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The Prognosis of Allergy-Based Diseases Using Pythagorean Fuzzy Hypersoft Mapping Structures and Recommending Medication

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ABSTRACT The Pythagorean fuzzy set (PFS), which Yager extended, is a novel tool for dealing with ambiguity when considering membership (MS) grade p and non-membership (NMS) q that fulfil the criteria $p^2 + q^2 \leq 1$ allowing the structure to characterise fuzziness more thoroughly and precisely than intuitionistic fuzzy sets. The Pythagorean Fuzzy Hypersoft (PFHS) set theory is a useful method for dealing with abnormalities and uncomfortable information in real-life situations. The Pythagorean fuzzy set and the Hypersoft set, which comprise the truthfulness grade (TG) and falsehood grade (FG) in the Pythagorean environment, are combined in the PFHS principle. This study tries to define the arguments around allergy diagnosis and the effects that arise with it. After considering the dire outcomes of Allergies, it becomes challenging to distinguish between the various types of Allergies and their complexity. Because the false portions of practical assessments are usually ignored, precision in the person's developmental history is difficult to recognize, and number of sessions cannot be projected. This work presents the PFHS set and PFHS mapping with its inverse mapping (INM) to alleviate these constraints. These notions are capable and necessary for correctly analyzing the problem by combining it with scientific modelling. This study establishes a link between symptoms and medications, lowering the narrative's complexity. For the various types of allergies, a table based on a fuzzy interval between $[0, 1]$ is created. The techniques that are based on PFHS-mapping, which is used to effectively identify a problem then choose the right treatment for each patient's condition.

INDEX TERMS Allergy, Pythagorean fuzzy hypersoft, mapping, inverse mapping.

I. INTRODUCTION

Over the last decade, a dramatic increase has been observed in allergic diseases in industrialized countries. An estimated of 30 percent of the population of these countries are affected by allergic diseases leading to a high economic burden of diseases. An allergic reaction causes the immune system of a human body to react to generally harmless substances like pollen, medication, food, or animal dander. Most allergic reactions affect the skin, respiratory system, eyes, and gastrointestinal tract but an allergic reaction can be observed in any organ of the human body. The symptoms of the allergic

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reaction are based upon the organs that are affected and the type of allergen. The symptoms may include vomiting, wheezing, nasal congestion, pruritus, cough, and dyspnea. A potentially fatal severe allergic reaction or anaphylaxis causes cardiovascular changes that lead to hypotension that may result in tachycardia [1].

Because of the expanding intricacy of the framework, it is hard for the leader to choose the best other option/object from a family of appealing choices. Be that as it may, it is difficult, to sum up, yet it is not staggering to accomplish the best single objective. Countless Multiple Criteria Decision Making (MCDM) issues exist in decision-making, where the rules are found to be dubious, equivocal, loose, and obscure. Therefore, the fresh set gives off an impression of being

inadequate in managing this vulnerability and imprecision in the information and can be handily managed by utilizing fuzzy data.

This shortcoming and ambiguity was addressed by Zadeh [15] with the introduction of the concept of Fuzzy Set. He introduced the concept of MS function that provided a MS value between 0-1 to each of the objectives. Atanssov [16] introduced the notion of Intuitionistic Fuzzy Set (IFS), that was utilized to connect each element in the universal set may or may not correspond with both MS and NMS functions where the sum of the two is 1 or less than 1. This allowed the explanation of the concepts in a more accurate and precise manner in comparison to Fuzzy Set. In some cases that correspond to real life situations, the sum of degrees of MS and NMS meeting and expert's criteria may be greater than 1, and their sum of their squares is less than or equal to 1. This situation can't be addressed by using IFS. A concept named after the great philosopher, thinker, mathematician Pythagoras was introduced by Yager [17] called Pythagorean fuzzy set. Yager elaborated a situation where one conveys his choice for an alternative y_j in a set of criteria D_i , where the degree of alternative y_j fulfils the requirements D_i as 0.6 and the ideal solution y_j which does not fulfils the requirements the requirement D_i as 0.5. This situation can't be clearly explained by IFS as $0.6 + 0.5 \geq 1$, but PFS can be employed to explain this situation as $(0.6)^2 + (0.5)^2 \leq 1$. One thing to be noted that all IFS must also be PFS but not all PFS are IFS. From this perspective, the PFS may be able to represent some decision-making scenarios that the IFS cannot. As a result, the PFS is seen to be a better model for dealing with complex decision-making difficulties.

Due to its large scope of description instances, Pythagorean fuzzy set has grabbed the attention of many researchers in a brief span of time. The scope of fuzzy concepts is taken to new heights using this concept as PFS has numerous real-life applications as this set introduced a new realm to deal with ambiguity. A deep revision of the specialized literature shows the rapid growth and serviceability of Pythagorean fuzzy set, which has been expanded to diverse point of visual angle, quantitative [17] and qualitative [18]. After their successful utilization, certain scholars have employed it in the natural environment of separated areas. For example, Garg [19] explored interval-valued PFS and their applications, Ayyildiz and Gumus [20] utilized the AHP method based on interval-valued PFS, Ejegwa *et al.* [21] implemented the correlation measures by using the PFS, Zhao *et al.* [22] explored TODIM method for interval-valued PFS, Gao *et al.* [23] developed the quantum Pythagorean fuzzy evidence theory, Pan *et al.* [24] proposed similarity measures for PFS, Zulqarnain *et al.* [25] initiated the TOPSIS method for Pythagorean fuzzy hyper-soft sets, Rani *et al.* [26] developed the weighted discrimination based approximation approach by using the PFS, Calik [27] initiated the AHP and TOPSIS method for PFS and discussed their application in green supplier chain management, Chen [28] developed the likelihood-based optimization based

on PFS. The proposition of neutrosophic soft expert set was put forward by Broumi *et al.* [60] which allowed the explanation of images and inverse images of neutrosophic soft expert frames.

Molodtsov [35] effectively applied soft set (SS) theory to a multitude of settings, including efficiency of function, Riemann integrate, Peran integration, Statistical analysis, Measurements, and so on. For the fragmentary information technology. Yang *et al.* [47] underlined the preferences of S-sets in developing expanded application. The concept of fuzzy SS with different aspects were introduced by Maji *et al.* [34]. They offered it as an appealing extension of S-sets, with extra properties such as uncertainty and vagueness at the highest level of incompleteness. Current research has demonstrated how to integrate the two approaches towards a more flexibility, highly framework for modelling and enhancing foggy data in the information system [33], [34], [36]. The concept of SS is applied to tackle a lot of issues in [37], [39], [41]–[44], [48]. Zulqarnain *et al.* [72] executed fundamental operations with their appropriate details under the PFHS set. In it, they defined logical operators and introduced the concept of requirement and possibility operations in the context of PFHS set.

The soft class and its similar approaches were given by Karaaslan in [32]. He was able to effectively apply it in decision-making. In 2009 and 2011, Athar *et al.* [29], [30] introduced the concepts of mappings in both structure fuzzy soft and soft classes respectively. The notion of a mapping on classes was introduced by Alkhezaleh *et al.* [49], inside which neutrosophic soft classes are assemblages of neutrosophic soft sets. The technique of mappings on multi-aspect fuzzy soft classes was developed by Sulaiman *et al.* [51]. Maruah [50] described some features of intuitionistic fuzzy soft images and inverse images have been used to identify the syntax of mapping on intuitionistic fuzzy soft classes.

In 2016, Borah and Hazarika [52] developed the composite mappings among hesitant fuzzy soft classes and analyzed some of their intriguing features.

In 2018, Samarandache [31] proposed the hyper-soft set (HSS) paradigm as an extension of soft set. Saeed *et al.* [39], [40], [43], [44], [48], [61], [62], [73], [77]–[79] discussed the fundamental of the Hypersoft set and their complete mappings in a hypersoft set environment, as well as their presentation of the Hypersoft set in object classification, cell imaging, and multi eligibility requirements. One patient has glycaemic control Osgouie and Azizi [63] has been used to deploy fuzzy based significant nonlinear model predictive control (DMRAC) for insulin pens regulation. Saeed *et al.* [74]–[76] presented the wide applications of hypersoft mappings in medical diagnosis of different diseases like brain tumor, Hepatitis, HIV and proposed their appropriate treatment with future prediction. Azizi and Seifipour [64] employed human brains to recreate the reshaping portion of the dermatological tissue regeneration operation. Wang *et al.* [65] presented the Pythagorean fuzzy interaction Hamacher powered membership functions

for measuring expressed service quality with unpredictability factor. Liu et al. [66] discovered the relationship amongst uncertain fuzzy sets and their use in diagnosis of diseases. Molla et al. [67] investigated the Pythagorean fuzzy set theory and how it would be implemented in diagnosis of diseases. Khan et al. [68], [69] for generating a spherical fuzzy rule that they deployed for Decision making problems and precision medicine.

A. MOTIVATION

The study contributes to the scientific society as it helps to visualize a real world clinical diagnostic problem and treating because it is hard to differentiate the concise type of allergy from its severity using previous theoretical perspectives such as [29], [30], [70], and [59] because these methodologies are limited to effective measures. With the division of parameters in various sub-parametric values, the approaches described in [29], [30] and [70] are fall short analyze the information to its fullest extent for extraction of concise results and proposition of correct treatment. They can also only examine the truthness (MS) of things, not their falsehood (NMS). Although the model given in [59] assesses input in a multipolar manner, it still falls short when there are subparametric values of a parameter. To address this problem, we standardized these structures as a hybrid of a hypersoft set that has the ability to deal with sub-parametric values in a better manner as compared to convention methodologies. A hypersoft set also has the ability to arrange information for its easy evaluation and analysis. Another hybrid structure introduced in this model related to PFS which can deal with ambiguity when considering MS grade p and NMS q that fulfil the criteria $p^2 + q^2 \leq 1$ and distributes the data into two possible positive and negative dimensions with respect to the patient’s condition and parametric values. One thing to be noted is that the dimensions are independent of one another. Mapping corresponds to the development of a connection between multiple domains regulated by a set of restrictions that transfers an embedded parameters to its facilitate understanding parameterized element predicated on the key and structural resemblances enabling one to analyze parameters of comparable type in a single related parameter. This methodology’s intention is to establish the assessment of Allergy and the indicators that characterize it. After looking into various Allergy side effects, we noticed that these Allergy viruses encapsulate similar symptoms, making it difficult to distinguish between them. The element about falsehood is commonly overlooked in clinical diagnosis. As a result of this problem, a great difficulty is observed for the medication process due to a doubtful diagnosis when proposed by the aid of patient’s history. These obstacles are overcome by the introduction of PFHS along with its mapping and INM. This allows for a better examination of the patient’s condition with the analysis of the patient’s symptoms with the help of PFHS mapping. These concepts are feasible and necessary for correctly analyzing the problem by combining it with scientific modelling. The intended study’s mul-

tifaceted aspect is diminished by this inquiry, which establishes a link between symptoms and medications. To begin this process, a table that highlights all types of allergies is created by using a fuzzy interval [0, 1]. This allows for a selection method for the possible disease and the selection of optimum treatment method of said disease. A computation based on PFHS mapping was built up for this process. Lastly, the generalised PFHS-mapping is provided to anticipate the patient’s condition over time, and if the given medicine has adverse impact on the patient, the INM is characterized to maintain the previous position and it facilitates a physician to enhanced the patient’s improvement till the disease is released. The following is how the content of the study is structured. Section 2 re-imagines certain basic concepts like as fuzzy set (FS), SS, Intuitionistic fuzzy set, PFS, HS set and PFHS set. Section 3 covers mapping on PFHS classes, as well as the PFHS image, PFHS inverse image. Chapter 4 provides a clinical implementation and comparative evaluation to expound on the proposed scheme’s dependability. The last findings are presented in the final portion.

