This article has been accepted for publication in a future issue of this journal, but has not been fully edited. Content may change prior to final publication. Citation information: DOI 10.1109/ACCESS.2021.3099335, IEEE Access

IEEE Access
Multidisciplinary | Rapid Review | Open Access Journal

Date of publication xxxx 00, 0000, date of current version xxxx 00, 0000.

Digital Object Identifier 10.1109/ACCESS.2017.DOI

The Study of HIV Diagnosis Using Complex Fuzzy Hypersoft Mapping and Proposing Appropriate Treatment

MUHAMMAD AHSAN[1], MUHAMMAD SAEED[1], ASAD MEHMOOD[1], MUHAMMAD HARIS SAEED[2], JIHAD ASAD[3]

[1]Department of Mathematics, University of Management and Technology, Lahore 54770, Pakistan; (e-mail: muhammad.saeed@umt.edu.pk, ahsan1826@gmail.com, a.asadkhan.khi@gmail.com,)
[2]Department of Chemistry, University of Management and Technology, Lahore 54770, Pakistan; (e-mail: abdullahsaeed74@gmail.com)
[3]Department of Physics, Palestine Technical University-Kadoorie, Tulkarm P304, Palestine; (e-mail: j.asad@ptuk.edu.ps,)

Corresponding author: Muhammad Saeed (e-mail:muhammad.saeed@umt.edu.pk).

ABSTRACT HIV is still a global epidemic more than 40 years after it was described initially, impacting mainly Sub-Saharan Africa, Southeast Asia, and Latin America. HIV is an RNA retrovirus that wreaks havoc on the immune system, making the infected individual vulnerable to opportunistic pathologies. For the diagnosis and therapy of infected patients, several models have been proposed in literature. The main goal of this paper is to present an innovative mathematical model for diagnosing and treating this pandemic based on a unique flexible fuzzy-like structure called the Complex Fuzzy Hypersoft (CFHS) set, which is a glued structure of complex fuzzy (CF) set and hypersoft sets (an extension of soft set). To address ambiguity and unclear data, the basic theory of CFHS set is created, which examines the amplitude term (A-term) and phase term (P-term) of complex numbers concurrently. In two aspects, this new fuzzy-like hybrid theory is adaptable. First, extending membership function values to the unit circle on an Argand plane and including an extra term, the P-term, to suit the recurring character of data that provide access to a wide range of membership function values. Second, it categorises the different attributes into matching disjoint attribute-valued sets for a more straightforward interpretation; it's tough to identify which HIV is and how serious it is after looking at the HIV side effects. To deal with such problems, the CFHS set, and CFHS-mapping with its inverse mapping is utilised. These concepts are practical and required for adequately assessing the situation using mathematical modelling. This investigation shows a relationship between symptoms and medications, making the story easier to follow. A table is constructed for the HIV kinds based on a fuzzy interval of $[0, 1]$. The calculation is based on CFHS-mapping, which correctly diagnoses the condition and prescribes the best medicine. A generalised CFHS-mapping is also offered, which can assist a specialist in extracting the patient's improvement record and estimating how long it will take to eradicate the infection.

INDEX TERMS HIV; Hypersoft (HS) set; Complex numbers (C-numbers); Complex Fuzzy Hypersoft (CFHS); Mapping; Inverse mapping.

I. INTRODUCTION

HIV or the Human Immunodeficiency virus is a significant threat to all communities around the globe. It attacks the body's immune system, makes it prone to infection, and may lead to AIDS (Acquired Immuno-Deficiency System). A mature virion has a lipid bilayer membrane that encapsulates a dense cone-shaped nucleocapsid containing the genomic RNA molecules and associated enzymes like reverse transcriptase, integrase, and various cellular factors. The virion has a diameter of 100-120 nm with spherical morphology [1]. The virus is categorized into two types, namely HIV-1 and HIV-2. It was found that HIV-2 viremia was less frequently detected in the plasma viral load in the patients with relatively similar conditions [2]–[4].

Zadeh [15] was the first to establish the fuzzy set (FS) theoretical idea in 1965. With the assistance of FS, The term "membership function" was defined, and the concept of "uncertainty" was discussed. The notion of Atanassov [16] generalized FS and included the degree of non-membership as a component, and came up with the idea of the intuitionistic fuzzy set (IFS). Molodtsov [23] presented the concept of soft set (SS) theory as another basic set theory in 1999. SS theory is now utilized in many science and technology sectors, and it has become one of the most popular branches of mathematics because of its wide range of applications in many fields of research. To tackle decision-making difficulties, Maji et al. [22] utilized soft sets. Yang et al. [33] stressed the importance of S-sets and their applications. The notion of fuzzy SS and its various properties were put forward by Maji et al. [21].

Broumi et al. [45] developed and characterized mappings between neutrosophic soft expert sets, as well as their images and inverse images. In [20], Karaaslan expands the idea of "soft class" and its accompanying methods. In 2009 and 2011, Kharal et al. [17], [18] established the concept of mappings on fuzzy soft classes and soft classes, respectively. Alkhazaleh et al. [35] explored the notion of a mapping on classes and categorized neutrosophic soft sets into neutrosophic soft classes. Sulaiman et al. [37] conceptualized the mappings between collections of multi-aspect fuzzy soft sets. Bashir established the concept of mappings between intuitionistic fuzzy soft sets and Salleh [36]. The Fuzzy Hypersoft (FHS) and Hypersoft (HS) sets were suggested by Samarandache [19] in 2018 as extensions of fuzzy soft and soft sets, respectively. Crisp, fuzzy, intuitionistic fuzzy, neutrosophic, and plithogenic early worlds were the types of initial universes he distinguished at that time. He also demonstrated that an FHS set might be crisp, intuitionistic, neutrosophic, and plithogenic in this way. Saeed et al. [26], [50] explained the rudiments of Hypersoft set. Numerous applications of SS, neutrosophic set, neutrosophic Hypersoft set in the pattern recognition, medical diagnostics, MCDM and described mappings in a hypersoft set scenario were also explained by Saeed et al. [14], [25], [27], [29], [30], [34], [49], [55], [56]. Osgouie and Azizi [57] presented the use of fuzzy logic direct model reference adaptive control (DMRAC) for insulin infusion control for diabetic type 1 patients. Azizi and Seifipour [58] attempted to simulate the remodeling phase of dermal wound healing processing using neural networks as an intelligence technique. Wang et al. [59] presented the Pythagorean fuzzy interactive Hamacher power aggregation operators for assessment of express service quality with entropy weight. Liu et al. [60] developed the relation between hesitant fuzzy sets with application in medical diagnosis. Molla et al. [61] discussed the Pythagorean fuzzy Promethee method and apply it in medical diagnosis. Khan et al. [62], [63] extended the concept of fuzzy set to spherical fuzzy set and applied it for decision making purpose and medical diagnosis.

Ramot et al. [52] presented the idea of a thorough examination of the mathematical characteristics of the CF set. The CF complement, union, and intersection were explored as basic set-theoretic operations on CF sets. Thirunavukarasu et al. [47] investigated the intuitive comprehension of the aggregation process of a CF soft set. They also presented aggregation operations applications, proving that the method may be utilized successfully in various circumstances, including uncertainties and periodicities. Rahman et al. [48] developed the complex hypersoft (CHS) set and used a CF set, a complex intuitionistic fuzzy set, and a complex neutrosophic set to create hypersoft hybrids. Al-Qudah et al. [46] introduced the notion of a complex multi-fuzzy set, which is a mix of CF sets and multi-fuzzy sets. By simultaneously preserving the amplitude and periodic nature of the C-numbers, their proposed approach will be prepared to handle with two-dimensional multi-fuzzy data's uncertainties and ambiguity.

A. MOTIVATION

Since it is difficult to determine the specific type of HIV from its severity using prior existing theories and methods [17], [18], [51], and [44] because these techniques are confined to complete models, the main goal of this study is to model a realistic scenario of HIV clinical diagnosis and appropriate and successful treatment. The techniques outlined in [17], [18], [51] and [44] are insufficient for a thorough examination of the data for improved comprehension and treatment. They are incapable of managing complex (two-dimensional) information. We extended these models to a complex system characterized by a merging of fuzzy set and Hypersoft (HS) set to address such issues. In two respects, this structure is more adaptable. First, its membership range expands to the unit circle in a complex plane by altering the CFHS to include an additional term, the P-term, to account for the data's periodic nature. Second, the attributes in CFHS may be subdivided into attributive values for better comprehension. A mapping is a relationship between two region regulated by some mathematical laws that convert an knotted parameter to its related fundamental parametric types of values based on structural and basis similarities. This mapping enables to deal with similar-type parameters in a individual basic parameter. The objective of the research is to describe HIV diagnoses in the area and the symptoms that accompany them. It's tough to identify which type of HIV is causing the issue and how serious it is after looking at the HIV side effects. To tackle this problem, the CFHS set is utilized and CFHS-mapping and its inverse mapping. This study shows a connection between symptoms and medicines, which helps to simplify the story. A table based on a fuzzy interval of $[0, 1]$ is developed for the various kinds of HIV. The computation is based on CFHS-mapping, which correctly identifies the condition and selects the optimum treatment for each patient's associated illness. Finally, a generalized CFHS-mapping is provided, which will aid a specialist in extracting the patient's improvement record and forecasting the length of therapies needed to clear the illness.

B. PAPER PRESENTATION

The following is how the rest of the article is organized. The concepts of CF soft set, HS set, CFHS set, HS mapping and HS inverse mapping are re-imagined in Section II. Section III describes mapping on CFHS classes, the CFHS image, inverse image of CFHS. The validity of the recommended approach is demonstrated in section IV by a practical implementation and a comparison study. Finally, the conclusion has been discussed in the last section.

II. PRELIMINARIES

A few fundamental definitions for the universe S are offered in this section.

Definition 1: [47] Let S and H be initial universal set and parameters set respectively, let $A \subseteq H$ and φ_A be a CF soft set over S for all $y \in H$. Then, an CF soft set φ_A over S defined by a function μ_A representing a mapping $\varphi_A : A \rightarrow C(S)$. Here, μ_A is called CF approximate function of the CF soft set φ_A, and the value μ_A is a CF set called y-element of the CF soft set for all $y \in A$. Thus, a CF soft set φ_A over S can be represented by the set of ordered pairs $\varphi_A = \{(y, \mu_A(y)) : y \in E, \mu_A(y) \in C(S)\}$. Note that the set of all the CF sets over S will be denoted by $C(S)$.

