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Applications of picture fuzzy matrix in medical diagnosis

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Abstract

The article explores knowledge of diagnosing a disease using picture fuzzy environment. It discusses about the patients who are affected by diseases like typhoid, yellow fever, chicken pox related to symptoms of fever, headache, feeling tired. We use Picture Fuzzy

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Matrix (PiFuMa) theory to ascertain the carnal knowledge between patients disease and the symptoms. Then formulate a method to diagonise the disease.

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1. Introduction

An algorithm for diagnosing a person’s condition in a picture-fuzzy environment is investigated in this manuscript. The research is based on the intuitionistic fuzzy matrix (InFuMa) theory [1], which is a development of the fuzzy matrix theory (FuMaTh) [2, 12]. Various scholars have contributed to the advancement of InFuMa theory and applications since its introduction [3, 4]. Unfortunately, the membership and non-membership components alone are considered in intuitionistic fuzzy matrix. The two components are insufficient to address the research gaps in many practical applications. As a result, a new component referred to as ‘neutrality’ was developed to fulfill the requirements [5, 6, 7, 14, 15]. As a special indication, an illness with three effects (positive, negative, and neutral) was examined.

P. Murugadas proposed some relevant PiFuMa Implication Operation Concepts [8]. Pham Hong Phong et al. evaluated the concepts of several fuzzy relation compositions [9] relevant to the present research outlined in this manuscript. The study investigates the use of fuzzy soft sets in healthcare diagnosis, with a particular focus on the fuzzy soft complement. Fuzzy soft sets are utilized as a tool for enhancing diagnostic processes, presumably offering a more flexible and nuanced approach [16]. Palash Dutta uses distance metrics between PiFuSs in his studies on medical diagnosis[17]. Sijia Zhu and Zhe Liu's research is centered around distance measures applied to picture fuzzy sets and interval-valued PiFuSs. This indicates a focus on developing and applying mathematical measures to assess the relationships and similarities between these sets, potentially contributing to improved understanding and analysis in various applications [24].The research by Kamalakannan, P. Murugadas, and M. Kavitha revolves around the GI of PiFumas. This suggests an exploration of mathematical operations and properties associated with picture fuzzy matrices, potentially contributing to the theoretical foundation of this area [27, 28].The study conducted by Van Hai Pham and colleagues involves the application of PiFuSs along with a PiFu database for patient identification at a medical facility. This suggests a practical implementation of picture fuzzy sets in healthcare information systems for more accurate and efficient patient identification [30]. Numerous researchers and academics have played pivotal roles in pushing forward the development and progress of applications involving picture fuzzy sets [20, 21, 22, 23]. These contributions encompass a diverse range of efforts, including theoretical advancements, methodological innovations, and practical implementations, all aimed at enhancing the understanding, utilization, and effectiveness of picture fuzzy applications. The collective expertise and insights from these scholars have significantly enriched the field, fostering a broader and more nuanced exploration of picture fuzzy concepts in various domains. Their contributions have not only strengthened the theoretical framework but also facilitated the practical use of PifuSs in addressing complex problems and enhancing decision-making across various fields [18, 19, 25, 26, 29].

2. Preliminaries

In this division, respective canonical concepts and operations close to PiFuMas are provided.

Definition 2.1: A PiFuMa of size $x \times y$ is defined as $(\langle \mu_{a_{ij}}, \eta_{a_{ij}}, \gamma_{a_{ij}} \rangle)$, where $\mu_{a_{ij}} \in [0,1], \eta_{a_{ij}} \in [0,1]$ and $\gamma_{a_{ij}} \in [0,1]$ represent the degrees of positive, neutral, and negative membership, respectively of a_{ij} for $i = 1,2,\ldots,x$ and $j = 1,2,\ldots,y$ satisfying $0 \leq \mu_{a_{ij}} + \eta_{a_{ij}} + \gamma_{a_{ij}} \leq 1$.

Definition 2.2: A PiFuMa is called a square PiFuMa if the No. of rows equals the No. of columns.

