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Infectious Diseases Diagnosis and Treatment Suggestions Using Complex Neutrosophic Hypersoft Mapping

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ABSTRACT Infectious diseases are one of the leading causes of death all over the world. This study aims to define the debates around the diagnosis of infectious diseases and their associated issues. After looking at the side effects of Infectious Diseases, it becomes difficult to distinguish the types of Infectious Diseases and their severities. It is difficult to detect the efficiency in treating a patient record and predicting the length of medicine because the indeterminacy, false components, amplitude term (A-term), phase term (P-term), and sub parametric values are commonly rejected in terms of practical evaluation. This paper introduces the Complex Neutrosophic Hypersoft (CNHS) set and CNHS mapping with its inverse mapping to overcome these limitations. This theory will be more flexible in three ways. First, it includes indeterminacy and falsity components, which will utilise parametric values to analyse data in all three dimensions of the patient's illness: positive, indeterminant, and negative. Secondly, for easier understanding, it separates the various attributes into distinct attribute-valued sets. Third, it provides for a large range of membership function values by expanding membership to the unit circle on an Argand plane and introducing an additional term known as the P-term to account for the periodic character of the data. To correctly analyse the problem, these principles can be coupled with scientific modelling. This study demonstrates a correlation between symptoms and treatments. A table with a fuzzily defined gap between 0 and 1 is created for different types of infectious diseases. The computation is based on CNHS mapping in order to properly detect the condition and select the appropriate prescription for each patient's ailment. Eventually, a generalised CNHS mapping is offered, which can assist a doctor in releasing the chronology of the patient's health status and predicting the time frame of therapy until the sickness is cleared.

INDEX TERMS Infectious Diseases; Complex Neutrosophic Hypersoft (CNHS); Mapping; Inverse mapping.

I. INTRODUCTION

Looking back in time, infectious diseases have been one of the most significant challenges faced by humanity ranging from the plagues to the recent outbreak of COVID-19 [1]. These diseases have profoundly affected the shape of our society as it has influenced the fates of great empires, their economies, and the wheel of civilization. Taking into account these numerous factors, infectious diseases have become a compelling subject when discussing the course of history [2]. When discussing infectious diseases, each has its separate identity as they set themselves apart due to their unique characteristics. Among these properties, their unpredictability and their potential to snowball on a worldwide scale are essential. The examples of this phenomenon were once observed in the 14th century in the case of the Bubonic-pneumonic plague, the influenza pandemic in 1918, and the case of COVID-19 nowadays [3]. Infectious diseases majorly present themselves in a sudden onset and are unambiguous. The onset on the healthy host is abrupt and unpredictable, unlike many other diseases [1]. Active case discovery, treatment, stoppage of transmission, and increase of immunity for susceptible individuals are all required to

control an infectious disease epidemic [9]. These infectious cases may pose an all-or-nothing situation in the absence of any treatment where the patient either dies or recovers spontaneously [1]. To tackle these cases and to minimize the loss of lives and resources, mathematical diagnostic models and machine learning tools have grown with time to support the medical staff in diagnostics, treatment, medication, and care of the infected patient [25]–[28]. This paper will focus on a diagnostic model based on Complex Neutrosophic Hypersoft (CNHS) set to diagnose a set of similar symptoms diseases that present ambiguity to medical staff when presenting a diagnosis. These diseases include COVID-19, Influenza, Diphtheria, and Tuberculosis. All of the listed diseases infect the lungs, heart, and breathing while presenting a similar set of symptoms.

Uncertainty is prevalent in a variety of areas, including modelling, medicine, and engineering. However, the topic of how to describe and apply the idea of uncertainty in mathematical modelling has been highlighted. Many researchers all around the globe have developed and advocated various ways to using uncertainty theory. First of all, Zadeh created the concept of fuzzy sets [15] to address problems including uncertainty and ambiguity. It has been noted that fuzzy sets are ineffective in some instances. To address these problems, Turksen [16] proposed the interval-valued fuzzy set (IVFS) as a solution. Under certain situations, membership and nonmembership values for the appropriate representation of an object in uncertain and ambiguous settings that fuzzy sets or IVFS could not manage. In [44] Atanassov developed the concept of an intuitionistic fuzzy set (IFS) to address these concerns. Atanassov's theory only addresses inadequate data in terms of both membership and nonmembership values; however, the IFSs theory is incapable of dealing with incompatible and imprecise data in general. Smarandache [45] proposed the neutrosophic set (NS) as a solution to such conflicting and inaccurate entries. Molodtsov [23] developed a comprehensive mathematical tool called a soft set (SS) to deal with uncertain information. Because of its vast range of applications in various research disciplines, SS theory is now employed in a wide range of technological fields, and it is among the most widely studied disciplines of mathematics. Maji et al. [22] used soft sets to help in decision-making. SS and their applications are important, according to Yang et al. [40]. Maji et al. [21] proposed the concept of fuzzy SS as well as its different characteristics. Broumi et al. [49] constructed the mappings among neutrosophic soft expert sets. Karaaslan focused on the concept of "soft class" and the techniques that go with it in [20]. In 2009 and 2011, Kharal et al. [17], [18] established the idea of mappings among fuzzy soft classes and soft classes, respectively. The concept of mappings among neutrosophic sets was developed by Alkhazaleh et al. [41]. Sulaiman et al. [43] proposed the concept of mappings between multi-aspect fuzzy soft sets. Bashir introduced the notion of mappings between intuitionistic fuzzy soft sets, and Salleh [42]. The Fuzzy Hypersoft (FHS) and Hypersoft (HS) sets were proposed by Samarandache [19] in 2018 as expansions of the fuzzy soft and soft sets, respectively. In this way, he showed that a FHS set might be crisp, intuitionistic, neutrosophic, and plithogenic. Saeed et al. [29]–[37] described the fundamentals of the Hypersoft set and for their thorough mappings in a hypersoft set scenario, as well as their explanation of hypersoft set in object recognition, biomedical imaging, and Multi criteria. The concept of a detailed analysis of the mathematical properties of the Complex Fuzzy (CF) set was introduced by Ramot et al. [52]. The CF complement, union, and intersection were investigated as primitive set-theoretic operations on CF sets. Thirunavukarasu et al. [54] looked at how a CF soft set's aggregation process is intuitively understood. They also demonstrated aggregating operations applications, demonstrating that the approach may be used in various situations, incorporating ambiguities and periodicities. To construct hypersoft hybrids, Rahman et al. [55] created the complex hypersoft (CHS) set, the complex intuitionistic fuzzy set, and a complex neutrosophic set. Al-Qudah et al. [53] defined a complex multi-fuzzy set as a combination of CF sets and multi-fuzzy sets. Their suggested technique will be developed to deal with the uncertainties and ambiguity of two-dimensional multi-fuzzy data by concurrently retaining the amplitude and periodic character of the C-numbers. The application of fuzzy logic direct model reference adaptive control (DMRAC) for insulin infusion management in diabetes type Osgouie presented 1 patient, and Azizi [56]. Azizi and Seifipour [57] used neural networks as an intelligent approach to mimic the remodelling phase of the cutaneous wound healing procedure. The Pythagorean fuzzy interactive Hamacher power aggregation operators for assessing express service quality with entropy weight were presented by Wang et al. [58]. The relationship between hesitant fuzzy sets and their use in medical diagnostics was developed by Liu et al. [59]. Molla et al. [60] looked into the Pythagorean fuzzy Promethee technique and how it may be used in medical diagnostics. Khan et al. [61], [62] developed a spherical fuzzy set and used it for MCDM and clinical diagnostics.

A. MOTIVATION

Because it is tough to tell the difference between a certain type of sickness and its seriousness based on existing concepts and methodologies such as [17], [18], [48], [50], [52] and [51], which are limited to comprehensive models, the goal of this research is to imitate a real-life situation of disease identification and treatment. When the parameters are divided into sub-parametric types of values, the strategies described in [17], [18], [48], [50], [52] and [51] are not sufficient to examine the data in a deep sense for better comprehension and suitable treatment. They can only assess the truthfulness (membership) of objects in [17], [18] and cannot consider nonmembership, indeterminacy, complex (two-dimensional) information/data (the degree of the impact and the total time of the influence) and sub-parametric values. In [48], [50] evaluates the data in bipolar fuzzy and

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multipolar neutrosophic natures, respectively; nonetheless, it still has flaws when sub-parametric values exist for a parameter and complex (two-dimensional) data. While the model described in [51], [52] covered complex (two-dimensional) data, it fails to handle when sub-parametric values are given for a single parameter. To address this problem, we combined these models with hybrids of hypersoft set that can cope with the parametric values of such situations in more depth considering/concerning the sub-parametric values and complex (two-dimensional) information/data (the degree of the influence and the total time of the influence) as well as their arrangement and order. A hypersoft set can organize information/data in such a comprehensive way that it can be analyzed and assessed easily. A neutrosophic structure is the second hybrid of this paradigm that analyzes data in all three conceivable dimensions of positive, indeterminant, and negative aspects of the patient's sickness in accordance with parametric values, where these dimensions are independent of one another. The third hybrid of this model allows for a wide range of membership function values by expanding them to the unit circle in an Argand plane with the inclusion of an additional term called the P-term to consider the periodic nature of the information, which considers both the amplitude term (A-term) and phase term (P-term) of the complex numbers at the same time to deal with uncertainties, vagueness, ambiguity and unclearness of data. A mapping is a relationship between two or more domains governed by rules that translate an entangled parameter to its corresponding basic parametric value based on structure and essential similarities. The goal of this research is to characterize the close diagnosis of illnesses and associated symptoms. The indeterminacy, false components, and periodic character of the data are usually overlooked in clinical diagnosis. This model develops a connection between symptoms and medicine. Finally, the generalized mapping will be built to predict patient improvement reports, and if the suggested therapy has negative side effects, the inverse mapping may be utilized to reverse the patients back to their beginning stage and recommence the treatment. This motivates a doctor to keep track of the patient's improvement until the illness is eradicated.

B. PAPER PRESENTATION

The rest of the article is arranged as follows. Section II reimagines the HS set, Neutrosophic Hypersoft set, CNHS set, HS image, and HS inverse image ideas. Section III covers CNHS class mapping, the CNHS image, and the inverse image of the CNHS. A realistic implementation and a comparative study are used to prove the validity of the suggested strategy in section IV. In the last section, the conclusion has been discussed.

II. PRELIMINARIES

This section contains certain fundamental concepts over the universal set Z.

Definition 1: [19] Suppose $\xi_1, \xi_2, \xi_3, \cdots, \xi_n$ be sets of attributed-valued for distinct attributes $x_1, x_2, x_3, \cdots, x_n$ respectively, and $\xi_m \cap \xi_n = \emptyset$, for $m \neq n$. Then (Φ, Q) is called as HS over Z, where Φ be any mapping from Q to the power set of Z; where $Q = \xi_1 \times \xi_2 \times \xi_3 \times ... \times \xi_n$. For more definition see [24], [30], [38], [39].

Definition 2: [19] Suppose $\xi_1, \xi_2, \xi_3, \cdots, \xi_n$ be sets of attributed-valued for distinct attributes $x_1, x_2, x_3, \cdots, x_n$ respectively, and $\xi_m \cap \xi_n = \emptyset$, for $m \neq n$. Then (ϖ, Q) is called as Neutrosophic Hypersoft set over Z, where ϖ be any mapping from Q to the power set of Z; and $\varpi(Q) = \{\langle z, T(\varpi(Q)), I(\varpi(Q)), F(\varpi(Q))\rangle\}$, where T, I, F is the membership, indeterminacy and non-membership respectively which maps from universe of discourse Z to fuzzy interval $[0, 1]$, $0 \leq T(\varpi(Q)) + I(\varpi(Q)) + F(\varpi(Q)) \leq 3$ and $Q = \xi_1 \times \xi_2 \times \xi_3 \times ... \times \xi_n$.