II. PRELIMINARIES

Certain rudimentary definitions over T are provided in this part. Consider $\varpi_1 \times \varpi_2 \times \varpi_3 \times \dots \times \varpi_n = K, \varpi'_1 \times \varpi'_2 \times \varpi'_3 \times \dots \times \varpi'_n = P, \eta_1 \times \eta_2 \times \eta_3 \times \dots \times \eta_n = Y, \eta'_1 \times \eta'_2 \times \eta'_3 \times \dots \times \eta'_n = \mathcal{P}, \Lambda_1 \times \Lambda_2 \times \Lambda_3 \times \dots \times \Lambda_n = \Lambda, \mathcal{L}_1 \times \mathcal{L}_2 \times \mathcal{L}_3 \times \dots \times \mathcal{L}_n = \mathcal{L}, (\lambda_1, \lambda_2, \lambda_3, \dots, \lambda_n) = \lambda$ and $(\varrho_1, \varrho_2, \varrho_3, \dots, \varrho_n) = \varrho$.

Definition 1 [15]: The FS, $W = \{(c, D(c)) \mid c \in T\}$ such that

$$D : T \rightarrow [0, 1],$$

where T denotes a set of individuals and $D(c)$ indicates the proportion of c members in T .

Definition 2 [35]: SS is a pair (D, H) over T , where D is a function given as

$$D : H \rightarrow P(T),$$

To put it another way, an SS is a parametric collection of universe T subsets. $D(\delta)$ depicted the set of δ approximation components of the SS (D, H) for $\delta \in H$.

Definition 3 [54]: Suppose T be a universe of discourse. An Intuitionistic fuzzy set P in T is given by $P = \{ \langle c, \mu_P(c), \gamma_P(c) \rangle \mid c \in T \}$, where $\mu_P : T \rightarrow [0, 1]$ denotes the MS and $\gamma_P : T \rightarrow [0, 1]$ denotes the NMS for $c \in T$ with the restriction $0 \leq (\mu_P(c) + (\gamma_P(c))) \leq 1$.

Definition 4 [71]: Let T be a universe of discourse. A PFS P in T is given by $P = \{ \langle c, \mu_P(c), \gamma_P(c) \rangle \mid c \in T \}$, where $\mu_P : T \rightarrow [0, 1]$ denotes the MS and $\gamma_P : T \rightarrow [0, 1]$ NMS for $c \in T$ with restriction $0 \leq (\mu_P^2(c) + (\gamma_P^2(c))) \leq 1$ and the indeterminacy $\pi_P(c) = \sqrt{1 - (\mu_P^2(c)) - (\gamma_P^2(c))}$. The following Fig 1 depicted the difference between Pythagorean fuzzy number and Intuitionistic fuzzy number.

Definition 5 [31]: Let $b_1, b_2, b_3, \dots, b_n$ be different attributes with attribute values that adhere to the sets

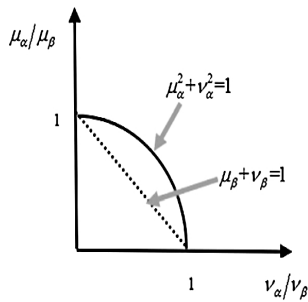


FIGURE 1. Difference between Pythagorean fuzzy number and Intuitionistic fuzzy number.

$\eta_1, \eta_2, \eta_3, \dots, \eta_n$ respectively, where $\eta_i \wedge \eta_j = \emptyset$, for $i \neq j$. HS set is a pair (ψ, Y) over T , where ψ is the function from Y to $P(T)$. For more definition see, [38], [40], [45], [46].

Definition 6 [72]: Let T be a universe of discourse, let $\partial_1, \partial_2, \partial_3, \dots, \partial_n$ be separate attributes with sub-values that pertain to the sets $\eta_1, \eta_2, \eta_3, \dots, \eta_n$ respectively, where $\eta_i \wedge \eta_j = \emptyset$, for $i \neq j$. A PFHS $(G, \eta_1 \times \eta_2 \times \eta_3 \times \dots \times \eta_n)$ is given by $(G, \eta_1 \times \eta_2 \times \eta_3 \times \dots \times \eta_n) = \{ \langle c, G(c) \rangle \mid c \in Y, G(c) \in PFS \}$, where $G(c) = \{ t, \mu_P(c)(t), \gamma_P(c)(t) \mid t \in T \}$, where $\mu_P : Y \rightarrow [0, 1]$ denotes the degree of MS and $\gamma_P : Y \rightarrow [0, 1]$ denotes the degree of NMS with the condition that $0 \leq (\mu_P^2(c)) + (\gamma_P^2(c)) \leq 1$. The degree of indeterminacy $\pi_P(c)(t) = \sqrt{1 - (\mu_P^2(c)(t)) - (\gamma_P^2(c)(t))}$.

III. PFHS MAPPINGS

This part developed the notion of mapping on PFHS classes. PFHS sets are assembled in PFHS classes. In addition, PFHS images, as well as PFHS inverse images, are discussed.

Definition 7 [25]: Assume T be universe of discourse, let $\partial_1, \partial_2, \partial_3, \dots, \partial_n$ be separate attributes with its sub-values that pertain to the sets $\eta_1, \eta_2, \eta_3, \dots, \eta_n$ respectively, where $\eta_i \wedge \eta_j = \Phi$, where i and j are disjoint sets, assume $\Upsilon = \{ \varpi_i \mid i = 1, 2, \dots, n \}$ be assembling of selection board. The PFHS set's indexed class is provided by $\sigma_{\varpi_i} = \{ \langle c, \mu_{\sigma_{\varpi_i}}(c), \gamma_{\sigma_{\varpi_i}}(c) \rangle \mid c \in Y \}$, where $\mu_{\sigma_{\varpi_i}} : Y \rightarrow [0, 1]$ denotes the degree of MS and $\gamma_{\sigma_{\varpi_i}} : Y \rightarrow [0, 1]$ denotes the degree of NMS of the element $c \in Y$ to the set P , respectively, with the condition that $0 \leq (\mu_{\sigma_{\varpi_i}}^2(c)) + (\gamma_{\sigma_{\varpi_i}}^2(c)) \leq 1$ is referred to as the PFHS class, and it may be represented by the symbol σ_Υ . If, for $\varpi_i \in \Upsilon, \sigma_{\varpi_i} = \Phi$, the PFHS set $\sigma_{\varpi_i} \notin \sigma_\Upsilon$.

Example 1: Let $\mathcal{V} = \{ a = \text{FCEV}, b = \text{BEV}, c = \text{HEV} \}$ be electric vehicles of various sorts are regarded as a discourse universe. Let $\partial_1 = \text{effectiveness}, \partial_2 = \text{size}, \partial_3 = \text{colour}$, separate attributes with sub-values that are part of the sets η_1, η_2, η_3 . Let $\eta_1 = \{ j_1 = \text{Good}, j_2 = \text{Very Good} \}, \eta_2 = \{ j_3 = \text{medium}, j_4 = \text{small} \}, \eta_3 = \{ j_5 = \text{brown} \}$ and let $\Upsilon = \{ \varpi_1, \varpi_1, \varpi_1 \}$ be a set of decision makers. If we consider PFHS sets $\sigma_{\varpi_1}, \sigma_{\varpi_2}, \sigma_{\varpi_3}$ given as

$$\begin{aligned} \sigma_{\varpi_1}(j_1, j_3, j_5) &= \{ a(0.8, 0.5), b(0.1, 0.7), c(0.8, 0.1) \}, \\ \sigma_{\varpi_2}(j_1, j_4, j_5) &= \{ a(0.6, 0.4), b(0.3, 0.8), c(0.2, 0.3) \}, \end{aligned}$$

$$\begin{aligned} \sigma_{\varpi_3}(j_2, j_3, j_5) &= \{ a(0.2, 0.7), b(0.4, 0.8), c(0.3, 0.2) \}, \\ \sigma_{\varpi_3}(j_2, j_4, j_5) &= \{ a(0.9, 0.2), b(0.8, 0.2), c(0.2, 0.2) \}, \end{aligned}$$

then $\sigma_\Upsilon = \{ \sigma_{\varpi_1}, \sigma_{\varpi_2}, \sigma_{\varpi_3} \}$ is a PFHS class. Now let

$$\begin{aligned} g_{\varpi_1}(j_1, j_3, j_5) &= \{ a(0.4, 0.5), b(0.1, 0.7), c(0.7, 0.6) \}, \\ g_{\varpi_1}(j_1, j_4, j_5) &= \{ a(0.5, 0.8), b(0.2, 0.5), c(0.4, 0.2) \}, \\ g_{\varpi_1}(j_2, j_3, j_5) &= \{ a(0.4, 0.8), b(0.2, 0.5), c(0.7, 0.4) \}, \\ g_{\varpi_1}(j_2, j_4, j_5) &= \{ a(0.6, 0.6), b(0.1, 0.3), c(0.7, 0.7) \}, \end{aligned}$$

is also PFHS class. PFHS classes can thus be expressed as $\{ \sigma_{\varpi_1}, \sigma_{\varpi_2}, \sigma_{\varpi_3} \}, \{ g_{\varpi_1}, g_{\varpi_2}, g_{\varpi_3} \}$.

Definition 8: Suppose (\mathcal{V}, Y) and $(\mathcal{N}, \mathcal{P})$ be two classes of PFHS sets over \mathcal{V} and \mathcal{N} respectively. Assume $\theta : \mathcal{V} \rightarrow \mathcal{J}$ and $\varphi : Y \rightarrow \mathcal{N}$ be the two sub mappings. Then the whole mapping is characterized in such manner; $\sigma = (\theta, \varphi) : (\mathcal{V}, Y) \rightarrow (\mathcal{N}, \mathcal{P})$, for PFHS set (ρ, Λ) in (\mathcal{V}, Y) and $\sigma(\rho, \Lambda)$ is PFHS set contained in $(\mathcal{N}, \mathcal{P})$ achieved in this technique, For $\varrho \in \varphi(Y) \subseteq \mathcal{J}$ and $c \in \mathcal{N}$, then

$$\begin{aligned} \sigma(\rho, \Lambda)(\varrho)(c) &= \begin{cases} \bigsqcup_{x \in \theta^{-1}(c)} \left(\bigsqcup_{\lambda \in \varphi^{-1}(\varrho) \wedge \Lambda} \rho(\lambda) \right)(x), & \text{if } \theta^{-1}(c) \neq \emptyset, \\ & \varphi^{-1}(\varrho) \wedge \Lambda \neq \emptyset \\ (0, 0) & \text{if otherwise} \end{cases} \end{aligned} \tag{1}$$

$\sigma(\rho, \Lambda)$ is called a PFHS image of PFHS set (ρ, Λ) .

