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AN APPLICATION OF INTERVAL INCLINE MATRICES IN MEDICAL DIAGNOSIS

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Abstract:

In the present paper, we extend Sanchez's approach for medical diagnosis utilizing the representation of an interval incline matrix as interval matrix of two incline matrices. We introduce weighted mean of an interval incline matrix as the weighted mean of its lower and upper matrices and propose a method to study Sanchez's approach of medical diagnosis through the weighted mean of interval matrix.

2020 Mathematical Science Classification: 16Y60, 15B15

Key Words: Interval Incline Matrix Medical Diagnosis, Arithmetic Mean, Internal Arithmetic Mean.

1. Introduction:

The concept of interval incline matrix (IIM) is one of the recent topics developed of fuzzy matrices, distributive lattice matrices, Boolean matrices and which is a special type of semirings. The Parameterization tool of Interval Incline matrix enhances the flexibility of its applications. Most of our real life problems in medical sciences, engineering, management environment and Social Sciences, automata theory often involve data. Such uncertainties are usually being handled with the help of the topics like probability, fuzzy Sets, intuitionistic fuzzy sets, interval mathematics and rough sets etc. The concept of IVFM as a generalization of fuzzy matrix was introduced and developed by Shyamal and pal [8] Incline matrices are generalizations. The notion of inclines and their applications are described comprehensively in Cao [4] Kim and Roush have surveyed and outlined algebraic properties of inclines and of matrices over inclines.

Let L_{mn} be the set of all mxn incline matrices over the Fuzzy algebra, Boolean algebra and distributing lattice algebra, De, Biswasard Roy [2] have Studied Sanchez's [5,6] method of medical diagnosis utilizing intuitionistic fuzzy set. Saikia et al. [7] have extended the method in [2] using intuitionistic fuzzy Soft set theory. In [1], Chetia and pastane studied samchez's approach of medical diagnosis through IVFSS Obtaining an improvement of the same presented in De et. al. [2, 7]. We have represented on IIM. $x = [x_{ijL}, x_{ijU}]$ as the interval matrix $x = [X_L, X_U]$ whose ij^{th} entry is the interval $[x_{ijL}, x_{ijU}]$, where the lower X_L and upper X_U are interval incline matrices such that $X_L \leq X_U$.

In this paper, by utilizing the representations of interval incline matrix. We provide the techniques to study Sanchez's approach of diagnosis of We have to compared our technique with the one found in [1], for the Same hypothetical Case Study presented in [1] and home exhibited that our technique is much simpler in the Computation of matrices involved. we have introduced the arithmetic mean (am) matrix of an IIM X as the average of the lower and upper matrices X_L and X_U and directly apply.

2. Preliminaries:

In this section, some basic definitions and notations are given. Let L^I denote the set of all interval Incline matrices, that is, Incline matrices with the entries are the (interval) elements belongs to the Interval Incline by (L^I). In particular the interval incline matrix have the lower incline matrix and upper incline matrix.

Definition 2.1:

For a pair of interval incline matrices $X = [x_{ijL}, x_{ijU}]$ and $Y = [y_{ijL}, y_{ijU}]$ in L_{mn} Such that $X \leq Y$ the interval incline matrix $[X, Y] = ([x_{ijL}, x_{ijU}], [y_{ijL}, y_{ijU}])$ is a Structure that ij^{th} entries is the limit incline with minimum entry $[x_{ijL}, x_{ijU}]$ and maximum entries $[y_{ijL}, y_{ijU}]$.

In Specific for X = Y Interval incline Matrix (IIM) $[X_L, X_U]$ is simplified to the interval incline matrix X™L_{mn}

For $X = [x_{ijL}, x_{ijU}] \in (IIM)_{mxn}$, clearly the interval incline matrix a x_{ijL} and x_{ijU} ™L^I_{mn} Such that $x_{ijL} \leq x_{ijU}$. Consequently, by these means Definition (2.1) a matrix can be inscribed as $X = [X_L, X_U] = [x_{ijL}, x_{ijU}]$ where x_{ijL} = lower matrix and x_{ijU} = upper matrix.

