Decision Making Using New Distances of Intuitionistic Fuzzy Sets and Study Their Application in the Universities

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Abstract. Most students in the universities experience big problem to select the suitable scope for jobbing that will be suitable with their creativity. In this work, we will investigate new two types of distances, these types of intuitionistic fuzzy set in decision making like an absolute normalize Euclidean distance and square hamming distance. Furthermore, we study their application to help these students to select the right scope. Furthermore, our work in this paper is examined.

Keywords: Decision making · Hamming distance · Normalize Euclidean distance · Intuitionistic fuzzy set

1 Introduction

There are many problems of decision making are discussed on different non-classical sets like fuzzy sets (FS), soft sets (SS) and others, see [1–6]. In 1986 [7], the degree of non-membership is added to (FS) and hence the new type is consider, it is called intuitionistic fuzzy set (IFS). This type looks more accurate to determine provides the occasion to completely model the problem established on surveillances the existing familiarity there are many application on non-classical sets,like fuzzy, soft, nano, permutation sets, see [8–25].

The main purpose of providing appropriate acquaintance to students for suitable career nominee cannot be overemphasized. This is important since the myriad problems of scarcity substantial career guide notable by students are of imposing consequence on their qualification and career nominee.

Thus it is dossier that students be presented full acquaintance on career determination or nominee to enhance appropriate planning, arranger and skillfulness. Among the career determining operators such as interest, academic achievement, personality industrialize etc.; the first mentioned exemplifies to be fundamental. An (IFS) is utilized as tool since here the membership (non-membership) degree

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will symbolize the marks of the true (fouls) answered by the student and the hesitation degree will symbolize the mark of the questions that are disregarded by student. In this work, new distances of intuitionistic fuzzy set in decision making like an absolute normalize Euclidean distance and square hamming distance are investigated and their application is shown.

2 Definitions and Notations

In this section, some basic definition of (IFS) are recalled.

Definition 2.1 [7]**:** We say $Y = \{(x, \mu_Y(x), \nu_Y(x)), x \in W\}$ is intuitionistic fuzzy set (IFS) where $\mu_Y(x) : W \longrightarrow [0,1]$, $\nu_Y(x) : W \longrightarrow [0,1]$ with the property $0 \leq \mu_Y(x) + \nu_Y(x) \leq 1, \forall x \in W$. The values $\mu_Y(x)$ and $\nu_Y(x)$ represent the degree of membership and non-membership of x to Y respectively.

Operations on (IFS) and Their Basic Relations 2.2 [7]**:** Assume that $Y = \{(x, \mu_Y(x), \nu_Y(x)), x \in W\}$ and $F = \{(x, \mu_F(x), \nu_F(x)), x \in W\}$ are two (IFSs) of W. Then some relations are considered as following:

(1) $Y \subseteq F$ if and only if $\mu_Y(x) \leq \mu_F(x)$ and $\nu_Y(x) \geq \nu_F(x)$ for all $\forall x \in W$,
(2) $Y = F$ if and only if $Y \subseteq F$ and $F \subseteq Y$,
(3) $Y \cup F = \{(x, max\{\mu_Y(x), \mu_F(x)\}, min\{\nu_Y(x), \nu_F(x)\}) : x \in W\}$,
(4) $Y \cap F = \{(x, min\{\mu_Y(x), \mu_F(x)\}, max\{\nu_Y(x), \nu_F(x)\}) : x \in W\}$,
(5) $Y^c = \{(x, \nu_Y(x), \mu_Y(x)), x \in W\}$.

These above relations are called (inclusion, equality, union, intersection, complement) respectively.

Definition 2.3 [7]**:** Let $\pi_Y(x) = 1 - \mu_Y(x) - \nu_Y(x)$ be the (IFS) index or hesitation margin of x in Y is the degree of indeterminateness of $x \in W$ to the IFS Y and $\pi_Y(x) \in [0,1]$. i.e., $\pi_Y(x) : W \longrightarrow [0,1]$ and $0 \leq \pi_Y \leq 1$ for every $x \in W$. $\pi_Y(x)$ expresses the lack of knowledge of whether x belongs to (IFS) Y or not. For instance, if Y is an (IFS) with $\mu_Y(x) = 0.7$ and $\nu_Y(x) = 0.2$, then $\pi_Y(x) = 1 - (0.7 + 0.2) = 0.1$. It can be interpreted as "the degree that the object x belongs to IFS Y is 0.7, the degree that the object x does not belong to IFS Y is 0.2 and the degree of hesitancy is 0.1".

