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Research Article

Application of the Intuitionistic Fuzzy Logic in Education

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Abstract. In this paper, we have proposed an application of intuitionistic fuzzy set in high school determination using distance measures. The purpose of this paper is to interpret the relationship between students' official test and the pilot test by means of distance measures in intuitionistic fuzzy sets. Distance measures have been compared and the most appropriate distance measure for this paper has been determined. This application of intuitionistic fuzzy set is very useful, because by calculating distance between each student and each school, the most proper school for each student has been determined. Available evaluation system could be renewed by using this application of intuitionistic fuzzy logic. Using this application in evaluation and determination system will have very beneficial results. The contribution of this new system are more stress-free, less anxious for testing, easier to implement, more economical and more advantageous in many ways. Thanks to this system, the enroll of students in high schools will not depend on a single test. Moreover, this is the first study to guide the students in the direction of students preferences in evaluation of success and this is the first one for evaluate with this application and offer recommendations in education.

Keywords. Intuitionistic fuzzy sets; High school determination; Distance measure; Decision making

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1. Introduction

The notion of fuzzy logic was firstly defined by L.A. Zadeh in 1965 [13]. Then, intuitionistic fuzzy sets (shortly IFS) were defined by K. Atanassov in 1986 [2]. Intuitionistic fuzzy sets form a generalization of the notion of fuzzy sets. The intuitionistic fuzzy set theory is useful in various application areas, such as algebraic structures, robotics, control systems, agriculture areas, computer, irrigation, economy and various engineering fields. The knowledge and semantic representation of intuitionistic fuzzy set become more meaningful, resourceful and applicable since it includes the membership degree, the non-membership degree and the hesitation margin [1]. Due to the flexibility of intuitionistic fuzzy set in handling uncertainty, it is a tool for a more human consistent reasoning under imperfectly defined facts and imprecise knowledge [9]. Various applications of intuitionistic fuzzy set have been carried out through distance measures approach. Many researchers have explored various applications of intuitionistic fuzzy set such as medical diagnosis, medical application, career determination, real life situations and education ([3–6, 8, 9, 11, 12]).

In this paper, we have proposed an application of intuitionistic fuzzy set in high school determination using distance measures in intuitionistic fuzzy sets. The purpose of this paper is to determine that the relationship between students' official test and the pilot test by means of distance measures in intuitionistic fuzzy sets. In this paper, enroll of students to the high schools has been intuitionally determined according to students' pilot test score. Distance measure has been utilized in order to measure the distance between the student and each high school. This distance represents the suitability of the student to enroll in that the high school and distance measures have been compared. The data in this paper have been calculated with all distance measures and the most appropriate distance measure for this paper has been determined. The schools, in which each of the students have enrolled, have been determined via distance measure depending on examination that is performed for transition to high school education. Solution has been stated by measuring the shortest distance between the student and each school.

The aim of this paper is to interpret the relationship between the student's pilot tests and the official test. For this paper, high schools in Kahramanmaraş city in Turkey have been researched. There is an exam in Turkey performed for transition to high school education. Each of the students has been enrolled in each high school taking their examination scores into account. Students' school achievement scores do not have a huge impact on their examination scores. Therefore, their school achievement scores have been assumed to be fixed. Besides, success scores of the schools have been assumed to be fixed. While searching database which is used in this paper, socio-economic status of students, student psychology, success of schools, teacher factor, order of preference, different city preference of students are ignored. The difficulty or ease of examination could change every year, but this alteration only affects the high school base points. Because of this alteration affects every student equally, the result will not change.

In this paper each high school base point has been calculated depending on student examination score (over 100 marks total). We have used intuitionistic fuzzy sets as a tool since it incorporates the membership degree(the marks of the questions that have been correctly answered by the student, the non-membership degree (the marks of the questions that have been wrongly answered by the student) and the hesitation degree (the marks of the questions that are free from any answer). Solution has been assumed by measuring the shortest distance between each student and each school via distance measure. In solution, high school has been intuitionally assumed. This research has utilized official data that were obtained from the Ministry of Education. In this paper firstly, approximately 7000 students have been searched for 2015-2016 academic year. Afterwards, some students who were randomly selected have been searched depending on scores of the official test. Thanks to this application, distance measures have been compared. The sequence of validity and reliability of the distance measures has been determined.