Definition 2.3: Let $A = (\langle \mu_{a_{ij}}, \eta_{a_{ij}}, \gamma_{a_{ij}} \rangle)$ and $B = (\langle \mu_{b_{ij}}, \eta_{b_{ij}}, \gamma_{b_{ij}} \rangle)$ be two square PiFuMas of size n. then $A.B$ is defined as $C = A.B = (\langle \mu_{c_{ij}}, \eta_{c_{ij}}, \gamma_{c_{ij}} \rangle)$, where $\mu_{c_{ij}} = \vee_k (\mu_{a_{ik}} \wedge \mu_{b_{kj}}), \eta_{c_{ij}} = \vee_k (\eta_{a_{ik}} \wedge \eta_{b_{kj}})$ and $\gamma_{c_{ij}} = \wedge_k (\gamma_{a_{ik}} \vee \gamma_{b_{kj}})$ for $i, j = 1,2,\ldots,x$.

Definition 2.4: Let $A = (\langle \mu_{a_{ij}}, \eta_{a_{ij}}, \gamma_{a_{ij}} \rangle)$ and $B = (\langle \mu_{b_{ij}}, \eta_{b_{ij}}, \gamma_{b_{ij}} \rangle)$ be two square PiFuMa of size n.
(i) Then $A \leq B$ if $\mu_{a_{ij}} \leq \mu_{b_{ij}}, \eta_{a_{ij}} \leq \eta_{b_{ij}}$ and $\gamma_{a_{ij}} \geq \gamma_{b_{ij}}$ for $i, j = 1,2,\ldots,x$.
(ii) $A^c = \langle \gamma_{a_{ij}}, \eta_{a_{ij}}, \mu_{a_{ij}} \rangle$

Definition 2.5: A special restricted square PiFuMa is called an identity special restricted PiFuMa if its diagonal entries are $\langle \epsilon_1, \epsilon_2, 0 \rangle$ and its non-diagonal entries are $\langle 0,0, \epsilon_3 \rangle$.

Definition 2.6: A special restricted square PiFuMa is called a null special restricted square PiFuMa if all its entries are $\langle 0,0, \epsilon_3, \rangle$.

3. Medical Diagnosis and decision Making

Sanchez's medical diagnostic model involves a significant use of fuzzy and intuitionistic relations [10, 11, 13]. We consider S to be a collection of symptoms, D to be a set of diagnoses, and P to be a set of patients in this model, which uses an image fuzzy matrix. Three primary actions are included in this methodology:

1. Determine the patient-symptom relationship: This relationship represents the patient-symptom correspondence.
2. Formulate the relationship between symptoms and diagnoses: This relationship describes what to diagnose based on the observed symptoms.
3. Diagnosis determination for all patients based on relationship configuration: The relationship between patient and diagnosis is the relationship of the above two relationships.

Definition 3.1: Let $X = (x_{ij}) = (\langle \mu_{x_{ij}}, \eta_{x_{ij}}, \gamma_{x_{ij}} \rangle)$ and $Y = (y_{ij}) = (\langle \mu_{y_{ij}}, \eta_{y_{ij}}, \gamma_{y_{ij}} \rangle)$ be the PiFuMa of order $m \times n$. Then the composition is defined as, $X\mathcal{C}Y = [A(\langle \mu_{s_{ij}}, \eta_{s_{ij}}, \gamma_{s_{ij}} \rangle, \langle \mu_{t_{ij}}, \eta_{t_{ij}}, \gamma_{t_{ij}} \rangle)\ \ Y(\langle \mu_{t_{ij}}, \eta_{t_{ij}}, \gamma_{t_{ij}} \rangle, \langle \mu_{u_{ij}}, \eta_{u_{ij}}, \gamma_{u_{ij}} \rangle)]$. Where $\mathcal{C}$ is denoted by composition of X and Y.

Definition 3.8: Let X and Y be any two given Picture Fuzzy Sets (PiFuSes), the division operation of the PiFuSes X and Y is defined as, $X\mathcal{D}Y = \frac{A}{B}$. Here $\mathcal{D}$ is denoted by division operation of X and Y. $X\mathcal{D}Y = \{x, \langle \frac{\mu_a(x)}{\mu_b(x)}, \frac{\eta_a(x)-\eta_b(x)}{1-\eta_b(x)}, \frac{\gamma_a(x)-\gamma_b(x)}{1-\gamma_b(x)} \rangle\}$ which is valid under the conditions $X \geq Y$, $\mu_b(x) \neq 0$, $\eta_b(x) \neq 1$, $\gamma_b(x) \neq 1$.

