Application of circulant triangular fuzzy number matrix in Swine Flu

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Abstract
The major and challenging process of Swine Flu confirmation has promoted attempts to model it with the use of circulant triangular fuzzy number. In this paper, calculate the Six different indications using occurrence relationship (Ro) and conformability relationship (Rc) based on proficient medical reports and analysis of affiliated patients with Swine Flu and extant some properties on circulant triangular fuzzy numbers matrices (CTFNMs). The first row of the CTFNMs dalliance much purpose in this study.

Keywords
Triangular fuzzy numbers matrices (TFNs), Circulant triangular fuzzy numbers matrices (CTFNs), Occurrence relation (Ro), Conformability relation(Rc), Swine Flu.

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1. Introduction

In 1965, computer scientist L.A. Zadeh given the hypothesis of a fuzzy concept for the first time in a scientific perceive. Certain imitable for sympathetic and instruction the medical diagnosis procedure given fuzzy set hypothesis differ in degree to which attempt to deal distinctive phase of intricacy, such as 1. Relative important prior to symptoms, 2. Symptom patterns of disease stage, 3. Relation between disease themselves, 4. Stages of hypothesis formation, 5. Preliminary and final diagnosis within diagnosis procedure. Such imitable ditto form the basis for a computerized medical expert program, which is useful for physicians in the diagnosis of certain identified categories of disease, which encourages us to create a model related to SWINE FLU disease, which is commonly observed in India. Enforced the concept TFM. In this paper, it give few basic definition recall TFM and CFM and its operations. In section II discussed the definition of CTFM and its operations. In section III, Swine Flu diagnosis problem using CTFM relations are discussed. Finally section IV presents the conclusion of this work.

2. Preliminaries

Definition 2.1. A TFNM of order m x n is represented as \( P = (p_{ij})_{m \times n} \) where \( p_{ij} = (p_{ijL}, p_{ijM}, p_{ijU}) \) is the i-jth element of \( P \). \( p_{ijL}, p_{ijM}, p_{ijU} \) are the left and right spreads of \( p_{ij} \) respectively and \( p_{ijM} \) is the middling value.

Definition 2.2. Let \( P = (p_{ij})_{n \times n} \) and \( Q = (q_{ij})_{n \times n} \) be two CTFM of same order. Then
(i) Addition Operation: \( \tilde{P}(+)\tilde{Q} = (p_{ij} + q_{ij})_{n \times n} \) where \( p_{ij} + q_{ij} = (p_{ijL} + q_{ijL}, p_{ijM} + q_{ijM}, p_{ijU} + q_{ijU}) \) is the i-jth element of \( \tilde{P}(+)\tilde{Q} \).
(ii) Subtraction Operation: \( \tilde{P}(-)\tilde{Q} = (p_{ij} - q_{ij})_{n \times n} \) where \( p_{ij} - q_{ij} = (p_{ijL} - q_{ijL}, p_{ijM} - q_{ijM}, p_{ijU} - q_{ijU}) \) is the i-jth element of \( \tilde{P}(-)\tilde{Q} \). The same condition holds for CTF membership number.

Definition 2.3. Let \( P = (p_{ij})_{m \times p} \) and \( Q = (q_{ij})_{p \times n} \) be two CTFNM. Then the Multiplication Operation:
\[ \tilde{P}(\cdot)\tilde{Q} = (c_{ij})_{m \times n}, \text{ where } (c_{ij}) = p \times k = 1p_{ik} \cdot q_{kj} \]
for \( i = 1, 2, \ldots, m \) and \( j = 1, 2, \ldots, n \).

Definition 2.4. Let \( \tilde{P} \) and \( \tilde{Q} \) be two fuzzy relations on \( (p, q) \) and \( (q, r) \) respectively then the max-avg composition is de-
noted as \( \hat{P} \hat{Q} \) is represented as
\[
\hat{P} \hat{Q}(P, R) = \left\{ \left( p, q \right), \frac{1}{2} \max r \in R \left[ \mu_{P_1}(p, q) + \mu_{P_2}(q, r) \right] \right\}
\]
\( \forall p \in P, q \in Q, r \in R. \)

**Definition 2.5.** Let \( \hat{P} = (a_{ij})_{n \times n} \) where \( a_{ij} = (p_{ijL}, p_{ijM}, p_{ijU}) \) and \( \hat{Q} = (q_{ij})_{n \times n} \) where \( q_{ij} = (q_{ijL}, q_{ijM}, q_{ijU}) \) be two TFNM of same order. Then the maximum on it is given by
\[
L_{\text{max}} = \max(\hat{P}, \hat{Q}) = \left( \sup \{ p_{ij}, q_{ij} \} \right)
\]

is the \( i \)th \( j \)th element of max(\( \hat{P}, \hat{Q} \)).