Afterwards, the students prepared for exam of transition to high school education have been searched in 2016-2017 academic year. Approximately 42000 students have been researched according to official data from the Ministry of Education. Pilot tests regularly applied to these students at special study centers have been followed up. Ten students have been randomly selected among these students. The results of application are consistent for all students. Averages of the scores of the pilot tests applied to students during the year have been taken at the end of the academic year. The high schools which students will enroll based on the average of the scores of the pilot tests have been determined using normalized hamming distance measure. Besides the official test scores of the students have been researched. The high schools which students will enroll based on the average of the scores of official test have been determined using normalized hamming distance measure. The relationship between students' official test and the pilot tests have been searched.

2. Preliminaries

Definition 1 ([13])**.** Let X be a nonempty set. A fuzzy set A drawn from X is defined as

$$A = \{\langle x, \mu_A(x)\rangle \mid x \in X\}$$

where

$$\mu_A(x) : X \to [0,1]$$

is the membership function of the fuzzy set A.

Definition 2 ([2])**.** Let X be a nonempty set. An intuitionistic fuzzy set A in X is an object having the form

$$A = \{\langle x, \mu_A(x), \nu_A(x)\rangle \mid x \in X\},$$

where the function

$$\mu_A(x), \nu_A(x) : X \to [0,1]$$

define respectively, the degree of membership and degree of nonmembership of the element $x \in X$, to the set A, which is a subset of X, and for every element $x \in X$,

$$0 \le \mu_A(x) + \nu_A(x) \le 1.$$

According to Fuzzy Set Theory, if the membership degree of an element x is $\mu(x)$, if the nonmembership degree of an element x is $1-\mu(x)$.

Furthermore, we have

$$\pi_A(x) = 1 - \mu_A(x) - \nu_A(x)$$

called the intuitionistic fuzzy set index or hesitation on margin of x in A. $\pi_A(x)$ is degree of indeterminacy of $x \in X$ to the IFS A and $\pi_A(x) \in [0,1]$ i.e.,

$$\pi_A : X \to [0,1]$$

for every $x \in X$. $\pi_A(x)$ expresses the lack of knowledge of whether x belongs to IFS A or not.

In the theory of fuzzy sets [11] two different types of distances are defined, generated from the following metric

$$m_A(x,y) = |\mu_A(x) - \mu_A(y)|$$

and the Hamming and Euclidean metrics coincide [1].

Definition 3 ([1]**).** In the case of the intuitionistic fuzzy sets these metrics are different for an intuitionistic fuzzy set A the Hamming metric is defined as:

$$h_A(x,y) = \frac{1}{2}(|\mu_A(x) - \mu_A(y)| + |\nu_A(x) - \nu_A(y)|).$$

Definition 4. Let X be nonempty set. Intuitionistic fuzzy sets $A,B,C \in X$. The distance measure d between intuitionistic fuzzy sets A and B is a mapping $d : X \times X \to [0,1]$, if $d(A,B)$ satisfies the following axioms:

(A1) $0 \le d(A,B) \le 1$;

(A2) $d(A,B)$ if and only if $A = B$;

(A3) $d(A,B) = d(B,A)$;

(A4) $d(A,C) + d(B,C) \ge d(A,B)$;

(A5) if $A \subseteq B \subseteq C$, then $d(A,C) \ge d(A,B)$ and $d(A,C) \ge d(B,C)$.

Distance measure is a term that describes the difference between intuitionistic fuzzy sets and can be considered as a dual concept of similarity measure. Distance measures between intuitionistic fuzzy sets are proposed ([10], [7]).

Definition 5. Let $A = \{\langle x, \mu_A(x), \nu_A(x), \pi_A(x)\rangle \mid x \in X\}$ and $B = \{\langle x, \mu_B(x), \nu_B(x), \pi_B(x)\rangle \mid x \in X\}$ be two intuitionistic fuzzy sets in $X = x_1, x_2, \dots, x_n$, $i = 1,2,\dots,n$. Based on the geometric interpretation of intuitionistic fuzzy set, Szmidt and Kacprzyk ([10], [7]) proposed the following four distance measures between A and B:

The Hamming distance

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

The Euclidean distance

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

The Normalized Hamming distance

$$d_{n-H}(A,B)=\frac{1}{2n}\sum_{i=1}^{n}(|\mu_A(x_i)-\mu_B(x_i)|+|\nu_A(x_i)-\nu_B(x_i)|+|\pi_A(x_i)-\pi_B(x_i)|)\ .$$

The Normalized Euclidean distance

$$d_{n-E}(A,B)=\sqrt{\frac{1}{2n}\sum_{i=1}^{n}[(\mu_A(x_i)-\mu_B(x_i))^2+(\nu_A(x_i)-\nu_B(x_i))^2+(\pi_A(x_i)-\pi_B(x_i))^2]}\ .$$

3. An Application on the Comparison of Distance Measures

Some students have been searched depending on scores of the official test. These students were randomly selected in 2016 academic year. Let $H=\{H_1,H_2,H_3,H_4,H_5\}$ be a set of high schools, $S=\{S_1,S_2,S_3,S_4,S_5,S_6,S_7,S_8,S_9,S_{10}\}$ be a set of students.