Definition 3.9: A PiFuRe R is a PiFuSs on $N \times M$, i.e., R is

$$R = \{((u,v), \mu_R(u,v), \eta_R(u,v), \gamma_R(u,v)) | (u,v) \in M \times N\}$$

where $\mu: M \times N \to [0,1]$, $\eta: M \times N \to [0,1]$, $\gamma: M \times N \to [0,1]$ satisfy the condition $\mu_R(u,v) + \eta_R(u,v) + \gamma_R(u,v) \leq 1, \forall\ (u,v) \in M \times N$.

Definition 3.10: Let $E \in \text{PiFuRe}(M \times N)$ and $P \in \text{PiFuRe}(N \times O)$. The max-min composed relation $P\mathcal{C}E$ is

$$P\mathcal{C}E = \{((x,z); \mu_{P\mathcal{C}E}(x,z), \eta_{P\mathcal{C}E}(x,z), \gamma_{P\mathcal{C}E}(x,z)) | (x,z) \in (M \times O), \}$$

$$\mu_{P\mathcal{C}E}(x,z) = \vee_y \{\mu_E(x,y) \wedge \mu_P(y,z)\},$$

$$\eta_{P\mathcal{C}E}(x,z) = \vee_y \{\mu_E(x,y) \wedge \mu_P(y,z)\},$$

$$\gamma_{P\mathcal{C}E}(x,z) = \wedge_y \{\mu_E(x,y) \vee \mu_P(y,z)\}.$$

Definition 3.11: $X = (\langle \mu_{x_{ij}}, \eta_{x_{ij}}, \gamma_{x_{ij}} \rangle)$ and $Y = (\langle \mu_{y_{ij}}, \eta_{y_{ij}}, \gamma_{y_{ij}} \rangle)$ be special restricted SePiFuMas. The definition of operation $\ominus$ is

$$X \ominus Y = \begin{cases} \langle \mu_{x_{ij}}, \eta_{x_{ij}}, \gamma_{x_{ij}} \rangle & \text{when } (\langle \mu_{x_{ij}}, \eta_{x_{ij}}, \gamma_{x_{ij}} \rangle) \geq \langle \mu_{y_{ij}}, \eta_{y_{ij}}, \gamma_{y_{ij}} \rangle \\ \langle 0,0,\epsilon_3, \rangle & \text{otherwise} \end{cases}$$

Definition 3.12: Let the variables u1 and u2 be specified on an universal set U. The function indicated by

$$F\left(\frac{\langle \mu_{x_{ij}}, \eta_{x_{ij}}, \gamma_{x_{ij}} \rangle}{\langle \mu_{y_{ij}}, \eta_{y_{ij}}, \gamma_{y_{ij}} \rangle}\right) = \frac{F_{\langle \mu_{y_{ij}}, \eta_{y_{ij}}, \gamma_{y_{ij}} \rangle}\left(\langle \mu_{x_{ij}}, \eta_{x_{ij}}, \gamma_{x_{ij}} \rangle\right) - F_{\langle \mu_{x_{ij}}, \eta_{x_{ij}}, \gamma_{x_{ij}} \rangle}\left(\langle \mu_{y_{ij}}, \eta_{y_{ij}}, \gamma_{y_{ij}} \rangle\right)}{\max\{F_{\langle \mu_{y_{ij}}, \eta_{y_{ij}}, \gamma_{y_{ij}} \rangle}\langle \mu_{x_{ij}}, \eta_{x_{ij}}, \gamma_{x_{ij}} \rangle - F_{\langle \mu_{x_{ij}}, \eta_{x_{ij}}, \gamma_{x_{ij}} \rangle}\langle \mu_{y_{ij}}, \eta_{y_{ij}}, \gamma_{y_{ij}} \rangle\}}$$

is called relativity function, where $F_{\langle \mu_{y_{ij}}, \eta_{y_{ij}}, \gamma_{y_{ij}} \rangle}(\langle \mu_{x_{ij}}, \eta_{x_{ij}}, \gamma_{x_{ij}} \rangle)$ is the function of membership $\langle \mu_{x_{ij}}, \eta_{x_{ij}}, \gamma_{x_{ij}} \rangle$ with regards to $\langle \mu_{y_{ij}}, \eta_{y_{ij}}, \gamma_{y_{ij}} \rangle$.

