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Research Article

Intuitionistic Fuzzy Sets and its Application in Carrier Determination by the Fusion of Score Function and Normalized Hamming Distance Method

Ruchi Trivedi[1], Vikas Kumar Mishra*[2], R. N. Dewangan[3], Manoj Kumar Dewangan[4] and Maheshwari[4]

[1] *Department of Mathematics, Bhilai Institute of Technology, Raipur, Chhattisgarh, India*
[2] *Department of Mathematics, Government Engineering College, Jagdalpur, Chhattisgarh, India*
[3] *Department of Mathematics, Government Engineering College, Raipur, Chhattisgarh, India*
[4] *Department of Mathematics, Shri Shankaracharya Institute of Professional Management and Technology, Raipur, Chhattisgarh, India*
*__Corresponding author:__ vm21084@gmail.com

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Abstract. Intuitionistic fuzzy sets are commonly used to solve decision making problems. In this paper, a new score and accuracy function of intuitionistic fuzzy sets have been proposed, and used to solve the carrier determination problems. The fusion of score function and normalized hamming distance method of intuitionistic fuzzy sets have been used to determine the distance between each students and each carrier. The results of this approach were then analyzed to determine the most suitable career paths for each student based on their individual characteristics and preferences.

Keywords. Intuitionistic fuzzy sets, Career determination, Score function distance method, Accuracy function, Decision-making, Uncertainty, Normalized Hamming distance, Intuitionistic fuzzy numbers

Mathematics Subject Classification (2020). 94D05

1. Introduction

The complex and constantly shifting nature of individual preferences and uncertainties in today's job market are often overlooked by traditional career selection methods. It might be too challenging for conventional decision-making frameworks to adequately capture the ambiguity surrounding employment decisions, where qualitative and quantitative factors interact. The need for a more nuanced approach has prompted research into intuitionistic fuzzy sets, which provide a solid mathematical basis for modeling uncertainty and missing knowledge. This work aims to provide a robust alternative to effective career selection by utilizing intuitionistic fuzzy sets and the Score Function Distance Method. Using this new perspective, decision-makers can evaluate potential career paths more thoroughly, accounting for people's degree of reluctance and doubt in addition to personal preferences. In the end, applying intuitionistic fuzzy logic to career counseling represents a significant advancement in decision-making methods, offering new insights into both professional and personal development.

Intuitionistic Fuzzy Sets (IFS) have been used extensively in decision-making, including choosing a career. To quantify the distance between IFS and determine the grade difference in the information conveyed by IFS. Oktaviani *et al*. [10] proposed the normalized Euclidean distance approach. In situations like choosing a career, decision-making frequently entails negotiating ambiguity and uncertainty.

Instead of depending just on binary classifications, *Intuitionistic Fuzzy Sets* (IFS) provide a convincing method for handling these difficulties by enabling the representation of partial truths. To assess students' potential for different academic majors, Oktaviani *et al*. [11] have suggested using intuitionistic fuzzy sets. The intuitionistic fuzzy sets have been used by Sutrisno *et al*. [12] to identify research subjects using the normalized distance method. Ngan *et al*. [8] have shown how to use intuitionistic fuzzy sets in medical diagnostics by employing δ-inequalities. Thus, such strong frameworks can be used in situations involving career decision-making, guaranteeing that choices are based on thorough and adaptable mathematical structures.

An effective framework for handling imprecision and uncertainty in a variety of decision-making situations is provided by the mathematical underpinnings of intuitionistic fuzzy sets. Fundamentally, a membership function and a non-membership function define an intuitionistic fuzzy set, offering a level of hesitancy that represents the uncertainty in allocating an element to a specific set. In order to solve transport handling difficulties, Chakraborty and Saha [3] used intuitionistic fuzzy set notions. Applying intuitionistic fuzzy sets to career decision-making allows for a more thorough assessment of candidate competencies, especially in situations where subjective assessments are crucial. This can be especially helpful when applying techniques like the fusion of Score Function and Hamming Distance Method, which successfully accounts for the intricacy of human assessments and improves the process of choosing a job when there is uncertain data. The score function for inter-valued intuitionistic fuzzy sets has been applied in decision-making by Nguyen [9]. The incorporation of these mathematical concepts into real-world applications ultimately opens the door to more trustworthy and knowledgeable results while making decisions about one's profession.