Definition 3: [55] Suppose $\xi_1, \xi_2, \xi_3, \cdots, \xi_n$ be sets of attributed-valued for distinct attributes $x_1, x_2, x_3, \cdots, x_n$ respectively; $Q = \xi_1 \times \xi_2 \times \xi_3 \times ... \times \xi_n$ and $\omega(q)$ be a CF set over Z for all $q = (\chi_1, \chi_2, \chi_3, \cdots, \chi_n) \in Q$, such that $\chi_1 \in \xi_1, \chi_2 \in \xi_2, \chi_3 \in \xi_3, \cdots, \chi_n \in \xi_n$. Then CNHS set (Φ, Q) over X is defined as $(\Phi, Q) = \{(q, \phi(q)) : q \in Q, \phi(q) \in CF(Z)\}$, where $\phi : Q \to CF(Z), \phi(q) = \emptyset$, if $q \notin Q$ is a CF approximate function of (Φ, Q) and its value $\phi(q)$ is said to be $q-$ member of CNHS set $\forall\, q \in Q$.

Definition 4: [35] Suppose two classes of Hypersoft sets as $(\xi, \mathcal{S})$ and $(\Im, \mathcal{T})$ over universe of discourse ξ and $\Im$ respectively. Let $\alpha : \xi \to \Im$ and $\beta : \mathcal{S} \to \mathcal{T}$ be two sub-mappings. Then a mapping $\Upsilon = (\alpha, \beta) : (\xi, \mathcal{S}) \to (\Im, \mathcal{T})$ can be defined for hypersoft set such that for any HS set (δ, R) in $(\xi, \mathcal{S})$ and $\Upsilon(\delta, R)$ is HS set in $(\Im, \mathcal{T})$ acquired in the following manner, For $\Upsilon \in \beta(\mathcal{S}) \subseteq \mathcal{T}$ and $u \in \Im$, then

$$\Upsilon(\delta, R)(\Upsilon)(u) = \begin{cases} \cup_{v \in \alpha^{-1}(u)} \left(\cup_{\eth \in \beta^{-1}(\Upsilon) \cap R} \delta(\eth) \right)(v), \text{if} \\ \qquad \alpha^{-1}u) \neq \emptyset,\ \beta^{-1}(\Upsilon) \cap R \neq \emptyset \\ 0 \qquad \text{if} \quad otherwise \end{cases} \tag{1}$$

$\Upsilon(\delta, R)$ is known as HS image of HS set (δ, R).

Definition 5: [35] Suppose two classes of Hypersoft sets as $(\xi, \mathcal{S})$ and $(\Im, \mathcal{T})$ over universe of discourse ξ and $\Im$ respectively. Let $\alpha : \xi \to \Im$ and $\beta : \mathcal{S} \to \mathcal{T}$ be two sub-mappings. Suppose (ℓ, G) be a HS set in $(\Im, \mathcal{T})$, where $G \subseteq \mathcal{T}$ then $\Upsilon^{-1}(\ell, G)$ is a HS set in $(\xi, \mathcal{S})$ defined as follows,

$$\Upsilon^{-1}(\ell, G)(\eth)(v) = \begin{cases} \ell(\beta(\eth)(\alpha(v) & \text{if } \beta(\eth) \in G \\ 0 & \text{if } otherwise \end{cases} \tag{2}$$

where $\eth \in \beta^{-1}(G) \subset \mathcal{S}$, then $\Upsilon^{-1}(\ell, G)$ referred to as HS inverse image of HS set (ℓ, G).

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III. MAPPINGS ON COMPLEX NEUTROSOPHIC HYPERSOFT CLASSES

This section introduces the concept of mapping on CNHS classes. The collection of CNHS sets is referred as CNHS class. CNHS characteristics such as CNHS images and CNHS inverse images of CNHS sets are also described. As you go through this section, keep the following concepts in mind:, $\xi_1 \times \xi_2 \times \xi_3 \times, ..., \times \xi_n = \mathcal{Q}$, $\xi_1' \times, \xi_2' \times \xi_3' \times, \cdots, \times \xi_n' = \mathcal{D}$.

Definition 6: Suppose two classes of Hypersoft sets as $(A, \mathcal{Q})$ and $(B, \mathcal{D})$ over universe of discourse A and B respectively. Let $\alpha : A \to B$ and $\beta : \mathcal{Q} \to \mathcal{D}$ be two sub-mappings. Consider $(\lambda, \mathcal{Q}) \in (A, \mathcal{Q})$ and $(\omega, \mathcal{D}) \in (B, \mathcal{D})$.

1) $\Upsilon(\lambda, \mathcal{Q})$ denotes the image of $(\lambda, \mathcal{Q})$, which is a CNHS in $(B, \mathcal{D})$ characterized as

$$\Upsilon((\lambda, \mathcal{Q})(\eth)(b) = \begin{cases} \underset{a \in \alpha^{-1}(b)}{\vee} \left(\underset{\mu \in \beta^{-1}(\eth) \cap \mathcal{Q}}{\vee} \lambda(\mu) \right), \text{if } \alpha^{-1}(b) \\ \qquad\qquad\qquad and \;\; \beta^{-1}(\eth) \cap \mathcal{Q} \neq \emptyset, \\ 0, \; otherwise \end{cases} \tag{3}$$

where Υ is a mapping $\Upsilon : (A, \mathcal{Q}) \to (B, \mathcal{D})$, $\eth \in \beta(\mathcal{Q}) \subseteq \mathcal{D}$, $\mu \in \beta^{-1}(\eth) \cap \mathcal{Q} \neq \emptyset$, $b \in B$ and $\lambda(\mu)$ represents complex membership, complex non-membership and complex indeterminacy. If $\alpha^{-1}(b)$ and $\beta^{-1}(\eth) \cap \mathcal{Q} \neq \emptyset$, then

$$\Upsilon((\lambda, \mathcal{Q})(\eth)(b) = \underset{a \in \alpha^{-1}(b)}{\vee} \left(\underset{\mu \in \beta^{-1}(\eth) \cap \mathcal{Q}}{\vee} \lambda(\mu) \right) \tag{4}$$

$$\begin{aligned} \Upsilon((\lambda, \mathcal{Q})(\eth)(b) &= \underset{a \in \alpha^{-1}(b)}{\vee} \left(\underset{\mu \in \beta^{-1}(\eth) \cap \mathcal{Q}}{\vee} \lambda(\mu) \right) \\ &= \underset{a \in A}{\vee} \left(\underset{\mu \in \{\mu_1, \mu_2, \mu_3, \cdots, \mu_n\}}{\vee} \lambda(\mu) \right) \end{aligned} \tag{5}$$

$= [max\langle max\{\nu_{\lambda(\mu_1)} a_i, \nu_{\lambda(\mu_2)} a_i, \nu_{\lambda(\mu_3)} a_i, \cdots, \nu_{\lambda(\mu_n)} u_i\}\rangle]$
$= [\max\{r_{\lambda(\mu_1)}(a_i), r_{\lambda(\mu_2)}(a_i), r_{\lambda(\mu_3)}(a_i), \cdots, r_{\lambda(\mu_n)}(a_i)\}$
$e^{imax\{arg_{\lambda(\mu_1)}(a_i), arg_{\lambda(\mu_2)}(a_i), arg_{\lambda(\mu_3)}(a_i), \cdots, arg_{\lambda(\mu_n)}(a_i)\}}]$,

where $a_i \in A, \mu_1, \mu_2, ..., \mu_n \in \beta^{-1}(\eth) \cap \mathcal{Q}$.

2) $\Upsilon^{-1}(\omega, \mathcal{D})$ represents the inverse image of $(\omega, \mathcal{D})$, is an CNHS in $(A, \mathcal{Q})$, and is defined as

$$\Upsilon^{-1}((\omega, \mathcal{D})(\mu)(a) = \begin{cases} H(\beta(\mu)\alpha(u)), & \text{if } \beta(\mu) \in \eth, \\ 0, & otherwise \end{cases} \tag{6}$$

for $\mu \in \beta^{-1}(\eth)$ and $a \in A$.

IV. INFECTIOUS DISEASES AND CNHS MAPPING

The disorders of infectious diseases and their related issues and causes are analysed in this study section. The causes, process of diagnosis, and appropriate medications of infectious illness of patients are investigated using the complete notion of the CNHS set and its relative and inverse mapping. This section demonstrates how the suggested mathematical model may create a strategy for patients with infectious diseases.

A. THE STUDY OF INFECTIOUS DISEASES AND THEIR ASSOCIATED PROPERTIES

In the medical profession, analytical research of infectious diseases and mathematical modelling have everlasting importance. In medicine, there are distinct types of infectious diseases, but here only four are under consideration.

- Tuberculosis (TB)
- COVID
- Influenza (flu)
- Diphtheria

1) COVID

COVID-19 has taken the world by storm by classifying itself as a global pandemic in 2020 even though it was identified in December 2019 [4]. Its cause is a novel coronavirus with structural similarity to the SARS virus that typically affects the respiratory system, but the effects can extend well beyond the respiratory organs. Numerous studies revealed most patients are asymptomatic or are minimally symptomatic, while some patients showed severe symptoms that proved to be life-threatening [4]. The virus belongs to the family Coronaviridae, whose other members, including SARS and MERS virus, have caused a bit of commotion in the past [12]–[14]. Please see Figures for further information 1, 2, 3 and 4.

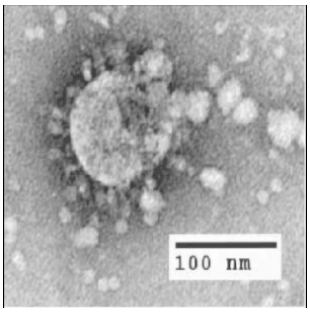

FIGURE 1. Micrograph with an electron microscope of SARS coronavirus virion. *Source*:https://www.csiro.au/en/research/health-medical/diseases/infectious-diseases/bats-confirmed-host-of-sars-virus

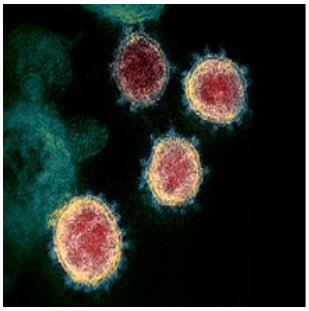

FIGURE 2. Transmission electron micrograph of SARS-CoV-2 virions with visible corona. *Source*:https://www.theguardian.com/world/2020/dec/19/what-is-the-new-covid-strain-and-will-vaccines-work-against-it

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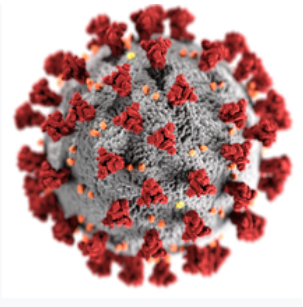

FIGURE 3. Illustration of a SARS-CoV-2 virion. *Source*:https://www.cdc.gov/media/subtopic/images.htm

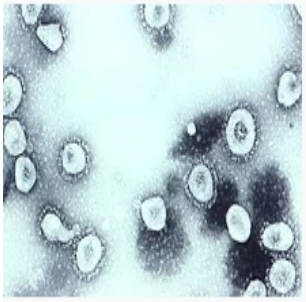

FIGURE 4. Transmission electron micrograph of human coronavirus OC43. *Source*:https://www.the-scientist.com/news-opinion/common-cold-coronaviruses-tied-to-less-severe-covid-19-cases-68146

2) Tuberculosis

It is characterized by a series of asymptomatic sub-clinical infections that may last for a week to maybe a decade. Its cause is Mycobacterium tuberculosis, and it usually attacks the lungs and the respiratory tract, but it may also affect other parts of the body like the brain, kidneys, and spinal cord [11]. Its interpersonal spread can occur through the air when a TB infected person to cough, sneezes, or talks. TB progresses from latent TB to active TB over time when the bacterium starts to multiply after overcoming the defense system of the human body [10]. Please see Figures for further information 5, 6.