Definition 9: Suppose (\mathcal{V}, Y) and $(\mathcal{N}, \mathcal{P})$ be classes of PFHS sets over \mathcal{V} and \mathcal{N} respectively. Suppose $\theta : \mathcal{V} \rightarrow \mathcal{J}$ and $\varphi : Y \rightarrow \mathcal{N}$ be mappings. Assume (χ, \mathcal{L}) be a PFHS set in $(\mathcal{N}, \mathcal{P})$, where $\mathcal{L} \subseteq \mathcal{P}$ then $\sigma^{-1}(\chi, \mathcal{L})$ is a PFHS set in (\mathcal{V}, Y) defined as,

$$\sigma^{-1}(\chi, \mathcal{L})(\lambda)(x) = \begin{cases} \chi(\varphi(\lambda)(\theta(x))) & \text{if } \varphi(\lambda) \in \mathcal{L} \\ (0, 0) & \text{if otherwise} \end{cases} \tag{2}$$

where $\lambda \in \varphi^{-1}(\mathcal{L}) \subset Y$, then $\sigma^{-1}(\chi, \mathcal{L})$ called to be the PFHS inverse image of PFHS set (χ, \mathcal{L}) .

Definition 10: Let $M_1 \in PFHS(\mathcal{V} \times \mathcal{P})$ and $M_2 \in PFHS(\mathcal{J} \times \mathcal{Q})$, then the composition of M_1 and M_2 can be as embodied by $M_1 \circ M_2$ and as indicated by $M_1 \circ M_2 = \{ (\mathcal{W}, \mathcal{W}'), T_{M_1 \circ M_2}(\mathcal{W}, \mathcal{W}'), I_{M_1 \circ M_2}(\mathcal{W}, \mathcal{W}'), F_{M_1 \circ M_2}(\mathcal{W}, \mathcal{W}') : \mathcal{W} \in \mathcal{V}, \mathcal{W}' \in \mathcal{Q} \}$, where $T_{M_1 \circ M_2}(\mathcal{W}, \mathcal{W}') = \max_{\mathcal{W}'' \in \mathcal{J}} (T_{M_1}(\mathcal{W}, \mathcal{W}'), T_{M_1}(\mathcal{W}', \mathcal{W}''))$, $F_{M_1 \circ M_2}(\mathcal{W}, \mathcal{W}') = \min_{\mathcal{W}'' \in \mathcal{J}} (F_{M_1}(\mathcal{W}, \mathcal{W}'), F_{M_1}(\mathcal{W}', \mathcal{W}''))$.

IV. IMPLEMENTATION OF THE PFHS MAPPING TO ALLERGY AND ADJACENT CHARACTERISTICS

For the analysis, 4 types of allergies are defined in this section, and their accompanying issues are assessed. By utilizing the tools based on PFHS set and its relevant mapping and INM concepts; the diagnostic process, and treatment of the patients can be addressed with great accuracy and precision. This section demonstrates how the recommended mathematical model can be used to design an allergy treatment plan.



FIGURE 2. Exanthematous rash. Source: <https://www.healthline.com/health/drug-rash-pictures>.



FIGURE 3. Drug-induced skin rash. Clinical view of drug-induced lesions on the skin on the back and arm of a 46-year-old man. Source: <https://www.sciencephoto.com/media/836852/view/drug-induced-skin-rash>.



FIGURE 4. Stuffed Up from Pollen Allergies. Source: <https://www.allergicliving.com/2012/05/02/all-stuffed-up-from-pollen-allergies>.



FIGURE 5. Artwork of pollen that causes hay fever. H E stain. Source: <https://www.gettyimages.com/detail/illustration/hay-fever-artwork-royalty-free-illustration/488635663>.

A. STUDY ON ALLERGIES AND ITS RELATED PROPERTIES

Research approach and numerical optimization are always useful for diagnosing. There are many other types of allergies in medicine, but only four are analyzed here.

- Drug Allergy
- Pollen Allergy
- Insect Allergy
- Latex Allergy

1) DRUG ALLERGY

Numerous people may present with adverse drug reactions when treated with a certain drug therapy for an ailment leading to issues unrelated to the ailment [3], [4]. These hold great significance as a cause of patient morbidity and mortality. It has also been observed that these allergic reactions make it impossible for an effective treatment process involving drug therapy. Serious cases of the above statement have also resulted in drug withdrawal [5]. The most commons affected by these drug allergies include the skin, liver, and the haemopoietic system. A high degree of patient selectivity is observed when it comes to the case of sever allergic reactions. It is impossible to develop drugs with zero idiosyncratic toxicity as most of the cases are detected in post-licensing stage of drug development [2]. For more detail see Fig. 2, 3.

2) POLLEN ALLERGY

Pollen Allergy, pollinosis, hay fever, and seasonal allergic rhinitis are common names for sensitization to pollen components. The relation between pollinosis and pollen was first confirmed 1873 by Charles Blackley when he confirmed the disease etiology by skin and provocation tests [6]. These allergens produce symptoms in the airway mucosa and the conjunctiva of sensitized individuals when come in contact. The family Poaceae of plants is the major cause of grass pollen allergies because of their significant pollen production ability and wide distribution around the globe [7]. For more detail, see Fig. 4, 5.

3) INSECT ALLERGY

Insect Allergy have increased over the years due to human population encroachment on insect habitat, climatic changes, and migration of various insect species [8]. Most allergic reactions are a result of stinging because it increases the systemic exposure to the insect antigens (venoms also include antigen proteins). Most insect bite (mosquito, ticks, midglets etc.) systemic reactions are localized to the point of biting but some bug or insect bites (caterpillar, scorpion) may lead to anaphylaxis [9]. For more detail, see Fig. 6, 7.

4) LATEX ALLERGY

Latex, due to its superior properties like strength, flexibility, durability, and barrier properties, more than 40,000 medical



FIGURE 6. Allergic reaction to an insect sting. Source: <https://www.healthline.com/health/insect-sting-allergy>.



FIGURE 9. Latex allergy. Source: <http://www.yogavanahill.com/diseases/latex-allergy>.



FIGURE 7. Pictures of skin rashes. Source: <https://www.pinterest.com/pin/363665738661069848>.



FIGURE 8. Latex allergy. Source: womenscorner.com.bd/en/health-tips-solution/article/262/what-is-latex-allergy.

consumer products are made from it [14]. Accurate figures are still unknown, but its estimated that about 1-2 of the population has natural rubber latex sensitivity [10]–[12]. A person who regularly wears latex gloves may be at risk of developing latex allergy [10]. The allergy is also associated with occupational allergy rhinitis, anaphylaxis, and urticaria [13]. For more detail, see Fig. 8, 9.

The patient is demonstrating several frequent allergy causes and symptoms. We have jotted down some of the symptoms that go along with these issues.

- sneezing and scratchy throat
- blockage or sticky nose
- eyes that are itching, inflamed, and watery
- coughing
- chest contraction

TABLE 1. Allergy diagnosis chart.

The Different Types of Allergies	Numerous ranges of [0, 1]
Drug Allergy	[0.6, 1]
Pollen Allergy	[0.42, 0.6)
Insect Allergy	(0.2, 0.4]
Latex Allergy	[0.1, 0.2]
No Allergy	[0, 0.1)

- Breathing difficulties
- a sore that is inflamed, painful, and reddish
- cheeks, tongue, eyes, or face swelled
- stomach ache, nausea, puking, or diarrhoea
- skin that is dry, red, and fractured

The technique that we will use for our scientific demonstration is discussed in the next section. We create an algorithm is based on PFHS-mapping to quantify the illness, give appropriate therapy, and monitor the progress of treatment scenes.

B. PROCEDURE

1) PRE STEP

Due to similar nature of symptoms, a doctor encounters some obstacles when assessing a patient with Allergy. The distinction between some of these classifications is hard to comprehend. It suggests that such problems occur involve ambiguities and vagueness, and that the PFHS is the right tool for the job. To convert verbal data into numerical language, we first construct the fuzzy interval [0, 1] for various types of Allergy. We plot a table to analyse a real kind of allergy for various types of allergies Table 1. Because each issue becomes much more entrenched as time passes. Each physician desires to keep track of at least 2-3 days of data before exposing the withdrawal symptoms for well finding in order to obtain the most providing a useful history of a patient. To investigate the Allergy, we generated several graphs of circumstances and their day-by-day fixation. This graph may be obtained in Table 2 or Figure 10. Fig. 10 shows a flow chart of the numerous targets allocated to these limitations.

TABLE 2. Recognise and their day-to-day obsession to examine Allergy.

situations	On the first day	Second day	Third day
serious Drug Allergy (SDA)	[0.72, 0.8)	[0.8, 1)	= 1
moderate Drug Allergy (MDA)	[0.75, 0.82)	[0.82, 0.87)	[0.87, 0.92)
low Drug Allergy (LDA)	[0.6, 0.65)	[0.65, 0.69)	[0.69, 0.74)
serious Pollen Allergy (SPA)	[0.421, 0.57)	[0.57, 0.58)	[0.58, 0.59)
moderate Pollen Allergy (MPA)	[0.551, 0.558)	[0.558, 0.559)	[0.559, 0.5596)
low Pollen Allergy (LPA)	[0.557, 0.559)	[0.59, 0.5597)	[0.5597, 0.5593)
serious Insect Allergy (SIA)	[0.2, 0.25)	[0.5, 0.3)	[0.3, 0.4)
moderate Insect Allergy (MIA)	[0.23, 0.25)	[0.5, 0.27)	[0.7, 0.4)
low Insect Allergy (LIA)	[0.22, 0.23)	[0.23, 0.235)	[0.235, 0.37)
serious Latex Allergy (SLA)	[0.1, 0.15)	[0.15, 0.17)	[0.17, 0.176)
moderate Latex Allergy (MLA)	[0.12, 0.13)	[0.13, 0.15)	[0.15, 0.157)
low Latex Allergy (LLA)	[0.123, 0.125)	[0.125, 0.129)	[0.129, 0.189)
No Allergy (NA)	[0.00, 0.01)	[0.01, 0.06)	[0.06, 0.08)

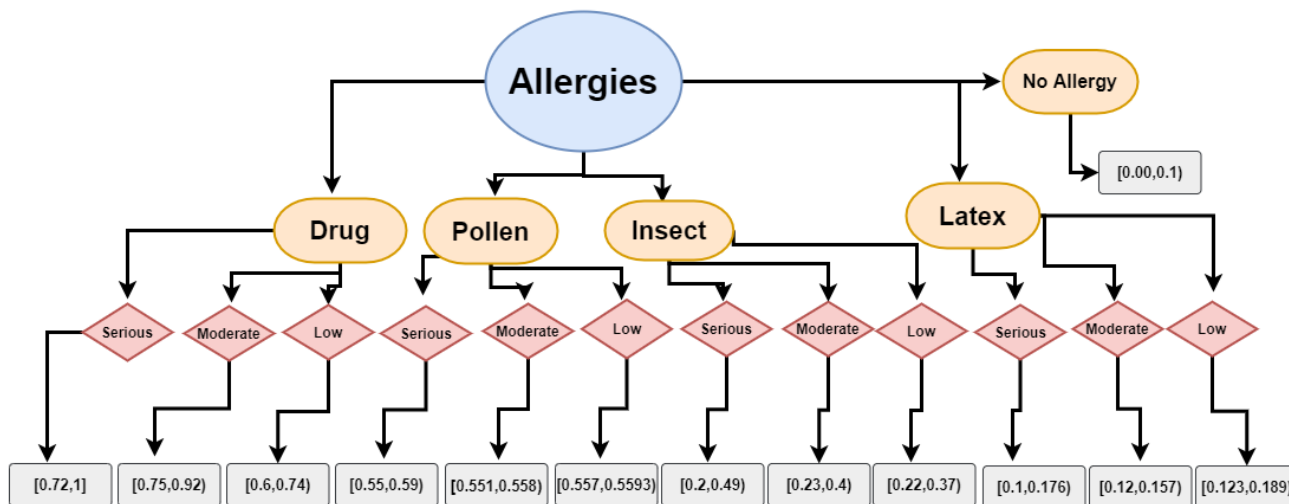


FIGURE 10. Flow diagram with various ranges as per the indicated allergy concerns.

