Konuralp Journal of Mathematics, 7(2) (2019) 438-441

Konuralp Journal of Mathematics

Journal Homepage: www.dergipark.gov.tr/konuralpjournalmath
e-ISSN: 2147-625X

Application of Ranking with Similarity Measure in Multi Criteria Decision Making

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Abstract

The aim of this paper is to proposed an application multi criteria decision making in intuitionistic fuzzy sets. Multicriteria decision making is a well known concept that aims to select the best solution among several alternatives in decision making. In this paper; success ranking of schools has been researched in multi criteria decision making. Also the most successful school has been determined among these ranked schools. For this paper have been benefitted from similarity measure for intuitionistic fuzzy sets in multi criteria decision making problem. Each option have been compared with both the positive-ideal solution and the negative-ideal solution. This application could be used in situations that are not dependent on a single criterion.

Keywords: *Intuitionistic fuzzy sets, Distance measure, Decision making, Multi criteria.*
2010 Mathematics Subject Classification: *03E72,90B50*

1. Introduction

Fuzzy logic was firstly defined by Zadeh in 1965 [1]. Then, intuitionistic fuzzy sets (shortly IFS) were defined by K.Atanassov in 1986 [2]. IFS form a generalization of the notion of fuzzy sets. IFS theory is advantageous in several application areas, such as algebraic structures, robotics, control systems, agriculture areas, computer, irrigation, economy and various engineering fields. 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, education, artificial intelligence, networking.
Decision making is the action of selecting between two or more options. Multi criteria decision making(MCDM) is a well known notion that aims to choose the best solution among various alternatives in decision making. The working style of all MCDM methods is like this: Selection of Criteria, Selection of Alternatives, Selection of Aggregation Methods and ultimately Selection of Alternatives based on weights or outranking [9]. Some of the MCDM methods are as follows: Analytical Hierarchy Process (AHP), Fuzzy Multi Criteria Decision Making Process, ELECTRE Method, Preference Ranking Organization Method for Enrichment of Evaluations, The TOPSIS Method. Bellman and Zadeh the firstly introduced decision making in fuzzy logic. Multi criteria fuzzy decision making has been one of the quickly growing area in recent years on account of its practicality. In MCDM problems, usually the best alternative is chosen from alternatives according to criteria. Applications of MCDM problem have increased in intuitionistic fuzzy set. MCDM methods based on IFSs were studied in Li, Lin, Yuan and Xia, Liu and Wang and Xu. Szmidt et al. provided a solution to a MCDM problem by using similarity measures for IFSs [7]. Later, Szmidt et al. have proposed a new method that not only deals with positive ideal solutions but also deals with negative ideal solutions [7]. Many researcher have introduced this field: Liu, Wang, Chen, Ye, Zhang, Xu, etc.

In this paper, we have introduced an application of MCDM in success ranking of high school using similarity measures in intuitionistic fuzzy sets. For this paper; high schools in Kahramanmaraş city in Turkey have been researched. 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). This research has utilized official data that were obtained from the Ministry of Education. In this paper; approximately 42000 students have been searched for $2016-2017$ academic year to determine high schools' base points.
Many institutions make decisions based on a single criterion in the selection of staff. But a single criterion may not always give accurate

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results. This application could be used in all situations that are not dependent on a single criterion. The situation in this study is related to enroll to high school. The options are high schools in this paper. Criteria that determine the success of high school are lessons. The criteria in this study have been determined as the basic lessons in high school. High school base points have been determined as criteria. Each criterion represents a lesson. Lessons are Turkish, Mathematics, Science, Social, English, Religion. The aim of this paper is to determination success ranking of high school according to these criteria. Also the most successful school has been determined among these ranked schools. Multi criteria decision making has many application areas. For this paper have been benefitted from similarity measures for IFSs that proposed new solution by Szmidt and Kacprzyk [7]. This method takes into account not only ideal positive alternative but also ideal negative alternative. It is important that the best choice is how close to the positive ideal solution and how far away from the negative ideal solution.

2. PRELIMINARIES

Definition 2.1. *[2]Let $X \neq \emptyset$. An intuitionistic fuzzy set A in X;*

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

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

defined membership degree, nonmembership degree and hesitation degree of the element $x \in X$ respectively.

$$\mu_A(x) + \nu_A(x) + \pi_A(x) = 1.$$

Definition 2.2. *[5] M be a set of options and C be a set of criteria*

$$M = \{M_1, M_2, ..., M_m\}, C = \{C_1, C_2, ..., C_n\}$$

where each option M_i is defined with intuitionistic fuzzy set;

$$M_i = \{(C_1, \mu_{i1}, \nu_{i1}), (C_2, \mu_{i2}, \nu_{i2}), ..., (C_n, \mu_{in}, \nu_{in})\}, i = 1, 2, ..., m$$

where μ_{ij} indicates the degree to which option M_i satisfies criterion C_j, ν_{ij} indicates the degree to which option M_i does not satisfy criterion C_j. The options should satisfy the criteria $C_j, C_k, ...,$ and C_p or criterion C_s, i.e.:

$$(C_j \ \text{ and } \ C_k \ \text{ and}, ..., \text{and } \ C_p) \ \text{ or } \ C_s \tag{2.1}$$

$A(\mu_A = 1, \nu_A = 0$ and $\pi_A = 0)$ represents the ideal positive solution and $B(\mu_B = 0, \nu_B = 1$ and $\pi_B = 0)$ represents the ideal negative solution. So, A is a fully satisfied criterion and B is a fully dissatisfied criterion.