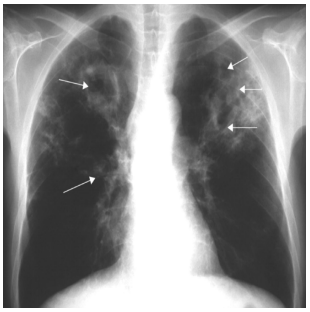

FIGURE 5. Chest radiograph showing extensive cavitary tuberculosis (arrows).*Source*:https://erj.ersjournals.com/content/42/1/5

3) Influenza

The influenza virus has been around for a while as it is the cause of seasonal and endemic infections and unpredictable

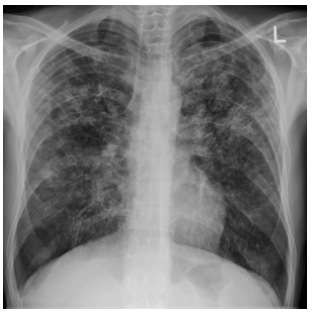

FIGURE 6. TB, Active TB, Chest x ray. *Source*:https://www.pinterest.com/pin/704391197954922775/

pandemics. It's regarded as the most common cause of respiratory tract infections today. The virus has a significant effect on the human respiratory system as it may prove to be fatal in the form of pneumonia [7]. The disease was first documented over 130 years ago, but the histopathology of the virus has not changed much over time. The H5N1 (Avian influenza viruses) virus of the influenza family of the virus has led to concern about the emergence of another pandemic [8]. The worst pandemic ever recorded caused by the influenza virus caused over 150 million deaths in 1918. For more detail, see Figure 7, 8.

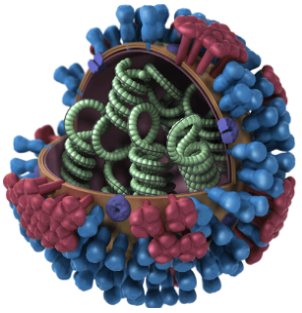

FIGURE 7. This is a picture of an influenza virus. Influenza A viruses are classified by subtypes based on the properties of their hemagglutinin (H) and neuraminidase (N) surface proteins.*Source*:"https://www.cdc.gov/flu/about/viruses/types.htm"

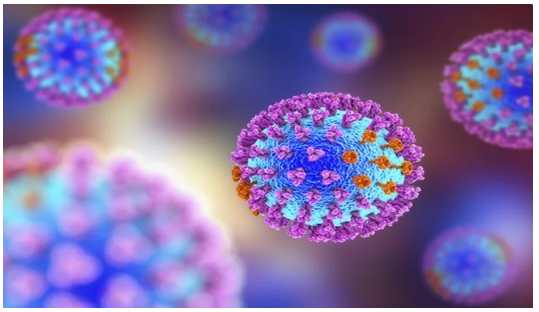

FIGURE 8. https://www.news-medical.net/health/What-is-Influenza.aspx.*Source*:"https://cdn.mdedge.com/files/s3fs-public/Document/March-2018/fdp_s16-s17.pdf"

4) Diphtheria

Diphtheria is a communicable bacterial disease caused by the release of an exotoxin by Corynebacterium diphtheriae. The bacterium generally grows in the pharynx with a pseudomembrane formation, while less common cases reveal its growth in the stomach or lungs [5]. The bacterial cells usually localize in the upper respiratory tract and cause inflammation in the pseudomembrane. Its mode of transmission involves direct contact or spread by coughing or sneezing. Its targets include people of all ages, but due to the high rate of immunization in the population, the distribution of the disease has only remained to the un immunized and poorly immunized adults [6]. For more detail, see Figure 9, 10.

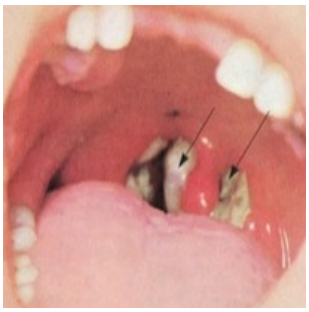

FIGURE 9. Membraneous Pharyngitis typical of Diphtheria infection..*Source*:"https://coryneforms.weebly.com/diphtheria.html"

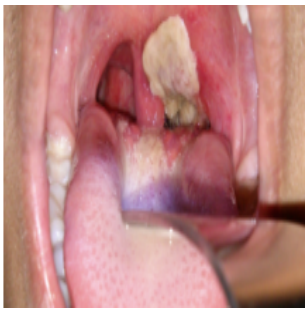

FIGURE 10. An adherent, dense, grey pseudomembrane covering the tonsils is classically seen in diphtheria.*Source*:"https://link.springer.com/chapter/10.1007/978-3-319-74835-1-19"

Some of the most signs and possible causes of these illnesses are being displayed by the patient. These are some of the symptoms associated with these problems.

- sneezing and an itchy
- headaches
- Cough
- Fever
- Fatigue
- Appetite loss
- Nausea
- Vomiting
- Abdominal pain
- Dark urine
- Stools in light colours
- Joint discomfort
- Jaundice
- chills
- Difficulty breathing
- tiredness
- aches and pains
- diarrhoea
- conjunctivitis
- chest pain
- congested or sticky nose
- aches and pains throughout the body
- difficulty breathing
- loss of speech or movement
- Malaise
- swollen lips

The approach utilised to solve the problem is explained in the next section. To assess the illness, offer effective therapy, and track the progression of treatment phases, a unique algorithm based on CNHS-mapping is utilised.

B. METHODOLOGY

When assessing a patient, a consultant has certain challenges due to the comparable symptoms of Infectious Diseases. The distinction between these classes is quite difficult to discern. It suggests that these types of problems are characterised by uncertainty and ambiguity and that the CNHS is well-suited to handle such information. For diverse forms of infectious diseases, a fuzzy interval [0, 1] is initially developed to translate spoken input into numerical language. A graph is created for many types of infectious diseases to analyse the unique type of infectious disease. Table 1 shows the representation of these diseases with specific ranges. Table 2 and in Figure 11 represents the day to day fixation of patients diseases and several ranges correlating to stated Infectious Diseases conditions.

TABLE 1. Ranges of Infectious Diseases

Infectious Diseases Types	Various ranges of $[0, 1]$
Covid	$[0.6, 1]$
Tuberculosis	$[0.5, 0.6)$
Influenza (flu)	$(0.2, 0.5)$
Diphtheria	$[0.1, 0.2]$
No Infectious Diseases	$[0, 0.1)$

1) Algorithm

Step 1.

To classify the infectious diseases. Suppose $R = \{r_1, r_2, r_3, ..., r_n\}$ be group of afflicted patients from infectious diseases and $A = \{s_1, s_2, s_3, ..., s_v\}$ be a clinical signs of infectious diseases with parametric values that relate to sets S_i's, where $S = \prod_{i=1}^{v} S_i$. The administration produces the daily diagnostic reports designated "t" as days; with the assistance of a mathematician (it can be configured as a

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TABLE 2. Infectious Diseases and their day-to-day concentration

conditions	First day	Day two and day three	After day 3
serious Covid (SC)	[0.72, 0.8)	[0.8,1)	$= 1$
moderate Covid (MC)	[0.75,0.82)	[0.82,0.87)	[0.87,0.92)
low Covid (LC)	[0.59,0.65)	[0.65,0.69)	[0.69,0.74)
serious Tuberculosis (ST)	[0.55,0.57)	[0.57,0.58)	[0.58,0.59)
moderate Tuberculosis (MT)	[0.51,0.53)	[0.53,0.54)	[0.54,0.55)
low Tuberculosis (LT)	[0.49,0.50)	[0.50, 0.501)	[0.501,0.51)
serious Influenza (SI)	[0.2,0.3)	[0.3,0.4)	[0.4,0.49)
moderate Influenza (MI)	[0.23,0.25)	[0.25,0.27)	[0.27,0.4)
low Influenza (LI)	[0.22,0.23)	[0.23,0.235)	[0.235,0.37)
serious Diphtheria (SD)	[0.1,0.15)	[0.15,0.17)	[0.17,0.176)
moderate Diphtheria (MD)	[0.12,0.13)	[0.13,0.15)	[0.15,0.157)
low Diphtheria (LD)	[0.123,0.125)	[0.125,0.129)	[0.129,0.189)
No Infectious Diseases (NH)	[0.00,0.01)	[0.01,0.06)	[0.06,0.08)

CNHS set). This report will support us in identifying the accurate infection of the patient. The specialist's CNHS set chart may be fitted up as follows after an significant evaluation at εth times.
$z_S^\varepsilon = \{z_p^\varepsilon = \{r, \langle T_p^\varepsilon(r), I_p^\varepsilon(r), F_p^\varepsilon(r)\rangle\} : r \in R, p \in S\}$, where $T_p^\varepsilon(r)$, $I_p^\varepsilon(r)$ and $F_p^\varepsilon(r)$ are complex membership, complex indeterminacy and complex non membership grades of Infectious Diseases for i-th symptoms and j-th patients respectively, $(\varepsilon = 1, 2, 3, ..., t; k = 1, 2, 3, ..., |S|; j = 1, 2, 3, ..., n)$. The union of CNHS sets is utilised to gather the maximum information.