2) ALGORITHM

Step 1: In order to distinguish the allergic ailment from other medical conditions, let $R = \{r_1, r_2, r_3, \dots, r_n\}$ be the individuals which are suspected to have Allergic symptoms and $A = \{w_1, w_2, w_3, \dots, w_v\}$ be the suspected symptoms whose corresponding sets are S_i 's, where $S = \prod_{i=1}^v S_i$. The PFHS set chart produced by the specialized following crucial appraisal at ε th places can be fitting up as follows:

$z_p^\varepsilon = \{z_p^\varepsilon = \{r, (T_p^\varepsilon(r), F_p^\varepsilon(r))\} : r \in R, p \in S\}$, where $T_p^\varepsilon(r)$ and $F_p^\varepsilon(r)$ are MS and NMS grades of Drug Allergy, Pollen Allergy, Insect Allergy, and Latex Allergy for k th symptoms and l th patients respectively, where ($l = 1, 2, 3, \dots, n, k = 1, 2, 3, \dots, |S|, \varepsilon = 1, 2, 3, \dots, t$). We take PFHS union of all information charts to assemble the underlying information of all patients.

Step 2: It is expected that $B = \{w'_1, w'_2, w'_3, \dots, w'_w\}$ a set of related symptoms (starting symptoms cover related essential symptoms) whose corresponding sets are S'_i 's, where

$S' = \prod_{i=1}^w |S'_i|$. A PFHS set is considered whose weights are designed by the medical specialist while considering the medical condition of the patient overtime ε .

Step 3: A mapping is defined as $\rho : R \rightarrow R$ and $\zeta : S \rightarrow S'$ characterized as follows $\rho(r_l) = r_l, \zeta(p_k) = (p'_k)$ (relying on the interaction between the primary symptoms). Let PFHS-mapping $\$ = (\rho, \zeta) : PFHS(R) \rightarrow PFHS(R)$ defined as

$$T_{\$(z_S)}(p')(r) = |T_{p'_k}| \begin{cases} \max_{r \in \rho^{-1}(r)} (\max_{p \in \zeta^{-1}(p') \cap S} T_{z_s}) (r) & \text{if } \rho^{-1}(r) \neq \emptyset, \zeta^{-1}(p') \cap S \neq \emptyset, \\ 0 & \text{if otherwise} \end{cases} \quad (3)$$

$$F_{\$(z_S)}(p')(r) = |F_{p'_k}| \begin{cases} \min_{r \in \rho^{-1}(r)} (\min_{p \in \zeta^{-1}(p') \cap S} F_{z_s}) (r) & \text{if } \rho^{-1}(r) \neq \emptyset, \zeta^{-1}(p') \cap S \neq \emptyset, \\ 1 & \text{if otherwise} \end{cases} \quad (4)$$

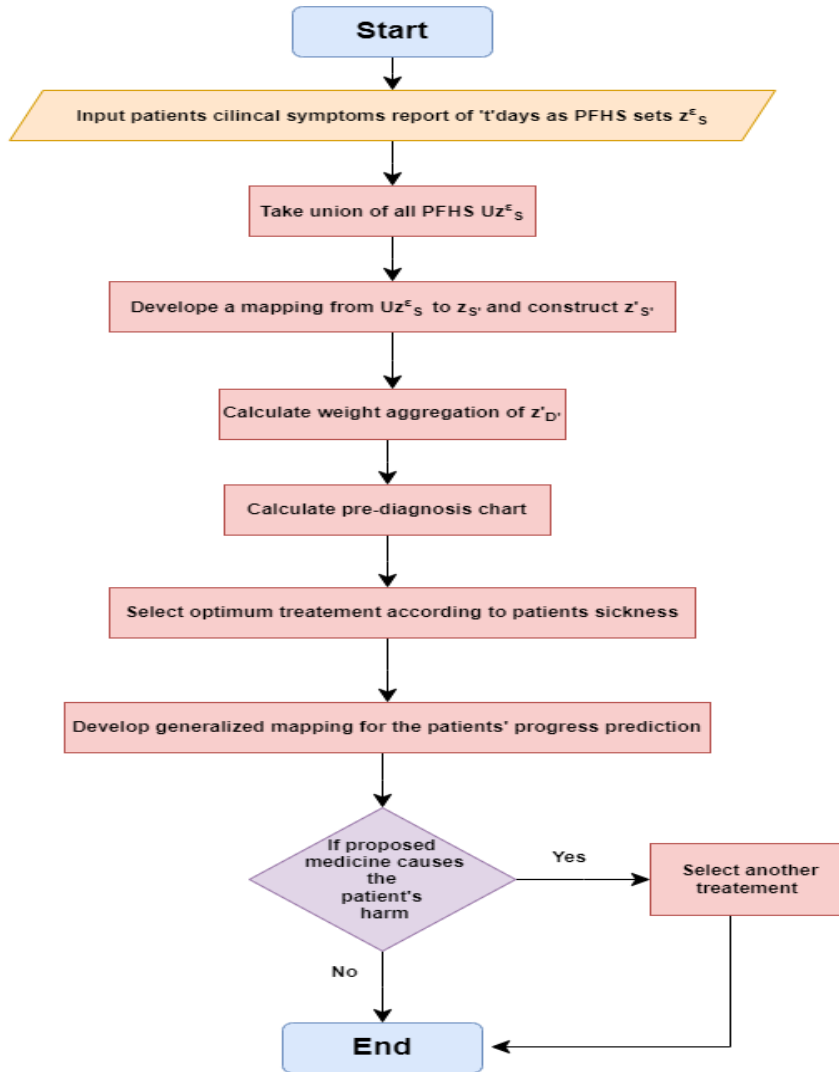


FIGURE 11. Frame diagram for the proposed algorithm.

where $T_{p'_k}$ and $F_{p'_k}$ are weights from $z_{S'}$ that are connected. Get the image of $\sqcup z^e_s$ by using the mappings $\$$ and denoted as $z'_{S'}$.

Step 4: Then, by utilizing the data from Table 2, form the after effects set and aggregate the pre-diagnosis table, through which the reliability of the complete study can be accessed.

Step 5: Evaluate the acquired PFHS set's scores and find the average of each score value that pertains to clinical manifestations. Then, considering Table 1 as a guide, carry out our ultimate result. Using this formula calculate the score esteems.

$$\text{Score function} = |T_s^e(r) - F_s^e(r)|.$$

Step 6: Assume a set of symptoms $B = \{w'_1, w'_2, w'_3, \dots, w'_w\}$

which are associated concurrently, where $k = \prod_{i=1}^w |S'_i|$ and $F = \{f_1, f_2, f_3, \dots, f_x\}$ is a list of potential medicines, then

we can build $\chi_{S'}$, where χ is PFHS function from S' to $P(F)$ which is the set of doctor's recommendations.

Step 7: Employing the definition 14, get R_F^1 by using min-max composition over $z'_{S'}$ and $\chi_{S'}$.

Step 8: Employ medication that provide added benefits while generally have fewer negative consequences. We follow the instructions in order to identify the child's condition.

Step 9: Suppose two mappings: $\rho' : R^{q-1} \rightarrow R^q$, $\zeta' : F^{q-1} \rightarrow F^q$ such that $\rho'(r_l) = r_l$ and $\zeta'(f_x) = f_x$. Then PFHS-mapping may also be constructed in this manner $\$' = (\rho', \zeta') : R_F^{q-1} \rightarrow R_F^q$ and can be regarded as:

$$R_F^q = \$'(R_F^{q-1})(f)(r) = \frac{1}{q} \begin{cases} \sqcup_{\pi \in \rho'^{-1}(r)} (\sqcup_{\varrho \in \zeta'^{-1}(f)} R_F^{q-1}(\pi)) & \text{if} \\ & \text{if } \rho'^{-1}(r) \neq \emptyset, \zeta'^{-1}(f) \cap F \neq \emptyset, \\ 0 & \text{if otherwise,} \end{cases} \quad (5)$$

where $q = 2, 3, 4 \dots$ shows that the number of options and $f \in \zeta'(F) \subseteq F, r \in R^q, \pi \in R^{q-1}, \rho \in F^{q-1}$.

Step 10: Continue step 9 whenever we assessed our outcomes. The Frame diagram for the proposed algorithm is shown in 11

3) LIMITATION OF THE METHOD

Before applying the algorithm to medical data and patient conditions, the following points must be kept in mind:

- 1) Because the form and basis of these parameters are equivalent, its compulsory to map them and to associate fundamental parametric value.
- 2) The two pairs on which mapping or compositions are determined must be distinct from one another and belong to the same structural class (PFHS).
- 3) The proper prescription for symptoms depend upon the history of particular individual, as per a doctor's advice.
- 4) Numerous ranges should be constructed with the guidance of a doctor.
- 5) If the medication method devised by the algorithm isn't helpful, INM would be used to reinstate the individual to his former state, after which a new antibiotic regimen can be commenced.
- 6) This model cannot be applied effectively if the sum of squares of NMS and MS functions is greater than 1.

