Research Article

Disease Identification Using Trapezoidal Fuzzy Numbers by Sanchez's Approach

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ABSTRACT

Sanchez's devolved a technique for medical diagnosis using fuzzy set theory. In this paper, we introduce a combined method of mathematical techniques and several features of the medical diagnosis to provide an effective tool in the field of therapeutics. Sanchez technique based on fuzzy soft set theory has been developed and employed to simplify the disease diagnosis procedure. Finally, to get more insight into the developed approach, an elaborative example assuming hypothetical data has also been presented.

Keywords: Soft set, fuzzy soft set, Trepzoidal fuzzy numbers (TFN), Disease identification, Sanchez's approach, fuzzy number.

INTRODUCTION

In our daily life, we faced a lot of difficulties in different fields of life such as management science, economics, environment, social science, and medical science, etc. To overcome these difficulties Zadeh introduced a mathematical tool known as fuzzy set in a study[1]. After that many other theories such as the theory of probability, intuitionistic fuzzy set, rough set, etc. were introduced. But these theories have their own problems, to solve those problems in a study[2] Molodtsov developed the idea of the soft set (SS). In a study[3] Maji et al. extended the concept of SS and introduced some definitions and properties on soft set theory, they also proved that De Morgan law satisfied in soft set theory. Irfan et al. [4] revised the work of Maji et al. and introduced some new notions on SS with properties. The concept of parametrization reduction of SS with a comparative study with attribute reduction of a rough set theory constructed in a study[5], the author's also used the parametrization reduction in decision making. The idea of fuzzy soft set theory was developed in a study[6] by combining the fuzzy set and SS.

In a study[7], the authors studied fuzzy soft set theory and constructed a decision-making method known as a fuzzy soft aggregation operator and successfully proved its utility to solve problems that contain uncertainty. Researchers studied the decision-making method which was developed by a fuzzy soft set theory known as the fuzzy TOPSIS method [8,9] and Intuitionistic Fuzzy TOPSIS [10] to solve multi-criteria decision-making (MCDM) problems. The problem of the trapezoidal approximation of fuzzy numbers was presented in a study[11] by Przemyslaw Grzegorzewski and Edyta Mrowka. In a study[12], the authors reviewed the similarity measure between generalized TFNs and introduced a new similarity measure generalized TFNs, they also introduced a tool to check the performance of different similarity measures. By using the centroid point and left/right spread of TFNs for space of all TFNs Ebadi et al.[13] introduced a distance measure. Rajarajeswari and Dhanalakshmi in [14] applied the fuzzy arithmetic operations to diagnose the on TFNs in fuzzy soft set theory. Salim Rezvani calculated the ranking on the base of the apex angles of TFNs in a study[15]. Chen and Wang [16] introduced the fuzzy distance of two TFNs. The concept of the trapezoidal fuzzy soft set with some operations and properties presented [17] on the bases of TFN and used for MCDM. In a study[18], the authors revised some results of [17] and presented a generalized form of fuzzy soft subset and fuzzy soft equal set along with some properties. Dayan and Zulqarnain developed the idea of generalized interval valued fuzzy soft matrices and discussed similarity measures between them[19]. Generalized trapezoidal fuzzy soft sets introduced in a study [20] and applied in decision making and medical diagnosis. In a study [21,22], the authors studied the TOPSIS method for medical diagnosis via crisp data and multi-criteria decision-making problems via SS respectively and used the TOPSIS method for selection of a medical clinic for diagonisis[23].

In a study[24], the authors studied Sanchez's method for medical diagnosis in intuitionistic fuzzy sets. Beg and Rashid constructed trapezoidal valued intuitionistic fuzzy relations and used for decision making in medical diagnosis[25], they also studied Sanchez's method[26,27] of medical diagnosis with the newly constructed notion.

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Fuzzy soft matrix and interval-valued fuzzy soft matrices (IVFSM) are used for decision-making in[28,29] also discussed the comparative study among fuzzy soft matrix and IVFSM. In a study[30], the authors extended Sanchez's approach for medical diagnosis by using the interval-valued fuzzy soft set. A decision-making method developed [31] on IVFSM known as "interval-valued fuzzy soft max-min decision-making method".