Definition 3.13: Let the n varibles $A = \{\langle \mu_{x_{ij}}, \eta_{x_{ij}}, \gamma_{x_{ij}} \rangle_1, \langle \mu_{x_{ij}}, \eta_{x_{ij}}, \gamma_{x_{ij}} \rangle_2, \ldots, \langle \mu_{x_{ij}}, \eta_{x_{ij}}, \gamma_{x_{ij}} \rangle_i, \langle \mu_{x_{ij}}, \eta_{x_{ij}}, \gamma_{x_{ij}} \rangle_{i+1} \ldots, \langle \mu_{x_{ij}}, \eta_{x_{ij}}, \gamma_{x_{ij}} \rangle_n$ be defined on a universal set U. Create a matrix with relativity values $F\left(\frac{\langle \mu_{x_{ij}}, \eta_{x_{ij}}, \gamma_{x_{ij}} \rangle_i}{\langle \mu_{y_{ij}}, \eta_{y_{ij}}, \gamma_{y_{ij}} \rangle_i}\right)$ where $\langle \mu_{x_{ij}}, \eta_{x_{ij}}, \gamma_{x_{ij}} \rangle_i$'s (for $i = 1 \ldots n$) are n specified variables on an universe U. The PiFuMa $R = \langle \mu_{r_{ij}}, \eta_{r_{ij}}, \gamma_{r_{ij}} \rangle_i$ is a matrix of size 'n' is said to be the comparison PiFuMa with

$$F\left(\frac{\langle \mu_{x_{ij}}, \eta_{x_{ij}}, \gamma_{x_{ij}} \rangle_i}{\langle \mu_{y_{ij}}, \eta_{y_{ij}}, \gamma_{y_{ij}} \rangle_i}\right) = F_{\langle \mu_{x_{ij}}, \eta_{x_{ij}}, \gamma_{x_{ij}} \rangle_j}\left(\langle \mu_{x_{ij}}, \eta_{x_{ij}}, \gamma_{x_{ij}} \rangle\right)_i.$$

3.1 *Procedure*

Let S, D and P be as defined in the previous section.

Step 1: Construct a symptom-disese PiFuMa $E = \langle \mu_{e_{ij}}, \eta_{e_{ij}}, \gamma_{e_{ij}} \rangle$ of order $m \times n$.

Step 2: Construct a symptom of patient PiFuMa $P = \langle \mu_{p_{ij}}, \eta_{p_{ij}}, \gamma_{p_{ij}} \rangle$ of order $m \times n$.

Step 3: Compute $C = E\mathcal{C}P$

Step 4: Create the complement of PiFuMas E^c and P^c of E and P of order $m \times n$.

Step 5: Calculating the PiFuMa $E^c\mathcal{C}P^c$ of E^c and P^c denoted by,

$$D = E^c\mathcal{C}P^c = \{E^c\left(\langle \gamma_{x_{ij}}, \eta_{x_{ij}}, \mu_{x_{ij}} \rangle, \langle y_{ij\mu}, y_{ij\eta}, y_{ij\gamma} \rangle\right),$$
$$P^c\left(\langle x_{ij\mu}, x_{ij\eta}, x_{ij\gamma} \rangle, \langle y_{ij\mu}, y_{ij\eta}, y_{ij\gamma} \rangle\right)\} \text{ and compute } M = C \ominus D.$$

Where $\ominus$ denotes the minus operator.

Step 6: After relativity values are calculated, the highest value in each will yield the highest ranking of the rows of R-PiFuMa.

4. Results

Consider there are patients P_1, P_3 and P_3 in a hospitalized with symptoms fever, headache, feeling tired. These symptoms are represented by S_1, S_2 and S_3. Let the potential illnesses associated to the above symptomes be typhoid, yellow Fever, chicken pox these are represented by d_1, d_2 and d_3 respectively.

