WASPAS Method for Healthcare Systems based on Intuitionistic Fuzzy Information

Abrar Hussain[1]; Saba Majeed[1]; Muhammad Shoaib[1]; Hammas Ali[1]; Kifayat Ullah[1]

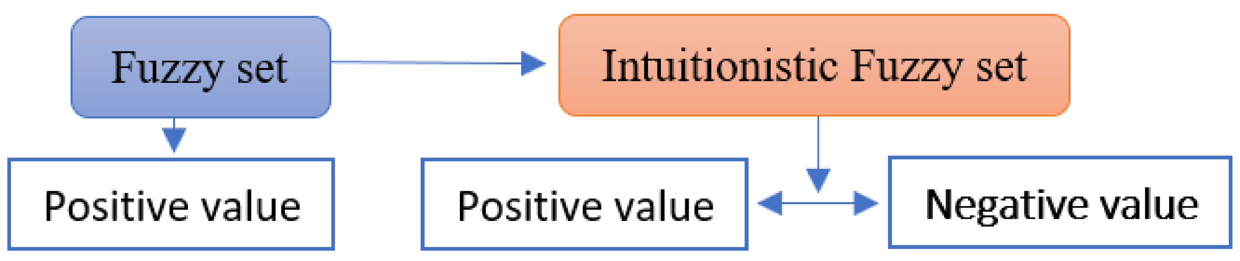
E-mail: abrar353eb@gmail.com, kifayat.khan.dr@gmail.com

[1]Department of Mathematics, Riphah International University (Lahore Campus), 54000, Lahore, Pakistan

RIPHAH INTERNATIONAL UNIVERSITY
DEPARTMENT OF MATHEMATICS

Abstract

An intuitionistic fuzzy set is a potent approach used to eliminate the effects of insufficient and vague type information on human opinion with two aspects of positive and negative values of an object. This presentation proposed an advanced optimization technique of the WASPAS method for the multi-criteria decision-making problem. We investigate artificial intelligence (AI) coordination in the healthcare system through numerical examples.



Literature Review and Methodologies

In 1965, Zadeh [1] established a novel approach to fuzzy sets (FS) by exploring the concepts of classical set theory. We know that human thinking is not unidirectional. Therefore, Atanassov [2] gave an innovative theory of intuitionistic fuzzy sets (IFSs). Many research scholars apply it to resolve various real-life applications.

Definition 1: [2] Consider $\hat{W}$ be a non-empty set and an IFS A on $\hat{W}$ is given by:

$$A = \{\zeta, (\alpha(\zeta), \beta(\zeta)) | \zeta \in \hat{W}\}$$

Where $\alpha: \hat{W} \to [0,1]$ and $\beta: \hat{W} \to [0,1]$ represent the positive value and negative value of ζ in A, respectively. The mathematical shape of an IFS is expressed as $0 \leq \alpha(\zeta) + \beta(\zeta) \leq 1$ for all $\zeta \in \hat{W}$. The hesitancy value of an IFS is given by $r(\zeta) = 1 - (\alpha(\zeta) + \beta(\zeta))$. The pair $\mathcal{F} = (\alpha(\zeta), \beta(\zeta))$ is known as an intuitionistic fuzzy value (IFV).

Basic operations of Sugeno-Weber t-norm and t-conorm are also formulated based on intuitionistic fuzzy information.

$$\mathcal{F}_1 \oplus \mathcal{F}_2 = \begin{pmatrix} \alpha_1(\zeta) + \alpha_2(\zeta) - \frac{\Psi}{1+\Psi}\alpha_1(\zeta).\alpha_2(\zeta), \\ \frac{\beta_1(\zeta) + \beta_2(\zeta) - 1 + \Psi\beta_1(\zeta).\beta_2(\zeta)}{1+\Psi} \end{pmatrix} \quad \Delta\mathcal{F} = \begin{pmatrix} \frac{1+\Psi}{\Psi}\left(1 - \left(1 - \alpha(\zeta)\left(\frac{\Psi}{1+\Psi}\right)\right)^{\Delta}\right), \\ \left((1+\Psi)\left(\frac{\Psi\beta(\zeta)+1}{1+\Psi}\right)^{\Delta} - 1\right)\frac{1}{\Psi} \end{pmatrix}$$