$L=\{\text{Turkish},\text{Mathematics},\text{Science},\text{Social},\text{English},\text{Religion}\}$ be a set of lessons. High schools' base points have been calculated in 2016 academic year for each lesson in L, in Table 1 ([11]).

Table 1

	Turkish	Mathematics	Science	Social	English	Religion
H_1	(0.965, 0.028, 0.007)	(0.985, 0.012, 0.003)	(0.995, 0.004, 0.001)	(0.990, 0.008, 0.002)	(0.975, 0.02, 0.005)	(0.995, 0.004, 0.001)
H_2	(0.91, 0.08, 0.01)	(0.945, 0.044, 0.011)	(0.945, 0.044, 0.011)	(0.92, 0.064, 0.016)	(0.9, 0.08, 0.02)	(0.99, 0.008, 0.02)
H_3	(0.845, 0.124, 0.031)	(0.8, 0.18, 0.02)	(0.825, 0.14, 0.035)	(0.85, 0.12, 0.03)	(0.855, 0.126, 0.019)	(0.95, 0.04, 0.01)
H_4	(0.71, 0.261, 0.029)	(0.57, 0.387, 0.043)	(0.75, 0.2, 0.05)	(0.825, 0.14, 0.035)	(0.65, 0.28, 0.07)	(0.69, 0.248, 0.062)
H_5	(0.64, 0.324, 0.036)	(0.4, 0.48, 0.12)	(0.55, 0.405, 0.045)	(0.61, 0.351, 0.039)	(0.57, 0.345, 0.085)	(0.83, 0.153, 0.017)

Students' official test scores in 2016 academic year have been indicated in Table 2.

Table 2

	Turkish	Mathematics	Science	Social	English	Religion
S_1	(0.95, 0.04, 0.01)	(0.98, 0.01, 0.01)	(0.99, 0.005, 0.005)	(0.95, 0.03, 0.02)	(0.98, 0.01, 0.01)	(0.95, 0.04, 0.01)
S_2	(0.9, 0.08, 0.02)	(0.98, 0.01, 0.01)	(0.95, 0.03, 0.02)	(0.99, 0.008, 0.002)	(0.98, 0.015, 0.005)	(0.99, 0.006, 0.004)
S_3	(0.65, 0.28, 0.07)	(0.45, 0.44, 0.11)	(0.6, 0.32, 0.08)	(0.4, 0.48, 0.12)	(0.35, 0.52, 0.13)	(0.65, 0.3, 0.05)
S_4	(0.6, 0.32, 0.08)	(0.45, 0.44, 0.11)	(0.7, 0.24, 0.06)	(0.8, 0.16, 0.04)	(0.8, 0.17, 0.03)	(0.8, 0.16, 0.04)
S_5	(0.7, 0.24, 0.06)	(0.8, 0.16, 0.04)	(0.85, 0.12, 0.03)	(0.75, 0.2, 0.05)	(0.9, 0.08, 0.02)	(0.95, 0.04, 0.01)
S_6	(0.85, 0.12, 0.03)	(0.95, 0.04, 0.01)	(0.95, 0.02, 0.03)	(0.95, 0.05, 0)	(0.85, 0.11, 0.04)	(0.95, 0.02, 0.03)
S_7	(0.9, 0.08, 0.02)	(0.95, 0.04, 0.01)	(0.95, 0.02, 0.03)	(0.95, 0.015, 0.035)	(0.9, 0.09, 0.01)	(0.95, 0.04, 0.01)
S_8	(0.75, 0.2, 0.05)	(0.61, 0.35, 0.04)	(0.72, 0.24, 0.04)	(0.82, 0.15, 0.03)	(0.7, 0.25, 0.05)	(0.7, 0.2, 0.1)
S_9	(0.65, 0.3, 0.05)	(0.68, 0.26, 0.06)	(0.72, 0.24, 0.04)	(0.79, 0.15, 0.06)	(0.75, 0.18, 0.07)	(0.78, 0.15, 0.07)
S_{10}	(0.6, 0.3, 0.1)	(0.55, 0.4, 0.05)	(0.8, 0.15, 0.05)	(0.74, 0.22, 0.04)	(0.9, 0.07, 0.03)	(0.4, 0.51, 0.09)

Shortest distance between each student (i.e. Table 2) and each high school (i.e. Table 1) has been calculated using euclidean distance method in Table 3.