For $X = [x_{ijL}, x_{ijU}]$ and $[y_{ijL}, y_{ijU}]$ is of order mxn in addition represented by X+Y defined as $[x_{ijL}, x_{ijU}]+[y_{ijL}, y_{ijU}] = [x_{ijL}+y_{ijL}, x_{ijL}+y_{ijU}]$ and their multiplication can be defined as,

$$[X_L, X_U\} [Y_L, Y_U] = [X_LY_L, X_UY_U] = ([Z_{ijL}, Z_{ijU}])$$

$$= \left(\sum_i x_{ikL} y_{kjL}, \sum_k x_{ikU} y_{kjU} \right), \text{ i=1, 2, 3, . . ., m and j=1, 2, . . . , p}$$

Where $X = [X_L, X_U]_{mxn}$ and $Y = [Y_L, Y_U]_{nxs}$

Their multiplication denoted by $[XY] = [X_LY_L, X_UY_U]_{mxp}$ $X \geq Y$ iff $x_{ijL} \geq y_{ijL}$ and $x_{ijU} \geq y_{ijU}$ iff X+Y=X

In Specific if $x_{ijL} = x_{ijU}$ and $y_{ijL} = y_{ijU}$, as a result, the given equation gives the standard composition of interval incline matrices.

3. Application of Interval Incline Matrices in Medical Diagnosis:

Suppose S is a set of symptoms of certain diseases, D is a set of diseases and P is a set of Patients, construct an Interval Incline matrix (F, D) over S, where F is a mapping F:D→F(S), F(S) is a set of all interval incline sets of S. A relation matrix say R_1 is constructed from the interval incline matrix (F, D) and called symptom-disease matrix.

Similarly its compliment $(F, D)^C$ gives another relation matrix, say R_2, called non symptom diseases matrix. Analogous to Sanchez's [6] notion of medical Knowledge, we refer to each to the matrices R_1 and R_2 as medical knowledge of an interval incline matrix. Again we construct another interval incline matrix (F_1, S) over P, where F_1 is a mapping given by $F_1: S \rightarrow F(P)$.

This Interval incline gives another relation matrix Q called patient-symptom matrix. Then we obtain two new relation matrices $E_1 = Q\,R_1$. and $E_2 = Q\,R_2$ called symptom patient matrix and non-symptom patient matrix respectively.

$$\text{Now, } E_1 = [E_{1L}, E_{1U}] = [Q_L.R_{1L}, Q_U R_{1U}] \quad \rightarrow (3.1)$$
$$E_2 = [E_{2L}, E_{2U}] = [Q_L.R_{2L}, Q_U R_{2U}] \quad \rightarrow (3.2)$$

Where $[E_{1L}, E_{1U}]$, $E_2 = [E_{2L}, E_{2U}]$, $Q = [Q_L, Q_U]$, $R_1 = [R_{1L}, R_{1U}]$ and $R_2 = [R_{2L}, R_{2U}]$ be the representation of the interval incline matrices E_1, E_2, Q, R_1 and R_2.

Then by using the IIM operation (2.1) and (2.2) in (3.1) and (3.2)

$$\text{We get } E_{1L} = Q_L.R_{1L} \text{ and } E_{1U} = Q_U.R_{1U} \quad \rightarrow (3.3)$$
$$E_{2L} = Q_L.R_{2L} \text{ and } E_{2U} = Q_U.R_{2U} \quad \rightarrow (3.4)$$

Let as define the non-disease matrices E_{3L}, E_{3U}, E_{4L} and E_{4U} corresponding to E_{1L}, E_{1U}, E_{2L} and E_{2U} respectively as

$$E_{3L} = Q_L.(H-R_{1L}) \text{ and } E_{3U} = Q_U.(H-R_{1U}) \quad \rightarrow (3.5)$$
$$E_{4L} = Q_L.(H-R_{2L}) \text{ and } E_{4U} = Q_U.(H-R_{2U}) \quad \rightarrow (3.6)$$

Where H is the matrix with all entries ‘1’. The Boolean algebra {0, 1} is an incline under Boolean operations.