C. STUDY PLAN AND MATHEMATICAL ILLUSTRATION

The implementation of the proposed methodology to a medical scenario is the emphasis of this part of the paper. The medical condition upon first examination are put in the algorithm and the algorithm converts them in mathematical syntax. Next, the algorithm selects the patient's with the allergic symptoms that the doctor has identified. From there, a comprehensive map for the situations of the patients in their related domains (Table 1) and their daily circumstances (Table 2) about their diagnosis was constructed under the monitoring of the doctor. Using these tables, the indications can be investigated in severity and duration of the illness. The strongest part of the approach is that it may be used to identify the precise type of the disease by incorporating the basic data into the model. The methodology can also help in advising the course of treatment for the specific type of ailment. The method will allow for a comprehensive generalized mapping that will anticipate the patient's recovery, relative case analysis, and appropriate criteria that will aid in the technique's optimization in the near future. As the diagnostic process involves complexity and high levels of diagnosticians intuition, it's difficult to get the diagnosis of each patient properly; information is collected from multiple challenged persons for the analytical interpretation and modelling of descriptive ideas for the algorithm. We discuss four people who have a system problem that requires a doctor's diagnosis. Its hard to identify a single disease as most diseases have overlapping symptoms. Based on the patient's behavior, recent and prior traumatic impacts, the patient's history,

hereditary and neurological stress factors, and other variables, the therapist rules out some dynamics.

Step 1: Suppose $R = \{r_1, r_2, r_3, r_4\}$ be bunch of four patients. Let $w_1 = \text{Skin}, w_2 = \text{Swollen}, w_3 = \text{Rash}$, be individual conditions' attributes with corresponding sub-values that are appropriate to the sets S_1, S_2, S_3 . Let $S_1 = \{w_{11} = \text{Red}, w_{12} = \text{Cracked}\}, S_2 = \{w_{21} = \text{Lips}\}, S_3 = \{w_{31} = \text{Itchy}, w_{32} = \text{Red}\}$, this can be confirmed by a doctor after a thorough analysis. One can construct a chart of two ($\varepsilon = 2$) days regarding the underlying basic data with the physician's information supplied as $\zeta_S^\varepsilon \in PFHS(R)$ and 1st, 2nd-day record underlying as (3) and (4) independently, which are in PFHS. Next, calculate PFHS-union over the ζ_S^1 and ζ_S^2 . The resultant PFHS $\sqcup \zeta_S^\varepsilon$ is underlying in table 5.

Step 2: Assume $w'_1 = \text{consciousness}, w'_2 = \text{Swelling}, w'_3 = \text{Skin}$, be distinct attributes of coupled allergy symptoms whose accompanying sub-values are components of the collections S'_1, S'_2, S'_3 . Let $S'_1 = \{w'_{11} = \text{Collapsing}, w'_{12} = \text{Losing}\}, S'_2 = \{w'_{21} = \text{throat}\}, S'_3 = \{w'_{31} = \text{Blue}, w'_{32} = \text{Red}\}$. Specialists assign weight to clinical conditions based on data obtained from patients, and we transcribe oral converted into numerical terms to form the kind of PFHS seen in table 6.

Step 3: Describe mappings in such a way: $\rho : R \rightarrow R, \zeta : S \rightarrow S'$ such that $\rho(r_1) = r_1, \rho(r_2) = r_2, \rho(r_3) = r_3, \rho(r_4) = r_4$, and $\zeta(w_{11}, w_{21}, w_{31}) = (w'_{11}, w'_{21}, w'_{31}), \zeta(w_{11}, w_{21}, w_{32}) = (w'_{11}, w'_{21}, w'_{32}), \zeta(w_{12}, w_{21}, w_{31}) = (w'_{12}, w'_{21}, w'_{31}), \zeta(w_{12}, w_{21}, w_{32}) = (w'_{12}, w'_{21}, w'_{32})$. Then PFHS-mapping can be expressed in this manners $\$ = (\rho, \zeta) : PFHS(R) \rightarrow PFHS(R)$. Now calculate the image of $\sqcup \zeta_S^\varepsilon$ represented as $\sqcup \zeta_{S'}^\varepsilon$ in table 7 by employing the aforementioned mapping technique in methodology that can be seen Step 3.

Step 4: In this step, compare table 7 and Table 2 for initial diagnosis 8. This will be used afterward to determine the stability of the calculated outcomes.

Step 5: We are now assessing the PFHS scores from the table 7 for each patient in regard to their clinical conditions. The next step involves the finding of scores by utilizing the score function present in the algorithm and afterwards takes an average of all values for each patient. Likewise, we can notice it for the others, and it can be drawn in Table 9. From table 9, a comparison of the results can be obtained with the diagnostic parameter chart of the Allergy illustrated in table 1. Patients r_1, r_2, r_3 have been revealed to have Insect Allergy, whereas patient r_4 has been identified to have Pollen Allergy.

Step 6: After evaluating severity of each clinical history, the doctor advised a course of therapy. A specialized PFHS set is developed in accordance with the specialized recommendation and a treatment method is suggested corresponding to the presented diagnosis. Let $S' = \{(w'_{11}, w'_{21}, w'_{31}), (w'_{11}, w'_{21}, w'_{32}), (w'_{12}, w'_{21}, w'_{31}), (w'_{12}, w'_{21}, w'_{32})\}$ be an assembling of associated symptoms of Allergy. Suppose, $F = \{f_1 = \text{Immunotherapy}, f_2 = \text{Fexofenadine}, f_3 = \text{Desloratadine}\}$, be set of

TABLE 3. Tabular representation of z_S^1 .

symptoms / patients	r_1	r_2	r_3	r_4
(w_{11}, w_{21}, w_{31})	(0.4, 0.5)	(0.7, 0.3)	(0.5, 0.5)	(0.2, 0.8)
(w_{11}, w_{21}, w_{32})	(0.7, 0.8)	(0.1, 0.4)	(0.4, 0.6)	(0.8, 0.9)
(w_{12}, w_{21}, w_{31})	(0.4, 0.5)	(0.4, 0.5)	(0.4, 0.5)	(0.6, 0.5)
(w_{12}, w_{21}, w_{32})	(0.5, 0.3)	(0.3, 0.6)	(0.6, 0.3)	(0.9, 0.3)

TABLE 4. Tabular representation of z_S^2 .

symptoms / patients	r_1	r_2	r_3	r_4
(w_{11}, w_{21}, w_{31})	(0.5, 0.9)	(0.5, 0.1)	(0.5, 0.8)	(0.6, 0.3)
(w_{11}, w_{21}, w_{32})	(0.4, 0.5)	(0.4, 0.7)	(0.4, 0.8)	(0.6, 0.6)
(w_{12}, w_{21}, w_{31})	(0.1, 0.6)	(0.2, 0.5)	(0.6, 0.5)	(0.3, 0.8)
(w_{12}, w_{21}, w_{32})	(0.6, 0.5)	(0.3, 0.5)	(0.4, 0.5)	(0.4, 0.5)

TABLE 5. Tabular representation of $\cup z_S^e$.

symptoms / patients	r_1	r_2	r_3	r_4
(w_{11}, w_{21}, w_{31})	(0.5, 0.5)	(0.7, 0.1)	(0.5, 0.5)	(0.6, 0.3)
(w_{11}, w_{21}, w_{32})	(0.7, 0.5)	(0.4, 0.4)	(0.4, 0.6)	(0.8, 0.6)
(w_{12}, w_{21}, w_{31})	(0.4, 0.5)	(0.4, 0.5)	(0.6, 0.5)	(0.6, 0.5)
(w_{12}, w_{21}, w_{32})	(0.6, 0.3)	(0.3, 0.5)	(0.6, 0.3)	(0.9, 0.3)

TABLE 6. Tabular representation of $z_{S'}$.

symptoms / patients	r_1	r_2	r_3	r_4
$(w'_{11}, w'_{21}, w'_{31})$	(0.4, 0.7)	(0.6, 0.3)	(0.5, 0.2)	(0.6, 0.1)
$(w'_{11}, w'_{21}, w'_{32})$	(0.8, 0.2)	(0.9, 0.4)	(0.7, 0.3)	(0.8, 0.2)
$(w'_{12}, w'_{21}, w'_{31})$	(0.9, 0.3)	(0.7, 0.4)	(0.9, 0.3)	(0.6, 0.4)
$(w'_{12}, w'_{21}, w'_{32})$	(0.9, 0.1)	(0.8, 0.4)	(0.7, 0.1)	(0.8, 0.1)

TABLE 7. Tabular representation of $z'_{S'}$.

symptoms / patients	r_1	r_2	r_3	r_4
$(w'_{11}, w'_{21}, w'_{31})$	(0.2, 0.245)	(0.42, 0.081)	(0.25, 0.02)	(0.36, 0.003)
$(w'_{11}, w'_{21}, w'_{32})$	(0.32, 0.02)	(0.36, 0.08)	(0.42, 0.45)	(0.48, 0.08)
$(w'_{12}, w'_{21}, w'_{31})$	(0.63, 0.045)	(0.28, 0.064)	(0.36, 0.054)	(0.48, 0.096)
$(w'_{12}, w'_{21}, w'_{32})$	(0.54, 0.003)	(0.24, 0.08)	(0.42, 0.003)	(0.72, 0.003)

TABLE 8. To analyze the reliability of findings, a tabular description of the initial prognosis table is used.

symptoms / patients	r_1	r_2	r_3	r_4
$(w'_{11}, w'_{21}, w'_{31})$	(SIA, MHC)	(SHC, LHD)	(LHO, NA)	(SIA, NA)
$(w'_{11}, w'_{21}, w'_{32})$	(SIA, NA)	(SIA, LE)	(SIA, SIA)	(SIA, LLA)
$(w'_{12}, w'_{21}, w'_{31})$	(LDA, NA)	(LIA, NA)	(SIA, NA)	(SIA, LLA)
$(w'_{12}, w'_{21}, w'_{32})$	(MDA, NA)	(SIA, NA)	(SIA, NA)	(SDA, NA)

treatments suggested by doctor. Now, we develop $\chi_{S'} \in PFHS(R)$ presented as table 10. The recommendations in table 10 are adjusted depending on each patient regarding. Membership scores take the positive effects of medicines for each kind of Allergies as well as its justifications,

whereas falsity values describe the negative effects of the medicine for each form of Allergies including its clear signs.