The structure of the following paper organized as follows. In section 2, we present some basic definitions on fuzzy sets and soft sets with operations used in the sequel. In section 3, we developed a mathematical technique using TFN by operating Sanchez's approach. In section 4, we used the proposed method in medical diagnoses by using hypothetical data. Lastly, section 5 consists of a conclusion.

PRELIMINARIES

Definition 2.1 [1]

A fuzzy set A in M is characterized by a membership function $f_A(y_i)$ which associates with each object of M in the interval [0, 1], with the value of $f_A(y_i)$ where y_i representing the grade of membership of y in A.

Definition 2.2 [24]

A fuzzy subset μ is convex, on the universal set $\mathbb{R}$ iff for all $c, d \in \mathbb{R}, \mu(\alpha c + \beta d) \geq \mu(c) \wedge \mu(d)$, where $\alpha + \beta = 1$.

On the universal set V, a fuzzy subset μ is entitled as a normal fuzzy subset if here a subset $c_i \in V$ such that $\mu(c_i) = 1$.

Stated upon the universal set S, a fuzzy number is a fuzzy subset that exists as together convex and normal.

Definition 2.3 [1]

A fuzzy subset k of V is defined as a function from V to [0,1]. The class of all fuzzy subsets of V is represented by G(V). Assume $k, l \in G(V)$ and $n \in V$. So, the union and intersection of k and l are expressed as following

$$(k \vee l)(n) = k(n) \vee l(n)$$

$$(k \wedge l)(n) = k(n) \wedge l(n)$$

$k \leq l$ if and only if $k(n) \leq l(n)\ \forall\, n \in V$.

Definition 2.4 [32]

A fuzzy number C = δ_C in the set of real numbers as follows

$$\delta_C(t) = \begin{cases} C_L(t) & \text{if } x_1 \leq t \leq y_1 \\ 1 & \text{if } y_1 \leq t \leq z_1 \\ C_R(t) & \text{if } z_1 \leq t \leq m_1 \\ 0 & \text{Otherwise} \end{cases}$$

for all "$x_1, y_1, z_1, m_1 \in \mathbb{R}$ and C_L: $[x_1, y_1] \to [0, 1]$ and C_R: $[z_1, m_1] \to [0, 1]$ are two nondecreasing and non-increasing continuous functions with $C_L(x_1) = 0$, $C_L(y_1) = 1$ and $C_R(z_1) = 1$, $C_R(m_1) = 0$ respectively.

Definition 2.5 [33]

If C = (x_1, y_1, z_1) for all $x_1, y_1, z_1, \in \mathbb{R}$ is a fuzzy number with piecewise linear membership function defined as follows

$$\delta_C(t) = \begin{cases} \frac{t - x_1}{y_1 - x_1} & \text{if } x_1 \leq t \leq y_1 \\ 1 & \text{if } t = y_1 \\ \frac{z_1 - t}{z_1 - y_1} & \text{if } y_1 \leq t \leq z_1 \\ 0 & \text{Otherwise} \end{cases}$$

Then C = (x_1, y_1, z_1) is called a triangular fuzzy number.

Definition 2.6 [34]

If $\tilde{t} = (x_1, y_1, z_1, m_1)$ be a fuzzy number with member ship function $\delta_{\tilde{t}}(t)$ as follows

$$\delta_{\tilde{t}}(t) = \begin{cases} 0 & \text{if } t < x_1 \\ \frac{t - x_1}{y_1 - x_1} & \text{if } x_1 \leq t \leq y_1 \\ 1 & \text{if } y_1 \leq t \leq z_1 \\ \frac{t - m_1}{z_1 - m_1} & \text{if } z_1 \leq t \leq m_1 \\ 0 & \text{if } t > m_1 \end{cases}$$

Then $\delta_{\tilde{t}}$ is said to be a trapezoidal fuzzy number (TFN).

A set that consists of two or more than two TFN's is called trapezoidal fuzzy set.

Definition 2.7 [2]

A pair (F, A) is called an SS over M if A is any subset of E, and there exists a mapping from A to P (M) is F, P (M) is the parameterized family of subsets of the M but not a set.