Definition 2.3. *[7]*

$$Sim(C_i, A) = \frac{l_{IFS}(C_i, A)}{l_{IFS}(C_i, B)} \tag{2.2}$$

$l_{IFS}(C_i, A)$ and $l_{IFS}(C_i, B)$ are defined as:

$$l_{IFS}(C_i, A) = \frac{1}{2}\sum_{i=1}^{n}(|1 - \mu_{C_i}| + |0 - \nu_{C_i}| + |0 - \pi_{C_i}|) \tag{2.3}$$

$$l_{IFS}(C_i, B) = \frac{1}{2}\sum_{i=1}^{n}(|0 - \mu_{C_i}| + |1 - \nu_{C_i}| + |0 - \pi_{C_i}|) \tag{2.4}$$

For, $0 \le Sim(C_i, A) \le \infty$.

The problem of finding an option M_i satisfying in the best way condition 2.1 can be solved by evaluating each option M_i

$$E(M_i) = Sim(A, M_i) = \min\{\max[Sim(A, C_j), Sim(A, C_k), ... \tag{2.5}$$

$$..., Sim(A, C_p)], Sim(A, C_s)\}$$

Condition 2.5 means that for each M_i we look for the worst satisfied criterion W_i among $C_j, C_k, ...,$ and C_p and next- we look for the better criterion between W_i and C_s. The worst means the least similar and the least similar and the best means the most similar.
The smallest value among $E(M_i), i = 1, ..., m$ (2.5) points out the option which best satisfies condition (2.1).

3. Application of Success Ranking with Similarity Measure

In this paper, we have introduced an application of MCDM in success ranking of high school using similarity measures in intuitionistic fuzzy sets. 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). The options are high schools in this paper. Criteria that determine the success of high school are lessons. The criteria in this study have been determined as the basic lessons in high school. High school base points have been determined as criteria. Each criterion represents a lesson. Lessons are Turkish, Mathematics, Science, Social, English, Religion. The aim of this paper is to determination success ranking of high school according to these criteria. Also the most successful school has been determined among these ranked schools. $H=\{H_1,H_2,H_3,H_4,H_5\}$ be set of high schools.
$L=\{L_1,L_2,L_3,L_4,L_5,L_6\}$ be set of criteria. Set of criteria respectively are $L=\{Turkish, Mathematics, Science, Social, English, Religion\}$.
Table 1: High school base points have been calculated based on lessons as following:

Options	L_1	L_2	L_3	L_4	L_5	L_6
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)

Table 2: From(2.5),(2.2); calculations for H_1 are as follows:

H_1	$Sim(L_1)=0.0412$	$Sim(L_2)=0.052$
	$Sim(L_3)=0.005$	$Sim(L_4)=0.0306$
	$Sim(L_5)=0.0515$	$Sim(L_6)=0.003$

$E(H_1)=\min[0.0515,0.052]=0.0515$

Table 3: From(2.5),(2.2); calculations for H_2 are as follows:

H_2	$Sim(L_1)=0.0851$	$Sim(L_2)=0.0744$
	$Sim(L_3)=0.0736$	$Sim(L_4)=0.1052$
	$Sim(L_5)=0.0947$	$Sim(L_6)=0.0202$

$E(H_2)=\min[0.1052,0.0744]=0.0744$

Table 4: From(2.5),(2.2); calculations for H_3 are as follows:

H_3	$Sim(L_1)=0.1612$	$Sim(L_2)=0.2045$
	$Sim(L_3)=0.3125$	$Sim(L_4)=0.1704$
	$Sim(L_5)=0.2317$	$Sim(L_6)=0.1052$

$E(H_3)=\min[0.3125,0.2045]=0.2045$

Table 5: From(2.5),(2.2); calculations for H_4 are as follows:

H_4	$Sim(L_1)=0.5$	$Sim(L_2)=0.8035$
	$Sim(L_3)=0.5$	$Sim(L_4)=0.2289$
	$Sim(L_5)=0.5285$	$Sim(L_6)=0.7758$

$E(H_4)=\min[0.7758,0.8035]=0.7758$

Table 6: From(2.5),(2.2); calculations for H_5 are as follows:

H_5	$Sim(L_1)=0.909$	$Sim(L_2)=2$
	$Sim(L_3)=0.552$	$Sim(L_4)=0.4533$
	$Sim(L_5)=0.5147$	$Sim(L_6)=0.2235$

$E(H_5)=\min[0.909,2]=0.909$

The smallest value among $E(H_i)$ points out the option which best satisfies condition. When the results of calculations are compared; the ranking of the options: H_1,H_2,H_3,H_4,H_5. H_1 is the best option among H_1-H_5. Then according to the above calculations when success rankings are made between high school according to the above calculations, the most successful high school is H_1. Also success rankings of high schools:H_1,H_2,H_3,H_4,H_5.

4. Conclusion and Suggestions

For this paper have been benefitted from similarity measures for IFS that proposed new solution by Szmidt and Kacprzyk [7]. The advantage of this method; this application takes into account not only ideal positive alternative but also ideal negative alternative. It is important that the best choice is how close to the positive ideal solution and how far away from the negative ideal solution. In this paper; success ranking of high schools has done by multi criteria method. Also the most successful school has been determined among these ranked schools. This method is suitable in order to achieve more sensible results. This application is a method that gives very important and rational results in decision making, in education. This article is the first article that evaluates with application and offers suggestions in education. This application has been implemented for the first time in Turkey to achieve more consistent and better results. Using this method, the success of school could be observed every year. This method could be used to determine the success of each lesson. Applications could be made in different areas with this method. Many institutions make decisions based on a single criterion in the selection of staff. But a single criterion may not always give accurate results. This application could be used in all situations that are not dependent on a single criterion.

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