Definition 2: [19] Let $\delta_1, \delta_2, \delta_3, \cdots, \delta_n$ be attribute valued sets of distinct attributes $t_1, t_2, t_3, \cdots, t_n$ respectively, where $\delta_l \cap \delta_m = \emptyset$, for $l \neq m$. Then (Ψ, N) is said to be HS set over S, where Ψ is the mapping from N to the power set of S and $N = \delta_1 \times \delta_2 \times \delta_3 \times ... \times \delta_n$. For more detail please see [24], [26], [31], [32], [54].

Definition 3: [48] Let $\delta_1, \delta_2, \delta_3, \cdots, \delta_n$ be attribute valued of distinct attributes $t_1, t_2, t_3, \cdots, t_n$ respectively, for $n \geq 1$, $N = \delta_1 \times \delta_2 \times \delta_3 \times ... \times \delta_n$, and $\chi(\gamma)$ is said to be CF set over S for all $\gamma = (\varrho_1, \varrho_2, \varrho_3, ..., \varrho_n) \in N$, such that $\varrho_1 \in N_1, \varrho_2 \in N_2, \varrho_3 \in N_3, ..., \varrho_n \in N_n$. Then, CFHS set (Ψ, N) over S is represented as $(\Psi, N) = \{(\gamma, \psi(\gamma)) : \gamma \in N, \psi(\gamma) \in C(S)\}$, where $\psi : N \rightarrow C(S), \psi(\gamma) = \emptyset$, if $\gamma \notin N$ is a CF map of (Ψ, N) and $\psi(\gamma)$ is said to be $\gamma-$member of CFHS set $\forall\, \gamma \in N$.

Definition 4: [49] Let $(\Im, \mathcal{J})$ and $(\xi, \mathcal{W})$ be two classes of HS sets with universal sets $\Im$ and ξ respectively. Let $\mu : \Im \rightarrow \xi$ and $\varrho : \mathcal{J} \rightarrow \mathcal{W}$ be mappings. Then a mapping $\vartheta = (\mu, \varrho) : (\Im, \mathcal{J}) \rightarrow (\xi, \mathcal{W})$ is defined as for HS set $(\hbar, \aleph)$ in $(\Im, \mathcal{J})$ and $\vartheta(\hbar, \aleph)$ is HS set in $(\xi, \mathcal{W})$ obtained as follows, For $\vartheta \in \varrho(\mathcal{J}) \subseteq \mathcal{W}$ and $y \in \xi$, then

$$\vartheta(\hbar, \aleph)(\vartheta)(y) = \begin{cases} \cup_{x \in \mu^{-1}(y)} \left(\cup_{\varepsilon \in \varrho^{-1}(\vartheta) \cap \aleph} \hbar(\varepsilon) \right)(x), \text{if} \\ \qquad \mu^{-1}(y) \neq \emptyset,\ \varrho^{-1}(\vartheta) \cap \aleph \neq \emptyset \\ 0 \qquad \text{if} \quad otherwise \end{cases} \tag{1}$$

$\vartheta(\hbar, \aleph)$ is called a HS image of HS set $(\hbar, \aleph)$.

Definition 5: [49] Let $(\Im, \mathcal{J})$ and $(\xi, \mathcal{W})$ are two classes of HS sets, where $\Im$ and ξ considers as the universal sets respectively. Suppose $\mu : \Im \rightarrow \xi$ and $\varrho : \mathcal{J} \rightarrow \mathcal{W}$ be mappings. Now, let $(\ell, \Im)$ be a HS set in $(\xi, \mathcal{W})$, where $\Im \subseteq \mathcal{W}$ then $\vartheta^{-1}(\ell, \Im)$ is a HS set in $(\Im, \mathcal{J})$ represented in the following way,

$$\vartheta^{-1}(\ell, \Im)(\varepsilon)(x) = \begin{cases} \ell(\varrho(\varepsilon)(\mu(x) & \text{if } \varrho(\varepsilon) \in \Im \\ 0 & \text{if } otherwise \end{cases} \tag{2}$$

where $\varepsilon \in \varrho^{-1}(\Im) \subset \mathcal{J}$, then $\vartheta^{-1}(\ell, \Im)$ called to be HS inverse image of HS set $(\ell, \Im)$.

III. COMPLEX FUZZY HYPERSOFT CLASSES MAPPINGS

This portion introduces the idea of mapping on CFHS classes. CFHS sets are gathered in CFHS sets. We also characterise the features of CFHS, such as CFHS images and CFHS inverse images of CFHS sets. Consider the following points as you read through this section, $\delta_1 \times \delta_2 \times \delta_3 \times ... \times \delta_n = \mathcal{D}$, $\delta_1' \times, \delta_2' \times \delta_3' \times ... \times \delta_n' = \mathcal{Q}$.

Definition 6: Let $(X, \mathcal{D})$ and $(Y, \mathcal{Q})$ be two classes of CFHS over X and Y respectively. Let $\eta : X \rightarrow Y$ and $\theta : \mathcal{D} \rightarrow \mathcal{Q}$ be mappings, and let $(\chi, \mathcal{D}) \in (X, \mathcal{D})$ and $(\psi, \mathcal{Q}) \in (Y, \mathcal{Q})$.

1) The image of $(\chi, \mathcal{D})$, denoted by $\varphi(\chi, \mathcal{D})$ is an $CFHS$ in $(Y, \mathcal{Q})$ defined as

$$\varphi((\chi, \mathcal{D})(\tau)(y) = \begin{cases} \bigvee_{x \in \eta^{-1}(y)} \left(\bigvee_{\nu \in \theta^{-1}(\tau) \cap \mathcal{D}} \chi(\nu) \right), \text{if } \eta^{-1}(y) \\ \qquad and\ \ \theta^{-1}(\tau) \cap \mathcal{D} \neq \emptyset, \\ 0,\ otherwise \end{cases} \tag{3}$$

where φ is a mapping $\varphi : (X, \mathcal{D}) \rightarrow (Y, \mathcal{Q})$, and $\tau \in \theta(\mathcal{D}) \subseteq \mathcal{Q}$, $\nu \in \theta^{-1}(\tau) \cap \mathcal{D} \neq \emptyset$, and $y \in Y$. If $\eta^{-1}(y)$ and $\theta^{-1}(\tau) \cap \mathcal{D} \neq \emptyset$, then

$$\varphi((\chi, \mathcal{D})(\tau)(y) = \bigvee_{x \in \eta^{-1}(y)} \left(\bigvee_{\nu \in \theta^{-1}(\tau) \cap \mathcal{D}} \chi(\nu) \right) \tag{4}$$

$$\varphi((\chi, \mathcal{D})(\tau)(y) = \bigvee_{x \in \eta^{-1}(y)} \left(\bigvee_{\nu \in \theta^{-1}(\tau) \cap \mathcal{D}} \chi(\nu) \right) \tag{5}$$

$$= \bigvee_{x \in X} \left(\bigvee_{\nu \in \{\nu_1, \nu_2, \nu_3, ..., \nu_n\}} \chi(\nu) \right)$$

$$= [max\langle max\{\mu_{\chi(\nu_1)} u_i, \mu_{\chi(\nu_2)} u_i, \mu_{\chi(\nu_3)} u_i ... \mu_{\chi(\nu_n)} u_i\}\rangle]$$
$$= [\max\{r_{\chi(\nu_1)}(u_i), r_{\chi(\nu_2)}(u_i), r_{\chi(\nu_3)}(u_i) ... r_{\chi(\nu_n)}(u_i)\} \\ e^{imax\{arg_{\chi(\nu_1)}(u_i), arg_{\chi(\nu_2)}(u_i), arg_{\chi(\nu_3)}(u_i) ... arg_{\chi(\nu_n)}(u_i)\}}],$$

where $u_i \in X, \nu_1, \nu_2, ..., \nu_n \in \theta^{-1}(\tau) \cap \mathcal{D}$.

2) The inverse image of $(\psi, \mathcal{Q})$, denoted by $\varphi^{-1}(\psi, \mathcal{Q})$, is an CFHS in $(X, \mathcal{D})$, and is defined as

$$\varphi^{-1}((\psi, \mathcal{Q})(\nu)(u) = \begin{cases} G(\theta(\nu)\eta(u)), & \text{if } \theta(\nu) \in \tau, \\ 0, & otherwise \end{cases} \tag{6}$$

for $\nu \in \theta^{-1}(\tau)$ and $u \in X$.

Definition 7: Let $\varphi : (X, \mathcal{D}) \rightarrow (Y, \mathcal{Q})$ be a mapping and $(\chi, \mathcal{D})$ and $(\psi, \mathcal{Q})$ be the two CFHS sets in $(X, \mathcal{D})$. Then, for $\tau \in \mathcal{Q}$, CFHS union and intersection of CFHS images of $(\chi, \mathcal{D})$ and $(\psi, \mathcal{Q})$ in $(X, \mathcal{D})$ are given as;

$$(\varphi(\chi, \mathcal{D}) \cup \varphi(\psi, \mathcal{Q}))(\tau) = \varphi(\chi, \mathcal{D})(\tau) \cup \varphi(\psi, \mathcal{Q})(\tau),$$

$$(\varphi(\chi, \mathcal{D}) \cap \varphi(\psi, \mathcal{Q}))(\tau) = \varphi(\chi, \mathcal{D})(\tau) \cap \varphi(\psi, \mathcal{Q})(\tau).$$

This article has been accepted for publication in a future issue of this journal, but has not been fully edited. Content may change prior to final publication. Citation information: DOI 10.1109/ACCESS.2021.3099335, IEEE Access

Definition 8: Let $\varphi : (X, \mathcal{D}) \rightarrow (Y, \mathcal{Q})$ be a mapping and $(\chi, \mathcal{D})$ and $(\psi, \mathcal{Q})$ be the two CFHS sets in $(X, \mathcal{D})$. Then for $\nu \in \mathcal{D}$, CFHS union and intersection of CFHS inverse images of $(\chi, \mathcal{D})$ and $(\psi, \mathcal{Q})$ in $(X, \mathcal{D})$ are given as;

$$(\varphi^{-1}(\chi, \mathcal{D}) \cup \varphi^{-1}(\psi, \mathcal{Q}))(\nu) = \varphi^{-1}(\chi, \mathcal{D})(\nu) \cup \varphi^{-1}(\psi, \mathcal{Q})(\nu),$$

$$(\varphi^{-1}(\chi, \mathcal{D}) \cap \varphi^{-1}(\psi, \mathcal{Q}))(\nu) = \varphi^{-1}(\chi, \mathcal{D})(\nu) \cap \varphi^{-1}(\psi, \mathcal{Q})(\nu).$$

The properties of CFHS mapping are illustrated in the following manner.