The Score Function Distance Method is a crucial tool for determining a profession since it successfully addresses the complex nature of making decisions in the face of uncertainty.

By using this technique, people can methodically evaluate their skills and preferences in relation to several career pathways, which helps them make decisions that can sometimes seem overwhelming. This method's success in optimizing outcomes based on collective evaluations, Henra *et al*. [6] used in educational contexts, namely in the selection of video conferencing platforms for learning mathematics. The fusion of Score Function and Hamming Distance Method, offers a strong framework that not only makes career decisions easier but also dynamically adjusts to unique situations and goals within a contextual environment.

The combination of the score function and the hamming distance method offers a sophisticated framework for assessing different career routes through an intuitionistic fuzzy lens in the search for the best career choices. By recognizing the inherent ambiguity and complexity of individual preferences and market dynamics, this method successfully harmonizes decision-making with practical circumstances. Decision-makers can evaluate job possibilities in a more comprehensive way by combining qualitative and quantitative information. Applications of intuitionistic fuzzy sets in the healthcare sector were first presented by Wardani *et al*. [14]. Finally, using the combination of the hamming distance method and intuitionistic fuzzy score function not only expedites career assessments but also enables people to make well-informed decisions that align with their skills and professional goals.

Ejegwa *et al*. [5] have been used the normalized Euclidean distance method of intuitionistic fuzzy sets for career determination. To reduce the computational error and to get more precise result the combination of score function and normalized hamming distance method have been introduced to solve the career determination related problems.

2. Methodology

Definition 2.1 ([1])**.** Let X be a non-empty set. An Intuitionistic Fuzzy Set A in X is the collection of the form $A = \{(\xi, \mu_A(\xi), \nu_A(\xi), \pi_A(\xi))) : x \in X\}$, where $\mu_A, \nu_A, \pi_A : X \to [0,1]$, and $0 \le \mu_A(\xi) + \nu_A(\xi) \le 1$. $\mu_A(\xi)$ is the grade of belongingness of the element ξ in A and $\nu_A(\xi)$ is the grade of non-belongingness of ξ in A. For each $\xi \in X$, $\pi_A(\xi) = 1 - \mu_A(\xi) - \nu_A(\xi)$ is called the grade of hesitation.

Definition 2.2 ([2])**.** An Intuitionistic Fuzzy Set A is called an Intuitionistic Fuzzy Number if it satisfies the following conditions:

(i) *Normality*: If there exists $\xi \in X$ such that $\mu_A(\xi) = 1$ and $\nu_A(\xi) = 0$.

(ii) *Convexity*: Set A is convex with respect to its membership function and concave with respect to non-membership function.

(iii) *Continuity*: Its membership function is upper semi continuous and its non-membership function is lower semi continuous.

(iv) *Boundedness*: Set A is bounded.

Definition 2.3 ([4, 7])**.** For any intuitionistic fuzzy number $\xi = (\mu_\xi, \nu_\xi)$, the Score of ξ can be calculated by the formula: $S(\xi) = \mu_\xi - \nu_\xi$ where $S(\xi) \in [-1, 1]$.

Definition 2.4 ([7])**.** For any IFN $\xi = (\mu_\xi, \nu_\xi)$, the accuracy function is defined as $H(\xi) = \mu_\xi + \nu_\xi$ where $H(\xi) \in [0, 1]$.

Definition 2.5 ([4]). Let $\xi_1 = (\mu_{\xi_1}, \nu_{\xi_1})$ and $\xi_2 = (\mu_{\xi_2}, \nu_{\xi_2})$ be two intuitionistic fuzzy numbers. Then $S(\xi_1) = \mu_{\xi_1} - \nu_{\xi_1}$ and $S(\xi_2) = \mu_{\xi_2} - \nu_{\xi_2}$ also $H(\xi_1) = \mu_{\xi_1} + \nu_{\xi_1}$ and $H(\xi_2) = \mu_{\xi_2} + \nu_{\xi_2}$ be the scores and accuracy functions of the IFNs ξ_1 and ξ_2, respectively. Then

(I) If $S(\xi_1) < S(\xi_2)$, then $\xi_1 < \xi_2$.