Table 3

E	H_1	H_2	H_3	H_4	H_5
S_1	0.0568	0.1107	0.2949	0.6491	0.9039
S_2	0.0757	0.0987	0.697	0.6729	0.8889
S_3	0.9633	0.8184	0.61004	0.4247	0.4119
S_4	0.7075	0.6225	0.4371	0.2585	0.3649
S_5	0.4002	0.2949	0.1704	0.4187	0.5935
S_6	0.5424	0.0775	0.2141	0.5296	0.7993
S_7	0.5507	0.0583	0.2142	0.6131	0.8261
S_8	0.6737	0.5254	0.3389	0.1012	0.3927
S_9	0.5839	0.4768	0.2972	0.1915	0.43001
S_{10}	0.8226	0.71707	0.6187	0.5204	0.53906

Shortest distance between each student (i.e. Table 2) and each high school (i.e. Table 1) has been calculated using normalized euclidean distance method in Table 4.

Table 4

$n-E$	H_1	H_2	H_3	H_4	H_5
S_1	0.0231	0.045	0.1204	0.2675	0.36903
S_2	0.0308	0.04279	0.27589	0.27471	0.365
S_3	0.43412	0.391	0.3375	0.20901	0.13595
S_4	0.29438	0.37369	0.17615	0.17789	0.14159
S_5	0.22332	0.1204	0.06946	0.17097	0.24231
S_6	0.27333	0.0333	0.0815	0.22134	0.33569
S_7	0.05085	0.03291	0.09209	0.2341	0.33903
S_8	0.27506	0.2168	0.13836	0.0415	0.16034
S_9	0.2383	0.1946	0.1213	0.07818	0.17555
S_{10}	0.33582	0.29274	0.25261	0.21248	0.2266

Shortest distance between each student (i.e. Table 2) and each high school (i.e. Table 1) has been calculated using hamming distance method in Table 5.

Table 5

H	H_1	H_2	H_3	H_4	H_5
S_1	0.0261	0.0458	0.1125	0.2675	0.3623
S_2	0.0257	0.0363	0.107	0.2658	0.365
S_3	0.434	0.4053	0.3375	0.1845	0.1315
S_4	0.2872	0.2418	0.1625	0.0941	0.1183
S_5	0.1465	0.1101	0.056	0.1576	0.2308
S_6	0.0692	0.0333	0.0701	0.2176	0.3184
S_7	0.0539	0.0163	0.08	0.2341	0.333
S_8	0.2519	0.2168	0.1375	0.0415	0.156
S_9	0.2539	0.2051	0.1258	0.0766	0.1513
S_{10}	0.3139	0.2701	0.206	0.1341	0.2266

Shortest distance between each student (i.e. Table 2) and each high school (i.e. Table 1) has been calculated using normalized hamming distance method in Table 6.

Table 6

$n-H$	H_1	H_2	H_3	H_4	H_5
S_1	0.0043	0.0076	0.0187	0.0445	0.0603
S_2	0.0042	0.006	0.0178	0.0443	0.0608
S_3	0.0723	0.0675	0.0562	0.0307	0.0219
S_4	0.0478	0.0403	0.027	0.0156	0.0197
S_5	0.0244	0.0183	0.0093	0.0262	0.0384
S_6	0.0115	0.0055	0.0116	0.0362	0.053
S_7	0.0089	0.0027	0.0133	0.039	0.0555
S_8	0.0419	0.0361	0.0229	0.0069	0.026
S_9	0.0423	0.0341	0.0209	0.0127	0.0252
S_{10}	0.0523	0.045	0.0343	0.0223	0.0377

Distance between each student and each school has been calculated by four different distance measures. Comparison of distance measures is in the following table (Table 7).