$$\mathcal{F}_1 \otimes \mathcal{F}_2 = \begin{pmatrix} \frac{\alpha_1(\zeta) + \alpha_2(\zeta) - 1 + \Psi\alpha_1(\zeta).\alpha_2(\zeta)}{1+\Psi}, \\ \beta_1(\zeta) + \beta_2(\zeta) - \frac{\Psi}{1+\Psi}\beta_1(\zeta).\beta_2(\zeta) \end{pmatrix} \quad \mathcal{F}^{\Delta} = \begin{pmatrix} \frac{1}{\Psi}\left((1+\Psi)\left(\frac{\Psi\alpha(\zeta)+1}{1+\Psi}\right)^{\Delta} - 1\right), \\ \frac{1+\Psi}{\Psi}\left(1 - \left(1 - \beta(\zeta)\left(\frac{\Psi}{1+\Psi}\right)\right)^{\Delta}\right) \end{pmatrix}$$

Definition 2: Let a collection of IFVs $\mathcal{F}_j = (\alpha_j(\zeta), \beta_j(\zeta)), j = 1, 2, \ldots, n$ with $\Psi > 0$. The intuitionistic fuzzy Sugeno-Weber weighted average (IFSWWA) and intuitionistic fuzzy Sugeno-Weber weighted geometric (IFSWWG) operators are expressed as follows:

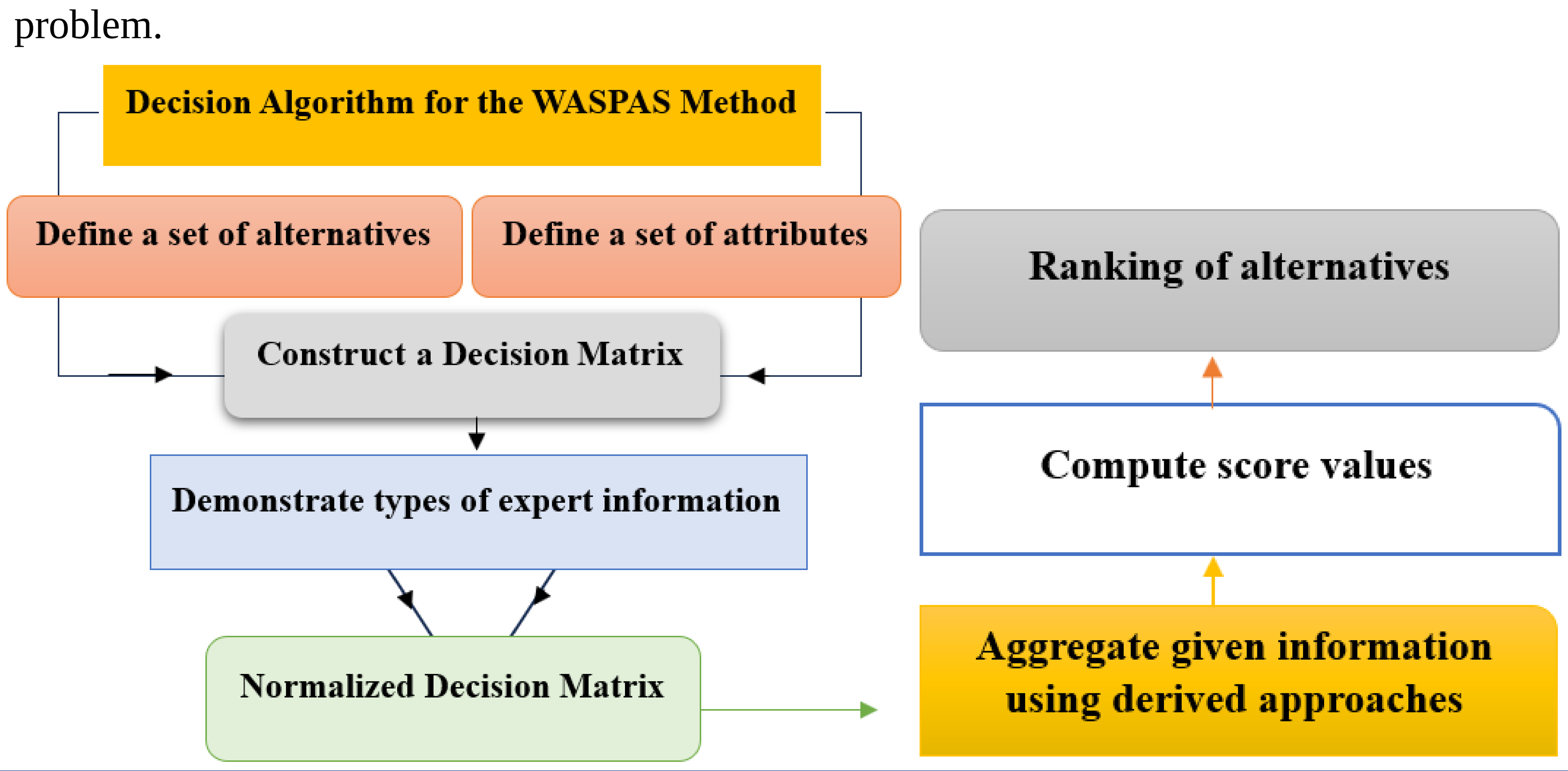
$$IFSWWA(\mathcal{F}_1, \mathcal{F}_2, \ldots, \mathcal{F}_n) = \bigoplus_{j=1}^{n} \omega_j \mathcal{F}_j = \begin{pmatrix} \frac{1+\Psi}{\Psi}\left(1 - \prod_{j=1}^{n}\left(1 - \alpha_j(\zeta)\left(\frac{\Psi}{1+\Psi}\right)\right)^{\omega_j}\right), \\ \frac{1}{\Psi}\left(\left(\frac{1}{+\Psi}\right)\prod_{j=1}^{n}\left(\frac{\Psi\beta_j(\zeta)+1}{1+\Psi}\right)^{\omega_j} - 1\right) \end{pmatrix}$$