Step 1: Suppose the symptom disease PiFuMa, E of order 3×3

$$E = \begin{pmatrix} <0.05 \quad 0.02 \quad 0.05> & <0.06 \quad 0.02 \quad 0.04> & <0.04 \quad 0.02 \quad 0.06> \\ <0.02 \quad 0.02 \quad 0.07> & <0.07 \quad 0.02 \quad 0.00> & <0.03 \quad 0.02 \quad 0.05> \\ <0.06 \quad 0.02 \quad 0.04> & <0.04 \quad 0.02 \quad 0.06> & <0.07 \quad 0.02 \quad 0.00> \end{pmatrix}$$

Step 2: Consider a patient-symptoms PiFuMa P as,

$$P = \begin{pmatrix} <0.04 \quad 0.02 \quad 0.06> & <0.02 \quad 0.02 \quad 0.07> & <0.07 \quad 0.02 \quad 0.04> \\ <0.04 \quad 0.02 \quad 0.05> & <0.06 \quad 0.02 \quad 0.04> & <0.09 \quad 0.02 \quad 0.00> \\ <0.07 \quad 0.02 \quad 0.00> & <0.05 \quad 0.02 \quad 0.05> & <0.08 \quad 0.02 \quad 0.00> \end{pmatrix}$$

Step 3: Compute $\mathrm{C} = \mathrm{E}\mathcal{C}\mathrm{P}$ where $\mathcal{C}$ composition of E and P.

$$C = \begin{pmatrix} <0.04 \quad 0.02 \quad 0.06> & <0.06 \quad 0.02 \quad 0.04> & <0.06 \quad 0.02 \quad 0.04> \\ <0.04 \quad 0.02 \quad 0.05> & <0.06 \quad 0.02 \quad 0.04> & <0.07 \quad 0.02 \quad 0.00> \\ <0.07 \quad 0.02 \quad 0.00> & <0.05 \quad 0.02 \quad 0.05> & <0.07 \quad 0.02 \quad 0.00> \end{pmatrix}$$

Step 4: From the complement of PiFuMas are E^{c}, P^{c}.

$$E^c = \begin{pmatrix} <0.05 \quad 0.02 \quad 0.05> & <0.04 \quad 0.02 \quad 0.06> & <0.06 \quad 0.02 \quad 0.04> \\ <0.07 \quad 0.02 \quad 0.02> & <0.00 \quad 0.02 \quad 0.07> & <0.05 \quad 0.02 \quad 0.03> \\ <0.04 \quad 0.02 \quad 0.06> & <0.06 \quad 0.02 \quad 0.04> & <0.00 \quad 0.02 \quad 0.07> \end{pmatrix}$$

$$P^c = \begin{pmatrix} <0.06 \quad 0.02 \quad 0.04> & <0.07 \quad 0.02 \quad 0.02> & <0.04 \quad 0.02 \quad 0.07> \\ <0.05 \quad 0.02 \quad 0.04> & <0.04 \quad 0.02 \quad 0.06> & <0.00 \quad 0.02 \quad 0.09> \\ <0.00 \quad 0.02 \quad 0.07> & <0.05 \quad 0.02 \quad 0.05> & <0.00 \quad 0.02 \quad 0.08> \end{pmatrix}$$

Step 5: Computing the composition PiFuMas are $\mathrm{E}^{\mathrm{c}}\mathcal{C}\mathrm{P}^{\mathrm{c}}$ denoted by D.

$$D = E^c \mathcal{C} P^c$$

$$= \begin{pmatrix} <0.05 \quad 0.02 \quad 0.05> & <0.05 \quad 0.02 \quad 0.05> & <0.04 \quad 0.02 \quad 0.07> \\ <0.06 \quad 0.02 \quad 0.04> & <0.07 \quad 0.02 \quad 0.02> & <0.04 \quad 0.02 \quad 0.07> \\ <0.05 \quad 0.02 \quad 0.04> & <0.04 \quad 0.02 \quad 0.06> & <0.04 \quad 0.02 \quad 0.06> \end{pmatrix}$$

and

$$M = C \ominus D = \begin{pmatrix} <0.00 \quad 0.00 \quad \varepsilon_3> & <0.06 \quad 0.02 \quad 0.04> & <0.06 \quad 0.02 \quad 0.04> \\ <0.00 \quad 0.00 \quad \varepsilon_3> & <0.00 \quad 0.00 \quad \varepsilon_3> & <0.07 \quad 0.02 \quad 0.00> \\ <0.07 \quad 0.02 \quad 0.00> & <0.05 \quad 0.02 \quad 0.05> & <0.07 \quad 0.02 \quad 0.00> \end{pmatrix}$$

indicates the relationship between the illnesses and patients.

