APPLICATION OF INTUITIONISTIC FUZZY SETS IN CAREER DETERMINATION

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Abstract: *Choosing a career is an important decision that you have to take a student. Choosing caries can be considered as an application of intuitionistic fuzzy sets. Solving such a decision-making problems using intuitionistic fuzzy sets becomes possible using different types of distances. In this article, I propose the application of such concepts to determine career using different types of distances and calculating entropy. A possible choice could be made by choosing the smallest distance.*

Key words: *Intuitionistic Fuzzy Sets, Decision making, career choice, Distance between intuitionistic fuzzy sets*.

1. INTRODUCTION

The fuzzy set (FS) was introduced by L. Zadeh [14] in 1965, where each element had a degree of membership.

$$A=\{(x,\mu_A(x))|x\in X\} \quad (1)$$

The intuitionistic fuzzy set (IFS) on a universe X was introduced by K. Atanassov in 1983 as a generalization of FS,

$$A=\{(x,\mu_A(x),\nu_A(x))|x\in X\} \quad (2)$$

where besides the degree of membership $\mu_A : X \to [0,1]$ of each element $x\in X$ to a set A there was considered a degree of non-membership $\nu_A : X \to [0,1]$, but such that

$$0\le \mu_A(x)+\nu_A(x)\le 1, \forall x\in X \quad (3)$$

We call degrees of indeterminacy of *x* to *A*, for each *A* in *X* the numbers [2]:

$$\pi_A(x)=1-\mu_A(x)-\nu_A(x)\ , \ \forall x\in X \quad (4)$$

It is a hesitancy degree of *x* to *A* [1-5]. It is obvious that

$$0\le \pi_A(x)\le 1, \forall x\in X \quad (5)$$

For each fuzzy set $A\in X$, evidently, we have

$$\pi_A(x)=1-\mu_A(x)-[1-\mu_A(x)], \forall x\in X \quad (6)$$

A geometric interpretation of intuitionistic fuzzy sets and fuzzy sets is presented in Fig. 1 [\13] which summarizes considerations presented in [12]. An intuitionistic fuzzy set *X* is mapped into the triangle ABD [13] in that each element of *X* corresponds to an element of *ABD* - in Fig. 1, [13], as an example, a point $x\in ABC$ corresponding to $x\in X$ is marked (the values of $\mu_A(x),\nu_A(x),\pi_A(x)$ fulfill Eq. (4)). When $\pi_A(x)=0$, then $1=\mu_A(x)-\nu_A(x)$. In Fig. 1, this condition is fulfilled only on the segment AB. Segment AB may be therefore viewed to represent a fuzzy set.

$$e(A,B)=\sqrt{\sum_{i=1}^{n}(\mu_A(x_i)-\mu_B(x_i))^2+(\nu_A(x_i)-\nu_B(x_i))^2+(\pi_A(x_i)-\pi_B(x_i))^2}$$

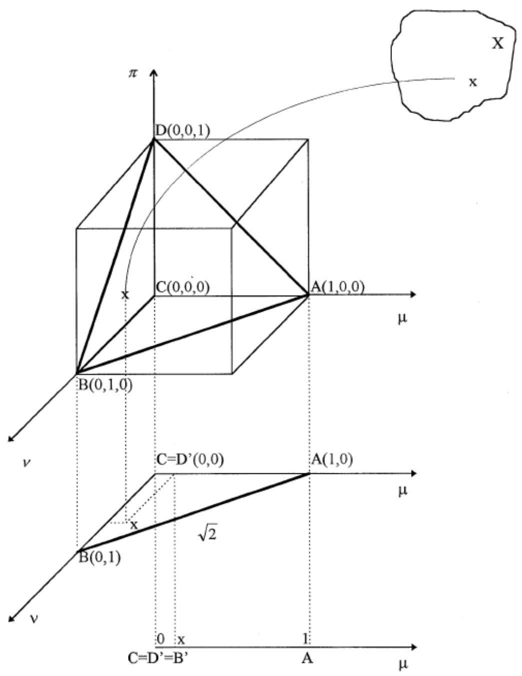

Figure 1 A geometrical interpretation of an intuitionistic fuzzy set.

The orthogonal projection of the triangle ABD gives the representation of an intuitionistic fuzzy set on the plane. (The orthogonal projection transfers $x^{'} \in \square ABD$ into $x^{''} \in \square ABC$.) The interior of the triangle *ABC =ABD'* is the area where π>0. Segment *AB* represents a fuzzy set described by two parameters: μ and ν. The orthogonal projection of the segment AB on the axis μ (the segment [0; 1] is only considered) gives the fuzzy set represented by one parameter μ only.
As it was shown in [12], distances between intuitionistic fuzzy sets should be calculated taking into account three parameters describing an intuitionistic fuzzy set. The most popular distances between intuitionistic fuzzy sets A, B in $X = \{x_1, \ldots, x_n\}$ are [12]:

- The Euclidian distance between *A* and *B* is defined as follows:

$$e(A,B) = \sqrt{\sum_{i=1}^{n} (\mu_A(x_i) - \mu_B(x_i))^2 + (\nu_A(x_i) - \nu_B(x_i))^2 + (\pi_A(x_i) - \pi_B(x_i))^2} \quad (7)$$

- The relative Euclidian distance is

$$\varepsilon(A,B) = \frac{e(A,B)}{\sqrt{2}} \quad (8)$$

- The normalized Euclidean distance:

$$\mathrm{q}(A,B) = \sqrt{\frac{1}{n}\sum_{i=1}^{n} (\mu_A(x_i) - \mu_B(x_i))^2 + (\nu_A(x_i) - \nu_B(x_i))^2 + (\pi_A(x_i) - \pi_B(x_i))^2} \quad (9)$$