Table 7

		H_1	H_2	H_3	H_4	H_5
S_1	d_E	0.0568	0.1107	0.2949	0.6491	0.9039
	d_H	0.0261	0.0458	0.1125	0.2675	0.3623
	d_{n-E}	0.0231	0.045	0.1204	0.2675	0.36903
	d_{n-H}	0.0043	0.0076	0.0187	0.0445	0.0603
S_2	d_E	0.0757	0.0987	0.697	0.6729	0.8889
	d_H	0.0257	0.0363	0.107	0.2658	0.365
	d_{n-E}	0.0308	0.04279	0.27589	0.27471	0.365
	d_{n-H}	0.0042	0.006	0.0178	0.0443	0.0608
S_3	d_E	0.9633	0.8184	0.61004	0.4247	0.4119
	d_H	0.434	0.4053	0.3375	0.1845	0.1315
	d_{n-E}	0.43412	0.391	0.3375	0.20901	0.13595
	d_{n-H}	0.0723	0.0675	0.0562	0.0307	0.0219
S_4	d_E	0.7075	0.6225	0.4371	0.2585	0.3649
	d_H	0.2872	0.2418	0.1625	0.0941	0.1183
	d_{n-E}	0.29438	0.37369	0.17615	0.17789	0.14159
	d_{n-H}	0.0478	0.0403	0.027	0.0156	0.0197
S_5	d_E	0.4002	0.2949	0.1704	0.4187	0.5935
	d_H	0.1465	0.1101	0.056	0.1576	0.2308
	d_{n-E}	0.22332	0.1204	0.06946	0.17097	0.24231
	d_{n-H}	0.0244	0.0183	0.0093	0.0262	0.0384
S_6	d_E	0.5424	0.0775	0.2141	0.5296	0.7993
	d_H	0.0692	0.0333	0.0701	0.2176	0.3184
	d_{n-E}	0.27333	0.0333	0.0815	0.22134	0.33569
	d_{n-H}	0.0115	0.0055	0.0116	0.0362	0.053
S_7	d_E	0.5507	0.0583	0.2142	0.6131	0.8261
	d_H	0.0539	0.0163	0.08	0.2341	0.333
	d_{n-E}	0.05085	0.03291	0.09209	0.2341	0.33903
	d_{n-H}	0.0089	0.0027	0.0133	0.039	0.0555
S_8	d_E	0.6737	0.5254	0.3389	0.1012	0.3927
	d_H	0.2519	0.2168	0.1375	0.0415	0.156
	d_{n-E}	0.27506	0.2168	0.13836	0.0415	0.16034
	d_{n-H}	0.0419	0.0361	0.0229	0.0069	0.026
S_9	d_E	0.5839	0.4768	0.2972	0.1915	0.43001
	d_H	0.2539	0.2051	0.1258	0.0766	0.1513
	d_{n-E}	0.2383	0.1946	0.1213	0.07818	0.17555
	d_{n-H}	0.0423	0.0341	0.0209	0.0127	0.0252
S_{10}	d_E	0.8226	0.71707	0.6187	0.5204	0.53906
	d_H	0.3139	0.2701	0.206	0.1341	0.2266
	d_{n-E}	0.33582	0.29274	0.25261	0.21248	0.2266
	d_{n-H}	0.0523	0.045	0.0343	0.0223	0.0377

According to Table 7, four different distance measures give coherent results. According to the results of each distance measures, the schools in which each of the students will enroll are same. Besides, these results and the official data from the Ministry of Education are coherent with each other. According to Table 7, the student S_1 is to enroll in H_1 high school, the student S_2 is to enroll in H_1 high school, the student S_3 is to enroll in H_5 high school, the student S_4 is to enroll in H_4 high school, the student S_5 is to enroll in H_3 high school, the student S_6 is to enroll in H_2 high school, the student S_7 is to enroll in H_2 high school, the student S_8 is to enroll in H_4 high school, the student S_9 is to enroll in H_4 high school, the student S_{10} is to enroll in H_4 high school. From Table 7, the sequence of validity and reliability of the distance measures is this, $d_{n-H} < d_{n-E} < d_E < d_H$. According to this comparison, the normalized hamming distance measure gives the shortest results. Therefore, the applications performed in the continuation of this paper have been made using the normalized hamming distance measure.

4. Determination of the High School Where the Students Will Enroll Using the Normalized Hamming Distance Measure

In this section of the paper, the students prepared for exam of transition to high school education have been searched in 2016-2017 academic year. Approximately 42000 students have been researched according to official data from the Ministry of Education. Pilot tests regularly applied to these students at special study centers have been followed up. Ten students have been randomly selected among the students. The results of application are consistent for all students. The following tables are based on randomly selected ten students. Averages of the scores of the pilot tests applied to students during the year have been taken at the end of the academic year. The high schools which students will enroll based on the average of the scores of the pilot tests have been determined using normalized hamming distance measure. Besides the official test scores of the students have been researched. The high schools which students will enroll based on the average of the scores of official test have been determined using normalized hamming distance measure. The relationship between students' official test and the pilot tests have been searched. Let $H = \{H_1, H_2, H_3, H_4, H_5\}$ be a set of high schools, $S = \{S_1, S_2, S_3, S_4, S_5, S_6, S_7, S_8, S_9, S_{10}\}$ be a set of students.