$$SE_{1L} = \sup_{i,j}\left[E_{1L}\left(p_i, d_j\right), E_{4L}\left(p_i, d_j\right)\right] \text{ and}$$

$$SE_{1U} = \sup_{i,j}\left[E_{1U}\left(p_i, d_j\right), E_{4U}\left(p_i, d_j\right)\right] \rightarrow (3.7), \text{ for all i=1, 2, 3 and j=1, 2}$$

$$SE_{2L} = \sup_{i,j}\left[E_{2L}\left(p_i, d_j\right), E_{3L}\left(p_i, d_j\right)\right] \text{ and}$$

$$SE_{2U} = \sup_{i,j}\left[E_{2U}\left(p_i, d_j\right), E_{3U}\left(p_i, d_j\right)\right] \rightarrow (3.8), \text{ for all i=1, 2, 3 and j=1, 2}$$

We calculate the diagnosis score SE1 and SE2 for and against the diseases respectively.

$$SE_1 = \sup_{i,j}\left[SE_{1U}\left(p_i, d_j\right), SE_{2L}\left(p_i, d_j\right)\right] \rightarrow (3.9), \text{ for all i=1, 2, 3 and j=1, 2}$$

$$SE_2 = \sup_{i,j}\left[SE_{1L}\left(p_i, d_j\right), SE_{2U}\left(p_i, d_j\right)\right] \rightarrow (3.10), \text{ for all i=1, 2, 3 and j=1, 2}$$

$$\text{Now if } \sup_{j}\left[SE_1\left(p_i, d_j\right) - SE_2\left(p_i, d_j\right)\right] \rightarrow (3.11)$$

Occurs for exactly (p_i, d_j) only, then we conclude that the acceptable diagnostic hypothesis for patient p_i is the disease d_k. In case there is a tie, the process has to be repeated for patient p_i by reassessing the symptoms.

Algorithm 3.1:

Step1: Input the interval incline matrices (F, D) and $(F, D)^c$ over the set S of Symptoms S, Where D is the set of diseases. Also write the medical knowledge matrix R_1 and R_2 representing the relation interval incline matrices of the IIM (F, D) and $(F, D)^c$ respectively.

Step2: $R_2 = 1 - R_1 = [1-R_{1U}, 1-R_{1L}]$

Step3: Input the IIM (F_1,S) over the set P of Patients

Step4: write its relation interval incline matrix Q.

Step5: compute the relation interval incline matrices

$$E_{1L} = Q_L.R_{1L} \text{ and } E_{1U} = Q_U.R_{1U}$$
$$E_{2L} = Q_L.R_{2L} \text{ and } E_{2U} = Q_U.R_{2U}$$
$$E_{3L} = Q_L.(H-R_{1L}) \text{ and } E_{3U} = Q_U.(H-R_{1U})$$
$$E_{4L} = Q_L.(H-R_{2L}) \text{ and } E_{4U} = Q_U.(H-R_{2U})$$

Step6: Compute SE_{1L}, SE_{IU}, SE_{2L} and SE_{2U}

Step7: Compute the diagnosis scores SE_1 and SE_2

Step8: Find $S_k = \sup_{j}\left[SE_1\left(p_i, d_j\right) - SE_2\left(p_i, d_j\right)\right]$ then we conclude that the patent p_i is suffering from the disease d_k.

Step9: If S_k has more than one value then go to step1 and repeat for the process by reassessing patient.

Illustration 3.2:

Suppose there are three patient's p_1, p_2 & p_3 in a hospital with symptoms fever, headache, Cough and stomach problem. Let the possible diseases relating to the above Symptoms be viral fever and malaria.

we consider the Set S={e_1, e_2, e_3, e_4} as universal set, where e_1, e_2, e_3 and e_4 represent the symptoms fever, headache, Cough and stomach problem respectively and the Set D={dı, d_2} where dı and d_2 represent the parameters viral fever, dengue and malaria respectively.
Suppose that

$$F(d_1)=\left[\langle e_1,[0.8,1]\rangle,\langle e_2,[0.2,0.5]\rangle,\langle e_3,[0.6,0.7]\rangle,\langle e_4,[0.3,0.5]\rangle\right]$$

$$F(d_2)=\left[\langle e_1,[0.7,0.9]\rangle,\langle e_2,[0.5,0.6]\rangle,\langle e_3,[0.4,0.7]\rangle,\langle e_4,[0.9,1]\rangle\right]$$

The Interval Incline matrix (F, D) is a parameterized family [F(d_1), F(d_2)] of all interval incline matrix over the set S and are determined from expert medical documentation.