Definition 2.4 [7]**:** Let $Y = \{(x, \mu_Y(x), \nu_Y(x)), x \in W\}$and $F = \{(x, \mu_F(x), \nu_F(x)), x \in W\}$ be IFS in W. Then,

(1) The normalize Euclidean distance between Y and F is defined as:

$$d(Y,F) = (1/2n)\sum_{i=1}^{n}[(\mu_Y(x_i) - \mu_F(x_i))^2 + (\nu_Y(x_i) - \nu_F(x_i))^2 + (\pi_Y(x_i) - \pi_F(x_i))^2]$$

where $x_i \in W$, for $i = 1, 2, \ldots, n$.

(2) The Hamming distance between Y and F is defined as:

$$d(Y,F) = (1/2n)\sum_{i=1}^{n}[|\mu_Y(x_i) - \mu_F(x_i)| + |\nu_Y(x_i) - \nu_F(x_i)| + |\pi_Y(x_i) - \pi_F(x_i)|]$$

where $x_i \in W$, for $i = 1, 2, \ldots, n$.

3 New Class of Intuitionistic Fuzzy Sets

In this work, we will introduce new category of intuitionistic fuzzy set in decision making and study its application to help the students to select the right scope.

Definition 3.1. Let $Y = \{(x, \mu_Y(x), \nu_Y(x)), x \in W\}$ and $F = \{(x, \mu_F(x), \nu_F(x)), x \in W\}$ be IFS in W. An absolute normalize Euclidean distance between Y and F is denoted by $d_Y(Y, F)$ and define as:

$$d_Y(Y,F) = (1/2n)\sum_{i=1}^{n}[(\mu_Y(x_i) - \mu_F(x_i))^2 + (\nu_Y(x_i) - \nu_F(x_i))^2 + |\pi_Y(x_i) - \pi_F(x_i)|] \quad (1)$$

where $x_i \in W$, for $i = 1, 2, \ldots, n$.

Definition 3.2. Let $Y = \{(x, \mu_Y(x), \nu_Y(x)), x \in W\}$ and $F = \{(x, \mu_F(x), \nu_F(x)), x \in W\}$ be IFS in W. A square Hamming distance between Y and F is denoted by $d_s(Y, F)$ and define as:

$$d_s(Y,F) = (1/2n)\sum_{i=1}^{n}[|\mu_Y(x_i) - \mu_F(x_i)| + |\nu_Y(x_i) - \nu_F(x_i)| + (\pi_Y(x_i) - \pi_F(x_i))^2] \quad (2)$$

where $x_i \in W$, for $i = 1, 2, \ldots, n$.

4 Applications on Intuitionistic Fuzzy Sets

The main purpose of providing appropriate acquaintance to students for suitable career nominee cannot be overemphasized. This is important since the myriad problems of scarcity substantial career guide notable by students are of imposing consequence on their qualification and career nominee. So, it is dossier that students be presented full acquaintance on career determination or nominee to enhance appropriate planning, arranger and skillfulness. Among the career determining operators such as interest, academic achievement, personality industrialize etc.; the first mentioned exemplifies to be fundamental. An (IFS) is utilized as tool since here the membership (non-membership) degree will symbolize the marks of the true (fouls) answered by the student and the hesitation degree will symbolize the mark of the questions that are disregarded by student. Assume that these sets $U = \{u_1, u_2, u_3, u_4\}$, $H = \{Surgery, Pharmacy, Medicine, Anatomy\} = \{Sur., Phar., Med., Anat.\}$ and $K = \{Biology, Mathematics, EnglishLanguage, Physics, Chemistry\} = \{Bi., Math., En.L., Phys., Chem.\}$ are the sets of students, careers and subjects, respectively. Suppose the members of U sit for examinations, where the total degree is 100 marks on the above aforesaid subjects to limited their career deployment and nominees. The related between subjects requirements and careers is shown in Table 1.