Step 6: Calculate values of $\mathrm{f}\left(\frac{\mathrm{p_i}}{\mathrm{d_i}}\right)$ and form the comparison PiFuMa

$$\mathrm{R} = \left(\langle \mathrm{x}_{\mathrm{ij}\mu}, \mathrm{x}_{\mathrm{ij}\eta}, \mathrm{x}_{\mathrm{ij}\gamma} \rangle\right), = \mathrm{f}\left(\frac{\mathrm{p_i}}{\mathrm{d_i}}\right)_{\mathrm{i}=1,2,3}$$

$$\mathrm{f}\left(\frac{\mathrm{p_i}}{\mathrm{d_i}}\right) = \frac{\mathrm{F_{di}(p_i)} - \mathrm{F_{pi}(d_i)}}{\max\{\mathrm{F_{di}(p_i)}, \mathrm{F_{pi}(d_i)}\}}$$

$$f\left(\frac{p_1}{d_1}\right) = \frac{F_{d1}(p_1) - F_{p1}(d_1)}{\max\{F_{d1}(p_1), F_{p1}(d_1)\}} = \frac{\langle 0,0,\epsilon_3 \rangle - \langle 0,0,\epsilon_3 \rangle}{\max(\langle 0.05,0.02,0.5 \rangle, \langle 0.05,0.02,0.5 \rangle)} = \langle 0,0,\epsilon_3 \rangle$$

$$f\left(\frac{p_1}{d_2}\right) = \frac{F_{d2}(p_1) - F_{p1}(d_2)}{\max\{F_{d2}(p_1), F_{p1}(d_2)\}} = \frac{\langle 0.06,0.02,0.04 \rangle - \langle 0,0,\epsilon_3 \rangle}{\max(\langle 0.06,0.02,0.04 \rangle, \langle 0,0,\epsilon_3 \rangle)}$$

$$= \frac{\langle 0.06,0.02,-0.96 \rangle}{\langle 0.06,0.02,0.04 \rangle} = \langle 1,0,-1.04 \rangle$$

$$f\left(\frac{p_1}{d_3}\right) = \frac{F_{d3}(p_1) - F_{p1}(d_3)}{\max\{F_{d3}(p_1), F_{p1}(d_3)\}} = \frac{\langle 0.06,0.02,0.04 \rangle - \langle 0.07,0.02,0 \rangle}{\max(\langle 0.06,0.02,0.04 \rangle, \langle 0.07,0.02,0 \rangle)}$$

$$= \frac{\langle -0.01,0.00,0.04\rangle}{\langle 0.07,0.02,0.00\rangle} = \langle -014, -0.02, 0.04\rangle$$

$$f\left(\frac{p_2}{d_1}\right) = \frac{F_{d1}(p_2) - F_{p2}(d_1)}{\max\{F_{d1}(p_2), F_{p2}(d_1)\}} = \frac{\langle 0,0,\epsilon_3\rangle - \langle 0.06,0.02,0.04\rangle}{\max(\langle 0,0,\epsilon_3\rangle, \langle 0.06,0.02,0.04\rangle)}$$

$$= \frac{\langle -0.06,-0.02,-0.96\rangle}{\langle 0.06,0.02,0.04\rangle} = \langle 1,0,-0.96\rangle$$

$$f\left(\frac{p_2}{d_2}\right) = \frac{F_{d2}(p_2) - F_{p2}(d_2)}{\max\{F_{d2}(p_2), F_{p2}(d_2)\}} = \frac{\langle 0,0,\epsilon_3\rangle - \langle 0,0,\epsilon_3\rangle}{\max(\langle 0,0,\epsilon_3\rangle, \langle 0,0,\epsilon_3\rangle)} = \langle 0,0,\epsilon_3\rangle$$