**Definition 2.6.** Let \( \hat{P} = (a_{ij})_{(a_1, a_2, a_3)} \) be a TFN then
\[
AM(\hat{P}) = (a_1 + a_2 + a_3). The same condition holds for TM membership number.

**Definition 2.7.** An \( n \times n \) circulant matrix has the form
\[
\begin{bmatrix}
a_1 & a_2 & a_3 & \cdots & a_{n-1} & a_n \\
a_n & a_1 & a_2 & \cdots & a_{n-2} & a_{n-1} \\
\vdots & \vdots & \vdots & \ddots & \vdots & \vdots \\
a_3 & a_4 & a_5 & \cdots & a_1 & a_2 \\
a_2 & a_3 & a_4 & \cdots & a_n & a_1
\end{bmatrix}
\]

**Definition 2.8.** A fuzzy matrix \( \hat{P} = (a_{ij}) \) is said to be CFM if all the elements of \( \hat{P} \) can be determined completely by its first row. Suppose the first row of \( \hat{P} \) is \([a_1, a_2, \ldots, a_n]\). Then any element \( a_{ij} \) of \( \hat{P} \) can be determined as \( p_{ij} = p_{ij(n-i+1)} \) with \( p_{ij(n+k)} = p_{1k} \).

**Definition 2.9.** Let \( \hat{P} = [p_{ij}] \in \text{circulant FM}_{m \times n} \) according to the definition in the representation of the complement of the FM \( \hat{P} \) which is denoted by \( \hat{P}^c \) and then \( \hat{P}^c \) is called CF complement matrix if \( \hat{P}^c = [(1 - p_{ij})]_{m \times n} \) for all \( p_{ij} \in [0, 1] \).

**3. Medical Diagnosis Under Fuzzy Matrix**

Let \( \hat{S} \) be the set of symptoms of certain diseases, \( \hat{D} \) is a set of diseases and \( \hat{P} \) is a set of patients. The elements of CTFNM are defined as \( \hat{P} = (p_{ij})_{m \times n} \) where \( p_{ij} = (p_{ijL}, p_{ijM}, p_{ijU}) \) is the \( i \)th \( j \)th element of \( \hat{P} \) such that \( 0 \leq p_{ijL} \leq p_{ijM} \leq p_{ijU} \leq 10 \). Here \( p_{ijL} \) is the lower bound, \( p_{ijM} \) is the middling value and \( p_{ijU} \) is the upper bound.

**3.1 Procedure**

Step 1:
To Contra a CTFNM(\( \hat{F}, \hat{D} \)) over \( \hat{S} \), where \( \hat{F} \) is a mapping defined by \( F : \hat{D} \rightarrow \hat{F}(\hat{S}) \), \( \hat{F}(\hat{S}) \) is a set of all CTF sets of \( \hat{S} \). This matrix is denoted by \( \hat{M} \) which the fuzzy occurrence matrix or symptom-disease CTFM is.

**Step 2:**
To Contra a CTFNM(\( \hat{F}, \hat{D} \)) over \( \hat{S} \), where \( \hat{F} \) is a mapping defined by \( F : \hat{D} \rightarrow \hat{F}(\hat{S}) \), \( \hat{F}(\hat{S}) \) is a set of all CTF sets of \( \hat{S} \). This matrix is represented by \( \hat{M} \) which is the fuzzy conformation or symptom-disease CTF number matrix.

**Step 3:**
To Contra another CTFNM(\( \hat{F}_1, \hat{S} \)) over \( \hat{P} \), where \( \hat{F}_1 \) is a mapping defined by \( \hat{F}_1 : \hat{S} \rightarrow F(\hat{P}) \). It is represented by \( \hat{M}_s \) which is the patient-symptom CTFNM.

**Step 4:**
To Contra the elements of CTFNM into its membership grade function as follows: Membership grade function of \( p_{ij} = (p_{ijL}, p_{ijM}, p_{ijU}) \) is denoted as...
$\mu_{p_{ij}} = (\frac{p_{ij}}{p_{ijL}} \leq \frac{p_{ij}}{p_{ijM}} \leq \frac{p_{ij}}{p_{ijU}})$ if $0 \leq p_{ijL} \leq p_{ijM} \leq p_{ijU} \leq 1$,

where $0 \leq \frac{p_{ij}}{p_{ijL}} \leq \frac{p_{ij}}{p_{ijM}} \leq \frac{p_{ij}}{p_{ijU}} \leq 1$.