$L = \{\text{Turkish}, \text{Mathematics}, \text{Science}, \text{Social}, \text{English}, \text{Religion}\}$ be a set of lessons.

High school base point in 2017 academic year has been calculated for each lesson in L, in Table 8.

Table 8

	Turkish	Mathematics	Science	Social	English	Religion
H_1	(0.96, 0.03, 0.01)	(0.95, 0.04, 0.01)	(0.995, 0.004, 0.001)	(0.97, 0.02, 0.01)	(0.95, 0.03, 0.02)	(0.997, 0.002, 0.001)
H_2	(0.92, 0.06, 0.02)	(0.93, 0.06, 0.01)	(0.93, 0.05, 0.02)	(0.9, 0.05, 0.05)	(0.91, 0.05, 0.04)	(0.98, 0.01, 0.01)
H_3	(0.85, 0.07, 0.08)	(0.82, 0.12, 0.06)	(0.75, 0.20, 0.05)	(0.85, 0.12, 0.03)	(0.81, 0.18, 0.01)	(0.9, 0.05, 0.05)
H_4	(0.65, 0.3, 0.05)	(0.55, 0.44, 0.01)	(0.65, 0.3, 0.05)	(0.81, 0.17, 0.02)	(0.63, 0.3, 0.07)	(0.55, 0.42, 0.03)
H_5	(0.5, 0.45, 0.05)	(0.3, 0.65, 0.05)	(0.63, 0.33, 0.04)	(0.66, 0.25, 0.09)	(0.65, 0.32, 0.03)	(0.81, 0.15, 0.04)

Average of students' who were randomly selected pilot tests score in 2016-2017 academic year has been determined in Table 9.

Table 9

	Turkish	Mathematics	Science	Social	English	Religion
S_1	(0.9, 0.05, 0.05)	(0.92, 0.07, 0.01)	(0.95, 0.03, 0.02)	(0.87, 0.1, 0.03)	(0.95, 0.05, 0)	(0.92, 0.04, 0.04)
S_2	(0.86, 0.1, 0.04)	(0.83, 0.15, 0.02)	(0.82, 0.14, 0.04)	(0.89, 0.1, 0.01)	(0.68, 0.25, 0.07)	(0.89, 0.09, 0.02)
S_3	(0.82, 0.1, 0.08)	(0.77, 0.15, 0.08)	(0.66, 0.25, 0.09)	(0.77, 0.2, 0.03)	(0.63, 0.3, 0.07)	(0.9, 0.05, 0.05)
S_4	(0.76, 0.2, 0.04)	(0.59, 0.36, 0.05)	(0.51, 0.45, 0.04)	(0.68, 0.24, 0.08)	(0.54, 0.4, 0.06)	(0.89, 0.09, 0.02)
S_5	(0.95, 0.04, 0.01)	(0.9, 0.05, 0.05)	(0.92, 0.03, 0.05)	(0.95, 0.04, 0.01)	(0.87, 0.1, 0.03)	(0.95, 0.05, 0)
S_6	(0.36, 0.55, 0.09)	(0.35, 0.6, 0.05)	(0.29, 0.6, 0.11)	(0.375, 0.5, 0.125)	(0.265, 0.65, 0.085)	(0.4, 0.5, 0.1)
S_7	(0.9, 0.05, 0.05)	(0.95, 0.03, 0.02)	(0.9, 0.06, 0.04)	(0.95, 0.01, 0.04)	(0.95, 0.02, 0.03)	(0.95, 0.05, 0)
S_8	(0.95, 0.04, 0.01)	(1, 0, 0)	(0.9, 0.05, 0.05)	(1, 0, 0)	(1, 0, 0)	(1, 0, 0)
S_9	(0.7, 0.2, 0.1)	(0.8, 0.15, 0.05)	(0.9, 0.05, 0.05)	(0.95, 0.03, 0.02)	(0.9, 0.07, 0.03)	(0.9, 0.08, 0.02)
S_{10}	(0.6, 0.3, 0.1)	(0.8, 0.18, 0.02)	(0.4, 0.35, 0.25)	(0.9, 0.07, 0.03)	(0.5, 0.42, 0.08)	(0.8, 0.11, 0.09)

Distance between each student (i.e. Table 8) and each high school (i.e. Table 7) has been calculated using normalized hamming distance method depending upon average of students' pilot tests, in Table 10.