Step 2.
Suppose $B = \{s'_1, s'_2, s'_3, ..., s'_w\}$ to indicate a group of related symptoms for A, whose corresponding attributive sets are $S'i$'s, where $S' = \prod_{i=1}^{w} S'_i$ and compute a CNHS set (bearing in mind that the weights are allocated based on the expert assessments of patients' ε fundamental symptoms on a daily basis).
Step 3.
Create a mapping based on the characteristics listed as: $\eth : R \to R$ and $\eth : S \to S'$ characterised as follows; $\eth(r_j) = r_j$, $\eth(p_k) = (p'_{k'})$, $(k = 1, 2, 3, ..., |S|; k' = 1, 2, 3, ..., |S'|; j = 1, 2, 3, ..., n)$ based on the primary and secondary symptoms' relationship.
Consider CNHS-mapping $\mho = (\eth, \eth) : CNHS(R) \to CNHS(R)$ defined as

$$T_{\mho(z_S)}(p')(r) = |T_{p'_{k'}}| \begin{cases} \min_{r\in\eth^{-1}(r)}\left(\min_{p\in\eth^{-1}(p')\cap S} T_{z_S}\right)(r) \text{ if} \\ \quad \eth^{-1}(r) \neq \emptyset, \eth^{-1}(p') \cap S \neq \emptyset, \\ 0 \text{ if } otherwise \end{cases} \tag{7}$$

$$I_{\mho(z_S)}(p')(r) = |I_{p'_{k'}}| \begin{cases} \min_{r\in\eth^{-1}(r)}\left(\min_{p\in\eth^{-1}(p')\cap S} I_{z_S}\right)(r) \text{ if} \\ \quad \eth^{-1}(r) \neq \emptyset, \eth^{-1}(p') \cap S \neq \emptyset, \\ 1 \text{ if } otherwise \end{cases} \tag{8}$$

$$F_{\mho(z_S)}(p')(r) = |F_{p'_{k'}}| \begin{cases} \min_{r\in\eth^{-1}(r)}\left(\min_{p\in\eth^{-1}(p')\cap S} F_{z_S}\right)(r) \text{ if} \\ \quad \eth^{-1}(r) \neq \emptyset, \eth^{-1}(p') \cap S \neq \emptyset, \\ 1 \text{ if } otherwise \end{cases} \tag{9}$$

where $T_{p'_{k'}}$, $I_{p'_{k'}}$ and $F_{p'_{k'}}$ are weights from $z_{S'}$ that are linked. Get the $\sqcup z_S^\varepsilon$ image with the specified mapping $\mho$, which may be built as $z'_{S'}$.
Step 4.
To obtain weighted aggregation values, convert the CNHS set to the Neutrosophic Hypersoft set using the formula: $T_{\mho(z_S)}(p')(r) = w_1\mu_{z'(p')}(r) + w_2(\frac{1}{2\pi})\omega_{z'(p')}(r)$, $I_{\mho(z_S)}(p')(r) = w_1\mu_{z'(p')}(r) + w_2(\frac{1}{2\pi})\omega_{z'(p')}(r)$, $F_{\mho(z_S)}(p')(r) = w_1\mu_{z'p')}(r)+w_2(\frac{1}{2\pi})\omega_{z'(p')}(r)$ [51], where $\mu_{z'('s)}(p)$ and $\omega_{z'(p')}(r)$ are the amplitude and phase terms in the CNHS set respectively, $T_{\mho(z_S)}(p')(r)$, $I_{\mho(z_S)}(p')(r)$, $F_{\mho(z_S)}(p')(r)$ are the membership, indeterminacy, non membership functions in the Neutrosophic Hypersoft set respectively, where $w_1, w_2 \in [0, 1]$ are the weights for the amplitude terms (degrees of influence) and the phase terms (time of influence).
Step 5.
Compare the findings from Step 4 to Table 2 to arrive at a preliminary diagnosis. These findings will be evaluated afterwards to ensure that the acquired results are reliable.
Step 6.
Calculate the obtained CNHS set's score function values $z'_{S'}$ and average each score value corresponding to related symptoms using

$$\tfrac{1}{2}|T_s^\varepsilon(r) - 2I_s^\varepsilon(r) - F_s^\varepsilon(r)|.$$

Then use Table 1 to determine our final result.
Step 7.
Suppose that $B = \{s'_1, s'_2, s'_3, ..., s'_w\}$ be the series of related symptoms, where $k = \prod_{i=1}^{w} |S'_i|$ and $C = \{c_1, c_2, c_3, ..., c_x\}$ e a set of potential treatments then construct $\chi_{S'}$, where χ is CNHS function from S' to $P(C)$ which is the set of doctor's recommendations with the appropriate treatment corresponding to the symptoms of Infectious Diseases.
Step 8.

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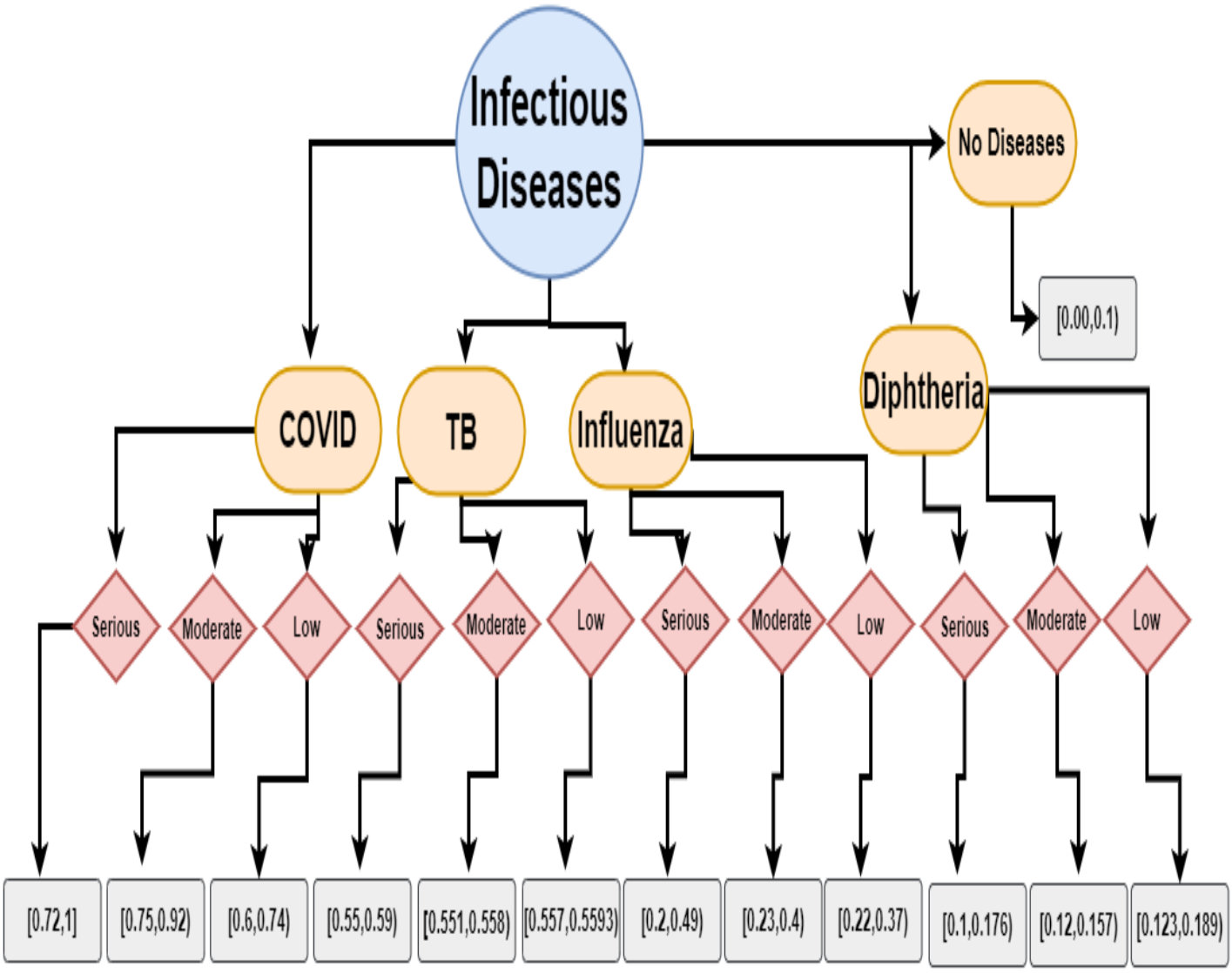

FIGURE 11. Flow chart showing several ranges correlating to stated Infectious Diseases conditions.

Applying the definition 14, we get R_C^1 by using min-max composition over $z'_{S'}$ and $\chi_{S'}$.

Step 9.

Select medicines (treatments) with more benefits and fewer negative side effects. For the patient's progress history, the following steps are required.

Step 10.

Define a distinct set of generalised mappings;

$\eth' : R^{q-1} \to R^q$ and $\supset' : C^{q-1} \to C^q$ such that $\eth'(r_j) = r_j$ and $\supset'(c_x) = c_x$. Then CNHS-mapping is defined in the form of $\mho' = (\eth', \supset') : R_C^{q-1} \to R_C^q$ and can be evaluated as:

$R_C^q = \mho'(R_C^{q-1})(c)(r)$

$$= \frac{1}{q} \begin{cases} \sqcup_{\pi \in \eth'^{-1}(r)} \left(\sqcup_{\vartheta \in \supset'^{-1}(c) \cap C} R_C^{q-1} \right)(\pi) \text{ if} \\ \qquad \eth'^{-1}(r) \neq \emptyset, \supset'^{-1}(c) \cap C \neq \emptyset, \\ 0 \text{ if } otherwise \end{cases} \tag{10}$$

where $q = 2, 3, 4...$ is the number of medications (treatments) episodes and $c \in \supset'(C) \subseteq C$, $r \in R^q$, $\pi \in R^{q-1}$, $\vartheta \in (C)^{q-1}$.

Step 11.

Step 10 must repeated until the desired outcomes are achieved.

The flowchart of proposed algorithm is shown in 12

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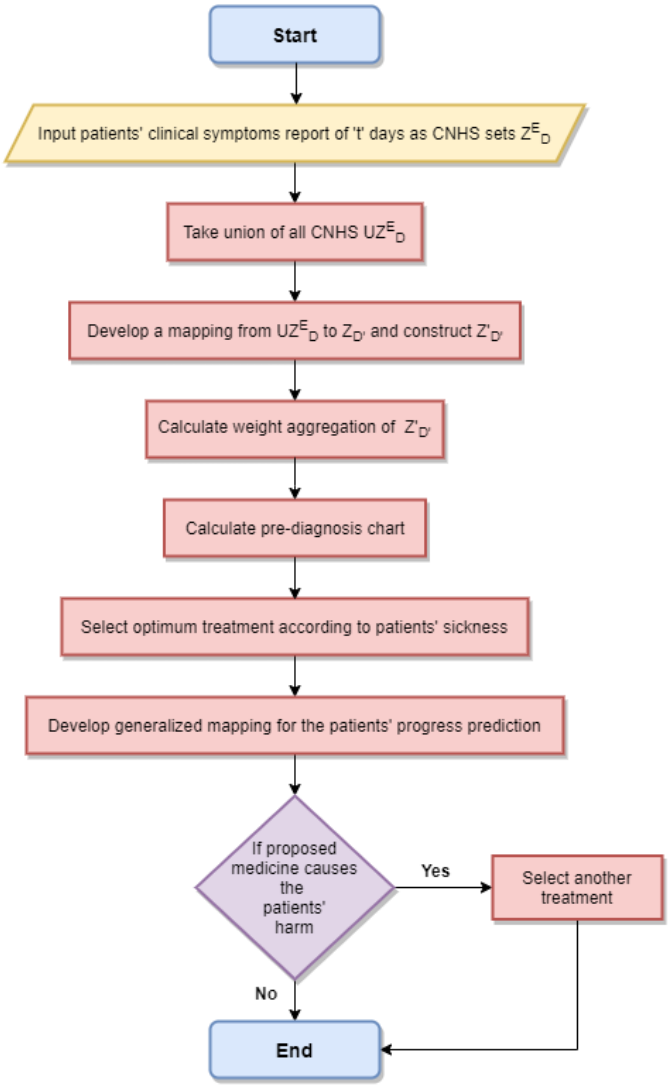

FIGURE 12. Flowchart of proposed algorithm

2) Limitations in Methodology

Before implementing the method, make sure the limitations of the suggested technique are encountered:

1) Since the attached parameter and its basic parametric value had the same structure and foundation; there would be a mapping that converted the linked parameter into its basic parametric value.
2) Within the same structural class, both sets of requirements for mapping should be self-contained.
3) The appropriate prescription for the disease's symptoms must be activities that have contributed to the illness's supporting evidence, according to a doctor's authorization.
4) A wide range of severe diseases must be recognized with the help of a doctor.
5) If the recommended medicine does the patient damage, we can apply inverse CNHS-mapping to reinstate him to his proper position, and then we'll have to commence over with the medicines.