Theorem 1: Let $\varphi : (X, \mathcal{D}) \rightarrow (Y, \mathcal{Q})$ be a CFHS mapping, let $(\chi, \mathcal{D})$, $(\psi, \mathcal{Q})$ be the two CFHS sets in $(X, \mathcal{D})$ we have,

1) $\varphi(\emptyset) = \emptyset$
2) $\varphi(X) \subset Y$
3) $\varphi((\chi, \mathcal{D}) \cup (\psi, \mathcal{Q})) = \varphi(\chi, \mathcal{D}) \cup \varphi(\psi, \mathcal{Q})$.
4) $\varphi((\chi, \mathcal{D}) \cap (\psi, \mathcal{Q})) \supseteq \varphi(\chi, \mathcal{D}) \cap \varphi(\psi, \mathcal{Q})$.
5) If $(\chi, \mathcal{D}) \subseteq (\psi, \mathcal{Q})$ then $\varphi(\chi, \mathcal{D}) \subseteq \varphi(\psi, \mathcal{Q})$.

Following theorem provides some important properties of inverse CFHS mapping under two sets.

Theorem 2: Let $\varphi : (X, \mathcal{D}) \rightarrow (Y, \mathcal{Q})$ be a mapping, $(\chi, \mathcal{D})$ and $(\psi, \mathcal{Q})$ be the two CFHS sets in $(X, \mathcal{D})$ we have,

1) $\varphi^{-1}(\emptyset) = \emptyset$,
2) $\varphi^{-1}(Y) = X$,
3) $\varphi^{-1}((\chi, \mathcal{D}) \cup (\psi, \mathcal{Q})) = \varphi^{-1}(\chi, \mathcal{D}) \cup \varphi^{-1}(\psi, \mathcal{Q})$,
4) $\varphi^{-1}((\chi, \mathcal{D}) \cap (\psi, \mathcal{Q})) = \varphi^{-1}(\chi, \mathcal{D}) \cap \varphi^{-1}(\psi, \mathcal{Q})$,
5) If $(\chi, \mathcal{D}) \subseteq (\psi, \mathcal{Q})$ then $\varphi^{-1}((\chi, \mathcal{D}) \subseteq \varphi^{-1}(\psi, \mathcal{Q})$.

IV. APPLICATIONS OF CFHS SET IN HIV

In this section, HIV and its relevant problems are analyzed. The factors taken into consideration are reasons, symptoms, diagnosis, and treatment of HIV patients. We go through the CFHS set's overall notion and its relative mapping, and inverse mapping. Then it is demonstrated how to build a treatment plan using the suggested mathematical model for HIV patients.

A. HIV AND ITS PROPERTIES ARE BEING INVESTIGATED

The importance of HIV analytical research and mathematical modeling in the medical profession is immeasurable. There are two types of HIV which are under consideration.

- HIV-1
- HIV-2

1) HIV-1

The HIV-1 virus's genome comprises two similar 9.2 kb single-stranded RNA chains encapsulated within the virion. The consistent for the virus presents itself as proviral double-stranded DNA when tested inside an infected cell. One of the significant signs of progression of AIDS in an HIV-1 infected patient is the respective decline of $CD4'$ lymphocytes that serve as the primary attachment site for HIV and the induction of specific cell-mediated responses [7]. Also, it was found that high levels of plasma viral RNA can cause an increased progression rate; a great deal of emphasis has been put on ways to reduce plasma viremia. Many antiretroviral drugs have been designed to alleviate the issue of stopping the life cycle of the virus [5], [6]. For more detail see Fig 1, 2.

FIGURE 1. Scanning electron micrograph of HIV-1 (in green) budding from cultured lymphocyte. Multiple round bumps on cell surface represent sites of assembly and budding of virions. *Source*: https:en.wikipedia.org/wiki/HIV

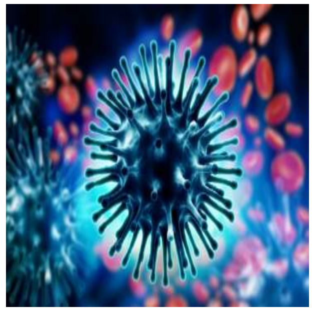

FIGURE 2. Diagram of the immature and mature forms of HIV. *Source*:https:www.drugtargetreview.com/news/33677/igm-antibodies-hiv-1/

2) HIV-2

HIV-2 is regarded as the second type of virus that leads to AIDS. It has been found that the HIV-2 virus has been tested positive in heterosexual communities in West Africa, but its spread is very limited [8], [9]. In addition, it has been reported that the infection of the HIV-2 virus has milder effects in comparison to the HIV-1 virus [10]. Also, the isolation of asymptomatic HIV-2 virus from the peripheral blood mononuclear cells is far less than the HIV-1 virus infection, but with the decline in the $CD4'$ levels, the virus equally efficient leading to a higher rate of disease spread [11], [12]. For more detail see Fig 3 and 4.

- Fever
- Chills
- Rash
- Night sweats
- Muscle aches
- Sore throat
- Fatigue
- Swollen lymph nodes
- Mouth ulcers

This article has been accepted for publication in a future issue of this journal, but has not been fully edited. Content may change prior to final publication. Citation information: DOI 10.1109/ACCESS.2021.3099335, IEEE Access

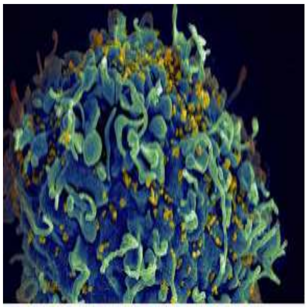

FIGURE 3. HIV-2: The Less Common Cousin of HIV-1. *Source*: https: www.verywellhealth.com/what-is-hiv-49346

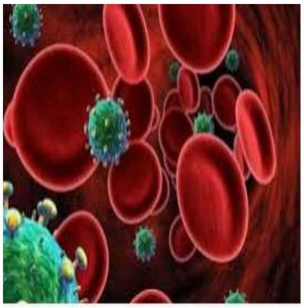

FIGURE 4. Human immunodeficiency virus 2. *Source*:https:viralzone.expasy.org/64 outline=all by species

- Rapid weight loss
- Pneumonia

B. METHODOLOGY

1) Pre Stage

Because of the same symptoms of HIV, a specialist has a few challenges while examining an HIV patient. The contrast between the different classification of HIV is complicated to grasp. It suggests that these kinds of barriers are made up of ambiguity and vagueness. For this purpose, the CFHS set is suited for dealing with such data. A chart between 0 and 1 has been created to assess the genuine kind of HIV from its different types; see Table 1.

TABLE 1. Diagnosis chart of HIV

Kinds of HIV	Various ranges of $[0, 1]$
HIV-1	$[0.6, 1]$
HIV-2	$[0.1, 0.6)$
No HIV	$[0, 0.1)$

Since each issue becomes more concentrated over time, the paper will collect more helpful information about a patient's history, and each physician will compare the appearance of side effects to at least 2-3 days of data after monitoring side effects, if there is any, of disease. To examine the HIV patient's condition, additional graphs of conditions and their day-by-day fixation have been created. This may be found in Table 2 and Figure 5. For each type of HIV, there are three stages: serious, moderate, and low. The flow chart in Figure 5 also shows the different ranges that have been allocated to these constraints.

2) Algorithm

Step 1.
To classify the HIV family. Let $P = \{p_1, p_2, p_3, ..., p_n\}$ be group of patients suffering from HIV and $A = \{d_1, d_2, d_3, ..., d_v\}$ be a collection of clinical symptoms of HIV whose parametric values links to sets D_i's, where $D = \prod_{i=1}^{v} D_i$. With the help of a mathematician, the administration creates the number of daily diagnostic charts denoted as "t." (which may be fitted up as a CFHS set). This chart will aid us in determining the patient's proper infection. After an important assessment at εth times, the specialist's CFHS set chart might be fitted up as follows:
$z^{\varepsilon}_{D} = \{z^{\varepsilon}_{s} = \{p, \langle \mathcal{T}^{\varepsilon}_{s}(p)\rangle\} : \mathcal{T}^{\varepsilon}_{s}(p) \in C(D), p \in P, s \in D\}$, where $\mathcal{T}^{\varepsilon}_{s}(p)$ are CFHS membership of HIV-1, HIV-2 for kth symptoms and lth patients respectively and $(l = 1, 2, 3, ..., n, k = 1, 2, 3, ..., |D|, \varepsilon = 1, 2, 3, ..., t)$. To get maximum information union of CFHS sets is used.
Step 2.
Assume $B = \{d'_1, d'_2, d'_3, ..., d'_w\}$ to represent the collection of linked symptoms to A whose attribute values correspond to sets D'_i's, where $D' = \prod_{i=1}^{w} D'_i$ and evaluate a CFHS set (keep in mind the patients ε number of daily assessments of basic symptoms specialists allots the weights).
Step 3.
Develop a mapping with the following properties: $\theta : P \to P$ and $\sigma : D \to D'$ characterized as follows; $\theta(p_l) = p_l$, $\sigma(s_k) = (s'_{k'})$, $(l = 1, 2, 3, ..., n, k = 1, 2, 3, ..., |D|, k' = 1, 2, 3, ..., |D'|)$ depending on the link between the primary and secondary symptoms.
Let CFHS-mapping $\varpi = (\theta, \sigma) : CFHS(P) \to CFHS(P)$ defined as;

$$\mathcal{T}_{\varpi(z_D)}(s')(p) = |\mathcal{T}_{s'_{k'}}| \begin{cases} \max_{p\in\theta^{-1}(p)} \left(\max_{s\in\sigma^{-1}(s')\cap D} \mathcal{T}_{z_D}\right)(p) \text{ if} \\ \qquad \theta^{-1}(p) \neq \emptyset, \sigma^{-1}(s') \cap D \neq \emptyset, \\ 0 \text{ if } otherwise \end{cases} \tag{7}$$

where $\mathcal{T}_{s'_{k'}}$ corresponds to associated weights from $z_{D'}$. Get the $\sqcup z^{\varepsilon}_{D}$ image under the described mapping ϖ,, which may be constructed as $z'_{D'}$.
Step 4.
Convert CFHS set to fuzzy hypersoft set to get weighted aggregation values by using the formula, $\mathcal{T}_{z'(s')}(p) = w_1\mu_{z'(s')}(p) + w_2(\frac{1}{2\pi})\omega_{z'(s')}(p)$ [53], where $\mu_{z'(s')}(p)$ and $\omega_{z'(s')}(p)$ are the amplitude and periodic terms in the CFHS set respectively, $\mathcal{T}_{z'(s')}(p)$ is the membership function in the fuzzy Hypersoft set for $w_1, w_2 \in [0, 1]$.
Step 5.
Compare these results obtained from Step 4 with the Table 2 and get basic diagnosis. These results will later be assessed to verify the reliability of the obtained results.
Step 6.
Calculate the average of each individual patient corresponding to their connected symptoms. Now, the results obtained are compared with the diagnosis Table 1.

