{IVINV} and B_{IVINV}, denoted by $A_{IVINV} \cup B_{IVINV} = C_{IVINV}$, is an IVINVset in E defined as follows:

$$T_C^L = \left[\max\left(T_A^{L^-}, T_B^{L^-}\right), \max\left(T_A^{L^+}, T_B^{L^+}\right)\right],$$
$$T_C^U = \left[\max\left(T_A^{U^-}, T_B^{U^-}\right), \max\left(T_A^{U^+}, T_B^{U^+}\right)\right],$$
$$I_C^L = \left[\min\left(I_A^{L^-}, I_B^{L^-}\right), \min\left(I_A^{L^+}, I_B^{L^+}\right)\right],$$
$$I_C^U = \left[\min\left(I_A^{U^-}, I_B^{U^-}\right), \min\left(I_A^{U^+}, I_B^{U^+}\right)\right],$$
$$F_C^L = \left[\min\left(F_A^{L^-}, F_B^{L^-}\right), \min\left(F_A^{L^+}, F_B^{L^+}\right)\right],$$
$$F_C^U = \left[\min\left(F_A^{U^-}, F_B^{U^-}\right), \min\left(F_A^{U^+}, F_B^{U^+}\right)\right],$$

(iv) the *intersection* of A_{IVINV} and B_{IVINV}, denoted by $A_{IVINV} \cap B_{IVINV} = D_{IVINV}$, is defined as follows:

$$T_D^L = \left[\min\left(T_A^{L^-}, T_B^{L^-}\right), \min\left(T_A^{L^+}, T_B^{L^+}\right)\right],$$
$$T_D^U = \left[\min\left(T_A^{U^-}, T_B^{U^-}\right), \min\left(T_A^{U^+}, T_B^{U^+}\right)\right],$$
$$I_D^L = \left[\max\left(I_A^{L^-}, I_B^{L^-}\right), \max\left(I_A^{L^+}, I_B^{L^+}\right)\right],$$
$$I_D^U = \left[\max\left(I_A^{U^-}, I_B^{U^-}\right), \max\left(I_A^{U^+}, I_B^{U^+}\right)\right],$$
$$F_D^L = \left[\max\left(F_A^{L^-}, F_B^{L^-}\right), \max\left(F_A^{L^+}, F_B^{L^+}\right)\right],$$
$$F_D^U = \left[\max\left(F_A^{U^-}, F_B^{U^-}\right), \max\left(F_A^{U^+}, F_B^{U^+}\right)\right].$$

Example 3.7. Consider two IVINVsets A_{IVINV} and B_{IVINV} in a universe $E = \{x_1, x_2, x_3\}$ defined by:

$$A_{IVINV}(x_1) = \langle [[0.2, 0.4], [0.1, 0.3]], [[0.1, 0.2], [0.2, 0.3]], [[0.6, 0.8], [0.7, 0.9]] \rangle,$$
$$A_{IVINV}(x_2) = \langle [[0.2, 0.4], [0.1, 0.2]], [[0.1, 0.2], [0.3, 0.4]], [[0.6, 0.8], [0.8, 0.9]] \rangle,$$
$$A_{IVINV}(x_3) = \langle [[0.6, 0.9], [0.7, 0.8]], [[0.1, 0.2], [0.2, 0.3]], [[0.1, 0.4], [0.2, 0.3]] \rangle,$$
$$B_{IVINV}(x_1) = \langle [[0.2, 0.4], [0.1, 0.3]], [[0.2, 0.3], [0.1, 0.4]], [[0.6, 0.8], [0.7, 0.9]] \rangle,$$
$$B_{IVINV}(x_2) = \langle [[0.7, 0.9], [0.6, 0.8]], [[0.1, 0.2], [0.2, 0.3]], [[0.1, 0.3], [0.2, 0.4]] \rangle,$$
$$A_{IVINV}(x_3) = \langle [[0.6, 0.9], [0.8, 0.9]], [[0.2, 0.3], [0.1, 0.4]], [[0.1, 0.4], [0.1, 0.2]] \rangle.$$

Then we obtain $A_{IVINV} \cup B_{IVINV}$ and $A_{IVINV} \cap B_{IVINV}$:

$(A_{IVINV} \cup B_{IVINV})(x_1) = \langle [[0.2, 0.4], [0.1, 0.3]], [[0.1, 0.2], [0.1, 0.3]], [[0.6, 0.8], [0.7, 0.9]] \rangle,$