Definition 2.8 [6]

Let V be a universal set and E be a set of parameters such that $B \subseteq E$. Then a pair (G, A) is called FSS over V, where G is a mapping provided by

$$G: B \to G(V).$$

Definition 2.9 [6]

Let (E, B) and (H, C) be two FSS on a universal set V. Then

- (E, B) is a fuzzy soft subset of (H, C) if $B \subseteq C$ and $E(c) \leq H(c)$ for each $c \in B$. Herein.
- The complement of FSS (E, B) is characterized by $(E, B)^c = (E^c, B)$, where $E^c: B \to E(V)$ is a function given by $E^c(c) = 1 - E(c)\ \forall\, c \in E$.
- Any FSS (E, B) is said to be the absolute FSS over V, if $G(c) = 1_V\ \forall\, c \in B$.
- Any FSS(E, B) is said to be the null FSS over V, represented by ϕ, if $G(c) = 0_V\ \forall\, c \in B$.

Definition 2.10 [6]

The union of FSS(E, B) and (H, C) characterizes the FSS$(K, T) = (E, B)\ \tilde{\cup}\ (H, C)$ over V, where $T = B \cup C$ and

$$K(u) = \begin{cases} E(u) & \text{if } u \in B \backslash C \\ H(u) & \text{if } u \in C \backslash B \\ E(u) \vee H(u) & \text{if } u \in B \cap C \end{cases}$$

for all $u \in T$.

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The restricted intersection of $FSS(E, B)$ and (H, C) is regarded as the $FSS(K, T) = (E, B) \widetilde{\sqcap} (H, C)$ over V, where $T = B \cap C \neq \emptyset$ and $T(u) = E(e) \wedge H(u)$ for all $u \in T$.

The restricted union of $FSS(E, B)$ and (H, C) is characterized as the FSS $(K, T) = (E, B) \widetilde{\sqcup} (H, C)$ over V, where $T = B \cap C \neq \emptyset$ and $K(u) = E(u) \wedge H(u)\ \forall\, u \in T$.

The extended intersection of $FSS(E, B)$ and (H, C) is described as the $FSS(K, T) = (E, B) \widetilde{\cap} (H, C)$ over V, where $T = B \cup C$ and

$$K(u) = \begin{cases} E(u) & \text{if } u \in B \backslash C \\ H(u) & \text{if } u \in C \backslash B \\ E(u) \wedge H(u) & \text{if } u \in B \cap C \end{cases}$$

for all $u \in T$.

The $\wedge$- intersection of FSS (E, B) and (H, C)emerges as the $FSS(K, T) = (E, B) \widetilde{\wedge} (H, C)$over V, where $T = B \times C$ and $K(s, t) = E(s) \wedge H(t)\ \forall\, (s, t) \in B \times C$.

The $\vee$ –union of FSS (E, B) and (H, C) is termed as the FSS $(K, T) = (E, B) \widetilde{\vee} (H, C)$ over V", where $T = B \times C$ and $K(s, t) = E(s) \vee H(t)\ \forall\, (s, t) \in B \times C$.

Example 2.1

Let $K = \{k_1, k_2, k_3\}$ be a set of three houses under consideration and X= {x_1 (expensive), x_2 (wonderful), x_3 (grassy green background)} exist as a set of parameters. Let two FSS (G, B) and (H, C) where $B = \{x_1, x_2\}$ and $C = \{x_1, x_2, x_3\}$ given by

(G, B) = {G(x_1) = {(k_1, 0.7), (k_2, 0.5), (k_3, 0.3)}, G(x_2) = {(k_1, 0.7), (k_2, 0.6), (k_3, 0.5)}} and

(H, C) = {H(x_1) = {(k_1, 0.7), (k_2, 0.5), (k_3, 0.3)}, H(x_2) = {(k_1, 0.7), (k_2, 0.6), (k_3, 0.5)}, H(x_3) = {(k_1, 0.2), (k_2, 0.4), (k_3, 0.5)}}. Then

$(G, B)^c$ = {$G^c(x_1)$ = {(k_1, 0.3), (k_2, 0.5), (k_3, 0.7)}, $G^c(x_2)$ = {(k_1, 0.3), (k_2, 0.4), (k_3, 0.5)}}

$(G, B) \widetilde{\subseteq} (H, C)$

Proposition 2.1 [6]

Let (E, M) and (W, N) be two FSS over a universal set V. Then the following properties holds

I. $(E, M) \cup (E, M) = (E, M)$

II. $(E, M) \cap (E, M) = (E, M)$

III. $((E, M) \cup (W, N))^c = (E, M)^c \cap (W, N)^c$

IV. $((E, M) \cap (W, N))^c = (E, M)^c \cup (W, N)^c$

V. $((E, M) \vee (W, N))^c = (E, M)^c \wedge (W, N)^c$

VI. $((E, M) \wedge (W, N))^c = (E, M)^c \vee (W, N)^c$

Proof of the above proposition is straight forward.