(II) If $S(\xi_1) = S(\xi_2)$, then

- (i) If $H(\xi_1) = H(\xi_2)$, then $\xi_1 = \xi_2$.
- (ii) If $H(\xi_1) < H(\xi_2)$, then $\xi_1 < \xi_2$.

Definition 2.6. Szmidt and Kacprzyk [13] introduced the normalized hamming distance between two intuitionistic fuzzy sets A and B as:

$$d(x,y) = \frac{1}{2n} \sum_{i=1}^{n} |\mu_A(x_i) - \mu_B(x_i)| + |\vartheta_A(x_i) - \vartheta_B(x_i)| + |\pi_A(x_i) - \pi_B(x_i)|.$$

3. Result and Discussion

Definition 3.1. The new score function for IFN $\xi = (\mu_\xi, \nu_\xi, \pi_\xi)$ is given by $S_1(\xi) = \mu_\xi - \frac{\nu_\xi + \pi_\xi}{2}$, where $S_1(\alpha) \in [-1, 1]$.

Remark 3.1. (a) If $\xi = (1,0,0)$, then $S_1(\xi) = 1$.

(b) If $\xi = (0,1,0)$ or $\xi = (0,0,1)$, then clearly, $S_1(\xi) = -\frac{1}{2}$.

Definition 3.2. The new accuracy function for IFN $\alpha = (\mu_\xi, \nu_\xi, \pi_\xi)$ is given by $H_1(\xi) = \mu_\xi + \frac{\nu_\xi + \pi_\xi}{2}$, where $H_1(\xi) \in [0, 1]$.

3.1 Numerical Examples

Consider the IFNs $\xi_1 = (0.8, 0.1, 0.1)$, $\xi_2 = (0.5, 0.2, 0.3)$. Apply Definition 3.1 to ξ_1 and ξ_2 we get $S_1(\xi_1) = 0.8 - \left(\frac{0.1+0.1}{2}\right) = 0.7$, $S_1(\xi_2) = 0.25$. Since $S_1(\xi_1) > S_1(\xi_2)$ we get $\xi_1 > \xi_2$. Consider the IFNs $\xi_1 = (0.8, 0.1, 0.1)$, $\xi_2 = (0.5, 0.2, 0.3)$, $\xi_3 = (0.4, 0.4, 0.2)$. By Definition 3.1, we get $S_1(\xi_1) = 0.7$, $S_1(\xi_2) = 0.25$, $S_1(\xi_3) = 0.1$. Order of the scores is $S_1(\xi_1) > S_1(\xi_3) > S_1(\xi_2)$. Therefore, the ordering of ξ_1, ξ_2 and ξ_3 is given by $\xi_1 > \xi_3 > \xi_2$. Consider the IFNs $\xi_1 = (0.8, 0.1, 0.1)$, $\xi_2 = (0.5, 0.2, 0.3)$, $\xi_3 = (0.4, 0.4, 0.2)$, $\xi_4 = (0.3, 0.5, 0.2)$, $\xi_5 = (0.9, 0.1, 0)$. By Definition 3.1, we get $S_1(\xi_1) = 0.7$, $S_1(\xi_2) = 0.25$, $S_1(\xi_3) = 0.1$, $S_1(\xi_4) = -0.5$, $S_1(\xi_5) = 0.85$. Here $S_1(\xi_5) > S_1(\xi_1) > S_1(\xi_2) > S_1(\xi_3) > S_1(\xi_4)$. So, the ordering of $\xi_1, \xi_2, \xi_3, \xi_4$ and ξ_5 is given by $\xi_5 > \xi_1 > \xi_3 > \xi_2 > \xi_4$.

3.2 Career Determination by the Fusion of Score Function and Normalized Hamming Distance

The importance of giving students enough knowledge to make informed career decisions cannot be overstated. This is crucial because the various issues that students encounter due to a lack of appropriate career guidance have a significant impact on their efficiency and choice of career. Students should therefore be provided with enough information about choosing a career in order to improve their ability to plan, prepare, and perform. Among the elements that determine a career, such as academic achievement, interests, personality traits, etc., the first one appears to be the most important. A career determination problem has been considered to demonstrate the application of the score function and Hamming distance method.