Now the matrices $M_0$, $M_t$ and $\tilde{M}_t$ are converted into CTF membership matrices namely $\tilde{M}_0$, $\tilde{M}_t$ and $\tilde{M}_t$.

**Step 5:**

To Compute the following relation,

$M_1 = (M_0 \circ \text{mem}(\tilde{M}_0))$, it is calculated using Definition 2.5.

$M_2 = (M_0 \circ \text{mem}(\tilde{M}_0))$ and $M_3 = (M_0 \circ \text{mem}(\tilde{M}_0))$, where $J$ is the TF membership matrix in which all entries are $(1, 1, 1)$.

$(J(\tilde{M}_0))$ is the complement of $(M_0)$ and it is called as non-symptom disease TF membership matrix. $M_2$ and $M_3$ are calculated using subtraction procedure and $M_4 = \max\{M_2, M_3\}$. The elements of $M_1, M_2, M_3, M_4$ is of the form

$\nu_{ij} = (y_{ijL}, y_{ijM}, y_{ijU})$ where $0 \leq y_{ijL} \leq y_{ijM} \leq y_{ijU} \leq 1$.

$M_4 = M_1 - M_2$. It is calculated using subtraction procedure.

The elements of $M_4$ is of the form $z_{ij} = (z_{ijL}, z_{ijM}, z_{ijU}) \in [-1, 1]$ where $z_{ijL} \leq z_{ijM} \leq z_{ijU}$.

**Step 6:**

To compute $\tilde{M}_t = AM(z_{ij})$ and Row $^t_i$ = Maximum of $^t_i$ row which helps the decision maker to stoutly confirm the disease for the patient.

**Case Study:**

Suppose there are three patients $\tilde{P}_1, \tilde{P}_2$ and $\tilde{P}_3$ in a hospital with symptoms fever, sore throat, nausea and vomiting problem. Let the feasible diseases clicking to the above symptoms be Normal viral fever and early stage of Swine Flu and Final stage of Swine Flu.

**Step 1:**

Consider the set $\tilde{S} = \{\tilde{s}_1, \tilde{s}_2, \tilde{s}_3\}$ as universal set where $\tilde{s}_1, \tilde{s}_2$ and $\tilde{s}_3$ represent the symptoms fever, sore throat, nausea and vomiting problem respectively and the set $\tilde{D} = \{d_1, d_2, d_3\}$ where $d_1, d_2$ and $d_3$ denote the parameters Normal viral fever and Early stage of Swine Flu and Final stage of Swine Flu respectively.

Suppose that

$F(d_1) = [(e_1, (1, 2, 3)), (e_2, (2, 3, 4)), (e_3, (1, 3, 4))]$

$F(d_2) = [(e_1, (1, 3, 4)), (e_2, (1, 2, 3)), (e_3, (2, 3, 4))]$

$F(d_3) = [(e_1, (2, 3, 4)), (e_2, (1, 3, 4)) > (e_3, (1, 2, 3))]$

The CTFNM($F, \tilde{D}$) denotes the relation matrix $\tilde{M}_0$ and it gives an approximate description of the CTFNM medical senses of the three diseases and their symptoms,

$\tilde{M}_0 = \begin{bmatrix}
s_1 & s_2 & s_3 \\
(1, 2, 3) & (1, 3, 4) & (2, 3, 4) \\
(2, 3, 4) & (1, 2, 3) & (1, 3, 4) \\
(1, 3, 4) & (2, 3, 4) & (1, 2, 3)
\end{bmatrix}$

**Step 2:**

Again

$F(d_1) = [(e_1, (2, 3, 4)), (e_2, (3, 4, 5)), (e_3, (2, 4, 5))]$

$F(d_2) = [(e_1, (2, 4, 5)), (e_2, (2, 3, 4)), (e_3, (3, 4, 5))]$

$F(d_3) = [(e_1, (3, 4, 5)), (e_2, (2, 4, 5)), (e_3, (2, 3, 4))]$

The CTFNM($F, \tilde{D}$) denotes the relation matrix $\tilde{M}_0$ and it gives an approximate description of the CTFNM medical senses of the two diseases and their symptoms,

$\tilde{M}_t = \begin{bmatrix}
s_1 & s_2 & s_3 \\
(2, 3, 4) & (2, 4, 5) & (3, 4, 5) \\
(3, 4, 5) & (2, 3, 4) & (2, 4, 5) \\
(2, 4, 5) & (3, 4, 5) & (2, 3, 4)
\end{bmatrix}$