C. PROPOSAL FOR STUDY AND MATHEMATICAL EXAMPLE

This section is dedicated to the use of the algorithm as mentioned above for diagnostic purposes. The medical personnel first gathers the data and inputs the sample values to be translated into mathematical syntax. Then the doctor identifies a group of patients with the symptoms of the infectious diseases mentioned. Under the supervision of a doctor, a day-to-day condition-based table (Table 2) is constructed that helps in generating a diagnostic map (Table 1) for diagnosing the distinct infectious disease of the patient. The purpose of these tables is to determine the severity of the disease

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based on the presented symptoms. The algorithm is superior to other models as it processes the initial data to figure out the sickness a patient has ahead of time and suggests an optimal treatment method for it. One of the prospects of this model is mapping the patient's rehabilitation with respect to the treatment given. To explain the working of the model, four patients with overlapping infectious disease symptoms are taken. As the symptoms overlap, it is challenging to identify a distinct infection just from an initial examination. Some of the dynamics that are usually involved in the diagnostic purposes like change in colour of skin, patient history before the examination, and genetic factors are ruled out for a better understanding of the working of the model. This model will act as a diagnostic assistant for a doctor as it will help verify the initial diagnosis and propose the treatment for said illness. Hypothetical data is used for the execution of the proposed model. It is a methodology that elaborates the way to utilize data for medical purposes. If real-time data were to be used in the model, accurate and efficient results can be extracted by analyzing appropriate information.

Step 1.

Let $R = \{r_1, r_2, r_3, r_4\}$ be a group of four patients. Suppose s_1 =Weight, s_2 =Strength and s_3 =Chills, be different symptom's properties with matching attribute values that pertain to the sets S_1, S_2 and S_3 respectively. Let $S_1 = \{s_{11}$ =Dizziness, s_{12} =Heartburn$\}$, $S_2 = \{s_{21}$ =Weakness$\}$, $S_3 = \{s_{31}$ =Numbness, s_{32} =Changes in skin color$\}$, After a thorough examination, the doctor can appraise the situation. With the information obtained by the doctor supplied as $(\varepsilon = 1, 2)$, construct a two-day chart $z_S^\varepsilon \in CNHS(R)$ for the first and second days underlying as (Table 3) and (Table 4), respectively. As indicated by the underlying initial information of patients with the above defined symptoms which are taken in the form of CNHS. Now take CNHS-union over the z_S^1 and z_S^2. Table 5 contains the resulting CNHS $\sqcup z_S^\varepsilon$.

Step 2.

Let s_1' =Cough, s_2' =Fatigue, s_3' =Fever, be different characteristics of linked Infectious Diseases symptoms, whose relevant attribute values are assigned to the sets S_1', S_2', S_3'. Let $S_1' = \{s_{11}'$ =Hoarseness, s_{12}' =Wheezing$\}$, $S_2' = \{s_{21}'$ =Tiredness$\}$, $S_3' = \{s_{31}'$ =Headache, s_{32}' =Muscle aches$\}$. Doctors weight related symptoms depending on patient information, and we utilise the CNHS $z_{S'}$ type to translate verbal data to numerical notation, as shown in Table 6.

Step 3.

Suppose two mappings in such a way; $\eth : R \to R$ and $\eth : S \to S'$ such that

$\eth(r_1) = r_1, \eth(r_2) = r_2, \eth(r_3) = r_3, \eth(r_4) = r_4$, and

$\eth(s_{11}, s_{21}, s_{31}) = ('s_{11}, 's_{21}, 's_{31})$,

$\eth(s_{11}, s_{21}, s_{32}) = ('s_{12}, 's_{21}, 's_{31})$,

$\eth(s_{12}, s_{21}, s_{31}) = ('s_{11}, 's_{21}, 's_{32})$,

$\eth(s_{12}, s_{21}, s_{32}) = ('s_{12}, 's_{21}, 's_{32})$.

Then $\mho = (\eth, \eth) : CNHS(R) \to CNHS(R)$ is used to represent CNHS-mapping. Using the aforementioned mapping in Step 3 of the method, assess the image of $\sqcup z_S^\varepsilon$ supplied as $z_{S'}'$ in table 7.

Step 4.

To acquire weighted aggregate values in Table 8, use the formula (given in step 4 algorithm portion with weights $w_1 = 0.2$, $w_2 = 0.4$) to convert Table 7 CNHS set to Neutrosophic Hypersoft set.

Step 5.

To acquire the table of first diagnosis (Table 9), compare Table 8 with Table 2. This table will be used subsequently to assess the accuracy of our results.

Step 6.

CNHS score estimates based on table 8 using

$$\tfrac{1}{2}|T_s^\varepsilon(r) - 2I_s^\varepsilon(r) - F_s^\varepsilon(r)|.$$

for each patient's related symptoms. After estimating score values of each patient, Table 10 depicts these figures. Now, the Infectious Diseases diagnostic chart (Table 1) is utilised to verify the obtained results in Table 10. Patients r_1, r_3 and r_4 are diagnosed with influenza (flu), whereas patient r_2 is diagnosed with TB, according to correlation.

Step 7.

The doctor will provide medicine to the patients after determining the true nature of their disease. We created the CNHS package based on expert advice and correct treatment for many infectious diseases. Consider $C = \{c_1 =$ Rapivab (peramivir), c_2 =ethambutol (EMB) , $c_3 =$ rifampin (RIF), $c_4 =$ Relenza (zanamivir)$\}$ be distinct treatments then create $\chi_{S'}$, which is a collection of doctor's suggestions for treating Infectious Disease symptoms with the right therapy. The set $\chi_{S'} \in CNHS(R)$ underlying as Table 11. The assessments in Table 11 are offered in accordance with each patient's historical context. Membership grades show the positive benefits of medicine (treatment) for each type, indeterminacy grades show the impartial effects of each type, and falsity grades show the side effects of drugs (treatments) for each kind of Infectious Diseases, as well as their symptoms.

Step 8.

Compute the composition between two CNHS sets $\chi_{S'}$ and $z_{S'}'$ to obtain the relationship between proposed medications and patients as a Neutrosophic soft set $\chi_{S'} \circ z_{S'}' = R^1C$, see Table 12.

Step 9.

Patients will benefit from the medicine (therapy) since it has fewer adverse situation. Now find the scores by applying the score function to the medications for each patient (Table 13), which is supplied in algorithm step 4. From Table 13, it can be evaluated that the medications c_1 is the best option for the patient r_1 and r_3, c_2 is best for r_2 and c_4 is best for r_4. The ultimate decision is based on the patient's current condition as well as his/her medical history and the nature of disease.

Step 10.

The illness type and the patient's record define the patient's

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TABLE 3. z_S^1: Symptoms on the first day of patients from S are depicted in a chart.

symptoms/patients	r_1	r_2	r_3	r_4
(s_{11}, s_{21}, s_{31})	$(0.1e^{i0.3\theta}, 0.1e^{i0.4\theta}, 0.5e^{i0.2\theta})$	$(0.5e^{i0.2\theta}, 0.2e^{i0.3\theta}, 0.6e^{i0.2\theta})$	$(0.5e^{i0.7\theta}, 0.2e^{i0.2\theta}, 0.7e^{i0.1\theta})$	$(0.3e^{i0.3\theta}, 0.1e^{i0.2\theta}, 0.1e^{i0.6\theta})$
(s_{11}, s_{21}, s_{32})	$(0.2e^{i0.1\theta}, 0.2e^{i0.6\theta}, 0.4e^{i0.7\theta})$	$(0.7e^{i0.9\theta}, 0.2e^{i0.4\theta}, 0.9e^{i0.2\theta})$	$(0.4e^{i0.7\theta}, 0.8e^{i0.1\theta}, 0.2e^{i0.7\theta})$	$(0.8e^{i0.2\theta}, 0.6e^{i0.2\theta}, 0.6e^{i0.2\theta})$
(s_{12}, s_{21}, s_{31})	$(0.5e^{i0.7\theta}, 0.2e^{i0.8\theta}, 0.2e^{i0.9\theta})$	$(0.4e^{i0.5\theta}, 0.2e^{i0.6\theta}, 0.7e^{i0.5\theta})$	$(0.3e^{i0.5\theta}, 0.6e^{i0.6\theta}, 0.3e^{i0.5\theta})$	$(0.4e^{i0.4\theta}, 0.2e^{i0.4\theta}, 0.1e^{i0.5\theta})$
(s_{12}, s_{21}, s_{32})	$(0.6e^{i0.7\theta}, 0.3e^{i0.7\theta}, 0.2e^{i0.6\theta})$	$(0.3e^{i0.6\theta}, 0.2e^{i0.7\theta}, 0.9e^{i0.4\theta})$	$(0.2e^{i0.7\theta}, 0.2e^{i0.4\theta}, 0.6e^{i0.4\theta})$	$(0.3e^{i0.5\theta}, 0.2e^{i0.4\theta}, 0.8e^{i0.2\theta})$

TABLE 4. z_S^2: Symptoms on the second day of patients from S are depicted in a chart.

symptoms/patients	r_1	r_2	r_3	r_4
(s_{11}, s_{21}, s_{31})	$(0.3e^{i0.4\theta}, 0.1e^{i0.2\theta}, 0.3e^{i0.4\theta})$	$(0.3e^{i0.4\theta}, 0.1e^{i0.2\theta}, 0.3e^{i0.4\theta})$	$(0.3e^{i0.4\theta}, 0.1e^{i0.2\theta}, 0.5e^{i0.4\theta})$	$(0.3e^{i0.4\theta}, 0.1e^{i0.2\theta}, 0.3e^{i0.4\theta})$
(s_{11}, s_{21}, s_{32})	$(0.4e^{i0.7\theta}, 0.2e^{i0.4\theta}, 0.8e^{i0.9\theta})$	$(0.2e^{i0.5\theta}, 0.2e^{i0.2\theta}, 0.4e^{i0.6\theta})$	$(0.2e^{i0.4\theta}, 0.1e^{i0.2\theta}, 0.5e^{i0.2\theta})$	$(0.6e^{i0.1\theta}, 0.2e^{i0.9\theta}, 0.8e^{i0.3\theta})$
(s_{12}, s_{21}, s_{31})	$(0.8e^{i0.5\theta}, 0.2e^{i0.7\theta}, 0.6e^{i0.8\theta})$	$(0.2e^{i0.3\theta}, 0.8e^{i0.1\theta}, 0.2e^{i0.4\theta})$	$(0.8e^{i0.2\theta}, 0.1e^{i0.2\theta}, 0.3e^{i0.4\theta})$	$(0.3e^{i0.4\theta}, 0.1e^{i0.2\theta}, 0.3e^{i0.4\theta})$
(s_{12}, s_{21}, s_{32})	$(0.5e^{i0.7\theta}, 0.9e^{i0.1\theta}, 0.2e^{i0.9\theta})$	$(0.2e^{i0.5\theta}, 0.2e^{i0.2\theta}, 0.8e^{i0.2\theta})$	$(0.7e^{i0.4\theta}, 0.2e^{i0.3\theta}, 0.6e^{i0.7\theta})$	$(0.5e^{i0.7\theta}, 0.2e^{i0.2\theta}, 0.6e^{i0.5\theta})$