$$IFSWWG(\mathcal{F}_1, \mathcal{F}_2, \ldots, \mathcal{F}_n) = \bigotimes_{j=1}^{n} \mathcal{F}_j^{\omega_j} = \begin{pmatrix} \frac{1}{\Psi}\left((1+\Psi)\prod_{j=1}^{n}\left(\frac{\Psi\alpha_j(\zeta)+1}{1+\Psi}\right)^{\omega_j} - 1\right), \\ \frac{1+\Psi}{\Psi}\left(1 - \prod_{j=1}^{n}\left(1 - \beta_j(\zeta)\left(\frac{\Psi}{1+\Psi}\right)\right)^{\omega_j}\right) \end{pmatrix}$$

Where $(\omega_1, \omega_2, \ldots, \omega_n)$ be the set of weight vector of $\mathcal{F}_j$ such as $\omega_j > 0$ and $\sum_{j=1}^{n} \omega_j = 1$.

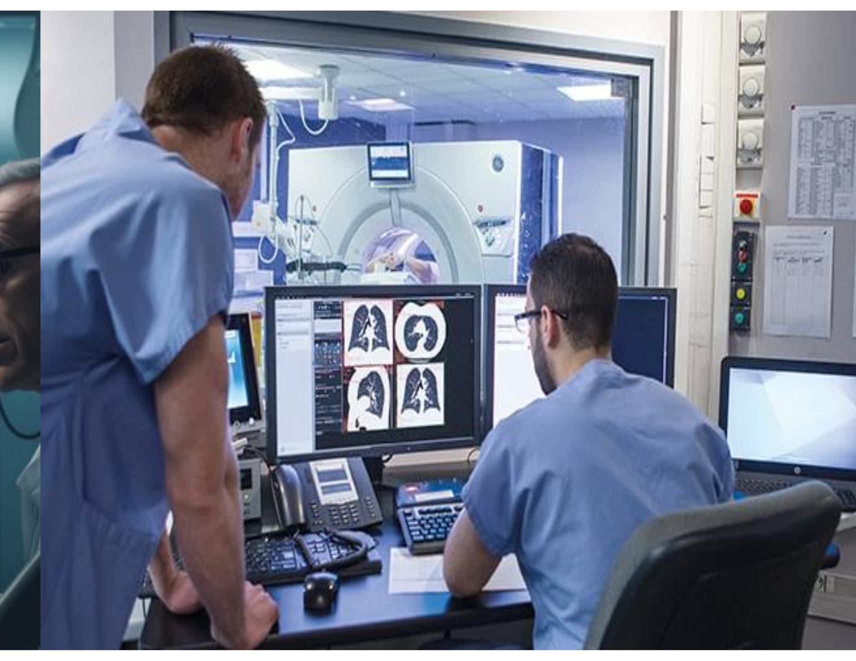
Decision Algorithm for the WASPAS Method

A novel approach to the WASPAS method was given by Zavadskas et al. [3] in 2012.We illustrate different steps of an Algorithm for the WASPAS Method based on the MCDM problem.