Thus the Fuzzy matrix (F, D) gives an approximate description of the interval incline matrix medical knowledge of the two diseases and their symptoms.

This interval incline matrix (F, D) and $(F, D)^c$ are represented by two relation matrices $R_1$and R_2 called symptom-disease matrix and non-symptom disease matrix respectively given by

$$R_1=\begin{matrix}e_1\\e_2\\e_3\\e_4\end{matrix}\begin{pmatrix}[0.8,1] & [0.7,0.9]\\ [0.2,0.5] & [0.5,0.6]\\ [0.6,0.7] & [0.4,0.7]\\ [0.3,0.5] & [0.9,1]\end{pmatrix} \text{ and } R_2=\begin{matrix}e_1\\e_2\\e_3\\e_4\end{matrix}\begin{pmatrix}[0.0,0.4] & [0.2,0.5]\\ [0.7,1.0] & [0.5,0.7]\\ [0.5,0.6] & [0.5,0.8]\\ [0.7,0.9] & [0.0,0.3]\end{pmatrix}$$

Using this X= [X_L, X_U] we have

$$R_{1L}=\begin{matrix}e_1\\e_2\\e_3\\e_4\end{matrix}\begin{pmatrix}0.8 & 0.7\\ 0.2 & 0.5\\ 0.6 & 0.4\\ 0.3 & 0.9\end{pmatrix} \text{ and } R_{1U}=\begin{matrix}e_1\\e_2\\e_3\\e_4\end{matrix}\begin{pmatrix}1.2 & 0.8\\ 0.5 & 0.7\\ 0.7 & 0.6\\ 0.5 & 1.1\end{pmatrix}$$

$$R_{2L}=\begin{matrix}e_1\\e_2\\e_3\\e_4\end{matrix}\begin{pmatrix}0.0 & 0.2\\ 0.6 & 0.5\\ 0.5 & 0.4\\ 0.7 & 0.0\end{pmatrix} \text{ and } R_{2U}=\begin{matrix}e_1\\e_2\\e_3\\e_4\end{matrix}\begin{pmatrix}0.3 & 0.5\\ 0.8 & 0.7\\ 0.4 & 0.6\\ 0.8 & 0.3\end{pmatrix}$$

Again we take P ={p_1, p_2, p_3} as the universal set where p_1, p_2 and p_3 patients respectively and S={e_1, e_2, e_3, e_4} as the set of parameters.
Suppose that,

$$F_1(e_1)=\left[\langle p_1,[0.6,0.9]\rangle,\langle p_2,[0.3,0.5]\rangle,\langle p_3,[0.7,0.9]\rangle\right]$$

$$F_2(e_2)=\left[\langle p_1,[0.3,0.6]\rangle,\langle p_2,[0.3,0.8]\rangle,\langle p_3,[0.2,0.7]\rangle\right]$$

$$F_3(e_3)=\left[\langle p_1,[0.8,1]\rangle,\langle p_2,[0.2,0.5]\rangle,\langle p_3,[0.5,0.8]\rangle\right] \text{ and}$$

$$F_4(e_4)=\left[\langle p_1,[0.6,0.9]\rangle,\langle p_2,[0.3,0.6]\rangle,\langle p_3,[0.2,0.6]\rangle\right]$$

The Interval incline matrix (F_1, S) is another parameterized family of all interval incline matrices and gives a collections of approximate description of the patient-Symptoms in the hospital. This interval incline matrix (F_1, S) represents a relation matrix Q called patient-Symptom matrix given by

$$Q=\begin{matrix}p_1\\p_2\\p_3\end{matrix}\begin{pmatrix}[0.6,0.9] & [0.3,0.6] & [0.8,1] & [0.6,0.9]\\ [0.3,0.5] & [0.3,0.8] & [0.2,0.5] & [0.3,0.6]\\ [0.7,0.9] & [0.2,0.7] & [0.5,0.8] & [0.2,0.6]\end{pmatrix}$$