- The Hamming distance:

$$\mathrm{h}(A,B) = \sum_{i=1}^{n} |\mu_A(x) - \mu_A(x)| + |\nu_A(x) - \nu_A(x)| + |\pi_A(x) - \pi_A(x)| \quad (10)$$

- The relative Hamming distance is

$$\delta(A,B) = \frac{\mathrm{h}(A,B)}{\sqrt{2}} \quad (11)$$

- The normalized Hamming distance:

$$\mathrm{l}(A,B) = \frac{1}{n}\sum_{i=1}^{n} |\mu_A(x_i) - \mu_B(x_i)| + |\nu_A(x_i) - \nu_B(x_i)| + |\pi_A(x_i) - \pi_B(x_i)| \quad (12)$$

We have the following relationships

$$\begin{aligned} 0 &\le \mathrm{h}(A,B) \le 2n \\ 0 &\le \mathrm{l}(A,B) \le 2 \\ 0 &\le e(A,B) \le \sqrt{2n} \\ 0 &\le q(A,B) \le \sqrt{2} \end{aligned} \quad (13)$$

2. A NUMERICAL EXAMPLE

The notion of defining intuitionistic fuzzy set as generalized fuzzy set is quite interesting and useful in many application areas. This idea of IFS seems to be resourceful in modeling many real life situations like negotiation processes, psychological investigations, reasoning, medical diagnosis among others. We show a novel application of intuitionistic fuzzy set career choice. An example of career determination will be presented, assuming there is a database (i.e. a description of a set of subjects 4, and a set of careers *C*).

We will describe the state of students knowing the results of their performance. The problem description uses the concept of IFS that makes it possible to render two important facts. First, values of each subject performance changes for each careers. Second, values of each Student's for each subject performance. We use the relative Hamming distance method given in (Szmidt and Kacprzyk,[8]-[12]) to measure the distance between each student and each career.

The smallest obtained value, points out a proper career determination based on academic performance. Let the set of students $S= \{S_1, S_2, S_3, S_4\}$, $C=\{c_1$ *(medicine)*, c_2 *(pharmachy)*, c_3*(economy)*, c_4 *(engineering)* $\}$ be the set of careers and $M= \{M_1$*(Biology)*, M_2,*(English Language)*, M_3,(Mathematics), M_4, (Physics), M_5 (Chemistry) $\}$, be the set of subjects related to the careers. We assume the above students sit for examinations on the above mentioned subjects to determine their career placements and choices. The table below shows careers and related subjects requirements.

Table 1. Subjects vs Careers

	medicine	*pharmachy*	*economy*	*engineering*
Biology	$(0.8, 0.1, 0.1)$	$(0.7, 0.1, 0.2)$	$(0.6, 0.2, 0.2)$	$(0.5, 0.3, 0.2)$
English Language	$(0.9, 0.1, 0.0)$	$(0.7, 0.2, 0.1)$	$(0.5, 0.4, 0.1)$	$(0.6, 0.1, 0.3)$
Mathematics	$(0.4, 0.5, 0.1)$	$(0.4, 0.4, 0.2)$	$(0.5, 0.2, 0.3)$	$(0.5, 0.3, 0.2)$
Physics	$(0.6, 0.4, 0.0)$	$(0.6, 0.3, 0.1)$	$(0.9, 0.0, 0.1)$	$(0.7, 0.1, 0.2)$
Chemistry	$(0.5, 0.4, 0.1)$	$(0.8, 0.1, 0.1)$	$(0.4, 0.3, 0.3)$	$(0.5, 0.5, 0.0)$

Each performance is described by membership, non-membership and hesitation margin.

After the various examinations, the students obtained the following marks as shown in the table below.

Table 2. Student's vs Subjects

	Biology	*English Language*	*Mathematics*	*Physics*	*Chemistry*
S_1	$(0.5, 0.5, 0.0)$	$(0.9, 0.0, 0.1)$	$(0.7, 0.1, 0.2)$	$(0.6, 0.3, 0.1)$	$(0.4, 0.5, 0.1)$
S_2	$(0.5, 0.2, 0.3)$	$(0.4, 0.4, 0.2)$	$(0.5, 0.4, 0.1)$	$(0.6, 0.1, 0.3)$	$(0.4, 0.3, 0.3)$
S_3	$(0.4, 0.5, 0.1)$	$(0.4, 0.3, 0.3)$	$(0.5, 0.3, 0.2)$	$(0.6, 0.4, 0.0)$	$(0.7, 0.1, 0.2)$
S_4	$(0.8, 0.1, 0.1)$	$(0.6, 0.4, 0.0)$	$(0.9, 0.0, 0.1)$	$(0.7, 0.1, 0.2)$	$(0.5, 0.5, 0.0)$

Using (7) above to calculate the distance between each student and each career with reference to the subjects, we get the table below.

Table 3. Student's vs Careers

	medicine	*pharmachy*	*economy*	*engineering*
S_1	0.1286	0.1838	0.1979	0.1414
S_2	0.1909	0.1697	0.0791	0.1272
S_3	0.1979	0.1414	0.1767	0.1555
S_4	0.1697	0.1979	0.1697	0.1414

From the above table, the shortest distance gives the proper career determination. S_1 is to read medicine, S_2 is to read economy S_3 is to read pharmacy, and S_4 is to read engineering. Let us calculate the entropy for an element F_1 with the coordinates $(0.5, 0.5, 0.0)$

4. CONCLUSION

This novel application of intuitionistic fuzzy sets in career determination is of great significance because it provides accurate and proper career choice based on academic performance. Career choice is a delicate decision making problem since it has a reverberator effect on efficiency and competency if not properly handled. In the proposed application, we used relative Hamming distance to calculate the distance of each student from each career in respect to the subjects, to obtained results.

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