$$f\left(\frac{p_2}{d_3}\right) = \frac{F_{d3}(p_2) - F_{p2}(d_3)}{\max\{F_{d3}(p_2), F_{p2}(d_3)\}} = \frac{\langle 0.07,0.02,0\rangle - \langle 0.07,0.02,0\rangle}{\max(\langle 0.07,0.02,0\rangle, \langle 0.07,0.02,0\rangle)}$$

$$= \frac{\langle 0,0,0\rangle}{\langle 0.07,0.02,0\rangle} = \langle 0,-0.02,0\rangle$$

$$f\left(\frac{p_3}{d_1}\right) = \frac{F_{d1}(p_3) - F_{p3}(d_1)}{\max\{F_{d1}(p_3), F_{p3}(d_1)\}} = \frac{\langle 0.07,0.02,0\rangle - \langle 0.06,0.02,0.04\rangle}{\max(\langle 0.07,0.02,0\rangle, \langle 0.06,0.02,0.04\rangle)}$$

$$= \frac{\langle 0.01,0.00,-0.04\rangle}{\langle 0.07,0.02,0\rangle} = \langle 0.142, -0.02, 0.04\rangle$$

$$f\left(\frac{p_3}{d_2}\right) = \frac{F_{d2}(p_3) - F_{p3}(d_2)}{\max\{F_{d2}(p_3), F_{p3}(d_2)\}} = \frac{\langle 0.05,0.02,0.05\rangle - \langle 0.04,0.02,0.7\rangle}{\max(\langle 0.05,0.02,0.05\rangle, \langle 0.07,0.02,0\rangle)}$$

$$= \frac{\langle -0.02,0.02,0.05\rangle}{\langle 0.07,0.02,0\rangle} = \langle -0.28, -0.02, 0.05\rangle$$

$$f\left(\frac{p_3}{d_3}\right) = \frac{F_{d3}(p_3) - F_{p3}(d_3)}{\max\{F_{d3}(p_3), F_{p3}(d_3)\}} = \frac{\langle 0.07,0.02,0\rangle - \langle 0.07,0.02,0\rangle}{\max(\langle 0.07,0.02,0\rangle, \langle 0.07,0.02,0\rangle)} = \frac{\langle 0,0,0\rangle}{\langle 0.07,0.02,0\rangle} = \langle 0,0,\epsilon_3\rangle$$

Therefore the comparison picture fuzzy matrix R

$$R = \begin{pmatrix} <0.00 \quad 0.00 \quad \varepsilon_3> & <1.00 \quad 0.00 \quad -1.04> & <-0.14 \quad -0.02 \quad 0.04> \\ <1.00 \quad 0.00 \quad -0.96> & <0.00 \quad 0.00 \quad \varepsilon_3> & <0.00 \quad -0.02 \quad 0.00> \\ <0.142 \quad -0.02 \quad 0.04> & <-0.28 \quad -0.02 \quad 0.05> & <0.00 \quad 0.00 \quad \varepsilon_3> \end{pmatrix}$$

$$\text{Maximum of i}^{\text{th}} \text{ row} = \begin{pmatrix} \langle 1.00, \ 0.00, \ -0.14\rangle \\ \langle 1.00, \ 0.00, \ -0.96\rangle \\ \langle 0.14, \ -0.02, \ 0.04\rangle \end{pmatrix}$$

Based on the rankings, it can be concluded that patient P_1 is highly susceptible to yellow fever, while patients P_2 and P_3 are both affected by typhoid.

5. Conclusion

The intuitionistic fuzzy matrix (InFuMa) theory was used to successfully analyze the parameters of Max Min composition validation and the evolution of medical diagnosis algorithm. A Picture fuzzy matrix concept was suggested, which has numerous theoretical and practical applications. Picture fuzzy relations are one of the most important concepts presented here. The validation of max-min composition was performed first, followed by the evolution of a medical diagnosis algorithm. An illustration was provided which offered valuable insights justifying the procedures involved. Future research will analyze the implementation factors of the algorithm's evolving outputs, paving the path for speeding diagnostic precision.

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