By our representation Q = [Q_L, Q_U] we have,

$$Q_L=\begin{matrix}p_1\\p_2\\p_3\end{matrix}\begin{pmatrix}0.6 & 0.3 & 0.8 & 0.6\\ 0.3 & 0.3 & 0.2 & 0.3\\ 0.7 & 0.2 & 0.5 & 0.2\end{pmatrix} \text{ and } Q_U=\begin{matrix}p_1\\p_2\\p_3\end{matrix}\begin{pmatrix}0.9 & 0.6 & 1 & 0.9\\ 0.5 & 0.8 & 0.5 & 0.6\\ 0.9 & 0.7 & 0.8 & 0.6\end{pmatrix}$$

Then Combining the relation matrices R_{1L}, R_{1U} and R_{2L}, R_{2U} separately with Q_L and Q_U we get the interval matrices E_1 = [E_{1L}, E_{1U}] and E_2 = [E_{2L}, E_{2U}]
From equations (3.3), (3.4), (3.5) and (3.6). We have

$$E_{1L} = Q_L.R_{1L} = \begin{matrix} p_1 \\ p_2 \\ p_3 \end{matrix}\begin{pmatrix} 0.6 & 0.6 \\ 0.3 & 0.3 \\ 0.7 & 0.7 \end{pmatrix} \text{ and } E_{1U} = Q_U.R_{1U} = \begin{matrix} p_1 \\ p_2 \\ p_3 \end{matrix}\begin{pmatrix} 0.9 & 0.9 \\ 0.5 & 0.6 \\ 0.9 & 0.9 \end{pmatrix}$$

$$E_{2L} = Q_L.R_{2L} = \begin{matrix} p_1 \\ p_2 \\ p_3 \end{matrix}\begin{pmatrix} 0.6 & 0.4 \\ 0.3 & 0.3 \\ 0.4 & 0.4 \end{pmatrix} \text{ and } E_{2U} = Q_U.R_{2U} = \begin{matrix} p_1 \\ p_2 \\ p_3 \end{matrix}\begin{pmatrix} 0.8 & 0.7 \\ 0.7 & 0.6 \\ 0.6 & 0.7 \end{pmatrix}$$

$$E_{3L} = Q_L.\left(H - R_{1L}\right) = \begin{matrix} p_1 \\ p_2 \\ p_3 \end{matrix}\begin{pmatrix} 0.6 & 0.7 \\ 0.3 & 0.3 \\ 0.5 & 0.5 \end{pmatrix} \text{ and } E_{3U} = Q_U.\left(H - R_{1U}\right) = \begin{matrix} p_1 \\ p_2 \\ p_3 \end{matrix}\begin{pmatrix} 0.6 & 0.4 \\ 0.6 & 0.4 \\ 0.6 & 0.4 \end{pmatrix}$$

$$E_{4L} = Q_L.\left(H - R_{2L}\right) = \begin{matrix} p_1 \\ p_2 \\ p_3 \end{matrix}\begin{pmatrix} 0.6 & 0.6 \\ 0.3 & 0.3 \\ 0.6 & 0.6 \end{pmatrix} \text{ and } E_{4U} = Q_U.\left(H - R_{2U}\right) = \begin{matrix} p_1 \\ p_2 \\ p_3 \end{matrix}\begin{pmatrix} 0.7 & 0.8 \\ 0.5 & 0.5 \\ 0.7 & 0.6 \end{pmatrix}$$

Now, from equations (3.7) and (3.8) we have,

$$SE_{1L} = \begin{matrix} p_1 \\ p_2 \\ p_3 \end{matrix}\begin{pmatrix} 0.6 & 0.6 \\ 0.3 & 0.3 \\ 0.7 & 0.7 \end{pmatrix} \text{ and } SE_{1U} = \begin{matrix} p_1 \\ p_2 \\ p_3 \end{matrix}\begin{pmatrix} 0.1 & 0.9 \\ 0.5 & 0.6 \\ 0.9 & 0.9 \end{pmatrix}$$

$$SE_{2L} = \begin{matrix} p_1 \\ p_2 \\ p_3 \end{matrix}\begin{pmatrix} 0.6 & 0.6 \\ 0.3 & 0.3 \\ 0.5 & 0.5 \end{pmatrix} \text{ and } SE_{2U} = \begin{matrix} p_1 \\ p_2 \\ p_3 \end{matrix}\begin{pmatrix} 0.8 & 0.8 \\ 0.7 & 0.7 \\ 0.6 & 0.6 \end{pmatrix}$$