$(A_{IVINV} \cup B_{IVINV})(x_2) = \langle [[0.7, 0.9], [0.6, 0.8]], [[0.1, 0.2], [0.2, 0.3]], [[0.1, 0.3], [0.2, 0.4]] \rangle,$

$(A_{IVINV} \cup B_{IVINV})(x_3) = \langle [[0.6, 0.9], [0.8, 0.9]], [[0.1, 0.2], [0.1, 0.3]], [[0.1, 0.4], [0.1, 0.2]] \rangle,$

$(A_{IVINV} \cap B_{IVINV})(x_1) = \langle [[0.2, 0.4], [0.1, 0.3]], [[0.2, 0.3], [0.2, 0.4]], [[0.6, 0.8], [0.7, 0.9]] \rangle,$

$(A_{IVINV} \cap B_{IVINV})(x_2) = \langle [[0.2, 0.4], [0.1, 0.2]], [[0.1, 0.2], [0.3, 0.4]], [[0.6, 0.8], [0.8, 0.9]] \rangle,$

$(A_{IVINV} \cap B_{IVINV})(x_3) = \langle [[0.6, 0.9], [0.7, 0.8]], [[0.2, 0.3], [0.2, 0.4]], [[0.1, 0.4], [0.2, 0.3]] \rangle.$

We can see that $A_{\text{IVINV}} \cap B_{\text{IVINV}}$ is not an IVINVset but it is an IVNVset.

Remark 3.8. (1) The union of two IVINVsets is an IVINVset but the intersection of two IVINVsets may not be an IVINVset.

(2) Let the family of all IVINVsets in a universe U be denoted by $IVINV(U)$. Then $IVINV(U)$ does not form a topology on U but it forms a supra topology on U.

Remark 3.9. For any two IVINVsets A_{IVINV} and B_{IVINV}, the followings do not hold in general (See Example 3.10):

$$(A_{IVINV} \cup B_{IVINV})^c = A^c_{IVINV} \cap B^c_{IVINV},$$
$$(A_{IVINV} \cap B_{IVINV})^c = A^c_{IVINV} \cup B^c_{IVINV}.$$

Example 3.10. Consider IVINVsets A_{IVINV} and B_{IVINV} in E given in Example 3.7. Then we have

$A^c_{IVINV}(x_1) \langle [[0.6, 0.8], [0.7, 0.9]], [[0.1, 0.2], [0.2, 0.3]], [[0.2, 0.4], [0.1, 0.3]] \rangle,$

$A^c_{IVINV}(x_2) \langle [[0.6, 0.8], [0.8, 0.9]], [[0.1, 0.2], [0.3, 0.4]], [[0.2, 0.4], [0.1, 0.2]] \rangle,$

$A^c_{IVINV}(x_3) \langle [[0.1, 0.4], [0.2, 0.3]], [[0.1, 0.2], [0.2, 0.3]], [[0.6, 0.9], [0.7, 0.8]] \rangle$

and

$B^c_{IVINV}(x_1) \langle [[0.6, 0.8], [0.7, 0.9]], [[0.2, 0.3], [0.1, 0.4]], [[0.2, 0.4], [0.1, 0.3]] \rangle,$

$B^c_{IVINV}(x_2) \langle [[0.1, 0.3], [0.2, 0.4]], [[0.1, 0.2], [0.2, 0.3]], [[0.7, 0.9], [0.6, 0.8]] \rangle,$

$B^c_{IVINV}(x_3) \langle [[0.1, 0.4], [0.1, 0.2]], [[0.2, 0.3], [0.1, 0.4]], [[0.6, 0.9], [0.8, 0.9]] \rangle.$

Thus we get

$(A^c_{IVINV} \cap B^c_{IVINV})(x_1)$
$= \langle [[0.6, 0.8], [0.7, 0.9]], [[0.2, 0.3], [0.2, 0.4]], [[0.2, 0.4][0.1, 0.5]] \rangle,$
$(A^c_{IVINV} \cap B^c_{IVINV})(x_2)$
$= \langle [[0.1, 0.3], [0.2, 0.4]], [[0.1, 0.2], [0.3, 0.4]], [[0.7, 0.9], [0.6, 0.8]] \rangle,$
$(A^c_{IVINV} \cap B^c_{IVINV})(x_3)$
$= \langle [[0.1, 0.4], [0.1, 0.2]], [[0.2, 0.3], [0.2, 0.4]], [[0.6, 0.9], [0.8, 0.9]] \rangle$