Let two TFN μ and β be parameterized by the triplet $\widetilde{c_2} = (c_1, d_1, e_1)$ and $\widetilde{d_2} = (c_2, d_2, e_2)$ correspondingly. Then their sum and multiplication gave as follows

$$\mu \oplus \beta = \widetilde{c_2} \oplus \widetilde{d_2} = (c_1, c_2, c_3) \oplus (d_1, d_2 d_3)$$

$$= (c_1 + d_1, c_2 + d_2, c_3 + d_3)$$

And

$$\mu \otimes \beta = \widetilde{c_2} \otimes \widetilde{d_2} = (c_1, c_2, c_3) \otimes (d_1, d_2 d_3)$$

$$= (c_1 \times d_1, c_2 \times d_2, c_3 \times d_3).$$

Subsequently, we provide the defuzzification technique of TFN. Choose a quadruplet (j, k, l, m) parameterized trapezoidal fuzzy number.

At that point the defuzzification value n of the FN is computed like so:

$$(n - k)(1) + \frac{1}{2}(k - j)(1) + \frac{1}{2}(m - 1)(1)$$

$$\Rightarrow (n - k) + \frac{1}{2}(k - j) = (l - n) + \frac{1}{2}(m - l)$$

$$\Rightarrow 2n = \frac{m + l + k + j}{2}$$

$$\Rightarrow n = \frac{m + l + k + j}{4}$$

Likewise, the defuzzification value e of a triangular $FN(a, b, c)$ is equal to

$$e = \frac{c + d + d + e}{4}$$

Definition 2.11 [1]

The membership function of generalized $N(c, d, e, f; z)$, where $c \leq d \leq e \leq f, 0 < z \leq 1$ is termed as

$$\mu_A(y) = \begin{cases} 0 & y < c \\ z\left(\frac{y - c}{d - c}\right) & c \leq y \leq d \\ w & d \leq y \leq e \\ z\left(\frac{y - e}{f - e}\right) & e \leq y \leq f \\ 0 & y > f \end{cases}$$

If $z = 1$ then generalized triangular fuzzy number A is a typical TFN $B = (c, d, e, f)$.

If $c = d$ and $e = f$ then $\widetilde{A}$ is a crisp interval,

If $d = e$ then $\widetilde{A}$ is a generalized triangular FN.

If $c = d = e = f$ and $z = 1$ then $\widetilde{A}$ is a real number.

METHODOLOGY AND ALGORITHM

A calculation for therapeutic diagnostics by utilizing fuzzy arithmetic operations are exhibited in this segment. Suppose that $S = \{s_1, s_2, s_3, \dots, s_m\}$ be a set of m patients, with a set of n manifestations $M = \{m_1, m_2, m_3, \dots, m_n\}$ associated with a set of k ailments $D = \{d_1, d_2, d_3, \dots, d_k\}$. We employ the FS notion to build up a strategy through the technique of Sanchez to analyze which patient is suffering what kind of sickness. For this, build an FSS (G, S) over M where G is a function $G: M \longrightarrow \mathcal{F}(m)$. This FSS offers the patient- disease sign matrix which is a ground that delineates relation between patient and symptom and is symbolized as T, where the entry items are FNs $\tilde{s}$ construct restrained by a quadruplet $(s - 2, s - 1, , s + 1, s + 2)$.

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At that point develop alternative FSS (H, M) upon A, where H is a mapping $H: M \longrightarrow \mathcal{F}(D)$. This FSS provides a relation matrix (weighted matrix, every component indicates the significance of the symptoms for a particular sickness. These components are considered identical to Trapezoidal FNs.