Table 1. Careers vs Subjects

	Bi.	Math.	En.L.	Phys.	Chem.
Med.	(0.9,0.0,0.1)	(0.7,0.2,0.1)	(0.8,0.1,0.1)	(0.6,0.3,0.1)	(0.8,0.1,0.1)
Phar.	(0.8,0.1,0.1)	(0.8,0.1,0.1)	(0.9,0.1,0.0)	(0.5,0.3,0.2)	(0.7,0.2,0.1)
Sur.	(0.9,0.0,0.1)	(0.5,0.2,0.3)	(0.5,0.3,0.2)	(0.5,0.4,0.1)	(0.7,0.1,0.2)
Ana.	(0.9,0.1,0.0)	(0.5,0.4,0.1)	(0.7,0.2,0.1)	(0.6,0.3,01)	(0.8,0.0,0.2)

Table 2. Students vs Subjects

	Bi.	Math.	En.L.	Phys.	Chem.
u_1	(0.6,0.2,0.2)	(0.5,0.4,0.1)	(0.6,0.3,0.1)	(0.5,0.3,0.2)	(0.5,0.5,0)
u_2	(0.5,0.3,0.2)	(0.6,0.2,0.2)	(0.5,0.3,0.2)	(0.4,0.5,0.1)	(0.7,0.2,0.1)
u_3	(0.7,01,0.2)	(0.6,0.3,0.1)	(0.7,0.1,0.2)	(0.5,0.4,0.1)	(0.4,0.5,0.1)
u_4	(0.6,0.0,0.4)	(0.8,0.1,0.1)	(0.6,0.4,0.0)	(0.6,0.3,01)	(0.5,0.3,0.2)

Table 3. Students vs Careers

	Sur.	Phar.	Med.	Ana.
u_1	0.085	0.079	0.062	0.087
u_2	0.079	0.093	0.072	0.079
u_3	0.109	0.068	0.08	0.101
u_4	0.097	0.093	0.09	0.101

There are three maps μ, ν and π describe each performance they are membership, non-membership and hesitation margin, respectively. The following marks for mummers (students) in set U after the different examinations which are shown in Table 2. Now, by Eq. (1) we will find the distance between each member (student) in set U and each member (career) in set H with reference to the subjects. That is explained in Table 3. We consider the following from Table 3, the lest distance provides the proper career assigned as flows:

(1) – u_1 is to mention surgery (surgeon),
(2) – u_2 is to mention surgery (surgeon),
(3) – u_3 is to mention pharmacy (pharmacist),
(4) – u_4 is to mention surgery (surgeon).

Moreover, there are many applications. For example, in Basrah university college of science in Iraq. For selecting the appropriate department to each member (student) in set U, we need to know students degree of each object. In another side, each department requires for them to be superior in determined objects as follows:

(1) In Mathematics Department: The student need to be superior in Mathematical and Computer.

Table 4. Departments vs. Subjects

	Math.	Phys.	Com.	Chem.	En.L.	Hum.Bi.
Dep.Math.	(0.9,0.1,0)	(0.5,0.4,0.1)	(0.8,0.1,0.1)	(0.5,0.3,0.2)	(0.5,0.5,0)	(0.5,0.2,0.3)
Dep.Phys.	(0.8,0.1,01)	(0.9,0.1,0)	(0.7,0.3,0)	(0.6,0.2,0.2)	(0.5,0.4,0.1)	(0.5,0.4,0.1)
Dep.Com.Sci.	(0.7,01,0.2)	(0.5,0.2,0.3)	(0.9,0.1,0)	(0.5,0.1,0.4)	(0.8,0.1,0.1)	(0.5,0.2,0.3)
Dep.Chem.	(0.5,0.1,0.4)	(0.5,0.5,0)	(0.8,0.2,0)	(0.9,0.1,0)	(0.8,0.1,0.1)	(0.5,0.1,0.4)
Dep.Bi.	(0.5,0.2,0.3)	(0.5,0.4,0.1)	(0.5,0.4,0.1)	(0.5,0.3,0.2)	(0.8,0.2,0)	(0.9,0.1,0)