and

$(A^c_{IVINV} \cup B^c_{IVINV})(x_1)$
$= \langle [[0.6, 0.8], [0.7, 0.9]], [[0.1, 0.2], [0.1, 0.3]], [[0.2, 0.4], [0.1, 0.3]] \rangle,$
$(A^c_{IVINV} \cup B^c_{IVINV})(x_2)$
$= \langle [[0.6, 0.8], [0.8, 0.9]], [[0.1, 0.2], [0.2, 0.3]], [[0.2, 0.4], [0.1, 0.2]] \rangle,$
$(A^c_{IVINV} \cup B^c_{IVINV})(x_3)$

$= \langle [[0.1, 0.4], [0.2, 0.3]], [[0.1, 0.2], [0.1, 0.3]], [[0.6, 0.9], [0.7, 0.8]] \rangle .$

On the other hand, we have

$(A_{IVINX} \cup B_{IVINX})^c(x_1)$
$= \langle [[0.6, 0.8], [0.7, 0.9]], [[0.1, 0.2], [0.1, 0.3]], [[0.2, 0.4], [0.1, 0.3]] \rangle ,$
$(A_{IVINX} \cup B_{IVINX})^c(x_2)$
$= \langle [[0.1, 0.3], [0.2, 0.4]], [[0.1, 0.2], [0.2, 0.3]], [[0.7, 0.9], [0.6, 0.8]] \rangle ,$
$(A_{IVINX} \cup B_{IVINX})^c(x_3)$
$= \langle [[0.1, 0.4], [0.1, 0.2]], [[0.1, 0.2], [0.1, 0.3]], [[0.6, 0.9], [0.8, 0.9]] \rangle$

and

$(A_{IVINX} \cap B_{IVINX})^c(x_1)$
$= \langle [[0.6, 0.8], [0.7, 0.9]], [[0.2, 0.3], [0.2, 0.4]], [[0.2, 0.4], [0.1, 0.3]] \rangle ,$
$(A_{IVINX} \cap B_{IVINX})^c(x_2)$
$= \langle [[0.6, 0.8], [0.8, 0.9]], [[0.1, 0.2], [0.3, 0.4]], [[0.2, 0.4], [0.1, 0.2]] \rangle ,$
$(A_{IVINX} \cap B_{IVINX})^c(x_3)$
$= \langle [[0.1, 0.4], [0.2, 0.3]], [[0.2, 0.3], [0.2, 0.4]], [[0.6, 0.9], [0.7, 0.8]] \rangle .$

So we get

$$(A_{IVINV} \cup B_{IVINV})^c \neq A^c_{IVINV} \cap B^c_{IVINV},$$
$$(A_{IVINV} \cap B_{IVINV})^c \neq A^c_{IVINV} \cup B^c_{IVINV}.$$

Definition 3.11. Let A_{IVINV} and B_{IVINV} be two IVINVsts in a universe E and w_i the weight with $w_i \geq 0$ $(i = 1,\ 2,\ 3)$ and $\Sigma_{i=1}^3 w_i = 1$. Then the *IVINV weighted Euclidean distance measure*, denoted by $d_p(A_{IVINV}, B_{IVINV})$, is defined as follows:

$$\begin{aligned}
& d_p(A_{IVINV}, B_{IVINV}) \\
&= \frac{1}{3}\Big\{ w_1 \left(\left[T_A^L(x), T_A^U(x)\right] - \left[T_B^L(x), T_B^U(x)\right] \right)^2 \\
&\quad + w_2 \left(\left[I_A^L(x), I_A^U(x)\right] - \left[I_B^L(x), I_B^U(x)\right] \right)^2 \\
&\quad + w_3 \left(\left[F_A^L(x), F_A^U(x)\right] - \left[F_B^L(x), F_B^U(x)\right] \right)^2 \Big\} \\
&= \frac{1}{3}\Big\{ w_1 \left(\left[T_A^L(x) - T_B^L(x), T_A^U(x) - T_B^U(x)\right] \right)^2 \\
&\quad + w_2 \left(\left[I_A^L(x) - I_B^L(x), I_A^U(x) - I_B^U(x)\right] \right)^2 \\
&\quad + w_3 \left(\left[F_A^L(x) - F_B^L(x), F_A^U(x) - F_B^U(x)\right] \right)^2 \Big\} \\
&= \frac{1}{3}\Big\{ w_1 \left(\Big[[T_A^{L^-}, T_A^{L^+}] - [T_B^{L^-}, T_B^{L^+}], [T_A^{U^-}, T_A^{U^+}] - [T_B^{U^-}, T_B^{U^+}] \Big] \right)^2 \\
&\quad + w_2 \left(\Big[[I_A^{L^-}, I_A^{L^+}] - [I_B^{L^-}, I_B^{L^+}], [I_A^{U^-}, I_A^{U^+}] - [I_B^{U^-}, I_B^{U^+}] \Big] \right)^2 \\
&\quad + w_3 \left(\Big[[F_A^{L^-}, F_A^{L^+}] - [F_B^{L^-}, F_B^{L^+}], [F_A^{U^-}, F_A^{U^+}] - [F_B^{U^-}, F_B^{U^+}] \Big] \right)^2 \Big\} \\
& [\text{By } [a, b] - [c, d] = [a - d, b - c]] \\
&= \frac{1}{3}\Big\{ w_1 \Big[[T_A^{L^-} - T_B^{U^+}, T_A^{L^+} - T_B^{U^-}], [T_A^{U^-} - T_B^{L^+}, T_A^{U^+} - T_B^{L^-}] \Big]^2 \\
&\quad + w_2 \Big[[I_A^{L^-} - I_B^{U^+}, I_A^{L^+} - I_B^{U-}], [I_A^{U^-} - I_B^{L^+}, I_A^{U^+} - I_B^{L^-}] \Big]^2 \\
&\quad + w_3 \Big[[F_A^{L^-} - F_B^{U^+}, F_A^{L^+} - F_B^{U^-}], [F_A^{U^-} - F_B^{L^+}, F_A^{U^+} - F_B^{L^-}] \Big]^2 \Big\}
\end{aligned}$$

[By putting the values of $T_A^L(x),\ I_A^L(x),\ F_A^L(x),\ T_A^U(x),\ I_A^U(x),\ F_A^U(x),$ $T_B^L(x),\ I_B^L(x),\ F_B^L(x),\ T_B^U(x),\ I_B^U(x),\ F_B^U(x)$]

$= \frac{1}{3}\left\{w_1\left([A_1 - A_2], [A_3 - A_4]\right)^2 + w_2\left([A_5 - A_6], [A_7 - A_8]\right)^2 \right.$
$\left. + w_3\left([A_9 - A_{10}], [A_{11} - A_{12}]\right)^2\right\}$
$[A_1 = [T_A^{L^-} - T_B^{U^+}, \cdots, A_{12} = [F_A^{U^+} - F_B^{L^-}]]$
$= \frac{1}{3}\left\{w_1\left(\left[\frac{A_1+A_2}{2}, \frac{A_3+A_4}{2}\right]\right)^2 + w_2\left(\left[\frac{A_5+A_6}{2}, \frac{A_7+A_8}{2}\right]\right)^2 \right.$
$\left. + w_3\left(\left[\frac{A_9+A_{10}}{2}, \frac{A_{11}+A_{12}}{2}\right]\right)^2\right\}$
$= \frac{1}{3}\left\{w_1\left([B_1, B_2]\right)^2 + w_2\left([B_3, B_4]\right)^2 + w_3\left([B_5, B_6]\right)^2\right\}.$
$[B_k = \frac{A_i+A_j}{2}$ for $k = 1, 2, 3, \ldots, 6$, A_i for $i = 1, 3, 5, 7, 9, 11$
and A_j for $j = 2, 4, 6, 8, 10, 12]$
$= \frac{1}{3}\left\{w_1\left(\left[\frac{B_1+B_2}{2}\right]\right)^2 + w_2\left(\left[\frac{B_3+B_4}{2}\right]\right)^2 + w_3\left(\left[\frac{B_5+B_6}{2}\right]\right)^2\right\}.$
$= \frac{1}{3}\left\{w_1\left(C_1\right)^2 + w_2\left(C_2\right)^2 + w_3\left(C_3\right)^2\right\}.$
$[C_1 = [\frac{B_1+B_2}{2}],\ C_2 = [\frac{B_3+B_4}{2}],\ C_2 = [\frac{B_5+B_6}{2}]]$

4. Application of interval-valued intuitionistic neutrosophic vague sets in career determination

Let $E = \{x_1, x_2, x_3, x_4\}$ be the set of students. C = {medicine, pharmacy, surgery, anatomy} be the set of careers. S = {English language, Biology, Physics, Chemistry} be the set of subject related to the careers. Assume that the above students sit for examination for 100 marks. They appear for examination on the above mentioned subject to determine their career placement and choices. The table shows careers and related subjects requirements.