Hence the conventional form of T is

$$T = \begin{array}{c} \\ s_1 \\ s_2 \\ s_3 \\ \vdots \\ s_m \end{array} \begin{array}{c} \begin{array}{cccccc} m_1 & m_2 & m_3 & \cdots & m_n \end{array} \\ \begin{bmatrix} \widetilde{a_{11}} & \widetilde{a_{12}} & \widetilde{a_{13}} & \cdots & \widetilde{a_{1n}} \\ \widetilde{a_{21}} & \widetilde{a_{22}} & \widetilde{a_{23}} & \cdots & \widetilde{a_{2n}} \\ \widetilde{a_{31}} & \widetilde{a_{32}} & \widetilde{a_{33}} & \cdots & \widetilde{a_{3n}} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ \widetilde{a_{m1}} & \widetilde{a_{m2}} & \widetilde{a_{m3}} & \cdots & \widetilde{a_{mn}} \end{bmatrix} \end{array}$$

As well as the conventional form of U is

$$U = \begin{array}{c} \\ m_1 \\ m_2 \\ m_3 \\ \vdots \\ m_m \end{array} \begin{array}{c} \begin{array}{cccccc} d_1 & d_2 & d_3 & \cdots & d_n \end{array} \\ \begin{bmatrix} \widetilde{b_{11}} & \widetilde{b_{12}} & \widetilde{b_{13}} & \cdots & \widetilde{b_{1k}} \\ \widetilde{b_{21}} & \widetilde{b_{22}} & \widetilde{b_{23}} & \cdots & \widetilde{b_{2k}} \\ \widetilde{b_{31}} & \widetilde{b_{32}} & \widetilde{b_{33}} & \cdots & \widetilde{b_{3k}} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ \widetilde{b_{m1}} & \widetilde{b_{m2}} & \widetilde{b_{m3}} & \cdots & \widetilde{b_{nk}} \end{bmatrix} \end{array}$$

Presently executing the transformation operation $T \otimes U$, we get the disease identification matrix of patient D^* like so:

$$D^* = \begin{array}{c} \\ s_1 \\ s_2 \\ s_3 \\ \vdots \\ s_m \end{array} \begin{array}{c} \begin{array}{cccccc} d_1 & d_2 & d_3 & \cdots & d_n \end{array} \\ \begin{bmatrix} \widetilde{c_{11}} & \widetilde{c_{12}} & \widetilde{c_{13}} & \cdots & \widetilde{c_{1k}} \\ \widetilde{c_{21}} & \widetilde{c_{22}} & \widetilde{c_{23}} & \cdots & \widetilde{c_{2k}} \\ \widetilde{c_{31}} & \widetilde{c_{32}} & \widetilde{c_{33}} & \cdots & \widetilde{c_{3k}} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ \widetilde{c_{m1}} & \widetilde{c_{m2}} & \widetilde{c_{m3}} & \cdots & \widetilde{c_{mk}} \end{bmatrix} \end{array}$$

where

$$C_{il} = \left(\begin{array}{c} \sum_{j=1}^{4} (a_{ij} - 2)(b_{ij} - 2), \sum_{j=1}^{4} (a_{ij} - 1)(b_{ij} - 1), \\ \sum_{j=1}^{4} (a_{ij} + 1)(b_{ij} + 1), \sum_{j=1}^{4} (a_{ij} + 2)(b_{ij} + 2) \end{array} \right)$$

At that point, defuzzifying every component of the exceeding framework by (1), we acquire the brief disease identification matrix like

$$D^{\cdot\cdot} = \begin{array}{c} \\ s_1 \\ s_2 \\ s_3 \\ \vdots \\ s_m \end{array} \begin{array}{c} \begin{array}{cccccc} d_1 & d_2 & d_3 & \cdots & d_n \end{array} \\ \begin{bmatrix} \widetilde{v_{11}} & \widetilde{v_{12}} & \widetilde{v_{13}} & \cdots & \widetilde{v_{1k}} \\ \widetilde{v_{21}} & \widetilde{v_{22}} & \widetilde{v_{23}} & \cdots & \widetilde{v_{2k}} \\ \widetilde{v_{31}} & \widetilde{v_{32}} & \widetilde{v_{33}} & \cdots & \widetilde{v_{3k}} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ \widetilde{v_{m1}} & \widetilde{v_{m2}} & \widetilde{v_{m3}} & \cdots & \widetilde{v_{mk}} \end{bmatrix} \end{array}$$

Presently if $\max v_{il} = v_{is}$ for $1 < l < k$, then we suppose that the disease suffering person s_i is experiencing ailment d_s. On the off chance that $\max v_{il}$ come about exceeding than 1 value of l, $1 \leq l \leq m$, henceforth we can reexamine the manifestations for coming towards an end.