Table 10

	H_1	H_2	H_3	H_4	H_5
S_1	0.0561	0.0358	0.0875	0.28	0.3258
S_2	0.136	0.10667	0.06833	0.19	0.24333
S_3	0.212	0.15667	0.0651	0.17166	0.195833
S_4	0.30033	0.24592	0.2	0.14167	0.14667
S_5	0.0471	0.0391	0.0958	0.2608	0.3333
S_6	0.63075	0.58833	0.49167	0.30667	0.29541
S_7	0.04216	0.03583	0.13	0.29	0.3333
S_8	0.03966	0.075	0.13667	0.335	0.385
S_9	0.112	0.08833	0.1075	0.2175	0.27833
S_{10}	0.30367	0.26333	0.18667	0.18333	0.235

Table 10 depicts that the shortest distance between each student and each high school has given that the student will enroll in the high school depending upon average of students' pilot tests. According to Table 9, the student S_1 is to enroll in H_2 high school, the student S_2 is to enroll in H_3 high school, the student S_3 is to enroll in H_3 high school, the student S_4 is to enroll in H_4 high school, the student S_5 is to enroll in H_2 high school, the student S_6 is to enroll in H_5 high school, the student S_7 is to enroll in H_2 high school, the student S_8 is to enroll in H_1 high school, the student S_9 is to enroll in H_2 high school, the student S_{10} is to enroll in H_4 high school.

Official test scores of the students in 2016-2017 academic year has been determined in Table 11.

Table 11

	Turkish	Mathematics	Science	Social	English	Religion
S_1	(0.8, 0.15, 0.05)	(0.85, 0.12, 0.03)	(1, 0, 0)	(1, 0, 0)	(0.9, 0.05, 0.05)	(0.9, 0.07, 0.03)
S_2	(0.75, 0.2, 0.05)	(0.8, 0.15, 0.05)	(1, 0, 0)	(0.95, 0.03, 0.02)	(0.7, 0.25, 0.05)	(0.95, 0.05, 0)
S_3	(0.85, 0.1, 0.05)	(0.75, 0.15, 0.1)	(0.95, 0.05, 0)	(0.9, 0.07, 0.03)	(0.75, 0.2, 0.05)	(0.9, 0.07, 0.03)
S_4	(0.75, 0.15, 0.1)	(0.55, 0.4, 0.05)	(0.6, 0.35, 0.05)	(0.6, 0.3, 0.1)	(0.5, 0.45, 0.05)	(0.85, 0.12, 0.03)
S_5	(0.75, 0.2, 0.05)	(0.75, 0.35, 0)	(0.85, 0.12, 0.03)	(0.95, 0.03, 0.02)	(0.9, 0.08, 0.02)	(0.95, 0.04, 0.01)
S_6	(0.25, 0.7, 0.05)	(0.35, 0.6, 0.05)	(0.5, 0.4, 0.1)	(0.45, 0.5, 0.05)	(0.45, 0.55, 0)	(0.7, 0.25, 0.05)
S_7	(0.8, 0.15, 0.05)	(0.95, 0.03, 0.02)	(1, 0, 0)	(0.95, 0.02, 0.03)	(0.85, 0.12, 0.03)	(0.9, 0.05, 0.05)
S_8	(1, 0, 0)	(1, 0, 0)	(0.8, 0.1, 0.1)	(1, 0, 0)	(1, 0, 0)	(1, 0, 0)
S_9	(0.5, 0.4, 0.1)	(0.95, 0.05, 0)	(0.9, 0.08, 0.02)	(0.8, 0.15, 0.05)	(0.9, 0.05, 0.05)	(0.85, 0.1, 0.05)
S_{10}	(0.61, 0.3, 0.09)	(0.5, 0.45, 0.05)	(0.64, 0.32, 0.04)	(0.84, 0.1, 0.06)	(0.65, 0.3, 0.05)	(0.52, 0.42, 0.06)

Distance between each student (i.e. Table 11) and each high school (i.e. Table 8) has been calculated using normalized hamming distance method depending upon official test scores of the students', in Table 12.

Table 12

	H_1	H_2	H_3	H_4	H_5
S_1	0.07367	0.06833	0.11	0.27166	0.36833
S_2	0.19466	0.18333	0.11166	0.22916	0.285
S_3	0.1205	0.16333	0.07166	0.22666	0.27
S_4	0.325	0.2891	0.2008	0.15	0.1441
S_5	0.10017	0.1	0.10916	0.21833	0.255
S_6	0.62142	0.58833	0.38	0.255	0.16167
S_7	0.067	0.07	0.10333	0.2833	0.31833
S_8	0.06133	0.07667	0.145	0.32667	0.385
S_9	0.15533	0.11833	0.14333	0.23667	0.2375
S_{10}	0.341	0.3	0.234	0.0375	0.1416

Table 12 depicts that the shortest distance between each student and each high school has given that the student will enroll in the high school depending upon official test scores of the students'. According to Table 11, the student S_1 is to enroll in H_2 high school, the student S_2 is to enroll in H_3 high school, the student S_3 is to enroll in H_3 high school, the student S_4 is to enroll in H_5 high school, the student S_5 is to enroll in H_2 high school, the student S_6 is to enroll in H_5 high school, the student S_7 is to enroll in H_1 high school, the student S_8 is to enroll in H_1 high school, the student S_9 is to enroll in H_2 high school, the student S_{10} is to enroll in H_4 high school.