Table-1

Careers Versus Subjects

	English	Biology	Physics	Chemistry
Medicine	$[[0.2, 0.4], [0.1, 0.3]]$ $[[0.1, 0.2], [0.2, 0.3]]$ $[[0.6, 0.8], [0.7, 0.9]]$	$[[0.6, 0.9], [0.8, 0.9]]$ $[[0.1, 0.2], [0.1, 0.3]]$ $[[0.1, 0.4], [0.1, 0.2]]$	$[[0.6, 0.8], [0.7, 0.9]]$ $[[0.1, 0.2], [0.2, 0.3]]$ $[[0.2, 0.4], [0.1, 0.3]]$	$[[0.1, 0.4], [0.1, 0.2]]$ $[[0.2, 0.5], [0.1, 0.4]]$ $[[0.6, 0.9], [0.8, 0.9]]$
Pharmacy	$[[0.1, 0.3], [0.2, 0.4]]$ $[[0.2, 0.3], [0.1, 0.2]]$ $[[0.7, 0.9], [0.6, 0.8]]$	$[[0.2, 0.4], [0.1, 0.3]]$ $[[0.1, 0.2], [0.1, 0.3]]$ $[[0.6, 0.8], [0.7, 0.9]]$	$[[0.6, 0.8], [0.8, 0.9]]$ $[[0.1, 0.2], [0.3, 0.4]]$ $[[0.2, 0.4], [0.1, 0.2]]$	$[[0.1, 0.3], [0.2, 0.4]]$ $[[0.1, 0.2], [0.2, 0.3]]$ $[[0.7, 0.9], [0.6, 0.8]]$
Surgery	$[[0.2, 0.4], [0.1, 0.3]]$ $[[0.2, 0.3], [0.1, 0.4]]$ $[[0.6, 0.8], [0.7, 0.9]]$	$[[0.6, 0.9], [0.7, 0.8]]$ $[[0.1, 0.2], [0.2, 0.3]]$ $[[0.1, 0.4], [0.2, 0.3]]$	$[[0.1, 0.4], [0.2, 0.3]]$ $[[0.1, 0.2], [0.2, 0.3]]$ $[[0.6, 0.9], [0.7, 0.8]]$	$[[0.6, 0.8], [0.7, 0.9]]$ $[[0.2, 0.3], [0.1, 0.4]]$ $[[0.2, 0.4], [0.1, 0.3]]$
Anatomy	$[[0.7, 0.9], [0.6, 0.8]]$ $[[0.1, 0.2], [0.2, 0.3]]$ $[[0.1, 0.3], [0.2, 0.4]]$	$[[0.2, 0.4], [0.1, 0.2]]$ $[[0.1, 0.2], [0.3, 0.4]]$ $[[0.6, 0.8], [0.8, 0.9]]$	$[[0.6, 0.9], [0.8, 0.9]]$ $[[0.2, 0.3], [0.1, 0.4]]$ $[[0.1, 0.4], [0.1, 0.2]]$	$[[0.1, 0.2], [0.2, 0.4]]$ $[[0.1, 0.2], [0.2, 0.3]]$ $[[0.8, 0.9], [0.6, 0.8]]$

Each performance is declared by three intervals:

$$\left[T^L, T^U\right], \left[I^L, I^U\right], \left[F^L, F^U\right],$$

where $T^L = \left[T^{L^-}, T^{L^+}\right], T^U = \left[T^{U^-}, T^{U^+}\right]$,

$F^L = \left[F^{L^-}, F^{L^+}\right], F^U = \left[F^{U^-}, F^{U^+}\right]$,

$I^L = \left[I^{L^-}, I^{L^+}\right], I^U = \left[I^{U^-}, I^{U^+}\right]$.

After finishing examination the students obtained the following marks in the Table-2.