Case Study

In the modern era, artificial intelligence plays a pivotal role in the healthcare system, including medical diagnosis, patient experience, robotic surgery and managing healthcare data. AI in healthcare is getting more sophisticated and efficient at supporting doctors and other medical professionals, as seen in the following Figures.



This numerical example evaluates information about hospitals having advanced technology for robotic surgery and medical diagnosis. We have four different alternatives and attributes are defined as follows: better patient care G_1, health monitoring and digital consultations G_2, ability to analyze data and improve diagnosis G_3 and managing medical records G_4. The aggregation process of attributes information under the following procedure.

Step 1: Arrange expert opinions about hospitals in the following decision matrix.

	G_1	G_2	G_3	G_4
δ_1	(0.21, 0.61)	(0.28, 0.58)	(0.47, 0.54)	(0.57, 0.35)
δ_2	(0.33, 0.28)	(0.19, 0.43)	(0.55, 0.26)	(0.19, 0.31)
δ_3	(0.17, 0.55)	(0.37, 0.26)	(0.45, 0.18)	(0.44, 0.28)
δ_4	(0.39, 0.42)	(0.21, 0.65)	(0.64, 0.22)	(0.39, 0.51)

Step 2: We computed a normalized decision matrix.

$$\begin{bmatrix} (0.0053, 0.0210) & (0.0074, 0.4603) & (0.2866, 0.4576) & (0.3631, 0.2734) \\ (0.0083, 0.0097) & (0.0050, 0.3413) & (0.3354, 0.2203) & (0.1210, 0.2422) \\ (0.0043, 0.0190) & (0.0097, 0.2063) & (0.2744, 0.1525) & (0.2803, 0.2188) \\ (0.0098, 0.0145) & (0.0055, 0.5159) & (0.3902, 0.1864) & (0.2484, 0.3984) \end{bmatrix}$$

Step 3: Utilized IFSWWA and IFSWWG approaches to investigate the value of WSA and WPA models.

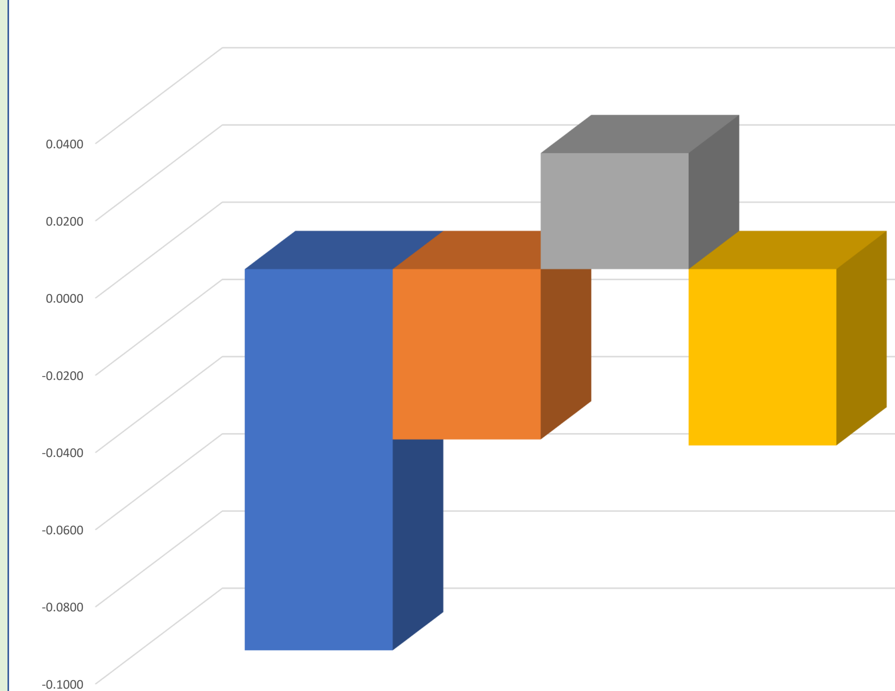
$$\delta_i^{WSA} = \{-0.0861, -0.0366, 0.0355, -0.0321\}$$