Step 7: The min-max composition of the PFHS set is evaluated among $\chi_{S'}$ and $z'_{S'}$ and assess the association between

TABLE 9. The patient scoring contains facts on accompanying symptoms.

patients / symptoms	$(w'_{11}, w'_{21}, w'_{31})$	$(w'_{11}, w'_{21}, w'_{32})$	$(w'_{12}, w'_{21}, w'_{31})$	$(w'_{12}, w'_{21}, w'_{32})$	Average score
r_1	0.045	0.339	0.23	0.357	0.242
r_2	0.3	0.28	0.03	0.4	0.25
r_3	0.585	0.216	0.306	0.384	0.37
r_4	0.537	0.16	0.417	0.717	0.45

TABLE 10. Tabular representation of $\chi_{S'}$.

treatments / symptoms	$(w'_{11}, w'_{21}, w'_{31})$	$(w'_{11}, w'_{21}, w'_{32})$	$(w'_{12}, w'_{21}, w'_{31})$	$(w'_{12}, w'_{21}, w'_{32})$
f_1	(0.5, 0.1)	(0.9, 0.1)	(0.2, 0.2)	(0.6, 0.4)
f_2	(0.5, 0.2)	(0.4, 0.1)	(0.7, 0.4)	(0.6, 0.2)
f_3	(0.6, 0.4)	(0.8, 0.6)	(0.6, 0.2)	(0.8, 0.3)

TABLE 11. Chart between primary symptoms and recommended treatments.

patients / treatments	f_1	f_2	f_3
r_1	(0.5, 0.1)	(0.5, 0.2)	(0.6, 0.4)
r_2	(0.9, 0.3)	(0.9, 0.1)	(0.9, 0.4)
r_3	(0.9, 0.2)	(0.9, 0.3)	(0.9, 0.2)
r_4	(0.8, 0.1)	(0.8, 0.1)	(0.8, 0.1)

TABLE 12. Chart between primary symptoms and recommended treatments.

patients / treatments	f_1	f_2	f_3	Maximum esteems	Selected treatment
r_1	0.4	0.3	0.2	0.4	f_1
r_2	0.6	0.8	0.5	0.8	f_2
r_3	0.7	0.6	0.7	0.7	f_1 or f_3
r_4	0.7	0.7	0.7	0.7	any one

TABLE 13. Tabular representation of R_F^1 .

patients / treatments	f_1	f_2	f_3
r_1	(0.25, 0.05)	(0.25, 0.1)	(0.3, 0.2)
r_2	(0.45, 0.15)	(0.45, 0.25)	(0.45, 0.2)
r_3	(0.45, 0.2)	(0.45, 0.3)	(0.45, 0.1)
r_4	(0.4, 0.05)	(0.8, 0.05)	(0.8, 0.05)

TABLE 14. Tabular representation of R_F^2 .

patients / treatments	f_1	f_2	f_3
r_1	(0.083, 0.016)	(0.083, 0.003)	(0.1, 0.067)
r_2	(0.15, 0.05)	(0.15, 0.083)	(0.15, 0.067)
r_3	(0.15, 0.003)	(0.15, 0.3)	(0.15, 0.003)
r_4	(0.13, 0.016)	(0.8, 0.016)	(0.8, 0.016)

prescribed prescriptions and individuals $\chi_{S'} \circ z'_{S'} = R_F^1$, see Table 11.

Step 8: The medicine (therapy) is optimal for the individuals, offering optimum benefit with minimal effect. In this technique, we can determine the scores for each patient's prescriptions by employing the score function specified in algorithm step 4. The score reflects the importance of each

patient's medicine, see Table 12. From Table 12, it is obvious that treatments f_1, f_1 or f_2 and f_1 or f_3 is fit for the patient of r_1, r_2 and r_3 respectively, and it can be chosen for r_4 . The overall posture is determined by the patient's current situation, along with his physical examination and the type of disorder.

Step 9: The position of each individual is unique, depending on the level of ailment and its background. Anyone can

TABLE 15. Tabular representation of R_F^3 .

patients / treatments	f_1	f_2	f_3
r_1	(0.020, 0.004)	(0.020, 0.008)	(0.025, 0.016)
r_2	(0.0375, 0.0125)	(0.9, 0.020)	(0.9, 0.016)
r_3	(0.0375, 0.2)	(0.0375, 0.3)	(0.0375, 0.008)
r_4	(0.033, 0.016)	(0.8, 0.004)	(0.8, 0.004)

TABLE 16. Tabular representation of R_F^4 .

patients / treatments	f_1	f_2	f_3
r_1	(0.004, 0.0008)	(0.004, 0.001)	(0.005, 0.003)
r_2	(0.007, 0.0025)	(0.007, 0.004)	(0.007, 0.003)
r_3	(0.007, 0.001)	(0.007, 0.3)	(0.007, 0.001)
r_4	(0.006, 0.016)	(0.8, 0.0008)	(0.8, 0.0008)

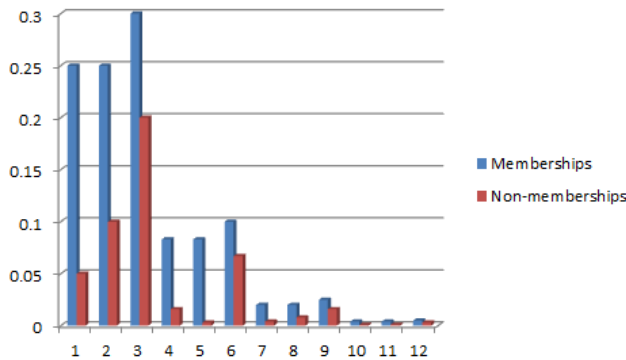


FIGURE 12. Progress chart of patient r_1 .

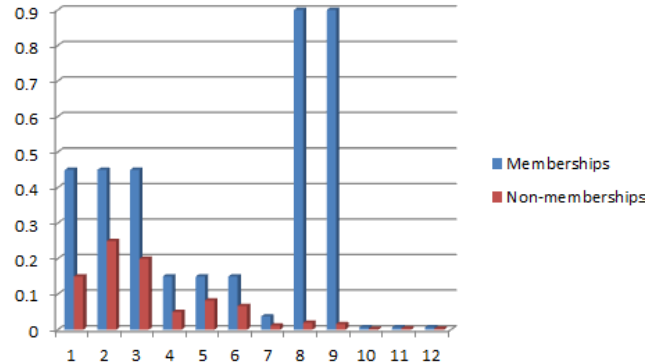


FIGURE 13. Progress chart of patient r_2 .

reenact scenarios before the disease is effectively treated. Using the PFHS-mapping tool, one can track each treatment plan. Now identify two mappings: $\rho' : R^{q-1} \rightarrow R^q, \zeta' : F^{q-1} \rightarrow F^q$ such that $\rho'(r_1) = r_1, \rho'(r_2) = r_2, \rho'(r_3) = r_3, \rho'(r_4) = r_4$, and $\zeta'(f_1) = f_1, \zeta'(f_2) = f_2, \zeta'(f_3) = f_3$.

The PFHS-mapping is $\mathcal{S}' = (\rho', \zeta') : R_F^{q-1} \rightarrow R_F^q$. The PFHS-mapping is given as

$$R_F^q = \mathcal{S}'(R_F^{q-1})(f)(r) = \frac{1}{q} \begin{cases} \sqcup_{\pi \in \rho'^{-1}(r)} (\sqcup_{\varrho \in \zeta'^{-1}(f) \cap F} R_F^{q-1}(\pi)) & \text{if } \rho'^{-1}(r) \neq \emptyset, \\ & \zeta'^{-1}(f) \cap F \neq \emptyset \\ (0, 0) & \text{if otherwise} \end{cases} \quad (6)$$

where $q = 2, 3, 4 \dots$ indicates the total number of sessions and $f \in \zeta'(F) \subseteq F, r \in R, \pi \in R^{q-1}, \varrho \in F^{q-1}$ and Therapy sessions can be specified in 13, 14, 15, 16 for different values of $q = 2, 3, 4, 5$.

Step 10: The use of Step 9 is maintained until the patient is completely cured and free of the ailment. Fig. 12,13,14,15 illustrates the progress update for individual.

D. BENEFICIARY OF THE PROPOSED MODEL

The algorithm intends to be a diagnostics assist for initial selection choices and detecting sufferers with conflicting clinical signs. This investigation shows a strong correlation between the indications and mathematically maps them to the adequate care. The system is constructed on trimming PFHS set designs that can detect a condition of the patient ahead of time and estimate the medical symptoms over time to know the health caused by medicine. It can be performed to anticipate the infection's restoration processes until the sickness is treated. In the near future, these pattern recognition algorithms will be designed to decrease medical error and retrieve impressive results depending on different patient settings.

E. DISCUSSIONS AND COMPARATIVE ANALYSIS

The recommended concept of PFHS mapping is both wide and relevant for chronic ailments. Existing theories cannot be used to respond and assess difficulties; although, they do have limits (see Table 17). These drawbacks prove to be a barrier limiting the medical staff's approach to acquire patient's initial data. Nonetheless, our proposed approach can translate a medical history of a patient into a mathematical

TABLE 17. The suggested PFHS is compared to scientific theories.

SN	References	Disadvantage	Ranking
1	[15]	When attributes may be broken down into additional attribute values, they lose their stability	Inadequate to govern
2	[53]	Whenever attributes may be separated into additional attribute values, they fail to maintain	Inadequate to govern
3	[54]	When attributes may be dissolved into some other data points, their consistency suffers	Inadequate to govern
4	[55]	When attributes may be dissolved into some other data points, their consistency suffers	Inadequate to govern
5	[56]	When attributes are sliced down into various data points, their reliability diminishes	Inadequate to govern
6	[57]	When attributes are sliced down into various data points, their reliability diminishes	Inadequate to govern
7	[58]	When attributes are dissected down into individual datasets, their credibility drops	Inadequate to govern
8	[59]	When attributes may be broken down into additional attribute values, they lose their stability	Inadequate to govern
9	[29]	When attributes are dissected down into individual datasets, their credibility drops	Inadequate to govern
10	[30]	When attributes are dissected down into individual datasets, their credibility drops	Inadequate to govern
11	[32]	When attributes are dissected down into individual datasets, their credibility drops.	Inadequate to govern
12	The approach recommended in this article is	Entails lengthy and complex computations	Sort out by computer algorithm

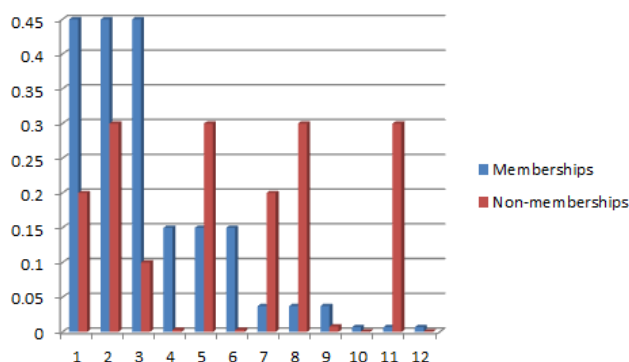


FIGURE 14. Progress chart of patient r_3 .

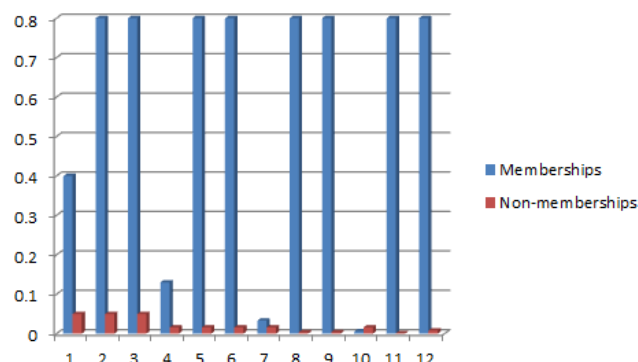


FIGURE 15. Progress chart of patient r_4 .

format with minimal loss of information, and we can get the excellent outcomes for diagnosis and diagnostic testing. We compare our proposed framework to current theories in Table 17. All existing theories, however, unable to handle when the characteristics are further separated into attribute values. This need is addressed by the recommended PFHS-mapping. It illustrates that, in comparison with existing processes, our framework is robust and suitably dealing with different concerns.