This article has been accepted for publication in a future issue of this journal, but has not been fully edited. Content may change prior to final publication. Citation information: DOI 10.1109/ACCESS.2021.3099335, IEEE Access

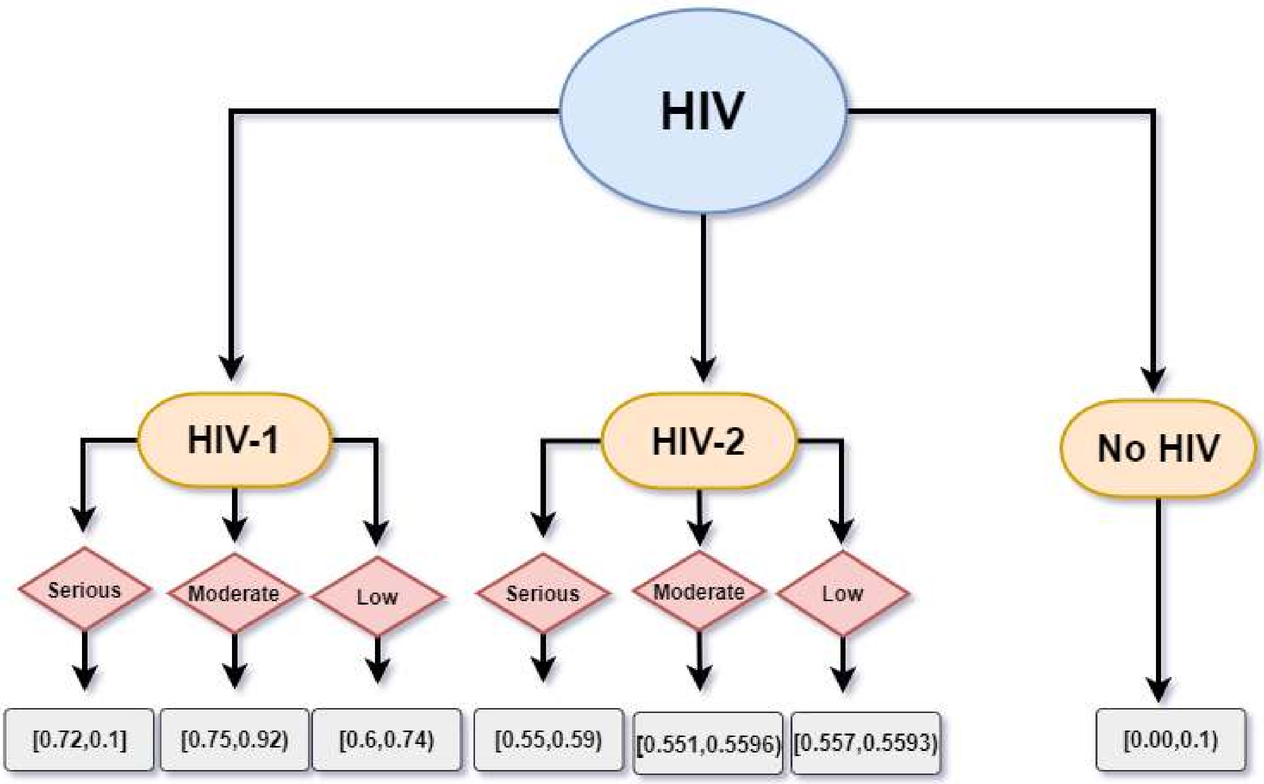

FIGURE 5. Flowchart with various ranges correlating to the HIV conditions stated.

TABLE 2. Associated restrictions to investigate HIV

settings	On the first day	On the second and third days	After the third day
serious (HIV-1)	[0.72,0.8)	[0.8,1)	= 1
moderate (HIV-1)	[0.75,0.82)	[0.82,0.87)	[0.87,0.92)
low (HIV-1)	[0.5,0.51)	[0.52,0.55)	[0.57,0.58)
serious (HIV-2)	[0.2,0.21)	[0.21,0.22)	[0.22,0.33)
moderate (HIV-2)	[0.12,0.192)	[0.192, 0.193)	[0.193,0.195)
low (HIV-2)	[0.18,0.182)	[0.182,0.183)	[0.183,0.184)
No HIV	[0.00,0.01)	[0.01,0.08)	[0.01,0.1)

Step 7.
Consider $B = \{d'_1, d'_2, d'_3, ..., d'_w\}$ to represent the collection of related symptoms, $C = \{g_1, g_2, g_3, ..., g_x\}$ is a collection of potential treatments and to create $\chi_{D'}$, where $k' = \prod_{i=1}^{w} |D'_i|$ is a accumulation of potential medications and $\chi = D' \rightarrow P(C)$ is a CFHS function from which is the bundle of doctor's recommendations accompanied with the right treatment for HIV symptoms.
Step 8.
Calculate CFHS set union among $z'_{D'}, \chi_{D'}$ and get P^1_C.
Step 9.
Choose medications (treatments) that offer extra benefits and have fewer negative impacts. The following procedures can be followed for the patient's improvement record.

Step 10.
Define a new class of generalised mappings: $\theta' : J^{q-1} \rightarrow J^q$ and
$\theta' : P^{q-1} \rightarrow P^q$ and $\sigma' : C^{q-1} \rightarrow C^q$ such that $\theta'(p_l) = p_l$ and $\sigma'(g_x) = g_x$. Then CFHS-mapping may be represented in the following way: $\varpi' = (\theta', \sigma') : P^{q-1}_C \rightarrow P^q_C$ and computed as:

$$P^q_C = \varpi'(P^{q-1}_C)(g)(p)$$
$$= \frac{1}{q} \begin{cases} \sqcup_{\pi \in \theta'^{-1}(p)} \left(\sqcup_{\vartheta \in \sigma'^{-1}(g) \cap C} P^{q-1}_C \right)(\pi) \text{ if} \\ \qquad \theta'^{-1}(p) \neq \emptyset, \sigma'^{-1}(g) \cap C \neq \emptyset, \\ 0 \ \text{ if } otherwise \end{cases} \quad (8)$$

where $g \in \sigma'(C) \subseteq C$, $p \in P^q$, $\pi \in P^{q-1}$, $\vartheta \in (C)^{q-1}$ for $q = 2, 3, 4....$
Step 11.

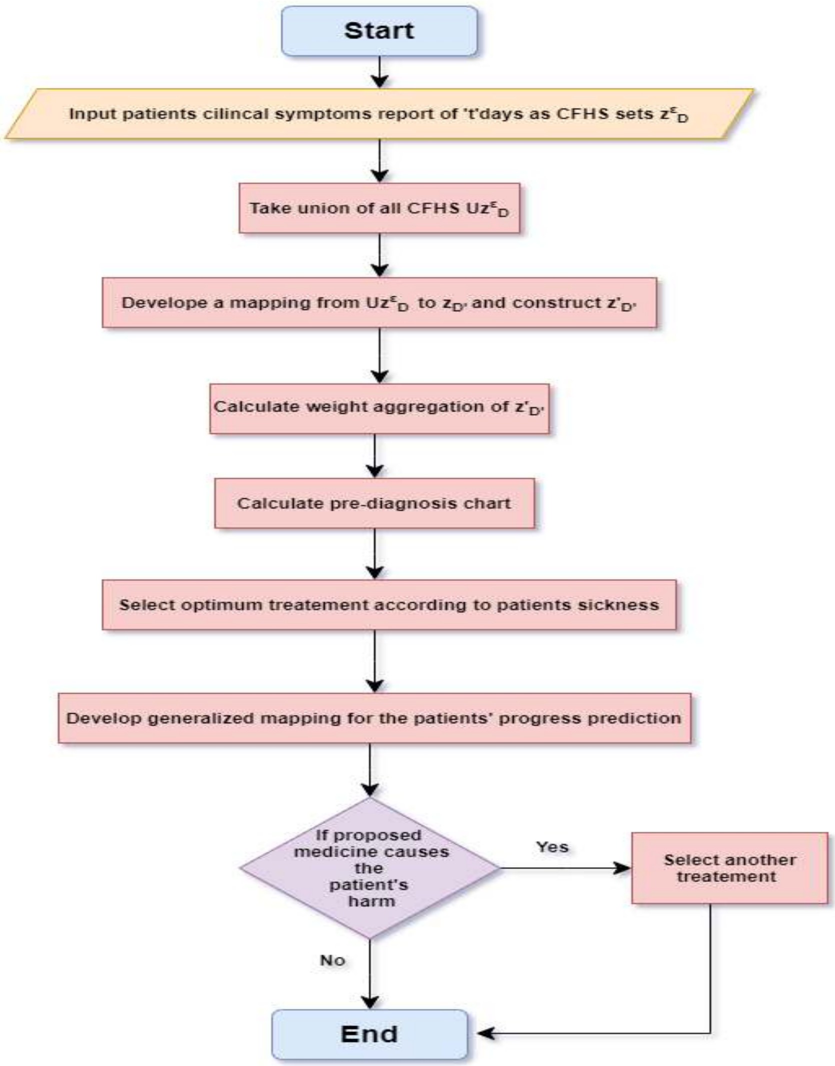

FIGURE 6. Flowchart for the proposed algorithm.