Table-2: Students Versus Subjects

	English	Biology	Physics	Chemistry
x_1	$[[0.2, 0.3], [0.1, 0.4]]$	$[[0.2, 0.3], [0.1, 0.4]]$	$[[0.6, 0.9], [0.8, 0.9]]$	$[[0.2, 0.4], [0.1, 0.3]]$
	$[[0.3, 0.4], [0.1, 0.2]]$	$[[0.2, 0.3].[0.2, 0.3]]$	$[[0.2, 0.3], [0.1, 0.4]]$	$[[0.2, 0.3], [0.1, 0.4]]$
	$[[0.7, 0.9], [0.6, 0.9]]$	$[[0.7, 0.8], [0.6, 0.9]]$	$[[0.1, 0.4], [0.1, 0.2]]$	$[[0.6, 0.8], [0.7, 0.9]]$
x_2	$[[0.1, 0.2], [0.2, 0.4]]$	$[[0.3, 0.4], [0.1, 0.2]]$	$[[0.2, 0.9], [0.1, 0.3]]$	$[[0.7, 0.5], [0.6, 0.8]]$
	$[[0.2, 0.4], [0.1, 0.3]]$	$[[0.1, 0.2], [0.2, 0.3]]$	$[[0.2, 0.3], [0.1, 0.4]]$	$[[0.1, 0.2], [0.2, 0.3]]$
	$[[0.8, 0.9], [0.6, 0.8]]$	$[[0.6, 0.7], [0.8, 0.9]]$	$[[0.6, 0.8], [0.7, 0.9]]$	$[[0.1, 0.3], [0.2, 0.3]]$
x_3	$[[0.6, 0.9], [0.8, 0.9]]$	$[[0.2, 0.3], [0.1, 0.9]]$	$[[0.2, 0.4], [0.1, 0.2]]$	$[[0.6, 0.8], [0.8, 0.9]]$
	$[[0.1, 0.2], [0.1, 0.3]]$	$[[0.3, 0.4], [0.1, 0.2]]$	$[[0.1, 0.2], [0.3, 0.4]]$	$[[0.2, 0.3], [0.1, 0.4]]$
	$[[0.1, 0.4], [0.1, 0.2]]$	$[[0.7, 0.8], [0.7, 0.9]]$	$[[0.6, 0.8], [0.8, 0.9]]$	$[[0.1, 0.4], [0.1, 0.2]]$
x_4	$[[0.7, 0.8], [0.5, 0.8]]$	$[[0.6, 0.8], [0.7, 0.9]]$	$[[0.2, 0.3], [0.1, 0.3]]$	$[[0.2, 0.4], [0.7, 0.3]]$
	$[[0.1, 0.2], [0.2, 0.3]]$	$[[0.1, 0.3], [0.2, 0.3]]$	$[[0.1, 0.2], [0.2, 0.3]]$	$[[0.2, 0.5], [0.1, 0.2]]$
	$[[0.2, 0.3], [0.3, 0.2]]$	$[[0.2, 0.4], [0.1, 0.3]]$	$[[0.7, 0.8], [0.7, 0.9]]$	$[[0.6, 0.8], [0.7, 0.9]]$

Using Definition 3.11, we calculate the distance between each student and each career with reference to the subjects in Table-3.

Logical justification for Table-1 and Table-2 are as follows:

Table-1

Careers Versus Subjects: Each performance is declared by three intervals, i.e., truth interval, indeterminancy and falsity interval.

Table-2

Students Versus Subjects: After finishing examination the students obtained the following marks in table-2 in terms of IVINVsets.

Table-3

Students Versus Careers

	Medicine	Pharmacy	Surgery	Anatomy
x_1	0.004	0.06125	0.00063	0.00033
x_2	0.000458	0.000083	0.0552	0.05
x_3	0.0883	0.0555	0.000458	0.000342
x_4	0.00033	0.0732	0.06628	09.00158

From the above Table-3, shortest distance gives the proper career determination x_1 is to take Anatomy, x_2 is to take Pharmacy, x_3 is to take Anatomy and x_4 is to take Medicine.

5. Conclusion

IVINVset's concept was effectively established. This concept was inspired by IVINset and the theory of ambiguous sets. The primary focus of neutrophilic set theory is inconsistent and ambiguous data. It is evident that decision-making issues including inherited uncertainties can be resolved with the use of IVINVsets. For IVINVsets, the fundamental union, complement, and intersection operations are defined. The fundamental characteristics of these IVINVset-related operations are then provided and quantitatively shown. Lastly, a few instances are shown. We calculate the separation between every student and every career, in turn. The answer lies in finding the shortest path between each student and each career. It can be applied to more realistic decision-making scenarios in the future.

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Declarations
Conflict of interest Authors declare that they have no conflict of interest.
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