- Because the Allergy patient can't analyse completely after the initial visit, we add numerous days to this estimate. The data correlating the severity of the patient's severity and his symptoms is given by the PFHS set and its union.
- In each patient trial, one can see that the link between related and crucial indicators/symptoms, as well as the diagnosing to them, is significant. Assume that if

we only select early symptoms at that time, the results obtained will be inconsistent and unspecific as the condition may change with the change of environment.

- In the next stage of the algorithm, it chooses a treatment method for patients depending on the nature of allergy they are under influence of. The score function can be used to rate the remedies that have been adopted.
- Lastly, use a more extended version of PFHS-mapping to track the patients' progress. All NMS are shrinking up to zero with each scene, signifying that allergy symptoms, neutral effects of medication therapy are converges to zero. The evolution of patients is depicted in this model as time passes.
- In the condition of the patient doesn't improve with the first course of medication therapy, inverse PFHS-mapping can be used to bring him back to his original state and restart the treatment.

- Under the influence of parameterizations, the suggested technique benefits numerous patients suffering from various diseases and multiform criteria. This investigation is constant and consistent in its approach to dealing with the issues in the clinical setting and MCDM.

V. CONCLUSION

The article's primary focus is to serve as a framework diagnostic tool for the prognosis of Allergy and the issues related to it. The model analyzes the patient's condition based on the symptoms and, with the help of PFHS-mapping and INM and presents a tentative diagnosis. The model is divided into 3 stages. The first stage involves the determination of the severity of the patient's condition based on the disease. The second stage involves the medication process that is mapped according to the symptoms and condition of the patient recorded in stage one of the algorithm using PFHS mapping. The third stage involves developing a generalized PFHS structure that utilizes the patient's history and anticipates the patient's medication and recovery time until the patient registers within normal ranges of diagnostic tests. This method has a multitude of applications as it can be applied to the analysis and diagnosis of numerous diseases. By correlating this method with literature, the results obtained are accurate, easy to deal with, and has great adaptability to analyze multi-criteria decision-making problems. The prospects of this method involve the expansion of the domains of the proposed methods in various other frameworks like Neutrosophic Hypersoft Set, Plithogenic Hypersoft Set, Hypersoft Set, Plithogenic Intuitionistic Fuzzy Hypersoft Set, q-rung orthopair fuzzy HS, and their hybrid structures. The applications of the proposed method are under words in medical imaging problems, image processing, and pattern recognition studies.

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REFERENCES

- [1] N. Meyer and J. Yun, "Introduction to allergies," in *Metabolism of Human Diseases Organ Physiology and Pathophysiology*, vol. 1, no. 1. Vienna, Austria: Springer, p. 323, 2014.
- [2] B. K. Park, D. J. Naisbitt, S. F. Gordon, N. R. Kitteringham, and M. Pirmohamed, "Metabolic activation in drug allergies," *Toxicology*, vol. 158, nos. 1–2, pp. 11–23, Feb. 2001.
- [3] B. K. Park, M. Pirmohamed, and N. R. Kitteringham, "Role of drug disposition in drug hypersensitivity: A chemical, molecular, and clinical perspective," *Chem. Res. Toxicol.*, vol. 11, no. 9, pp. 969–988, Sep. 1998.
- [4] J. Lazarou, B. H. Pomeranz, and P. N. Corey, "Incidence of adverse drug reactions in hospitalized patients a meta-analysis of prospective studies," *J. Amer. Med. Assoc.*, vol. 279, no. 15, pp. 1200–1205, 1998.
- [5] D. B. Jefferys, D. Leakey, J. A. Lewis, S. Payne, and M. D. Rawlins, "New active substances authorized in the united kingdom between 1972 and 1994," *Brit. J. Clin. Pharmacol.*, vol. 45, no. 2, pp. 151–156, Feb. 1998.
- [6] I. A. Staff, P. E. Taylor, P. Smith, M. B. Singh, and R. B. Knox, "Cellular localization of water soluble, allergenic proteins in rye-grass (*Lolium perenne*) pollen using monoclonal and specific IgE antibodies with immunogold probes," *Histochem. J.*, vol. 22, no. 5, pp. 276–290, May 1990.
- [7] E. A. Taketomi, M. C. Sopelete, P. F. de Sousa Moreira, and F. de Assis Machado Vieira, "Pollen allergic disease: Pollens and its major allergens," *Brazilian J. Otorhinolaryngol.*, vol. 72, no. 4, pp. 562–567, Jul. 2006.
- [8] C. S. Barnes, N. E. Alexis, J. A. Bernstein, J. R. Cohn, J. G. Demain, E. Horner, E. Levetin, A. Nel, and W. Phipatanakul, "Climate change and our environment: The effect on respiratory and allergic disease," *J. Allergy Clin. Immunol., Pract.*, vol. 1, no. 2, pp. 137–141, Mar. 2013.
- [9] L. Lichtenstein, M. Valentine, and A. Sobotka, "Insect allergy: The state of the art," *J. Allergy Clin. Immunol.*, vol. 64, no. 1, pp. 5–12, Jul. 1979.
- [10] G. E. Poley and J. E. Slater, "Latex allergy," *J. Allergy Clin. Immunol.*, vol. 105, no. 6, pp. 1054–1062, 2000.
- [11] D. L. Hepner and M. C. Castells, "Latex allergy," *Anesthesia Analgesia*, vol. 96, no. 4, pp. 1219–1229, 2003.
- [12] J. G. Marks, P. Elsner, and V. A. Deleo, "Occupations commonly associated with contact dermatitis," *Contact Occupational Dermatol.*, vol. 1, no. 1, pp. 395–399, 2002.
- [13] K. Kelly, V. Kurup, M. Zacharisen, A. Resnick, and J. Fink, "Skin and serologic testing in the diagnosis of latex allergy," *J. Allergy Clin. Immunol.*, vol. 91, no. 6, pp. 1140–1145, Jun. 1993.
- [14] J. S. Taylor and E. Erkek, "Latex allergy diagnosis and management," *Dermatol. Therapy*, vol. 17, no. 4, pp. 289–301, 2004.
- [15] L. A. Zadeh, "Fuzzy sets," *Inf. Control*, vol. 8, no. 3, pp. 338–353, Jun. 1965.
- [16] K. T. Atanassov, "Intuitionistic fuzzy sets," *Fuzzy Sets Syst.*, vol. 20, pp. 87–96, Aug. 1986.
- [17] R. R. Yager, "Pythagorean fuzzy subsets," in *Proc. Joint IFSA World Congr. NAFIPS Annu. Meeting (IFSA/NAFIPS)*, Edmonton, AB, Canada, Jun. 2013, pp. 57–61.
- [18] X. Peng and Y. Yang, "Multiple attribute group decision making methods based on Pythagorean fuzzy linguistic set," *Comput. Eng. Appl.*, vol. 52, no. 23, pp. 50–54, 2016.
- [19] H. Garg, "A novel accuracy function under interval-valued Pythagorean fuzzy environment for solving multicriteria decision making problem," *J. Intell. Fuzzy Syst.*, vol. 31, no. 1, pp. 529–540, Jun. 2016.
- [20] E. Ayyildiz and A. T. Gumus, "Interval-valued Pythagorean fuzzy AHP method-based supply chain performance evaluation by a new extension of SCOR model: SCOR 4.0," *Complex Intell. Syst.*, vol. 7, no. 1, pp. 559–576, Feb. 2021.
- [21] P. Ejegwa, S. Wen, Y. Feng, W. Zhang, and N. Tang, "Novel Pythagorean fuzzy correlation measures via Pythagorean fuzzy deviation, variance and covariance with applications to pattern recognition and career placement," *IEEE Trans. Fuzzy Syst.*, early access, Mar. 8, 2021, doi: 10.1109/TFUZZ.2021.3063794.
- [22] M. Zhao, G. Wei, C. Wei, and J. Wu, "TODIM method for interval-valued Pythagorean fuzzy MAGDM based on cumulative prospect theory and its application to green supplier selection," *Arabian J. Sci. Eng.*, vol. 46, no. 2, pp. 1899–1910, 2021.
- [23] X. Gao, L. Pan, and Y. Deng, "Quantum Pythagorean fuzzy evidence theory (QPET): A negation of quantum mass function view," *IEEE Trans. Fuzzy Syst.*, early access, Feb. 9, 2021, doi: 10.1109/TFUZZ.2021.3057993.
- [24] L. Pan, X. Gao, Y. Deng, and K. H. Cheong, "The constrained Pythagorean fuzzy sets and its similarity measure," *IEEE Trans. Fuzzy Syst.*, early access, Jan. 18, 2021, doi: 10.1109/TFUZZ.2021.3052559.
- [25] R. M. Zulqarnain, I. Siddique, F. Jarad, R. Ali, and T. Abdeljawad, "Development of TOPSIS technique under Pythagorean fuzzy hypersoft environment based on correlation coefficient and its application towards the selection of antivirus mask in COVID-19 pandemic," *Complexity*, vol. 2021, pp. 1–27, Mar. 2021.
- [26] P. Rani, A. R. Mishra, A. Saha, and D. Pamucar, "Pythagorean fuzzy weighted discrimination-based approximation approach to the assessment of sustainable bioenergy technologies for agricultural residues," *Int. J. Intell. Syst.*, vol. 36, no. 6, pp. 2964–2990, Jun. 2021.
- [27] A. Çalik, "A novel Pythagorean fuzzy AHP and fuzzy TOPSIS methodology for green supplier selection in the industry 4.0 era," *Soft Comput.*, vol. 25, no. 3, pp. 2253–2265, Feb. 2021.
- [28] T.-Y. Chen, "The likelihood-based optimization ordering model for multiple criteria group decision making with Pythagorean fuzzy uncertainty," *Neural Comput. Appl.*, vol. 33, no. 10, pp. 4865–4900, May 2021.
- [29] A. Kharal and B. Ahmad, "Mappings on soft classes," *New Math. Natural Comput.*, vol. 7, no. 3, pp. 471–481, Sep. 2011.
- [30] A. Kharal and B. Ahmad, "Mappings on fuzzy soft classes," *Adv. Fuzzy Syst.*, vol. 2009, no. 1, 2009, Art. no. 407890.