Repeat step 10 as needed till we achieve the desired results. The flow chart for the proposed algorithm is shown in 6

3) Methodological Limitations

Before performing the algorithm, it is necessary to check that the following limits of the proposed technique are met:

1) Because both parameters have the same structure and base, there must have been a mapping that converts the linked parameter into its basic parametric value.
2) Both sets of mapping or composition specifications should be independent of one another and belong to the same structural class.
3) According to a doctor's advice, the right medication for the disease's symptoms should be understood based on the illness's supporting evidence.
4) With the assistance of a doctor, the various ranges of concerning sorts of sickness must be identified.
5) If the proposed medicine causes the patient harm, inverse CFHS-mapping can be utilized to restore him to his proper level, and then we must restart medicine from the beginning.

C. STUDY PROPOSAL AND NUMERICAL EXAMPLE

This portion focuses on applying the recommended algorithm to a medical context. First, the input samples are translated and gathered in mathematical language with the help of medical personnel. The next stage is to choose a group of patients with HIV symptoms as identified by the doctor. A diagnostic map for the conditions of distinct HIV (Table 1) and their day-to-day circumstances (Table 2) about the diagnosis was developed under the supervision of the doctor. These tables can be used to compare HIV symptoms to

This article has been accepted for publication in a future issue of this journal, but has not been fully edited. Content may change prior to final publication. Citation information: DOI 10.1109/ACCESS.2021.3099335, IEEE Access

the severity of the disease. The technique's most significant benefit is that it lets you utilize the initial data from our suggested model to figure out what kind of sickness you have. In addition, the algorithm will suggest the optimal treatment choice for the identified condition's specific form. A generalised mapping of the patient's rehabilitation and optimum recovery for patients will help the approach expand in the future. Four patients had a specific type of HIV that required a doctor's diagnosis. However, it's challenging to pick the proper one because there are several overlapping symptoms for a comparable ailment. Numerous dynamics are ruled out the health of patient's, current and previous skin colour changes, history, hereditary variables, and other factors. Following the first evaluation of the patient, the doctor will recommend a treatment and rehabilitation plan. To execute the given method, we used hypothetical data. It's a methodology and a technique that demonstrates how to use mathematical calculations to compute the proposed model. However, if this model is created for real-time data, the required result can be obtained by analyzing appropriate information.

Step 1.

Let $P = \{p_1, p_2, p_3, p_4\}$ be collection of four patients. Let d_1 =Overexertion, d_2 = Headache, d_3 = Pneumonia, be symptoms with distinct attributes whose attribute values are related to the sets D_1, D_2 and D_3 respectively. Let $D_1 = \{d_{11} =$ feeling faint, $d_{12} =$ strains$\}$, $D_2 = \{d_{21} =$ Migraines$\}$, $D_3 = \{d_{31} =$ bacterial infections, $d_{32} =$ Chills$\}$, which can be evaluated by a doctor after a thorough examination. Based on the first information provided by patients with the symptoms described above, we can generate a chart of two ($\varepsilon = 2$) days with the data gathered by the doctor supplied as $z^{\varepsilon}_{D} \in CFHS(P)$ for the 1st and 2nd-day data given as Table 3 and Table 4 separately, both in CFHS. Next, we take CFHS-union over the z^1_D and z^2_D. The resultant CFHS $\sqcup z^{\varepsilon}_{D}$ is given as Table 5.

Step 2.

Let $D'_1 = \{d'_{11}$ =dizziness, d'_{12} = redness and swelling$\}$, $D'_2 = \{d'_{21}$ = sore or aching muscles$\}$, $D'_3 = \{d'_{31}$ = intermittent, d'_{32} = remittent$\}$ be three sets of attribute values corresponding to three distinct attributes d'_1 = Muscle aches, d'_2 = Fatigue, d'_3 =Fever respectively for HIV related symptoms. Doctors assign the weight to the related symptoms based on patient's information and transform verbally information to the numerical notation to create the CFHS $z_{D'}$ type shown in Table 6.

Step 3.

Now, consider two mappings; $\theta : P \to P$ and $\sigma : D \to D'$ such that;

$\theta(p_1) = p_1, \theta(p_2) = p_2, \theta(p_3) = p_3, \theta(p_4) = p_4$, and
$\sigma(d_{11}, d_{21}, d_{31}) = (d'_{11}, d'_{21}, d'_{31})$,
$\sigma(d_{11}, d_{21}, d_{32}) = (d'_{12}, d'_{21}, d'_{31})$,
$\sigma(d_{12}, d_{21}, d_{31}) = (d'_{11}, d'_{21}, d'_{32})$,
$\sigma(d_{12}, d_{21}, d_{32}) = (d'_{12}, d'_{21}, d'_{32})$.

Then CFHS-mapping can be written in this manner $\varpi = (\theta, \sigma) : CFHS(P) \to CFHS(P)$. Now, using the aforementioned mapping in Step 3 in algorithm, we calculate the image of $\sqcup z^{\varepsilon}_{D}$ provided as $z'_{D'}$ in Table 6.

Step 4.

Convert Table 6 (CFHS set) to fuzzy hypersoft set to get weighted aggregation values in Table 7 by using the formula $\mathcal{T}_{z'(s')}(p) = w_1\mu_{z'(s')}(p) + w_2(\frac{1}{2\pi})\omega_{z'(s')}(p)$ [53], with weights $w_1 = 0.2, w_2 = 0.4$.

Step 5.

Comparing the Tables 7 and 2 to acquire initial diagnosis table (8). This table will be used after analyzing the precision of our outcomes.

Step 6.

Calculate average of all the attributes corresponding to every individual's symptoms from Table 7. These values are given in Table 9. HIV's diagnosis Table 1 is now being compared to the results obtained in Table 9. The comparison revealed that patients p_1, p_3 are diagnosed with HIV-1 and patients p_2, p_4 are diagnosed with HIV-2.

Step 7.

After determining the true nature of each patient's disease, the doctor will recommend medication to them and to create the CFHS set based on the suggestions of specialists, including the appropriate treatment for the different sorts of HIV. Consider $C = \{g_1$ = emtricitabine, g_2 = lamivudine, g_3 = tenofovir DF, g_4 = zidovudine$\}$ be different viable medications (treatments), then construct $\chi_{D'}$, that is a set of doctor's suggestions for the best treatment for HIV symptoms and convert CFHS into fuzzy hypersoft set by using the formula $\mathcal{T}_{z'(s')}(p) = w_1\mu_{z'(s')}(p) + w_2(\frac{1}{2\pi})\omega_{z'(s')}(p)$ [53], with weights $w_1 = 0.2, w_2 = 0.4$ to get weighted aggregation. The set $\chi_{D'} \in CFHS(P)$ given as Table 10. In table 10, the assessments are given in accordance with each patient's medical history.

Step 8.

Calculate CFHS set union among $\chi_{D'}$ and $z'_{D'}$ and get the relationship between proposed medications and patients as CFHS set $\chi_{D'} \sqcup z'_{D'} = P^1_C$, see Table 11.

Step 9.

The recommended medicine is appropriate for those patients which shows improvement and less side effcts. The maximum values relating to each patient's medication are given in (Table 12). In Table 12, it is obvious that treatments g_4, g_1 or g_3 or g_4, g_1, g_4 is fit for the patient of p_1, p_2, p_3 and p_4 respectively. The final choice is made depending on the patient's present state, clinical history, and kind of sickness.

Step 10.

The patient's situation is determined by the type of sickness and the patient's medical history. The episodes can be repeated until the sickness has completely disappeared. One can track each patient's progress using the CFHS-mapping and establishing two mappings $\theta' : P^{q-1} \to P^q$ and $\sigma' : C^{q-1} \to C^q$ such that

$$\theta'(p_1) = p_1, \theta'(p_2) = p_2, \theta'(p_3) = p_3, \theta'(p_4) = p_4;$$

TABLE 3. Tabular representation of z_D^1

symptoms / patients	p_1	p_2	p_3	p_4
(d_{11}, d_{21}, d_{31})	$0.4e^{i0.7\pi}$	$0.1e^{i0.4\pi}$	$0.5e^{i0.2\pi}$	$0.3e^{i0.4\pi}$
(d_{11}, d_{21}, d_{32})	$0.1e^{i0.9\pi}$	$0.8e^{i0.1\pi}$	$0.4e^{i0.8\pi}$	$0.1e^{i0.4\pi}$
(d_{12}, d_{21}, d_{31})	$0.4e^{i0.2\pi}$	$0.8e^{i0.1\pi}$	$0.7e^{i0.9\pi}$	$0.1e^{i0.4\pi}$
(d_{12}, d_{21}, d_{32})	$0.3e^{i0.8\pi}$	$0.1e^{i0.3\pi}$	$0.2e^{i0.4\pi}$	$0.6e^{i0.4\pi}$

TABLE 4. Tabular representation of z_D^2

symptoms / patients	p_1	p_2	p_3	p_4
(d_{11}, d_{21}, d_{31})	$0.2e^{i0.9\pi}$	$0.2e^{i0.4\pi}$	$0.1e^{i0.5\pi}$	$0.2e^{i0.6\pi}$
(d_{11}, d_{21}, d_{32})	$0.2e^{i0.5\pi}$	$0.2e^{i0.3\pi}$	$0.6e^{i0.8\pi}$	$0.2e^{i0.4\pi}$
(d_{12}, d_{21}, d_{31})	$0.4e^{i0.2\pi}$	$0.8e^{i0.1\pi}$	$0.7e^{i0.9\pi}$	$0.1e^{i0.4\pi}$
(d_{12}, d_{21}, d_{32})	$0.5e^{i0.8\pi}$	$0.3e^{i0.4\pi}$	$0.6e^{i0.1\pi}$	$0.8e^{i0.4\pi}$

TABLE 5. Tabular representation of $\sqcup z_D^\varepsilon$

symptoms / patients	p_1	p_2	p_3	p_4
(d_{11}, d_{21}, d_{31})	$0.4e^{i0.9\pi}$	$0.2e^{i0.4\pi}$	$0.5e^{i0.5\pi}$	$0.3e^{i0.6\pi}$
(d_{11}, d_{21}, d_{32})	$0.2e^{i0.9\pi}$	$0.8e^{i0.3\pi}$	$0.6e^{i0.8\pi}$	$0.2e^{i0.4\pi}$
(d_{12}, d_{21}, d_{31})	$0.4e^{i0.2\pi}$	$0.8e^{i0.1\pi}$	$0.7e^{i0.9\pi}$	$0.1e^{i0.4\pi}$
(d_{12}, d_{21}, d_{32})	$0.5e^{i0.8\pi}$	$0.1e^{i0.3\pi}$	$0.6e^{i0.4\pi}$	$0.8e^{i0.4\pi}$