**Step 3:**

Consider $P = \{\tilde{P}_1, \tilde{P}_2, \tilde{P}_3\}$ as the universal set where $\tilde{P}_1, \tilde{P}_2$ and $\tilde{P}_3$ denote patients respectively and $\tilde{S} = \{\tilde{s}_1, \tilde{s}_2, \tilde{s}_3\}$ as the set of parameters suppose that,

$F_1(\tilde{s}_1) = [(\tilde{P}_1, (1, 3, 4)), (\tilde{P}_2, (2, 4, 5)), (\tilde{P}_3, (1, 4, 5))]$

$F_1(\tilde{s}_2) = [(\tilde{P}_1, (1, 4, 5)), (\tilde{P}_2, (1, 3, 4)), (\tilde{P}_3, (2, 4, 5))]$

$F_1(\tilde{s}_3) = [(\tilde{P}_1, (2, 4, 5)), (\tilde{P}_2, (1, 4, 5)), (\tilde{P}_3, (1, 3, 4))]$

The CTFNM($F_1, \tilde{S}$) represents a relation matrix $\tilde{M}_t$ called patient-symptom matrix given by

$\tilde{M}_t = \begin{bmatrix}
s_1 & s_2 & s_3 \\
(1, 3, 4) & (1, 4, 5) & (2, 4, 5) \\
(2, 4, 5) & (1, 3, 4) & (1, 4, 5) \\
(1, 4, 5) & (2, 4, 5) & (1, 3, 4)
\end{bmatrix}$

**Step 4:**

$\tilde{M}_0(\text{mem}) = \begin{bmatrix}
s_1 & s_2 & s_3 \\
(0, 1, 0.2, 0.3) & (0, 1, 0.3, 0.4) & (0, 2, 0.3, 0.4) \\
(0, 2, 0.3, 0.4) & (0, 1, 0.2, 0.3) & (0, 1, 0.3, 0.4) \\
(0, 1, 0.3, 0.4) & (0, 2, 0.3, 0.4) & (0, 1, 0.2, 0.3)
\end{bmatrix}$

$\tilde{M}_t(\text{mem}) = \begin{bmatrix}
s_1 & s_2 & s_3 \\
(0, 2, 0.3, 0.4) & (0, 2, 0.4, 0.5) & (0, 3, 0.4, 0.5) \\
(0, 3, 0.4, 0.5) & (0, 2, 0.3, 0.4) & (0, 2, 0.4, 0.5) \\
(0, 2, 0.4, 0.5) & (0, 3, 0.4, 0.5) & (0, 2, 0.3, 0.4)
\end{bmatrix}$

$\tilde{M}_t(\text{mem}) = \begin{bmatrix}
s_1 & s_2 & s_3 \\
(0, 1, 0.3, 0.4) & (0, 1, 0.4, 0.5) & (0, 2, 0.4, 0.5) \\
(0, 2, 0.4, 0.5) & (0, 1, 0.3, 0.4) & (0, 1, 0.4, 0.5) \\
(0, 1, 0.4, 0.5) & (0, 2, 0.4, 0.5) & (0, 1, 0.3, 0.4)
\end{bmatrix}$

**Step 5:**

$\tilde{M}_t = \begin{bmatrix}
s_1 & s_2 & s_3 \\
(0.15, 0.35, 0.45) & (0.2, 0.35, 0.45) & (0.15, 0.35, 0.45) \\
(0.15, 0.35, 0.45) & (0.15, 0.35, 0.45) & (0.2, 0.35, 0.45) \\
(0.2, 0.35, 0.45) & (0.15, 0.35, 0.45) & (0.15, 0.35, 0.45)
\end{bmatrix}$
Viral fever.

decision-making procedure in several different approaches.

Thus in this paper, Fuzzy set structure dinosaur produces varying degrees of obscurity with it. Thus the best report and other investigative process like ultra-sonic rays etc. The data provided by each of these sources knowledge from the aftereffects of the past history, lab test report and other investigative process like ultra-sonic rays and x-rays etc. The data provided by each of these sources produces varying degrees of obscurity with it. Thus the best

accurate definitions of disease entities often use obscurc lexical words. Thus in this paper, Fuzzy set structure dinosaur accustomed to imitable the medical diagnostic procedure and decision-making procedure in several different approaches.

4. Conclusion

Medicine is one of the fields where fuzzy set theory was recognized early on. The physician usually collects patient knowledge from the aftereffects of the past history, lab test report and other investigative process like ultra-sonic rays and x-rays etc. The data provided by each of these sources produces varying degrees of obscurity with it. Thus the best accurate definitions of disease entities often use obscurc lexical words. Thus in this paper, Fuzzy set structure dinosaur accustomed to imitable the medical diagnostic procedure and decision-making procedure in several different approaches.

References