Table 5. Students vs. Subjects

	Math.	Phys.	Com.	Chem.	En.L.	Hum. Bi.
t_1	(0.9,0.1,0)	(0.6,0.1,0.3)	(0.8,0.1,0.1)	(0.5,0.3,0.2)	(0.9,0.1,0)	(0.7,0.1,0.2)
t_2	(0.5,0.1,0.4)	(0.6,0.1,0.3)	(0.7,0.3,0)	(0.6,0.2,0.2)	(0.8,0.2,0)	(0.9,0.1,0)
t_3	(0.8,0.1,0.1)	(0.9,0.1,0)	(0.9,0.1,0)	(0.5,0.2,0.3)	(0.7,0.1,0.2)	(0.5,0.1,0.4)
t_4	(0.9,0.1,0)	(0.5,0.5,0)	(0.8,0.2,0)	(0.8,0.1,0.1)	(0.6,0.3,0.1)	(0.5,0.3,0.2)
t_5	(0.5,0.2,0.3)	(0.6,0.3,0.1)	(0.9,0.1,0)	(0.9,0.1,0)	(0.6,0.4,0)	(0.7,0.1,0.2)

(2) In Physics Department: The number u (student) need to be superior in Physic, Mathematical and Computer.
(3) In Computer Science Department: The number u (student) need to be superior in Computer, Mathematical and English.
(4) In Chemistry Department: The number u (student) need to be superior in Chemistry, Computer, and English.
(5) In Biology Department: The number u (student) need to be superior in Human Biology, and English.

We use (IFS) as tool because it is integrate the degree of membership (non-membership), it symbolize the marks of the true (fouls) answered by the student and the hesitation degree will symbolize the mark of the questions that are disregarded by student.

Assume that these sets $T = \{t_1, t_2, t_3, t_4, t_5, \}$, $D = \{$Department of Mathematics, Department of Physics, Department of Computer Science,Department of Chemistry, Department of Biology$\} = \{Dep.Math., Dep.Phys., Dep.Com.Sci., Dep.Bi.\}$ and $K = \{$Computer, Mathematical, Chemistry, Physics, Human Biology, English Language$\} = \{Com., Math., Chem., Phys., Hum.Bi., En.L., \}$ are the sets of students, departments and subjects, respectively. Suppose the members of T sit for examinations, where the total degree is 100 marks on the above aforesaid subjects to limited their department deployment and nominees. The related between subjects requirements and departments is shown in Table 4.

There are three maps μ, ν and π describe each performance they are membership, non-membership and hesitation margin, respectively. The following marks for mummers (students) in set T after the different examinations which are shown in Table 5.

Table 6. Students vs. Departments

	Dep. Math.	Dep. Phys.	Dep. Com. Sci.	Dep. Chem.	Dep. Bi.
t_1	0.129	0.225	0.149	0.096	0.175
t_2	0.186	0.186	0.118	0.144	0.222
t_3	0.101	0.148	0.086	0.144	0.168
t_4	0.188	0.158	0.174	0.109	0.125
t_5	0.173	0.088	0.231	0.223	0.192

Now, by Eq. (2) we will find the distance between each member (student) in set T and each member (department) in set D with reference to the subjects. That is explained in Table 6.

The decision making to select the right department to get suitable scope or right career for students after they graduated from the University can be consider from Table 6, the lest distance provides the proper department assigned as flows:

(1) – t_1 is to mention (Dep. Chemistry),
(2) – t_2 is to mention (Dep. Computer Science),
(3) – t_3 is to mention (Dep. Computer Science),
(4) – t_4 is to mention (Dep. Chemistry),
(5) – t_5 is to mention (Dep. Physics).

5 Conclusion

In this research, new distances of (IFS) in decision making like an absolute normalize Euclidean distance and square hamming distance are investigated and their application is shown. As planned research, we will study and discuss new notions of (IFS) in decision making and we will apply more applications.

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