When Table 10 and Table 12 are examined, consistent results have been obtained except for two students. When Table 10 and Table 12 were examined, it has been determined that two students (S_4 and S_7) went to a different high school than expected. According to Table 10, the student S_4 is to enroll in H_4 high school but according to Table 12, the student S_4 is to enroll in H_5 high school. Besides according to Table 10, the student S_7 is to enroll in H_2 high school but according to Table 12, the student S_7 is to enroll in H_1 high school. The first reason for this difference is that high school base points are very close to each other. The following comments could be made about inconsistent results: positive or negative factors such as disease, social problems, environmental factors, economy, psychology, motivation of the student on the exam day may have influenced.

5. Conclusion and Suggestions

In this paper firstly, distance measures have been compared. The sequence of validity and reliability of the distance measures is this, $d_{n-H} < d_{n-E} < d_E < d_H$. The normalized hamming distance measure gives the shortest results. The relationship between the student's official test and the pilot test has been observed. This paper could applicable for each student. Factors affecting student achievement in official exam could be researched. This paper has been researched only through student's pilot tests because of factors such as capacity of student's working, student's psychology could be unknown exactly.

In this paper, ten students who were randomly selected have been researched in order to form the above tables. Moreover, this research could be applicable for all students. Students' school achievement scores do not have a huge impact on their examination scores. Therefore, their school achievement scores have been assumed to be fixed. Besides, success scores of the schools have been assumed to be fixed. While searching database which is used in this paper, socio-economic status of students, student psychology, success of schools, teacher factor, order of preference, different city preference of students are ignored. The difficulty or ease of examination could change every year, but this alteration only affects the high school base points. Because of this alteration affects every student equally, the result will not change.

Afterwards, students' pilot tests and official test scores have been compared. Firstly, the high schools, in which each of the students have enrolled, have been determined according to the students' pilot tests scores. Then the high schools have been determined according to the students' official test scores. The relationship between official tests scores of the students and pilot tests scores of the students has been interpreted. Official tests scores and pilot tests scores are consistent with each other. Comments about inconsistent results have been made.

According to this paper, for the selection and enroll of high school students, regular, periodic pilot tests could be applied at the school. The contribution of this new system, that is we have achieved, are more stress-free, less anxious for testing, easier to implement, more economical and more advantageous in many ways. Thanks to this system, the enroll of students in high schools will not depend on a single test. A joint, formal, planned pilot tests could be applied nationwide by the Ministry of Education. Besides, the student could make up for the previous exams that failed in these pilot tests. These pilot tests could be applied regularly every year, not just at the year of the transition to high school. This system could be used for the initial stage of education and the final stage of education. Thus this system could be used for enroll to high school. The basic knowledge and skill data expected from the students in relevant departments in universities could be determined so other students could be selected using this system.

This application of intuitionistic fuzzy set in high school determination is very useful, because by calculating distance between each student and each school, the most proper school for each student has been determined. Available system results with the method which we have used are compatible. This paper has shown that used method could be applied to evaluation system through various arrangements. This method is suitable in order to achieve more sensible results. Available evaluation system could be renewed by using intuitionistic fuzzy logic. Especially, using this application of intuitionistic fuzzy logic will give very positive results in education system. Moreover by determining questions about a subject, it can be better researched how much the student knows. In some countries, without this logic is used, similar applications have applied in education. If this application is used in these countries, better results will be obtained. In addition, success of teachers and students could be observed by means of intuitionistic fuzzy logic. Using an intuitionistic fuzzy logic in evaluation and determination system will have very beneficial results. This is the first study to guide the students in the direction of their preferences in evaluation of success in education. Actually, this is the first study that evaluate with this application and offer recommendations in education. This application will carry out a more accurate, more objective, more rational result that is make decisions or preferences without instant evaluation based on more stress-free, easier long term observation and determination. In some countries, without this logic is used, similar applications have applied in education. If this application is used in these countries, better results will be obtained.

Competing Interests

The author declares that he has no competing interests.

Authors' Contributions

The author wrote, read and approved the final manuscript.

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