TABLE 5. $\sqcup z_S^{\varepsilon}$: CNHS union of z_S^1 and z_S^2

symptoms/patients	r_1	r_2	r_3	r_4
(s_{11}, s_{21}, s_{31})	$(0.3e^{i0.4\theta}, 0.1e^{i0.4\theta}, 0.5e^{i0.4\theta})$	$(0.5e^{i0.4\theta}, 0.2e^{i0.3\theta}, 0.6e^{i0.4\theta})$	$(0.5e^{i0.7\theta}, 0.2e^{i0.2\theta}, 0.7e^{i0.4\theta})$	$(0.3e^{i0.4\theta}, 0.1e^{i0.2\theta}, 0.3e^{i0.6\theta})$
(s_{11}, s_{21}, s_{32})	$(0.4e^{i0.7\theta}, 0.2e^{i0.6\theta}, 0.8e^{i0.9\theta})$	$(0.7e^{i0.9\theta}, 0.2e^{i0.4\theta}, 0.9e^{i0.6\theta})$	$(0.4e^{i0.7\theta}, 0.8e^{i0.2\theta}, 0.5e^{i0.7\theta})$	$(0.8e^{i0.2\theta}, 0.6e^{i0.9\theta}, 0.8e^{i0.3\theta})$
(s_{12}, s_{21}, s_{31})	$(0.8e^{i0.7\theta}, 0.2e^{i0.8\theta}, 0.6e^{i0.9\theta})$	$(0.4e^{i0.5\theta}, 0.8e^{i0.6\theta}, 0.7e^{i0.4\theta})$	$(0.8e^{i0.5\theta}, 0.6e^{i0.6\theta}, 0.3e^{i0.5\theta})$	$(0.4e^{i0.4\theta}, 0.2e^{i0.4\theta}, 0.3e^{i0.5\theta})$
(s_{12}, s_{21}, s_{32})	$(0.6e^{i0.7\theta}, 0.9e^{i0.7\theta}, 0.2e^{i0.9\theta})$	$(0.3e^{i0.6\theta}, 0.2e^{i0.7\theta}, 0.9e^{i0.4\theta})$	$(0.7e^{i0.7\theta}, 0.2e^{i0.4\theta}, 0.6e^{i0.7\theta})$	$(0.5e^{i0.7\theta}, 0.2e^{i0.4\theta}, 0.8e^{i0.5\theta})$

TABLE 6. $z_{S'}$: Weights of related symptoms S' for each patient in CNHS

symptoms/patients	r_1	r_2	r_3	r_4
$('s_{11}, 's_{21}, 's_{31})$	$(0.1e^{i0.4\theta}, 0.7e^{i0.5\theta}, 0.4e^{i0.8\theta})$	$(0.2e^{i0.4\theta}, 0.2e^{i0.8\theta}, 0.2e^{i0.9\theta})$	$(0.4e^{i0.5\theta}, 0.2e^{i0.3\theta}, 0.4e^{i0.7\theta})$	$(0.1e^{i0.9\theta}, 0.2e^{i0.7\theta}, 0.2e^{i0.5\theta})$
$('s_{11}, 's_{21}, 's_{32})$	$(0.3e^{i0.4\theta}, 0.1e^{i0.2\theta}, 0.3e^{i0.4\theta})$	$(0.3e^{i0.4\theta}, 0.1e^{i0.2\theta}, 0.3e^{i0.4\theta})$	$(0.3e^{i0.4\theta}, 0.1e^{i0.2\theta}, 0.3e^{i0.4\theta})$	$(0.3e^{i0.4\theta}, 0.1e^{i0.2\theta}, 0.3e^{i0.4\theta})$
$('s_{12}, 's_{21}, 's_{31})$	$(0.5e^{i0.1\theta}, 0.2e^{i0.7\theta}, 0.2e^{i0.6\theta})$	$(0.2e^{i0.5\theta}, 0.2e^{i0.3\theta}, 0.2e^{i0.8\theta})$	$(0.2e^{i0.7\theta}, 0.2e^{i0.3\theta}, 0.5e^{i0.4\theta})$	$(0.8e^{i0.2\theta}, 0.1e^{i0.7\theta}, 0.4e^{i0.4\theta})$
$('s_{12}, 's_{21}, 's_{32})$	$(0.6e^{i0.5\theta}, 0.2e^{i0.9\theta}, 0.1e^{i0.3\theta})$	$(0.7e^{i0.4\theta}, 0.2e^{i0.7\theta}, 0.2e^{i0.5\theta})$	$(0.2e^{i0.8\theta}, 0.2e^{i0.3\theta}, 0.6e^{i0.4\theta})$	$(0.2e^{i0.5\theta}, 0.2e^{i0.4\theta}, 0.2e^{i0.2\theta})$

TABLE 7. Under CNHS mapping,the image $(z'_{S'})$ of $\sqcup z_S^{\varepsilon}$.

symptoms/patients	r_1	r_2	r_3	r_4
$('s_{11}, 's_{21}, 's_{31})$	$(0.3e^{i0.4\theta}, 0.1e^{i0.4\theta}, 0.5e^{i0.4\theta})$	$(0.5e^{i0.4\theta}, 0.2e^{i0.3\theta}, 0.6e^{i0.4\theta})$	$(0.5e^{i0.7\theta}, 0.2e^{i0.2\theta}, 0.7e^{i0.4\theta})$	$(0.3e^{i0.4\theta}, 0.1e^{i0.2\theta}, 0.3e^{i0.6\theta})$
$('s_{12}, 's_{21}, 's_{31})$	$(0.8e^{i0.7\theta}, 0.2e^{i0.8\theta}, 0.6e^{i0.9\theta})$	$(0.4e^{i0.5\theta}, 0.8e^{i0.6\theta}, 0.7e^{i0.4\theta})$	$(0.8e^{i0.5\theta}, 0.6e^{i0.6\theta}, 0.3e^{i0.5\theta})$	$(0.4e^{i0.4\theta}, 0.2e^{i0.4\theta}, 0.3e^{i0.5\theta})$
$('s_{11}, 's_{21}, 's_{32})$	$(0.4e^{i0.7\theta}, 0.2e^{i0.6\theta}, 0.8e^{i0.9\theta})$	$(0.7e^{i0.9\theta}, 0.2e^{i0.4\theta}, 0.9e^{i0.6\theta})$	$(0.4e^{i0.7\theta}, 0.8e^{i0.2\theta}, 0.5e^{i0.7\theta})$	$(0.8e^{i0.2\theta}, 0.6e^{i0.9\theta}, 0.8e^{i0.3\theta})$
$('s_{12}, 's_{21}, 's_{32})$	$(0.6e^{i0.7\theta}, 0.9e^{i0.7\theta}, 0.2e^{i0.9\theta})$	$(0.3e^{i0.6\theta}, 0.2e^{i0.7\theta}, 0.9e^{i0.4\theta})$	$(0.7e^{i0.7\theta}, 0.2e^{i0.4\theta}, 0.6e^{i0.7\theta})$	$(0.5e^{i0.7\theta}, 0.2e^{i0.4\theta}, 0.8e^{i0.5\theta})$

TABLE 8. $z'_{S'}$: CNHS to Neutrosophic Hypersoft set

symptoms/patients	r_1	r_2	r_3	r_4
$('s_{11}, 's_{21}, 's_{31})$	$(0.31, 0.27, 0.35)$	$(0.35, 0.22, 0.37)$	$(0.53, 0.16, 0.39)$	$(0.31, 0.14, 0.43)$
$('s_{12}, 's_{21}, 's_{31})$	$(0.59, 0.54, 0.68)$	$(0.39, 0.53, 0.39)$	$(0.47, 0.49, 0.37)$	$(0.33, 0.29, 0.37)$
$('s_{11}, 's_{21}, 's_{32})$	$(0.51, 0.41, 0.72)$	$(0.7, 0.29, 0.55)$	$(0.51, 0.28, 0.53)$	$(0.28, 0.68, 0.34)$
$('s_{12}, 's_{21}, 's_{32})$	$(0.55, 0.61, 0.6)$	$(0.43, 0.47, 0.43)$	$(0.57, 0.29, 0.55)$	$(0.53, 0.29, 0.47)$

TABLE 9. To assess the accuracy of outcomes, a tabular depiction of the initial diagnosis chart is created.

symptoms / patients	r_1	r_2	r_3	r_4
$('s_{11}, 's_{21}, 's_{31})$	(SI, MI, SI)	(SI, LI, SI)	(MT, SD, SI)	(MI, SD, SI)
$('s_{11}, 's_{21}, 's_{32})$	(LC, MT, LC)	(SI, MT, SI)	(LT, LT, SI)	(SI, MI, SI)
$('s_{12}, 's_{21}, 's_{31})$	(MT, MI, LC)	(LO, NT, NT)	(MT, SI, MT)	(SI, LC, SI)
$('s_{12}, 's_{21}, 's_{32})$	(ST, LC, LC)	(SI, SI, LT)	(ST, SI, ST)	(SA, SI, ML)

status. It is possible to repeat the sessions till the illness is totally healed. By defining the CNHS-mapping and defining two sub mappings $\eth' : R^{q-1} \to R^q$ and $\eth' : C^{q-1} \to C^q$, one can see how each patient is improving.

$$\eth'(r_1) = r_1, \eth'(r_2) = r_2, \eth'(r_3) = r_3, \eth'(r_4) = r_4;$$

and

$$\eth'(c_1) = c_1, \eth'(c_2) = c_2, \eth'(c_3) = c_3.$$

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TABLE 10. Data on associated symptoms is valued by the patient score

patients / symptoms	$(' s_{11}, ' s_{21}, ' s_{31})$	$(' s_{11}, ' s_{21}, ' s_{32})$	$(' s_{12}, ' s_{21}, ' s_{31})$	$(' s_{12}, ' s_{21}, ' s_{32})$	Average score
r_1	0.3	0.23	0.09	0.4	0.25
r_2	0.58	0.53	0.44	0.41	0.5
r_3	0.553	0.215	0.29	0.71	0.442
r_4	0.635	0.47	0.28	0.26	0.41

TABLE 11. $\chi_{S'}$: Doctor's suggestions, along with the proper therapy for Infectious Diseases symptoms.

medications / symptoms	$(' s_{11}, ' s_{21}, ' s_{31})$	$(' s_{11}, ' s_{21}, ' s_{32})$	$(' s_{12}, ' s_{21}, ' s_{31})$	$(' s_{12}, ' s_{21}, ' s_{32})$
c_1	$(0.5, 0.3, 0.1)$	$(0.9, 0.5, 0.8)$	$(0.2, 0.5, 0.2)$	$(0.6, 0.3, 0.4)$
c_2	$(0.5, 0.3, 0.2)$	$(0.4, 0.6, 0.1)$	$(0.7, 0.3, 0.4)$	$(0.6, 0.3, 0.2)$
c_3	$(0.6, 0.1, 0.4)$	$(0.8, 0.1, 0.6)$	$(0.6, 0.3, 0.2)$	$(0.8, 0.2, 0.3)$
c_4	$(0.7, 0.3, 0.1)$	$(0.7, 0.2, 0.3)$	$(0.6, 0.1, 0.1)$	$(0.5, 0.5, 0.4)$

TABLE 12. R_C^1: Composition among $\chi_{S'}$ and $z'_{S'}$ to obtain the link between proposed medications and patients

patients / medications	c_1	c_2	c_3	c_4
r_1	$(0.5, 0.27, 0.1)$	$(0.9, 0.22, 0.37)$	$(0.53, 0.16, 0.2)$	$(0.6, 0.14, 0.4)$
r_2	$(0.59, 0.3, 0.2)$	$(0.4, 0.53, 0.1)$	$(0.7, 0.3, 0.37)$	$(0.6, 0.29, 0.2)$
r_3	$(0.6, 0.2, 0.4)$	$(0.8, 0.1, 0.55)$	$(0.6, 0.28, 0.2)$	$(0.8, 0.2, 0.3)$
r_4	$(0.7, 0.3, 0.1)$	$(0.7, 0.2, 0.3)$	$(0.6, 0.1, 0.1)$	$(0.53, 0.29, 0.4)$

TABLE 13. Patient score values and therapy recommendations are shown in a tabulated form.

patients / medications	c_1	c_2	c_3	c_4	Maximum esteems	Selected treatment
r_1	0.07	0.045	0.005	0.04	0.07	c_1
r_2	0.105	0.38	0.135	0.09	0.38	c_2
r_3	0.1	0.025	0.08	0.05	0.1	c_1
r_4	0	0	0.15	0.225	0.225	c_4

Then CNHS-mapping defined as follows;

$$\mho' = (\eth', \ni') : R_C^{q-1} \to R_C^q$$

The CNHS-mapping is as shown in;

$$R_C^q = \mho'(R_C^{q-1})(c)(r) = \frac{1}{q} \begin{cases} \vee_{\theta \in \eth'^{-1}(r)} (\vee_{\vartheta \in \ni'^{-1}(c) \cap C} R_C^{q-1}(\theta) \text{ if} \\ \qquad \eth'^{-1}(r) \neq \emptyset, \ni'^{-1}(c) \cap C \neq \emptyset \\ 0 \quad \text{if } otherwise \end{cases} \tag{11}$$

where $q = 2, 3, 4, ...$ represents the number of episodes of treatments and $c \in \ni'(C) \subseteq C$, $r \in R^q$, $\theta \in R^{q-1}$, $\vartheta \in C^{q-1}$ and treatment episodes can be written up in Tables 14, 15, 16 and 17 are given for $q = 2, 3, 4$ and 5 respectively.