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

symptoms / patients	p_1	p_2	p_3	p_4
$(d'_{11}, d'_{21}, d'_{31})$	$0.4e^{i0.7\pi}$	$0.1e^{i0.4\pi}$	$0.5e^{i0.2\pi}$	$0.3e^{i0.4\pi}$
$(d'_{11}, d'_{21}, d'_{32})$	$0.1e^{i0.9\pi}$	$0.8e^{i0.1\pi}$	$0.4e^{i0.8\pi}$	$0.1e^{i0.4\pi}$
$(d'_{12}, d'_{21}, d'_{31})$	$0.4e^{i0.2\pi}$	$0.8e^{i0.1\pi}$	$0.7e^{i0.9\pi}$	$0.1e^{i0.4\pi}$
$(d'_{12}, d'_{21}, d'_{32})$	$0.3e^{i0.8\pi}$	$0.1e^{i0.3\pi}$	$0.2e^{i0.4\pi}$	$0.6e^{i0.4\pi}$

and

$$\sigma'(g_1) = g_1, \sigma'(g_2) = g_2, \sigma'(g_3) = g_3, \sigma'(g_4) = g_4.$$

The CFHS-mapping may then be written in this manner

$$\varpi' = (\theta', \sigma') : P_C^{q-1} \to P_C^q$$

The CFHS-mapping is given as

$$P_C^q = \varpi'(P_C^{q-1})(g)(p) = \frac{1}{q}\begin{cases} \vee_{\pi\in\theta'^{-1}(p)}(\vee_{\vartheta\in\sigma'^{-1}(g)\cap C} P_C^{q-1}(\pi) \text{ if} \\ \qquad \theta'^{-1}(p) \neq \emptyset, \sigma'^{-1}(g) \cap C \neq \emptyset \\ 0 \quad \text{if } otherwise \end{cases} \tag{9}$$

where $g \in \sigma'(C) \subseteq C$, $p \in P^q$, $\pi \in P^{q-1}$, $\vartheta \in C^{q-1}$ denotes the number of treatments and treatment episodes, see Tables 13, 14, 15 and 16 for values of q.

Step 11.

Step 10 is repeated until the patients' outcomes are achieved. Figures 7, 8, 9 and 10 shows the progress report for each patient.

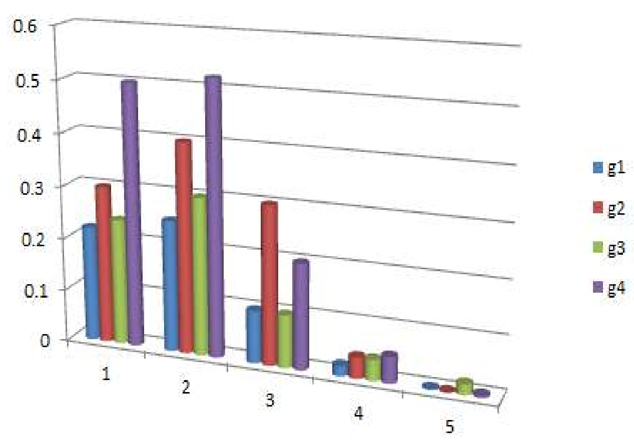

FIGURE 7. Patient p_1 progress graph

D. ADVANTAGES OF THE PROPOSED ALGORITHM

This model tries to find the closest diagnosis of any condition, as well as the symptoms that go with it. These ideas are capable and required for properly assessing an issue when combined with scientific modeling. This investigation shows a relationship between symptoms and medications, making the story easier to follow. To accurately identify the condition and determine the optimum therapy for each patient's ailmen-

This article has been accepted for publication in a future issue of this journal, but has not been fully edited. Content may change prior to final publication. Citation information: DOI 10.1109/ACCESS.2021.3099335, IEEE Access

TABLE 7. Tabular representation of fuzzy hypersoft set

symptoms / patients	p_1	p_2	p_3	p_4
$(d'_{11}, d'_{21}, d'_{31})$	0.22	0.12	0.24	0.2
$(d'_{11}, d'_{21}, d'_{32})$	0.2	0.18	0.24	0.1
$(d'_{12}, d'_{21}, d'_{31})$	0.1	0.18	0.32	0.09
$(d'_{12}, d'_{21}, d'_{32})$	0.22	0.08	0.12	0.2

TABLE 8. Initial diagnostic chart

symptoms / patients	p_1	p_2	p_3	p_4
$(d'_{11}, d'_{21}, d'_{31})$	serious HIV-2	moderate HIV-2	serious HIV-2	serious HIV-2
$(d'_{11}, d'_{21}, d'_{32})$	serious HIV-2	low HIV-2	serious HIV-2	No HIV
$(d'_{12}, d'_{21}, d'_{31})$	NO HIV	low HIV-2	serious HIV-2	NO HIV
$(d'_{12}, d'_{21}, d'_{32})$	serious HIV-2	NO HIV	moderate HIV-2	serious HIV-2

TABLE 9. Score values relating to associated symptoms

patients	Total average score
p_1	0.74
p_2	0.56
p_3	0.92
p_4	0.509

TABLE 10. $\chi_{D'}$: Doctor's recommendations for appropriate treatment.

treatments / symptoms	$(d'_{11}, d'_{21}, d'_{31})$	$(d'_{11}, d'_{21}, d'_{32})$	$(d'_{12}, d'_{21}, d'_{31})$	$(d'_{12}, d'_{21}, d'_{32})$
g_1	0.2	0.3	0.1	0.5
g_2	0.6	0.4	0.6	0.6
g_3	0.6	0.5	0.3	0.2
g_4	0.5	0.3	0.4	0.7

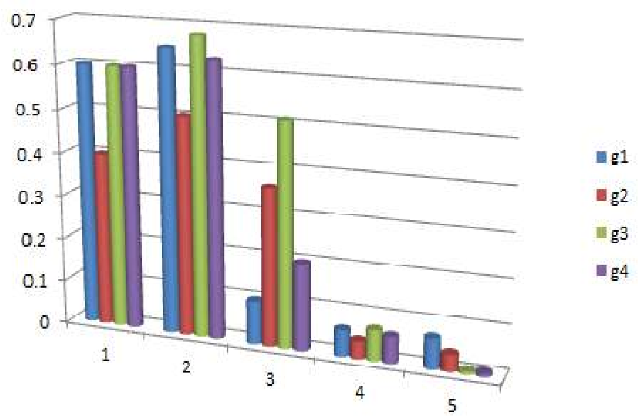

FIGURE 8. Patient p_2 progress graph

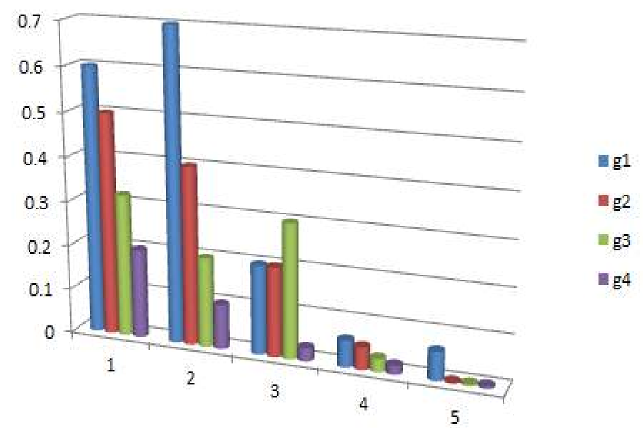

FIGURE 9. Patient p_3 progress graph

t, the computation depends on CFHS-mapping. The generalized CFHS-mapping will help a specialist (Doctor) forecast the patient's progress and estimate the time of therapy until the infection is relieved.

E. COMPARATIVE ANALYSIS

CFHS mapping is a comprehensive idea that may be used for a wide range of diseases. Existing theories cannot be utilised to address or investigate the issues; nevertheless, they do have limitations (see Table 17). Because of these restrictions, they are unable to collect all of a patient's initial

TABLE 11. P_C^1: Union of $\chi_{D'}$ and $z'_{D'}$ to create link between proposed medications and patients

patients / treatments	g_1	g_2	g_3	g_4
p_1	0.22	0.3	0.24	0.5
p_2	0.6	0.4	0.6	0.6
p_3	0.6	0.5	0.32	0.2
p_4	0.5	0.3	0.4	0.7

TABLE 12. Suggested treatment chart

patients / treatments	g_1	g_2	g_3	g_4	Maximum esteems	Selected treatment
p_1	0.22	0.3	0.24	0.5	0.5	g_4
p_2	0.6	0.4	0.6	0.6	0.6	g_1 or g_3 or g_4
p_3	0.6	0.5	0.32	0.2	0.6	g_1
p_4	0.5	0.3	0.4	0.7	0.7	g_4

TABLE 13. P_C^2: Patient's progress report after the second treatment cycle

patients / treatments	g_1	g_2	g_3	g_4
p_1	0.25	0.4	0.3	0.52
p_2	0.65	0.5	0.68	0.63
p_3	0.7	0.4	0.2	0.1
p_4	0.4	0.2	0.1	0.3

TABLE 14. P_C^3: Patient's progress report after the third treatment cycle

patients / treatments	g_1	g_2	g_3	g_4
p_1	0.1	0.3	0.1	0.2
p_2	0.1	0.36	0.51	0.2
p_3	0.2	0.2	0.3	0.03
p_4	0.3	0.02	0.3	0.12

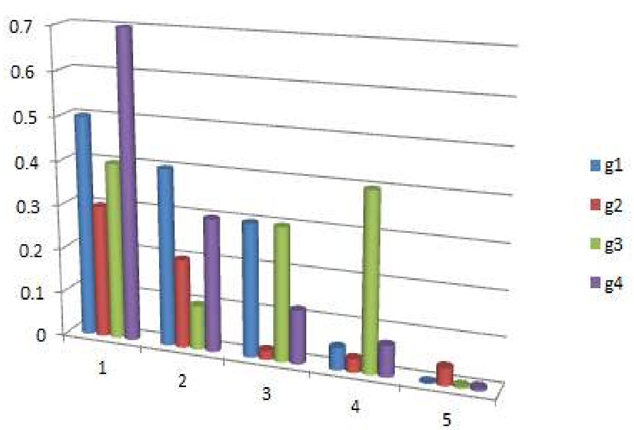

FIGURE 10. Patient p_4 progress graph

data. The proposed methodology can convert a patient's medical history into a mathematical format without losing any data, allowing us to achieve the most refined diagnosis and treatment outcomes. In Table 17, our suggested model is compared to current methodologies. When the attributes have been further split into attribute values, and the concerns include complex $(2D)$ information, all previous methods fail to execute. The proposed CFHS-mapping addresses this shortcoming. It demonstrates that, in comparison to existing methods, the proposed structure is sound and capable of successfully dealing with such challenges. Now, we talk about our proposed strategy and how precise it is.