- [31] F. Smarandache, "Extension of soft set to hypersoft set and then to plithogenic hypersoft set," *Neutrosophic Set Syst.*, vol. 22, no. 1, pp. 168–170, 2018.
- [32] F. Karaaslan, "Soft classes and soft rough classes with applications in decision making," *Math. Problems Eng.*, vol. 2016, no. 1, 2016, Art. no. 1584528.
- [33] Z. Kong, L. Gao, and L. Wang, "Comment on 'A fuzzy soft set theoretic approach to decision making problems'," *J. Comput. Appl. Math.*, vol. 223, no. 2, pp. 540–542, Jan. 2009.
- [34] P. K. Maji, R. Biswas, and A. R. Roy, "Fuzzy soft sets," *J. Fuzzy Math.*, vol. 9, no. 3, pp. 589–602, 2001.
- [35] D. Molodtsov, "Soft set theory—First results," *Comput. Math. Appl.*, vol. 37, nos. 4–5, pp. 19–31, Feb. 1999.
- [36] A. R. Roy and P. K. Maji, "A fuzzy soft set theoretic approach to decision making problems," *J. Comput. Appl. Math.*, vol. 203, no. 2, pp. 412–418, Jun. 2007.
- [37] A. Rauf, I. Zeba, and M. Saqlain, "Modified dust-lower-hybrid waves in quantum plasma," *Sci. Inquiry Rev.*, vol. 2, no. 5, pp. 11–21, 2018.
- [38] S. Rana, M. Qayyum, M. Saeed, F. Smarandache, and B. A. Khan, "Plithogenic fuzzy whole hypersoft set, construction of operators and their application in frequency matrix multi attribute decision making technique," *Neutrosophic Set Syst.*, vol. 28, no. 1, pp. 34–50, 2019.
- [39] M. Riaz, M. Saeed, M. Saqlain, and N. Jafar, "Impact of water hardness in instinctive laundry system based on fuzzy logic controller," *Punjab Univ. J. Math.*, vol. 51, no. 4, pp. 73–84, 2019.
- [40] M. Saeed, M. Ahsan, M. S. Khubab, and M. R. Ahmad, "A study of the fundamentals of hypersoft set theory," *Int. Sci. Eng.*, vol. 11, no. 1, pp. 320–329, 2020.
- [41] M. Saeed, M. Saqlain, and N. Jafar, "Consumer's perception and impact of pH on detergent in automatic washing machine based on fuzzy logic controller," *Sci. Inquiry Rev.*, vol. 2, no. 3, pp. 40–52, Jul. 2018.
- [42] M. Saeed, M. Saqlain, A. Mehmood, K. Naseer, and S. Yaqoob, "MultiPolar neutrosophic soft sets with application in medical diagnosis and decision-making," *Neutrosophic Set Syst.*, vol. 33, no. 1, pp. 183–207, 2020.
- [43] A. U. Rahman, M. Saeed, and A. Dhital, "Decision making application based on neutrosophic parameterized hypersoft set theory," *Neutrosophic Set Syst.*, vol. 41, no. 1, pp. 1–14, 2021.
- [44] M. Saeed, M. Ahsan, and T. Abdeljawad, "A development of complex multi-fuzzy hypersoft set with application in MCDM based on entropy and similarity measure," *IEEE Access*, vol. 9, pp. 60026–60042, 2021.
- [45] M. Saqlain, S. Moin, N. Jafar, M. Saeed, and S. Broumi, "Single and multi-valued neutrosophic hypersoft set and tangent similarity measure of single valued neutrosophic hypersoft sets," *Neutrosophic Sets Syst.*, vol. 32, pp. 317–329, Mar. 2020.
- [46] M. Saqlain, S. Moin, M. N. Jafar, M. Saeed, and F. Smarandache, "Aggregate operators of neutrosophic hypersoft set," *Neutrosophic Set Syst.*, vol. 32, no. 1, pp. 295–303, 2020.
- [47] X. Yang, D. Yu, J. Yang, and C. Wu, "Generalization of soft set theory from crisp to fuzzy case," *Fuzzy Inf. Eng.*, vol. 40, no. 1, pp. 345–354, 2007.
- [48] M. Zulfqarnain, F. Dayan, and M. Saeed, "Topsis analysis for the prediction of diabetes based on general characteristics of humans," *Int. J. Pharm. Sci. Res.*, vol. 9, no. 7, pp. 2932–2939, 2018.
- [49] S. Alkhazaleh and E. Marei, "Mappings on neutrosophic soft classes," *Neutrosophic Set Syst.*, vol. 2, no. 1, pp. 3–8, 2014.
- [50] M. Bashir and A. R. Salleh, "Mappings on intuitionistic fuzzy soft classes," *AIP Conf. Proc.*, vol. 1522, no. 1, pp. 1022–1032, 2013.
- [51] N. H. Sulaiman and D. Mohamad, "Mappings on multiaspect fuzzy soft classes," *AIP Conf. Proc.*, vol. 1602, no. 1, pp. 716–722, 2014.
- [52] M. J. Borah and B. Hazarika, "Composite mapping on hesitant fuzzy soft classes," 2016, *arXiv:1605.01304*.
- [53] L. A. Zadeh, "The concept of a linguistic variable and its application to approximate reasoning," *Inf. Sci.*, vol. 8, no. 3, pp. 199–249, 1974.
- [54] K. T. Atanassov, "Intuitionistic fuzzy sets, intuitionistic fuzzy sets," *Phys., Heidelberg*, vol. 8, no. 3, pp. 1–137, 1999.
- [55] F. Smarandache, *Neutrosophy: Neutrosophic Probability, Set, and Logic: Analytic Synthesis & Synthetic Analysis*. American Research Press, 1998, p. 105.
- [56] W.-R. Zhang and L. Zhang, "Bipolar logic and bipolar fuzzy logic," *Inf. Sci.*, vol. 165, nos. 3–4, pp. 265–287, 2004.
- [57] J. Chen, S. Li, S. Ma, and X. Wang, "M-polar fuzzy sets an extension of bipolar fuzzy sets," *Sci. World J.*, vol. 2014, no. 1, 2014, Art. no. 416530.
- [58] I. Deli, M. Ali, and F. Smarandache, "Bipolar neutrosophic sets and their application based on multi-criteria decision making problems," in *Proc. Int. Conf. Adv. Mech. Syst.*, Beijing, China, Aug. 2015, pp. 249–254.
- [59] M. Riaz and M. R. Hashmi, "M-polar neutrosophic soft mapping with application to multiple personality disorder and its associated mental disorders," *Artif. Intell. Rev.*, vol. 54, no. 4, pp. 2717–2763, Apr. 2021.
- [60] S. Broumi, A. Mumtaz, and F. Smarandache, "Mappings on neutrosophic soft expert sets," *J. New Theory*, vol. 5, no. 5, pp. 27–42, 2015.
- [61] M. Saeed, M. Ahsan, and A. U. Rahman, "A novel approach to mappings on hypersoft classes with application," in *Theory and Application of Hypersoft Set*. Brussels, Belgium: Pons Publication House, 2021, pp. 175–191.
- [62] M. Saeed, M. Ahsan, A. U. Rahman, and F. Smarandache, "An inclusive study on fundamentals of hypersoft set," in *Theory and Application of Hypersoft Set*. Brussels, Belgium: Pons Publication House, 2021, pp. 1–23.
- [63] K. G. Osgouie and A. Azizi, "Optimizing fuzzy logic controller for diabetes type I by genetic algorithm," in *Proc. ICCAE*, 2010, vol. 2, no. 1, pp. 4–8.
- [64] A. Azizi and N. Seifipour, "Modeling of dermal wound healing-remodeling phase by neural networks," in *Proc. Int. Assoc. Comput. Sci. Inf. Technol., Spring Conf.*, 2009, pp. 447–450.
- [65] L. Wang, H. Garg, and N. Li, "Pythagorean fuzzy interactive Hamacher power aggregation operators for assessment of express service quality with entropy weight," *Soft Comput.*, vol. 25, pp. 973–993, Jan. 2021.
- [66] X. Liu, Z. Wang, S. Zhang, and H. Garg, "Novel correlation coefficient between hesitant fuzzy sets with application to medical diagnosis," *Expert Syst. Appl.*, vol. 183, Nov. 2021, Art. no. 115393.
- [67] M. U. Molla, B. C. Giri, and P. Biswas, "Extended PROMETHEE method with Pythagorean fuzzy sets for medical diagnosis problems," *Soft Comput.*, vol. 25, no. 6, pp. 4503–4512, Mar. 2021.
- [68] T. Mahmood, K. Ullah, Q. Khan, and N. Jan, "An approach toward decision-making and medical diagnosis problems using the concept of spherical fuzzy sets," *Neural Comput. Appl.*, vol. 31, no. 11, pp. 7041–7053, Nov. 2019.
- [69] Q. Khan, T. Mahmood, and K. Ullah, "Applications of improved spherical fuzzy dombi aggregation operators in decision support system," *Soft Comput.*, vol. 25, no. 14, pp. 9097–9119, Jul. 2021.
- [70] M. Riaz and S. T. Tehrim, "Bipolar fuzzy soft mappings with application to bipolar disorders," *Int. J. Biomath.*, vol. 12, no. 7, Oct. 2019, Art. no. 1950080.
- [71] X. Zhang and Z. Xu, "Extension of TOPSIS to multiple criteria decision making with Pythagorean fuzzy sets," *Int. J. Intell. Syst.*, vol. 29, no. 12, pp. 1061–1078, 2014.
- [72] R. M. Zulfqarnain, X. L. Xin, and M. Saeed, "A development of Pythagorean fuzzy hypersoft set with basic operations and decision-making approach based on the correlation coefficient," *Neutrosophic Sets Syst.*, vol. 20, no. 1, pp. 1061–1078, 2014.
- [73] M. Saeed, A. Mehmood, T. Abdeljawad, M. H. Saeed, and M. Asim, "Application of similarity measure in pattern recognition of COVID-19 spread and its effects in Pakistan," *Appl. Comput. Math.*, vol. 20, no. 1, pp. 457–460, 2020.
- [74] M. Saeed, M. Ahsan, A. Ur Rahman, M. H. Saeed, and A. Mehmood, "An application of neutrosophic hypersoft mapping to diagnose brain tumor and propose appropriate treatment," *J. Intell. Fuzzy Syst.*, vol. 41, no. 1, pp. 1677–1699, Aug. 2021.
- [75] M. Saeed, M. Ahsan, M. H. Saeed, A. Mehmood, and T. Abdeljawad, "An application of neutrosophic hypersoft mapping to diagnose hepatitis and propose appropriate treatment," *IEEE Access*, vol. 9, pp. 70455–70471, 2021.
- [76] M. Ahsan, M. Saeed, A. Mehmood, M. H. Saeed, and J. Asad, "The study of HIV diagnosis using complex fuzzy hypersoft mapping and proposing appropriate treatment," *IEEE Access*, vol. 9, pp. 104405–104417, 2021.
- [77] M. Saeed, M. Ahsan, A. Mehmood, M. H. Saeed, and J. Asad, "Infectious diseases diagnosis and treatment suggestions using complex neutrosophic hypersoft mapping," *IEEE Access*, vol. 9, pp. 146730–146744, 2021.
- [78] M. Saeed, M. Ahsan, M. H. Saeed, A. Mehmood, and S. El-Morsy, "Assessment of solid waste management strategies using an efficient complex fuzzy hypersoft set algorithm based on entropy and similarity measures," *IEEE Access*, vol. 9, pp. 150700–150714, 2021.
- [79] M. Ahsan, M. Saeed, and A. U. Rahman, "A theoretical and analytical approach for fundamental framework of composite mappings on fuzzy hypersoft classes," *Neutrosophic Sets Syst.*, vol. 45, no. 1, pp. 268–285, 2021.



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