Step 11.
Step 9 is repeated until the patient's results are satisfactory. Figure 13, 14, 15 and 16 shows the progression of each patient's case.

D. THE PROPOSED ALGORITHM'S ADVANTAGES

This model aims to determine the most accurate diagnosis of any illness, as well as the symptoms that accompany it. The model aims to be a diagnostic assistant for shortlisting options and diagnosing patients with overlapping symptoms over a wide range of infectious diseases. This study constructs a relationship between the symptoms and mathematically maps them to the appropriate treatment. The model is based on the state of the art Complex Neutrosophic Hypersoft structures that can project a patient's symptoms ahead of time and forecast the patient's condition overtime to determine the changes in health with certain medication given. It can be used to forecast the recovery stages of the infection until the ailment has been averted. These machine learning tools are a requirement in the near future to minimize diagnostic errors and the extraction of significant results based on specific patient conditions.

E. COMPARATIVE ANALYSIS

The comprehensive idea based on CNHS mapping can be used for numerous infectious diseases that may or may not have overlapping symptoms. The limitations of other existing theories do not allow for the complete investigation of the issue; hence they can not be applied. All the models can collect the patient's data but cannot utilize it to the fullest extent to achieve the most refined diagnostic results. The limitations of some models compared to the model presented and what type of issues they address are given in the table (see Table 18). Most models fail when the attributes are further divided into sub-attributes and include complex $(2D)$ information. This shortcoming is addressed by CNHS-mapping and is capable of efficiently dealing with such issues. Below is how the proposed method works and how its more precise:

- The symptoms are recorded in such a way that to link them to the severity using CNHS, which utilizes all the patient data. That way, the algorithm adds a certain

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TABLE 14. R_C^2: Patient's recovery report after the second medication episode

patients / medications	c_1	c_2	c_3	c_4
r_1	$(0.25, 0.135, 0.05)$	$(0.45, 0.11, 0.185)$	$(0.265, 0.08, 0.1)$	$(0.3, 0.07, 0.2)$
r_2	$(0.295, 0.15, 0.1)$	$(0.2, 0.265, 0.05)$	$(0.35, 0.15, 0.185)$	$(0.3, 0.145, 0.1)$
r_3	$(0.3, 0.145, 0.1)$	$(0.3, 0.1, 0.2)$	$(0.4, 0.05, 0.275)$	$(0.3, 0.14, 0.1)$
r_4	$(0.4, 0.1, 0.15)$	$(0.35, 0.15, 0.05)$	$(0.3, 0.005, 0.005)$	$(0.265, 0.145, 0.2)$

TABLE 15. R_C^3: Patient's recovery report after the third medication episode

patients / medications	c_1	c_2	c_3	c_4
r_1	$(0.08, 0.04, 0.01)$	$(0.15, 0.03, 0.06)$	$(0.1, 0.083, 0.067)$	$(0.08, 0.02, 0.03)$
r_2	$(0.1, 0.02, 0.06)$	$(0.09, 0.05, 0.03)$	$(0.15, 0.083, 0.067)$	$(0.06, 0.08, 0.01)$
r_3	$(0.1, 0.05, 0.06)$	$(0.1, 0.04, 0.03)$	$(0.1, 0.03, 0.06)$	$(0.13, 0.01, 0.09)$
r_4	$(0.1, 0.04, 0.03)$	$(0.13, 0.03, 0.05)$	$(0.1, 0.05, 0.016)$	$(0.08, 0.04, 0.06)$

TABLE 16. R_C^4: Patient's recovery report after the fourth medication episode

patients / medications	c_1	c_2	c_3	c_4
r_1	$(0.02, 0.01, 0.004)$	$(0.0375, 0.009, 0.015)$	$(0.022, 0.006, 0.008)$	$(0.025, 0.005, 0.01)$
r_2	$(0.024, 0.0125, 0.0083)$	$(0.016, 0.022, 0.0041)$	$((0.0291, 0.0125, 0.015)$	$(0.025, 0.012, 0.0083)$
r_3	$(0.025, 0.0083, 0.0166)$	$(0.033, 0.0041, 0.022)$	$(0.025, 0.011, 0.008)$	$(0.033, 0.008, 0.0125)$
r_4	$(0.029, 0.0125, 0.0041)$	$(0.029, 0.0083, 0.0125)$	$(0.025, 0.0041, 0.004)$	$(0.022, 0.012, 0.016)$

TABLE 17. R_C^5: Patient's recovery report after the fifth medication episode

patients/ medications	c_1	c_2	c_3	c_4
r_1	$(0.004, 0.0022, 0.00083)$	$(0.0075, 0.0018, 0.0030)$	$(0.0044, 0.0013, 0.0016)$	$(0.005, 0.00116, 0.0033)$
r_2	$(0.0049, 0.0025, 0.0016)$	$(0.0033, 0.004, 0.00083)$	$(0.005, 0.002, 0.0030)$	$(0.005, 0.0024, 0.001)$
r_3	$(0.005, 0.0016, 0.003)$	$(0.006, 0.00083, 0.0045)$	$(0.005, 0.002, 0.0016)$	$(0.006, 0.001, 0.0025)$
r_4	$(0.00583, 0.0025, 0.0008)$	$(0.005, 0.0016, 0.0025)$	$(0.005, 0.0008, 0.0008)$	$(0.004, 0.002, 0.003)$

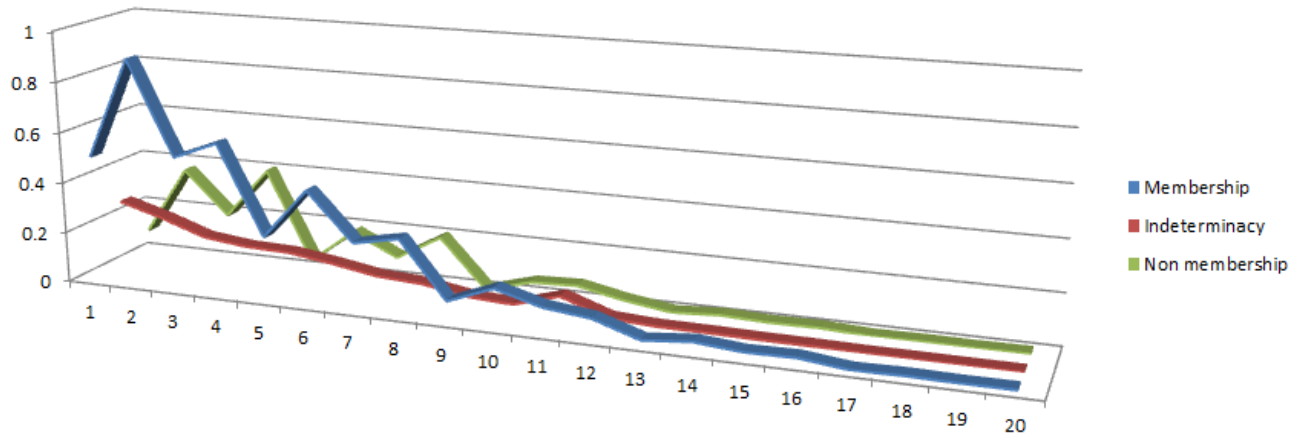

FIGURE 13. Improvement report of patient r_1

amount of time to provide a future predictive analysis that helps determine treatment.

- The symptoms presented at the initial stages of the disease may change over a short period of time, leading to an error. So, a connection is made between the essential indications of disease to calculate the weights based on a specific case.
- The second stage of the algorithm is primarily used to recommend therapy regarding the symptoms presented.
- To examine the patient's improvement history, we use a generalized form of CNHS-mapping. All of the assessments decrease up to zero with each episode, implying that infectious diseases symptoms, neutral effects of medicine with treatments, and side effects are all decreasing. This model shows the evolution of patients as time passes.
- If the patient's condition does not improve over time with the medication method, inverse mapping can be utilized to bring the patient to its original state.
- When it comes to parameterizations and multi-criterion

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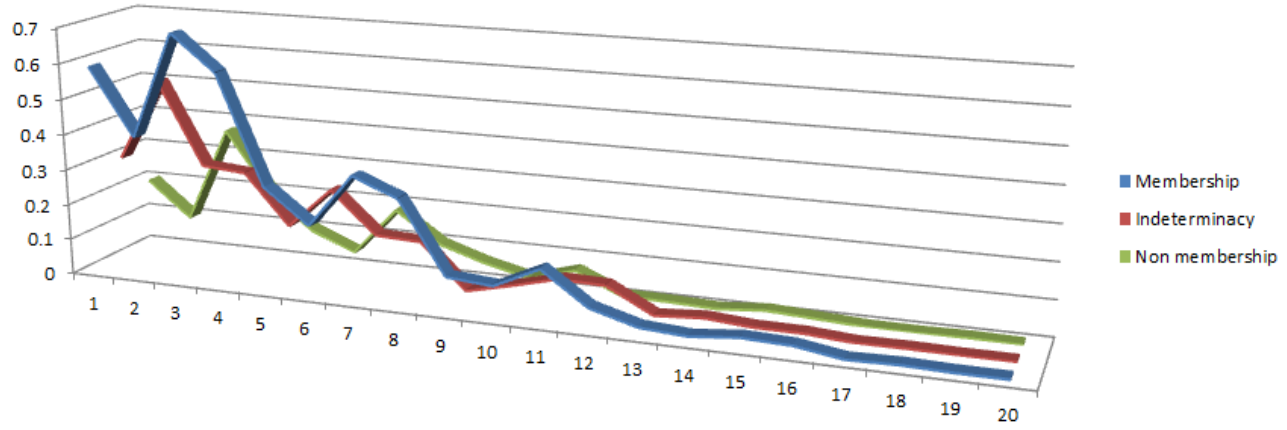