- Add several days to this estimate since the HIV patient cannot analyze thoroughly after the initial checkup. The CFHS set contains all of the patient's information, and symptoms may be connected to its union and severity.
- The connection between related and essential indications, as well as the weights allocated to them, is vital in every patient study. Assume the findings will be non-specific if we choose early symptoms at that time.
- In the second stage, to determine therapy for the patients depending on their HIV type.
- Follow the patients' development in the third stage using a generalized form of CFHS-mapping. All memberships drop with each scene until they approach zero, suggesting that HIV symptoms, treatment neutral outcomes, and side effects are all reducing. Thus, this model depicts the evolution of patients throughout period.

TABLE 15. P_C^4: Patient's progress report after the fourth treatment cycle

patients / treatments	g_1	g_2	g_3	g_4
p_1	0.02	0.04	0.04	0.05
p_2	0.06	0.04	0.07	0.06
p_3	0.06	0.05	0.03	0.02
p_4	0.05	0.03	0.4	0.07

TABLE 16. P_C^5: Patient's progress report after the fifth treatment cycle

patients / treatments	g_1	g_2	g_3	g_4
p_1	0.0025	0.001	0.02	0.004
p_2	0.07	0.04	0.007	0.008
p_3	0.064	0.003	0.004	0.005
p_4	0.002	0.04	0.005	0.007

TABLE 17. Superiority of CFHS set over existing theories

SN	References	Disadvantage	Ranking
1	Fuzzy Set [15]	fail to manage 2D data	Unable to address
2	Intuitionistic Fuzzy Set [39]	fail to manage 2D data	Unable to address
3	Neutrosophic Set [40]	fail to manage 2D data	Unable to address
4	Bipolar Fuzzy Set [41]	fail to manage 2D data	Unable to address
5	M-Polar Fuzzy Set [42]	fail to manage 2D data	Unable to address
6	Soft Class Mappings [17]	fail to manage 2D data and when attributes are subdivided into attribute values	Unable to address
7	Fuzzy Soft Class Mappings [18]	when attributes are split into attribute values and when 2D data is not managed	Unable to address
8	M-Polar Neutrosophic Soft Mapping [44]	when attributes are split into attribute values and when 2D data is not managed	Unable to address
9	Bipolar Fuzzy Soft Mappings [51]	when attributes are split into attribute values and when 2D data is not managed	Unable to address
10	Complex Fuzzy Set [52]	when attributes are split into attribute values, they fail to deal	Unable to address
11	Complex Multi-Fuzzy Soft Set [53]	when attributes are split into attribute values, they fail to deal	Unable to address
12	Proposed Method in this paper	Long and heavy calculations in decision-making	This problem can be solved with the use of a computer programme

- Suppose a patient fails to gain improvement, inverse mapping can be used to restore him to his correct level, and then medicine must be started over.
- The suggested technique is beneficial for many patients with varied diseases and multiform criteria when parameterizations are used. In dealing with difficulties in the medical profession and MCDM, this study is solid and consistent.
- The decision-making committee (Doctors) will evaluate the data in the form of CFHS by considering the degree of the influence and the total time of the influence as a complex number; along with the in-depth evaluation of the information by taking sub parametric values of assigned attributes as hypersoft structure; where all the data can be taken in a numeric value between 0 (degree of zero per cent match) and 1 (degree of hundred per cent match).

V. CONCLUSION

In this study, HIV and the problems that come with it are discussed. A technique for identifying the patient's significant symptoms and evaluating their HIV infection is proposed. Consequently, the CFHS-mapping and its inverse mapping are presented, as well as some actual work with connected characteristics. The calculation that has been established has three steps. First, CFHS-mapping was used in the second phase to find appropriate medicines for individuals based on their HIV severity. Finally, a generalised CFHS-mapping is created to follow the patient's recovery and predict when he would return to his normal range. To identify infections, this approach is valuable and efficient. According to correlation, the proposed technique to addressing MCDM challenges is dominating, simple to manage, resilient, significant, and adaptable. One can continue to investigate the domains of Neutrosophic Hypersoft Set, Plithogenic Crisp Hypersoft Set, Bipolar Crisp Hypersoft Set, Bipolar Fuzzy Hypersoft Set, Bipolar Intuitionistic Fuzzy Hypersoft Set, Bipolar Neutrosophic Hypersoft Set, Plithogenic Fuzzy Hypersoft Set, Plithogenic Intuitionistic Fuzzy Hypersoft Set, Plithogenic Neutrosophic Hypersoft Set, Complex Intuitionistic Fuzzy Hypersoft Set, Complex Neutrosophic Hypersoft Set, Pythagorean fuzzy uncertain environment, spherical fuzzy sets and their hybrid structures in the future. It can also be used in artificial intelligence, medical imaging, data min-

This article has been accepted for publication in a future issue of this journal, but has not been fully edited. Content may change prior to final publication. Citation information: DOI 10.1109/ACCESS.2021.3099335, IEEE Access

ing, pattern recognition, social understanding, recommender frameworks, machine learning, social networks, signal processing, the monetary framework, neural networks, image processing, quantum geometry, and game theory, among other things.

REFERENCES

[1] S. Sierra, B. Kupfer and R. Kaiser, Basics Of The Virology Of HIV-1 And Its Replication, J. Clin. Virol., vol. 34, no. 4, pp. 233-244, 2005.

[2] N. Berry, S. Jaffar, M.S. Loeff, K. Ariyoshi, E. Harding, P.T. N'Gom, F. Dias, A. Wilkins, D. Ricard, P. Aaby and R. Tedder, Low Level Viremia And High CD4 Predict Normal Survival In A Cohort Of HIV Type-2-Infected Villagers, AIDS Res. Hum. Retrovir., vol. 18, no. 16, pp. 1167-1173, 2002.

[3] S. Andersson, H. Norrgren, Z. da Silva, A. Biague, S. Bamba, S. Kwok, C. Christopherson, G. Biberfeld and J. Albert, Significantly Lower Plasma Virus Set Point In HIV-2 Infection Than In HIV-1 Infection, Arch. Intern. Med., vol. 160, no. 21, pp. 3286-3293, 2000.

[4] V. Shanmugam, W.M. Switzer, J.N. Nkengasong, G. Garcia-Lerma, T.A. Green, E. Ekpini, M. Sassan-Morokro, F. Antunes, K. Manshino, V. Soriano and S.Z. Wiktor, Lower HIV-2 Plasma Viral Loads May Explain Differences Between The Natural Histories Of HIV-1 And HIV-2 Infections, J. Acquir. Immune Defic. Syndr, vol. 24, no. 3, pp. 257-263, 1999.

[5] J.W. Mellors, C.R Rinaldo Jr, P. Gupta, R.M. White, J.A. Todd and L.A Kingsley, Prognosis In HIV-1 Infection Predicted By The Quantity Of Virus In Plasma, Science, vol. 272, no. 5265, pp. 1167-1170, 1996.

[6] Meylan, J.C. Guatelli, J.R. Munis, D.D. Richman, R.S. Kornbluth and L.A. Kingsley, Mechanisms For The Inhibition Of HIV Replication By Interferonsalpha, -beta, And -gamma In Primary Human Macrophages, Virology, vol. 193, no. 1, pp. 138-148, 1993.

[7] S. Sierra, B. Kupfer and R. Kaiser, Basics Of The Virology Of HIV-1 And Its Replication, J. Clin. Virol., vol. 34, no. 4, pp. 233-244, 2005.

[8] K.M. Cock and F. Brun-Vezinet, Epidemiology Of HIV-2 Infection, Aids, vol. 3, no. 1, pp. S89-S95, 1989.

[9] K.M. De Cock, F.B. Vezinet and B. Soro, HIV-1 And HIV-2 Infections And AIDS In West Africa, AIDS, vol. 5, no. 1, pp. S21-S28, 1991.

[10] B.M.L. Guenno, P. Barabe and P.A, Griffet, HIV-2 And HIV-1 AIDS Cases In Senegal: Clinical Patterns And Immunological Perturbations, J. Acquir. Immune Defic. Syndr. vol. 4, no. 4, pp. 421-427, 1991.

[11] I.M. Lisse, A.G. Poulsen and P. Aaby, Immunodeficiency In HIV-2 Infection A Community Study From Guinea-Bissau, AIDS, vol. 4, no. 12, pp. 1263-1266, 1990.

[12] J. Pepin, G. Morgan and D. Dunn, HIV-2-Induced Immunosuppression Among Asymptomatic West African Prostitutes Evidence That HIV-2 Is Pathogenic, But Less So Than HIV-1, AIDS, vol. 5, no. 10, pp. 1165-1172, 1991.

[13] K. Kestens, K. Brattegaard and G. Adjorlolo, Immunological Comparison Of HIV-1- HIV-2- And Dually-Reactive Women Delivering In Abidjan, AIDS, vol. 6, no. 6, pp. 803-807, 1992.

[14] M. Saeed, A. Mehmood, T. Abdeljawad, M.H. Saeed, 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.

[15] L.A. Zadeh, Fuzzy Sets, Inf. Control, vol. 8, no. 3, pp. 338–353, 1965.

[16] K.T. Atanassov, Intuitionistic fuzzy sets, Fuzzy Sets Syst., vol. 20, no.1, pp. 87-96, 1986.

[17] A. Kharal and B. Ahmad, Mappings On Soft Classes, NMNC, vol. 7, no. 3, pp. 471–481, 2011.