Let $G = \{G_1, G_2, G_3, G_4\}$ be the set of students, $M = \{M_1, M_2, M_3, M_4\}$ be the set of careers and $C = \{K_1, K_2, K_3, K_4, K_5\}$ be the set of courses corresponds to the careers. To decide their job placements and options, we assume that the aforementioned students take exams (i.e., more than 100 total points) in the aforementioned courses. The relation between careers and courses has been displayed in Table 1 and the relation between students and courses have been displayed in Table 2. Each trial is described by three numbers, i.e., degree of belongingness μ, degree of non-belongingness ϑ and the hesitation degree π. Score function values corresponding to Table 1 and Table 2 have been displayed in Table 3 and Table 4 respectively and have been calculated by using the formula mentioned in Definition 3.1. The normalized Hamming distance for Table 3 and Table 4 have been calculated in Table 5 by using the formula mentioned in Definition 2.6.

Table 1. Relation between careers and courses

	K_1	K_2	K_3	K_4	K_5
M_1	(0.8,0.1,0.1)	(0.5,0.2,0.3)	(0.2,0.8,0.0)	(0.6,0.2,0.2)	(0.1,0.6,0.3)
M_2	(0.0,0.8,0.2)	(0.4,0.4,0.2)	(0.6,0.1,0.3)	(0.1,0.7,0.2)	(0.1,0.8,0.1)
M_3	(0.8,0.1,0.1)	(0.8,0.1,0.1)	(0.0,0.6,0.4)	(0.2,0.7,0.1)	(0.0,0.5,0.5)
M_4	(0.3,0.6,0.1)	(0.5,0.4,0.1)	(0.3,0.4,0.3)	(0.7,0.2,0.1)	(0.3,0.4,0.3)

Table 2. Relation between students and courses

	K_1	K_2	K_3	K_4	K_5
G_1	(0.4,0.0,0.6)	(0.7,0.0,0.3)	(0.3,0.3,0.4)	(0.1,0.7,0.2)	(0.1,0.8,0.1)
G_2	(0.3,0.5,0.2)	(0.2,0.6,0.2)	(0.6,0.1,0.3)	(0.2,0.4,0.4)	(0.0,0.8,0.2)
G_3	(0.1,0.7,0.2)	(0.0,0.9,0.1)	(0.2,0.7,0.1)	(0.8,0.0,0.2)	(0.2,0.8,0.0)
G_4	(0.4,0.3,0.3)	(0.7,0.0,0.3)	(0.2,0.6,0.2)	(0.2,0.7,0.1)	(0.2,0.8,0.0)

Table 3. Score table for Table 1

	K_1	K_2	K_3	K_4	K_5
M_1	0.7	0.25	−0.2	0.4	−0.35
M_2	−0.5	0.1	0.4	−0.35	−0.35
M_3	0.7	0.7	−0.5	−0.2	−0.5
M_4	−0.05	0.25	−0.05	0.55	−0.05

Table 4. Score table for Table 2

	K_1	K_2	K_3	K_4	K_5
G_1	0.1	0.55	−0.05	−0.35	−0.35
G_2	−0.05	−0.2	0.4	−0.2	−0.5
G_3	−0.35	−0.5	−0.2	−0.7	−0.2
G_4	0.1	0.55	−0.2	−0.2	−0.2

Table 5. Normalized Hamming distance table

	M_1	M_2	M_3	M_4
G_1	0.09	0.14	0.30	0.11
G_2	0.16	0.10	0.18	0.21
G_3	0.16	0.25	0.33	0.14
G_4	0.16	0.21	0.26	0.06

The minimal distance in the above table provides the appropriate career determination. So proper carrier choice for G_1 is M_1, for G_2 is M_2, for G_3 is M_4, and for G_4 is M_4.

4. Conclusion

This innovative use of intuitionistic fuzzy sets in career selection is extremely significant as it offers a precise and appropriate profession decision based on academic performance. Choosing a career is a difficult decision since, if done incorrectly, it can have a ripple effect on skill and efficiency. To determine the distance between each student and each career in relation to the disciplines, we combined the score function and normalized Hamming distance in the suggested application.

Competing Interests

The authors declare that they have no competing interests.