APPLICATION IN MEDICAL DIAGNOSES

Assume there are 3 patients Addison, Barton, and Harry in a hospital having disease signs of fever, cerebral problem, cough, and stomach disorder. Let the probable illnesses in association with exceeding symptoms be pyrexia, liver inflammation, and pleurisy. Then consider $S = \{s_1, s_2, s_3\}$ as the ground set at which s_1, s_2 and s_3 symbolize patients Addison, Barton, and Harry, correspondingly. Then take into consideration the set $M = \{m_1, m_2, m_3, m_4\}$ as a universal set where m_1, m_2, m_3, m_4 denote symptoms fever, cerebral problem, cough, and stomach disease, in that order and the set $D = \{d_1, d_2, d_3\}$ where d_1, d_2, d_3 characterize the disorders pyrexia, liver inflammation, and pleurisy, individually.

Suppose

$$G(s_1) = \{m_1/\tilde{7}, m_2/\tilde{3}, m_3/\tilde{5}, m_4/\tilde{2}\}$$

$$G(s_2) = \{m_1/\tilde{6}, m_2/\tilde{2}, m_3/\tilde{3}, m_4/\tilde{5}\}$$

$$G(s_3) = \{m_1/\tilde{3}, m_2/\tilde{5}, m_3/\tilde{3}, m_4/\tilde{6}\}$$

At that point, the FSS(G, S) is a parameterized group of all fuzzy sets over and offers an assemblage of a rough depiction of the patient-disease indications in the hospital. This FSS(G, S) describe the patient-disease sign matrix (relation matrix) and is given by

$$T = \begin{array}{c} \\ s_1 \\ s_2 \\ s_3 \end{array} \begin{array}{c} \begin{array}{cccc} m_1 & m_2 & m_3 & m_4 \end{array} \\ \begin{bmatrix} \tilde{7} & \tilde{3} & \tilde{5} & \tilde{2} \\ \tilde{6} & \tilde{2} & \tilde{3} & \tilde{5} \\ \tilde{3} & \tilde{5} & \tilde{3} & \tilde{6} \end{bmatrix} \end{array}$$

Subsequently assume

$$H(m_1) = \{d_1/\tilde{9}, d_2/\tilde{5}, d_3/\tilde{1}\}$$

$$H(m_2) = \{d_1/\tilde{3}, d_2/\tilde{5}, d_3/\tilde{5}\}$$

$$G(s_3) = \{d_1/\tilde{5}, d_2/\tilde{2}, d_3/\tilde{5}\}$$

$$G(s_4) = \{d_1/\tilde{2}, d_2/\tilde{8}, d_3/\tilde{8}\}$$

At that point, the FSS (H, M) is a parameterized group $\{H(m_1), H(m_2), H(m_3), H(m_4)\}$ of all FS upon the set M where $H: M \rightarrow G(D)$ and is established after special health credentials. Hence the FSS(H, M) offers an estimated delineation of the 3 ailments and their manifestations. This SS is denoted by a relative matrix (symptom-disease matrix) T and is presented via

$$U = \begin{array}{c} \\ m_1 \\ m_2 \\ m_3 \\ m_4 \end{array} \begin{array}{c} \begin{array}{ccc} d_1 & d_2 & d_3 \end{array} \\ \begin{bmatrix} \tilde{9} & \tilde{5} & \tilde{1} \\ \tilde{3} & \tilde{5} & \tilde{5} \\ \tilde{5} & \tilde{2} & \tilde{5} \\ \tilde{2} & \tilde{8} & \tilde{8} \end{bmatrix} \end{array}$$

Presently executing the transformation operation $T \otimes U$, we acquire the disease identification matrix of the patient. Where C_{ij} can be calculated as follow

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$$C_{ij} = \begin{pmatrix} \sum_{j=1}^{4}(a_{ij}-2)(b_{ij}-2) , \sum_{j=1}^{4}(a_{ij}-1)(b_{ij}-1) , \\ \sum_{j=1}^{4}(a_{ij}+1)(b_{ij}+1) , \sum_{j=1}^{4}(a_{ij}+2)(b_{ij}+2) \end{pmatrix}$$