[18] A. Kharal and B. Ahmad, Mappings On Fuzzy Soft Classes, Adv. Fuzzy Syst., vol. 2009, no. 1, pp. 407890, 2009.

[19] 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.

[20] F. Karaaslan, Soft Classes And Soft Rough Classes With Applications In Decision Making, Math. Probl. Eng., vol. 2016, no. 1, pp. 1584528, 2016.

[21] P.K. Maji, R. Biswas and A.R. Roy, Fuzzy Soft Sets, J. Fuzzy Math, vol. 9, no. 3, pp. 589–602, 2001.

[22] P.K. Maji, A.R. Roy and R. Biswas, An Application Of Soft Sets In A Decision making Problem, Comput. Math. with Appl., vol. 44, no. 8-9, pp. 1077–1083, 2002.

[23] D. Molodtsov, Soft Set Theory First Results, Comput. Math. with Appl., vol. 37, no. 4-5, pp. 19–31, 1999.

[24] 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.

[25] 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.

[26] 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.

[27] M. Saeed, M. Saqlain, A. Mehmood, K. Naseer and S. Yaqoob, Multi-Polar Neutrosophic Soft Sets With Application In Medical Diagnosis And Decision-Making, Neutrosophic Set Syst., vol. 33, no. 1, pp. 183-207, 2020.

[28] S. Heilpern, Fuzzy Mappings And Fixed Point Theorem, J. Math. Anal. Appl., vol. 83, no. 2, pp. 566–569, 1981.

[29] 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.

[30] M. Saeed, M. Ahsan and T. Abdeljewad, A Development Of Complex Multi-Fuzzy Hypersoft Set With Application In MCDM Based On Entropy And Similarity Measure, IEEE Access, vol. 9, no. 1, pp. 60026 - 60042, 2021.

[31] M. Saqlain, N. Jafar, S. Moin, M. Saeed and S. Broumi, Single And Multi-Valued Neutrosophic Hypersoft Set And Tangent Similarity Measure Of Single Valued Neutrosophic Hypersoft Sets, Neutrosophic Set Syst., vol. 32, no. 1, pp. 317-329, 2020.

[32] 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.

[33] 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.

[34] M. Zulqarnain, 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.

[35] S. Alkhazaleh and E. Marei, Mappings On Neutrosophic Soft Classes, Neutrosophic Set Syst., vol. 2, no. 1, pp. 3-8, 2014.

[36] M. Bashir and A.R. Salleh, Mappings On Intuitionistic Fuzzy Soft Classes, AIP. Conf. Proc., vol. 1522, no. 1, pp. 1022–1032, 2013.

[37] N.H. Sulaiman and D. Mohamad, Mappings On Multiaspect Fuzzy Soft Classes, AIP. Conf. Proc., vol. 1602, no. 1, pp. 716–722, 2014.

[38] L.A. Zadeh, The Concept Of A Linguistic Variable And Its Application To Approximate Reasoning, Inf. Sci., vol. 8, no. 3, pp. 199-249, 1975.

[39] K.T. Atanassov, Intuitionistic Fuzzy Sets, Fuzzy Sets Syst., vol. 20, no. 1, pp. 87-96, 1986.

[40] F. Smarandache, Neutrosophy Neutrosophic Probability, Set And Logic: Analytic Synthesis Synthetic Analysis, American Research Press, 1998, 105 p.

[41] W.R. Zhang and L. Zhang, YinYang Bipolar Logic And Bipolar Fuzzy Logic, Inf. Sci., vol. 165, no. 3-4, pp. 265–287, 2004.

[42] 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, pp. 416530, 2014.

[43] I. Deli, M. Ali and F. Smarandache, Bipolar Neutrosophic Sets And Their Application Based On Multi-Criteria Decision-Making Problems, In Proceedings of 2015 international conference on advanced mechatronic systems Beijing China, pp. 249-254, 2015.

[44] 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, 2021.

[45] S. Broumi, A. Mumtaz and F. Smarandache, Mappings On Neutrosophic Soft Expert Sets, J. New Theory, vol. 5, no. 5, pp. 27-42, 2015.

[46] Y. Al-Qudah and N. Hassan, Operations On Complex Multi-Fuzzy Sets, J. Intell. Fuzzy. Syst., vol. 33, no. 3, pp. 1527-1540, 2017.

[47] P. Thirunavukarasu, R. Suresh and V. Ashokkumar, Theory Of Complex Fuzzy Soft Set And Its Applications, Int. J. Innov. Res. Sci. Technol., vol. 3, no. 10, pp. 13-18, 2017.

[48] A.U. Rahman, M. Saeed, F. Smarandache and M.R. Ahmad, Development Of Hybrids Of Hypersoft Set With Complex Fuzzy Set, Complex Intuitionistic Fuzzy Set And Complex Neutrosophic Set, Neutrosophic Set Syst., vol. 38, no.1, pp. 335-354, 2020.

[49] 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, 175-191.

[50] 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, 1-23.

[51] M. Riaz and S.T. Tehrim, Bipolar Fuzzy Soft Mappings With Application To Bipolar Disorders, Int. J. Biomath., vol. 12, no. 7, pp. 1950080, 2019.

[52] D. Ramot, R. Milo, M. Friedman and A. Kandel, Complex Fuzzy Sets, IEEE Trans. Fuzzy Syst., vol. 10, no. 2, pp. 171-186, 2002.

[53] Y. Al-Qudah and N. Hassan, Complex Multi-Fuzzy Soft Set: Its Entropy And Similarity Measure, IEEE Access, vol. 6, no. 1, pp. 65002-65017, 2018.

[54] M. Saeed, M. Ahsan, M.H. Saeed, A. Mehmood and T. Abdeljewad, An Application Of Neutrosophic Hypersoft Mapping To Diagnose Hepatitis And Propose Appropriate Treatment, IEEE Access, vol. 9, no.1, pp. 70455-70471, 2021.

[55] M. Saeed, M. Ahsan and A.U. Rahman, A Theoretical and Analytical Approach for Fundamental Framework of Composite mappings on Fuzzy Hypersoft Classes, Neutrosophic Set Syst (To be appear).

[56] M. Saeed, M. Ahsan and A.U. Rahman, M.H. Saeed and A. Mehmood, Neutrosophic Hypersoft Mapping To Diagnose Brain Tumor And Proposing Appropriate Treatment, J. Intell. Fuzzy Syst. (To appear).

[57] K.G. Osgouie and A. Azizi, Optimizing Fuzzy Logic Controller For Diabetes Type I By Genetic Algorithm, ICCAE, vol. 2, no.1, pp. 4-8, 2010.

[58] A. Azizi and N. Seifipour, Modeling Of Dermal Wound Healing-Remodeling Phase By Neural Networks, IACSIT-SC, pp. 447-450, 2009.

[59] 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, no.2, pp. 973-993, 2021.

[60] 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, no.1, pp. 115393, 2021.

[61] 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, 2021.

[62] 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, 2019.

[63] Q. Khan, T. Mahmood and K. Ullah, Applications Of Improved Spherical Fuzzy Dombi Aggregation Operators In Decision Support System, Soft Comput., vol. 25, no. 1, pp. 9097-9119, 2021.

MUHAMMAD AHSAN received the B.Sc. degree in mathematics from Punjab University, Pakistan, the M.Sc. degree in applied mathematics from GC University Faisalabad, Pakistan, M. Phil. degree from Riphah International University Islamabad, Pakistan, and he is currently Ph.D. scholar in University of Management and Technology, Pakistan. He has published 6 articles and 3 book chapter-s in recognized journals. His research interests include decision making, fuzzy sets, soft set, hypersoft set, fuzzy hypersoft set, Complex Fuzzy Hypersoft set.

DR. MUHAMMAD SAEED born in Pakistan in July 1970, taught mathematics at intermediate and degree level with exceptional results. He was awarded "Best Teacher" in the years 1999, 2000, 2001, 2002 and was involved as a teacher trainer for professional development for more than five years. He received his Ph.D. (Mathematics), 2012 from Quaid-i-Azam University, Islamabad, Pakistan. He worked as the Chairman of the Department of Mathematics at UMT, Lahore, from 2014 to January 2021. Under his dynamics leadership, the Mathematics department has produced 10 Ph.D.'s. He has supervised 17 M.S, 4 Ph.D.'s and published more than 100 articles in recognized journals. His research interests include Fuzzy Mathematics, Rough Sets, Soft Set Theory, Hypersoft Set, Neutrosophic Sets, Algebraic and Hybrid Structures of Soft sets and Hypersoft sets, Multicriteria Decision Making, Optimizations, Artificial Intelligence, Pattern recognition and optimization under convex environments, Graph theory in fuzzy-like, soft-like, and hypersoft-like environments, similarity, distance measures, and their relevant operators in multipolar hybrid structures.

ASAD MEHMOOD Asad Mehmood graduated from the PakTurk College Clifton, Karachi. He is currently Ph.D. scholar in the field of Mathematics at University of Management and Technology, Lahore, Pakistan. He is currently working as a Teacher's Assistant and doing his research in the hybrids of soft set and hypersoft set at UMT. He has published 6 articles in recognized journals in the field of fuzzy sets, soft set and hypersoft set.

MUHAMMAD HARIS SAEED grew up in Pakistan and graduated from the Govt. College Township, Lahore. At GCT, Haris opted for chemistry and biology as his majors while at GCT. He is currently enrolled in B.S. Chemistry at the University of Management and Technology, Lahore, Pakistan. He was on the captain of the basketball team and is currently working as a teacher assistant during his bachelor studies. He is now doing his research in computational Chemistry at UMT and currently has three research publications under his name. His research interests include applying MCDM in different aspects of chemistry and QSPR analysis using chemical graph theory. After graduation, he plans to carry on his research interests in his Master's studies at a foreign venue.

JIHAD ASAD Jihad Asad received the B.Sc. and M.Sc. degrees in Physics from An- Najah National University, Palestine, in 1995 and 1998, respectively, and received his Ph.D. in Theoretical Physics from The University of Jordan, Amman, Jordan in 2004. He is now working as a Full Professor of Theoretical Physics in Palestine Technical University- Kadoorie- Palestine. He has published more than 60 papers in international reviewed journals. His research interests include analysis of infinite and finite electric networks, in addition to fractional calculus and its applications. He is a member of the Institute of Physics (IOP), serves as a member of program committee of several national and international conferences and finally he serves as a reviewer for many international journals.

• • •