Authors' Contributions

All the authors contributed significantly in writing this article. The authors read and approved the final manuscript.

References

[1] K. T. Atanassov, Intuitionistic fuzzy sets, *Fuzzy Sets and Systems* **20**(1) (1986), 87 – 96, DOI: 10.1016/S0165-0114(86)80034-3.

[2] S. K. Bharati, Ranking method of intuitionistic fuzzy numbers, *Global Journal of Pure and Applied Mathematics* **13**(9) (2017), 4595 – 4608.

[3] S. Chakraborty and A. K. Saha, Selection of forklift unit for transport handling using integrated MCDM under neutrosophic environment, *Facta Universitatis - Series: Mechanical Engineering* **22**(2) (2024), 235 – 256 DOI: 10.22190/FUME220620039C.

[4] T.-Y. Chen, A comparative analysis of score functions for multiple criteria decision making in intuitionistic fuzzy settings, *Information Sciences* **181**(17) (2011), 3652 – 3676, DOI: 10.1016/j.ins.2011.04.030.

[5] P. A. Ejegwa, A. J. Akubo and O. M. Joshua, Intuitionistic fuzzy set and its application in career determination via normalized euclidean distance method, *European Scientific Journal* **10**(15) (2014), 529 – 536, URL: https://eujournal.org/index.php/esj/article/view/3478/3241.

[6] K. Henra, E. Efuansyah and R. Sulaiman, Selection of video conference application for mathematics learning using intuitionistic fuzzy max-min average composition method, *BAREKENG: Journal of Mathematics and Its Applications* **17**(1) (2023), 0305 – 0312, DOI: 10.30598/barekengvol17iss1pp0305-0312.

[7] D. H. Hong and C.-H. Choi, Multicriteria fuzzy decision-making problems based on vague set theory, *Fuzzy Sets and Systems* **114**(1) (2000), 103 – 113, DOI: 10.1016/S0165-0114(98)00271-1.

[8] R. T. Ngan, M. Ali and L. H. Son, δ-equality of intuitionistic fuzzy sets: A new proximity measure and applications in medical diagnosis, *Applied Intelligence* **48**(2) (2018), 499 – 525, DOI: 10.1007/s10489-017-0986-0.

[9] H. Nguyen, A generalized p-norm knowledge-based score function for an interval-valued intuitionistic fuzzy set in decision making, *IEEE Transactions on Fuzzy Systems* **28**(3) (2020), 409 – 423, DOI: 10.1109/TFUZZ.2019.2907068.

[10] D. R. Oktaviani, M. Habiburrohman and F. S. Nugroho, Alternative proof of the infinitude primes and prime properties, *BAREKENG: Journal of Mathematics and Its Applications* **17**(1) (2023), 0475 – 0480, DOI: 10.30598/barekengvol17iss1pp0475-0480.

[11] D. R. Oktaviani, M. Habiburrohman and I. K. Amalina, Application of intuitionistic fuzzy sets in determining the major in senior high school, *Desimal: Jurnal Matematika* **5**(3) (2022), 247 – 254, URL: https://core.ac.uk/download/590358306.pdf.

[12] S. Sutrisno, F. Hariyanti and R. Sulaiman, Application of intuitionistic fuzzy sets in determining research topics for mathematics education students through the normalized euclidean distance method, *BAREKENG: Journal of Mathematics and Its Applications* **17**(2) (2023), 0995 – 1006, DOI: 10.30598/barekengvol17iss2pp0995-1006.

[13] E. Szmidt and J. Kacprzyk, Distances between intuitionistic fuzzy sets and their applications in reasoning, in: *Computational Intelligence for Modelling and Prediction*, Studies in Computational Intelligence serues, Vol. 2, S. K. Halgamuge and L. Wang (editors), Springer Berlin Heidelberg, Berlin – Heidelberg, (2005), pp. 101 – 116, DOI: 10.1007/10966518_8.

[14] C. U. Wardani, S. Abusini and I. Darti, Synergizing IFTOPSIS and DEA for enhanced efficiency analysis in inpatient units, *Jurnal Optimasi Sistem Industri* **22**(2) (2023), 165 – 178, DOI: 10.25077/josi.v22.n2.p165-178.2023.