FIGURE 14. Improvement report of patient r_2

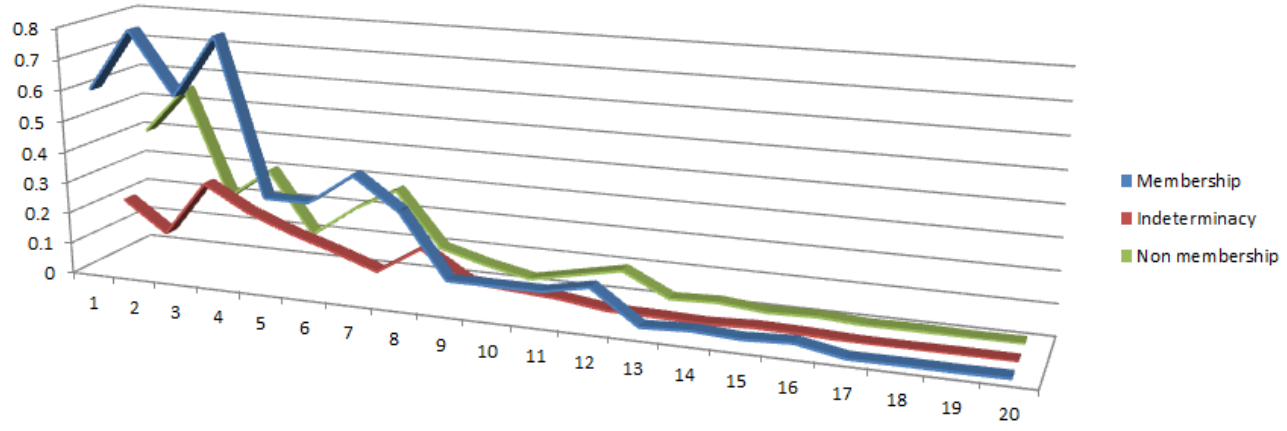

FIGURE 15. Improvement report of patient r_3

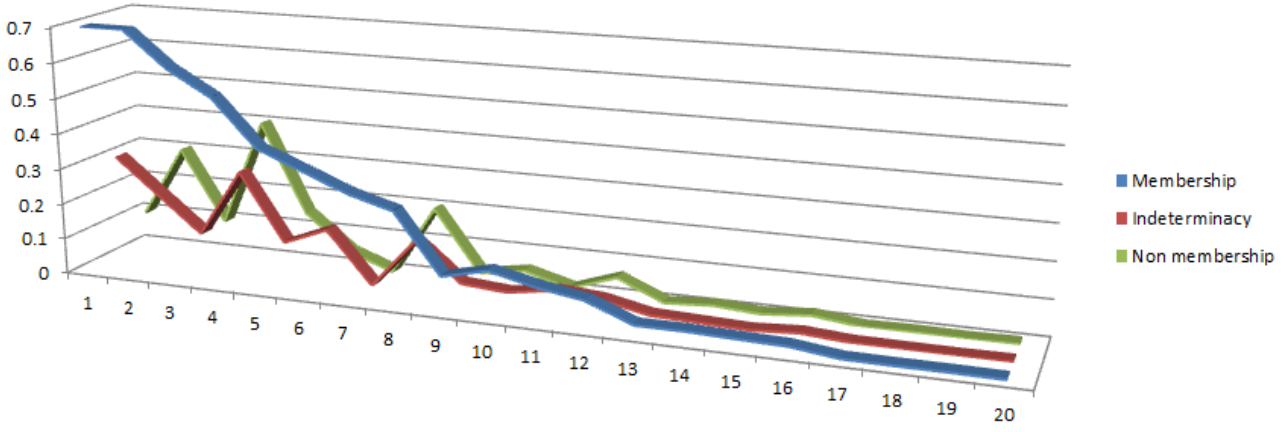

FIGURE 16. Improvement report of patient r_4

decision making, the proposed method is beneficial for numerous patients as it can deal with various diseases and produce solid and consistent results.

- The evaluation of the patients will be done in the presence of a doctor as they will a numerical value between 0 and 1 to the sub parametric values as hypersoft struc-

TABLE 18. The CNHS is superior than existing methodologies

SN	References	Drawback	Ranking
1	Fuzzy Set [15]	2D data does not well-managed	Unable to deal with
2	Intuitionistic Fuzzy Set [44]	2D data does not well-managed	Unable to deal with
3	Neutrosophic Set [45]	2D data does not well-managed	Unable to deal with
4	Bipolar Fuzzy Set [46]	2D data does not well-managed	Unable to deal with
5	M-Polar Fuzzy Set [47]	2D data does not well-managed	Unable to deal with
6	Soft Class Mappings [17]	2D data and attributes are not well-managed when they are split into attribute values	Unable to deal with
7	Fuzzy Soft Class Mappings [18]	2D data and attributes are not well-managed when they are broken into attribute values.	Unable to deal with
8	Mappings on M-Polar Neutrosophic Soft Sets [48]	2D data and attributes are not well-managed when they are broken into attribute values	Unable to deal with
9	Bipolar Fuzzy Soft Mappings [50]	2D data and attributes are not well-managed when they are broken into attribute values.	Unable to deal with
10	Complex Fuzzy Set [52]	Whenever attributes are broken down into attribute values, they are unable to deal with the complexity of the situation	Unable to deal with
11	Complex Multi-Fuzzy Soft Set [51]	Whenever attributes are broken down into attribute values, they are unable to deal with the complexity of the situation	Unable to deal with
12	Proposed Method in this paper	Decision-making entails lengthy and complex computations	This issue can be addressed by using a computer algorithm

tures. The degree of influence and the time of influence will be recorded in terms of a complex number.

V. CONCLUSIONS

This study investigates infectious diseases and the difficulties that accompany them. A method for recognizing and assessing a patient's major symptoms and infectious illnesses is proposed. There are three phases to the computation that was established. Initially, the model was used to estimate the severity of the patient's infectious diseases. CNHS-mapping is applied in the second stage to discover relevant medications for patients based on the severity of their infectious illnesses. Third, a generalized CNHS-mapping system is set up to find the patient's status and anticipate his prescription medication needs. To identify infections, this method is both effective and beneficial. According to correlation, the recommended method for dealing with MCDM problems is the most effective, simple to handle, robust, substantial, and flexible. The domains can be explored further for Complex Intuitionistic Fuzzy Hypersoft Set, Plithogenic Neutrosophic Hypersoft Set, Plithogenic Crisp Hypersoft Set, Plithogenic Intuitionistic Fuzzy Hypersoft Set, Bipolar Crisp Hypersoft Set, Plithogenic Fuzzy Hypersoft Set, Bipolar Intuitionistic Fuzzy Hypersoft Set, Bipolar Fuzzy Hypersoft Set, Bipolar Neutrosophic Hypersoft Set, Spherical fuzzy sets, Pythagorean fuzzy uncertain environment and their hybrids in the future. Machine learning, diagnostic imaging, information retrieval, information processing, contextual awareness, recommender structures, artificial intelligence, social networks, sensor fusion, the financial framework, neural nets, signal processing, particle physics configuration, and behavioural economics are just some of the applications.

REFERENCES

[1] S.S. Morse, "Factors In The Emergence Of Infectious Diseases", In Price-Smith A.T. (eds) Plagues and Politics, Global Issues Serie, Palgrave Macmillan, London, pp. 8-26, 2001.

[2] A.S. Fauci and D.M. Morens, "The Perpetual Challenge Of Infectious Diseases", N. Engl. J. Med., vol. 366, no. 5, 454-461, 2012.

[3] F. Prinzing, "Epidemics Resulting From Wars", Berlin, Boston, De Gruyter, 2020, pp. 535-540.

[4] A.S. Fauci, H.C. Lane and R.R. Redfield, "Covid-19 Navigating The Uncharted", N. Engl. J. Med., vol. 382, no. 1, pp. 1268-1269, 2020.

[5] L.T. Hadfield, P. McEvoy, Y. Polotsky, V.A. Tzinserling and A.A. Yakovlev, "The Pathology Of Diphtheria", J. Infect. Dis., vol. 181, no. S-1, pp. S116-S120, 2000.

[6] B.P. Loevinsohn, "The Changing Age Structure Of Diphtheria Patients: Evidence For The Effectiveness Of EPI In The Sudan", B. World Health Organ., vol. 68, no. 3, pp. 353-357, 1990.

[7] J.K. Taubenberger and D.M. Morens, "The Pathology Of Influenza Virus Infections", Annu. Rev. Pathol. Mech. Dis., vol. 3, no. 1, pp.499-522, 2008.

[8] M. Uiprasertkul, P. Puthavathana, K. Sangsiriwut, P. Pooruk, K. Srisook, M. Peiris, J.M. Nicholls, K. Chokephaibulkit, N. Vanprapar and P. Auewarakul, "Influenza A H5N1 Replication Sites In Humans", Emerg. Infect. Dis., vol. 11, no. 7, p.1036, 2005.

[9] M.X. Rangaka, S.C. Cavalcante, B.J. Marais, S. Thim, N.A. Martinson, S. Swaminathan and R.E. Chaisson, "Controlling The Seedbeds Of Tuberculosis: Diagnosis And Treatment Of Tuberculosis Infection", The Lancet, vol. 386, no. 10010, pp.2344-2353, 2015.

[10] American Thoracic Society (ATS) and CDC, "Diagnostic Standards And Classification Of Tuberculosis In Adults And Children", Am. J. Respir. Crit. Care Med., vol. 161, no. 1, pp. 1376-1395, 2000.

[11] M. Jassal and W.R. Bishai, "Extensively Drug-Resistant Tuberculosis", Lancet Infect. Dis., vol. 9, no. 1, pp. 19-30, 2009.

[12] A. Hafeez, S. Ahmad, S.A. Siddqui, M. Ahmad and S. Mishra, "A Review Of COVID-19 (Coronavirus Disease-2019) Diagnosis, Treatments And Prevention", EJMO, vol. 4, no. 2, pp. 116-125, 2020.

[13] C. Huang, Y. Wang, Z. Li, L. Ren, J. Zhao, Y. Hu, L. Zhang, G. Fan, J. Xu and X. Gu, "Clinical Features Of Patients Infected With 2019 Novel Coronavirus In Wuhan", The Lancet, vol. 395, no. 10223, pp. 497–506, 2020.

[14] S. Shekhar, R. Wurth, C.D. Kamilaris, G. Eisenhofer, F.J. Barrera, M. Hajdenberg, J. Tonleu, J.E. Hall, E.L. Schiffrin, F. Porter and C.A. Stratakis, "Endocrine Conditions And COVID-19", Horm. Metab. Res., vol. 52, no. 7, pp. 471, 2020.

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

[16] I.B. Turksen, "Interval Valued Fuzzy Sets Based On Normal Forms", Fuzzy Set Syst., vol. 20, no. 2, pp. 191-210, 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 Decisionmaking 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. 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.

[26] 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, pp. 70455-70471, 2021.

[27] 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.

[28] 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).

[29] 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.

[30] 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.

[31] 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.

[32] 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.

[33] 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.

[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] 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.

[36] 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.

[37] 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).

[38] 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.

[39] 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.

[40] 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.

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

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

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

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

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

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

[47] 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.

[48] 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.

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

[50] 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.

[51] 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.

[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, "Operations On Complex Multi-Fuzzy Sets", J. Intell. Fuzzy. Syst., vol. 33, no. 3, pp. 1527-1540, 2017.

[54] 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.

[55] 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.

[56] 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.

[57] A. Azizi and N. Seifipour, "Modeling of Dermal Wound Healing-Remodeling Phase by Neural Networks", 2009 IACST-SC, IEEE, 2009, pp. 447-450.

[58] 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.

[59] 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.

[60] 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.

[61] 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.

[62] 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.

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