C_{11} = {(a_{11} - 2) (b_{11} - 2) + (a_{12} - 2) (b_{12} - 2) + (a_{13} - 2) (b_{13} - 2) + (a_{14} - 2) (b_{14} - 2), (a_{11} - 1) (b_{11} - 1) + (a_{12} - 1) (b_{12} - 1) + (a_{13} - 1) (b_{13} - 1) + (a_{14} - 1) (b_{14} - 1), (a_{11} + 1) (b_{11} + 1) + (a_{12} +1) (b_{12} + 1) + (a_{13} + 1) (b_{13} + 1) + (a_{14} +1) (b_{14} + 1), (a_{11} + 2) (b_{11} + 2) + (a_{12} +2) (b_{12} + 2) + (a_{13} + 2) (b_{13} + 2) + (a_{14} +2) (b_{14} + 2)}

C_{11} = {(7 - 2) (9 - 2) + (3 - 2) (3 - 2) + (5 - 2) (5 - 2) + (2 - 2) (2 - 2), (7 - 1)(9 - 1) + (3 - 1) (3 - 1) + (5 - 1) (5 - 1) + (2 - 1) (2 - 1), (7 + 1)(9 + 1) + (3 + 1)(3 + 1) + (5 + 1) (5 + 1) + (2 + 1) (2 + 1), (7 + 2)(9 + 2) + (3+2) (3+2) + (5+2)(5+2) + (2 + 2) (2 + 2)}

C_{11} = {((5)(7) + (1)(1) + (3)(3) + (0)(0)), ((6)(8) + (2)(2) + (4)(4) + (1)(1)), ((8)(10) + (4)(4) + (6)(6) + (3)(3)), ((9)(11) + (5)(5) + (7)(7) + (4)(4))}

C_{11} = ((35 + 1 + 9 + 0), (48 + 4 + 16 + 1), (80 + 16 + 36 + 9), (99 + 25 + 49 + 16))

C_{11} = (45, 69, 141, 179)

C_{11} = (45, 69, 141, 179) = 141

C_{12} = (18, 43, 117, 166) = 117

C_{13} = (7, 31, 103, 151) = 103

C_{21} = (31, 54, 124, 171) = 124

C_{22} = (30, 54, 126, 174) = 126

C_{23} = (17, 40, 110, 157) = 110

C_{31} = (13, 37, 109, 157) = 109

C_{32} = (36, 61, 135, 184) = 135

C_{33} = (35, 59, 131, 179) = 131

$$D^* = T \otimes U = \begin{matrix} & d_1 & d_2 & d_3 \\ s_1 & \widetilde{141} & \widetilde{117} & \widetilde{103} \\ s_2 & \widetilde{124} & \widetilde{126} & \widetilde{110} \\ s_3 & \widetilde{109} & 135 & 131 \end{matrix}$$

Now de fuzzifying the above process, we get

$$v_{11} = \frac{45+69+141+179}{4} = \frac{434}{4} = 108.5,$$

$$v_{12} = \frac{18+43+117+166}{4} = \frac{344}{4} = 86,$$

$$v_{13} = \frac{7+31+103+151}{4} = \frac{292}{4} = 73$$

$$v_{21} = \frac{31+54+124+171}{4} = \frac{380}{4} = 95,$$

$$v_{22} = \frac{30+54+126+174}{4} = \frac{384}{4} = 96,$$

$$v_{23} = \frac{17+40+110+157}{4} = \frac{324}{4} = 81,$$

$$v_{31} = \frac{13+37+109+157}{4} = \frac{316}{4} = 79,$$

$$v_{32} = \frac{36+61+135+184}{4} = \frac{416}{4} = 104,$$

$$v_{33} = \frac{35+59+131+179}{4} = \frac{404}{4} = 101$$

Hence, defuzzifying the exceeding matrix is

$$D^{**} = \begin{matrix} & d_1 & d_2 & d_3 \\ s_1 & 108.5 & 86 & 73 \\ s_2 & 95 & 96 & 81 \\ s_3 & 79 & 104 & 101 \end{matrix}$$

From the exceeding matrix, it is evident that patient $s_1$experiencing disease d_1 and patients s_2 and s_3 together are be ill with the disease d_2.

CONCLUSION

In this paper, we present some basic concepts of fuzzy sets, soft sets, and fuzzy soft sets with some operations. We proposed a combined method of mathematical techniques using trapezoidal fuzzy numbers by operating Sanchez's method and discussed different features to provide effective tools in medical diagnoses. Finally, we used the proposed method in medical diagnoses for the identification of disease in a patient by using hypothetical data.

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