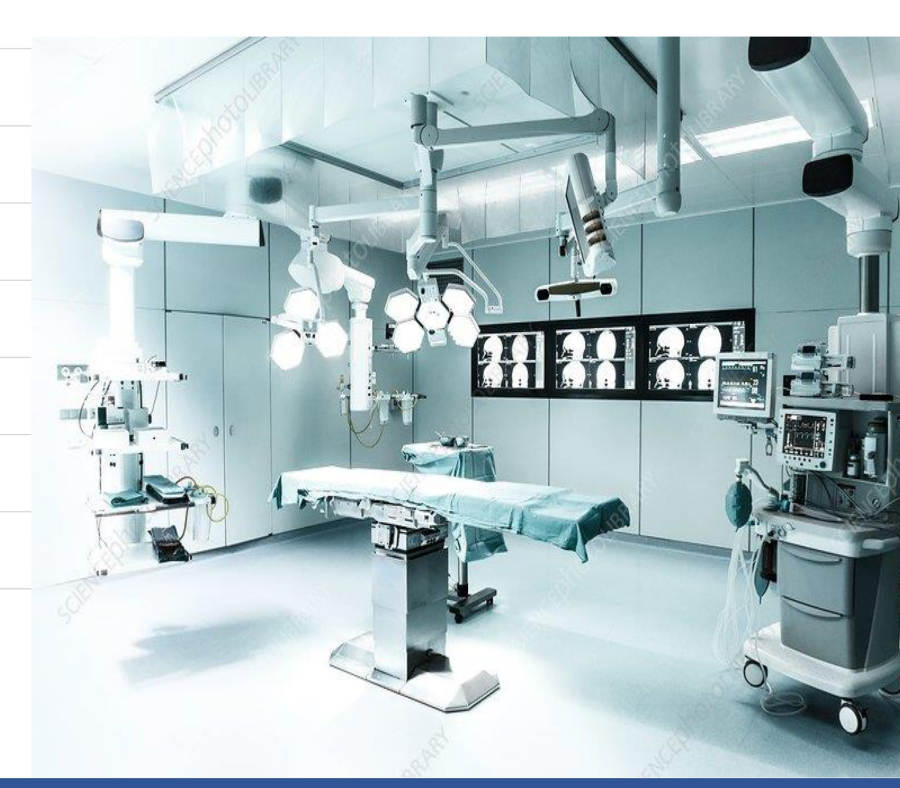
$$\delta_i^{WPA} = \{-0.1223, -0.0580, 0.0199, -0.0708\}$$

Step 4: Calculated final results using a convex formula of the WASPAS method $\delta_i = \tau\delta_i^{WSA} + (1-\tau)\delta_i^{WPA}$ at a fixed value of $\tau = 65$.

$$\delta_1 = -0.0988, \delta_2 = -0.0441, \delta_3 = 0.0300, \delta_4 = -0.0457$$

Step 5: The following figure shows the ranking of alternatives based on computed results.





Ranking of alternatives is $\delta_3 \succ \delta_2 \succ \delta_4 \succ \delta_1$

Conclusion

This presentation proposed some robust mathematical approaches to the Sugeno-Weber operators in the light of intuitionistic fuzzy information. We studied a novel approach of advanced optimization technique of the WASPAS method for multi-criteria decision-making problems. With the help of numerical examples and diagnosed theories, we evaluated a hospital with advanced artificial intelligence technology for robotic surgery and medical diagnosis.

References

1. L. A. Zadeh, "Fuzzy sets," *Inf. Control*, vol. 8, no. 3, pp. 338–353, 1965.
2. K. T. Atanassov, "Intuitionistic fuzzy sets," *Fuzzy Sets Syst.*, vol. 20, no. 1, pp. 87–96, Aug. 1986, doi: 10.1016/S0165-0114(86)80034-3.
3. E. K. Zavadskas, Z. Turskis, J. Antucheviciene, and A. Zakarevicius, "Optimization of Weighted Aggregated Sum Product Assessment," *Elektron. Ir Elektrotechnika*, vol. 122, no. 6, Art. no. 6, Jun. 2012, doi: 10.5755/j01.eee.122.6.1810.