We calculate the diagnosis score and against the diseases SE_1 and SE_2 from equation (3.9) and (3.10) we have,

$$SE_{1L} = \begin{matrix} p_1 \\ p_2 \\ p_3 \end{matrix}\begin{pmatrix} 0.9 & 0.9 \\ 0.5 & 0.6 \\ 0.9 & 0.9 \end{pmatrix} \text{ and } SE_{1U} = \begin{matrix} p_1 \\ p_2 \\ p_3 \end{matrix}\begin{pmatrix} 0.8 & 0.7 \\ 0.7 & 0.6 \\ 0.6 & 0.7 \end{pmatrix}$$

Now, from equation (3.11) we have the difference for and against the diseases by IIM method

SE_1-SE_2	d_1	d_2
p_1	0.1	0.2
p_2	-0.2	0
p_3	0.3	0.2

We conclude that the patient p_3 is suffering from the disease d_1 and patient's p_1 and p_2 both suffering from the disease d_2. The same conclusion is available in [1], by which in matrix computations involved are not uniform.

4. Weighted Mean Formula:

In this section, we apply Sanchez's method of medical diagnosis for the weighted mean of interval incline matrix. In this method is an attempt to improve the above section.

Definition 4.1

Let $X = [X_L, X_U] = [x_{ijL}, x_{ijU}]$ weighted mean of an interval incline matrix X = weighted mean of X_L and X_U denoted by am (X) is defined by $am\left(X\right) = \frac{X_L + X_U}{2} = \left[\frac{x_{ijL} + x_{ijU}}{2}\right]$ is the interval incline matrix.

The relation matrices R_1, R_2 and Q are Constructed as in Step 1, 2, 3, 4 of the algorithm (3.1) By utilizing the Definition (4.1) of the weighted Mean of an IIM, let as compute the am(R_1), am(R_2) and am(Q) for the matrices $Q = [Q_L, Q_U]$, $R_1 = [R_{1L}, R_{1U}]$ and $R_2 = [R_{2L}, R_{2U}]$.

By utilizing definition (4.1),

$$am\left(R_1\right) = \left[\frac{R_{1L} + R_{1U}}{2}\right] \qquad \rightarrow (4.1)$$

$$am\left(R_2\right) = \left[\frac{R_{2L} + R_{2U}}{2}\right] \qquad \rightarrow (4.2)$$

and

$$am(Q) = \left[\frac{Q_L + Q_U}{2}\right] \quad \rightarrow (4.3)$$

Then combining the relation matrices am (R_1) and am(R_2) separately with am(Q) under the lower matrix and upper matrix Composition of interval incline matrices. We get,

$$E_1 = am(Q).\ am(R_1) \quad \rightarrow (4.4)$$

$$E_2 = am(Q).\ am(R_2) \quad \rightarrow (4.5)$$

$$E_3 = am(Q).\ (H - am(R_1)) \quad \rightarrow (4.6)$$

$$E_4 = am(Q).\ (H - am(R_2)) \quad \rightarrow (4.7)$$

Where H is the matrix with all entries Unity. By utilizing sanchez's technique [5, 6]. We calculate the diagnosis score S E_1 and S E_2 for and against the disease respectively.

$$SE_1 = \sup_{i,j}\left[E_1(p_i, d_j), E_4(p_i, d_j)\right] \quad \rightarrow (4.8),\ \text{i=1, 2, 3 and j=1, 2}$$

$$SE_2 = \sup_{i,j}\left[E_2(p_i, d_j), E_3(p_i, d_j)\right] \quad \rightarrow (4.9),\ \text{i=1, 2, 3 and j=1, 2}$$

$$\text{Now, } \sup_{j}\left[SE_1(p_i, d_j) - SE_2(p_i, d_j)\right] \quad \rightarrow (4.10)$$

Occurs for exactly (p_i, d_j) only, then we Conclude that the acceptable diagnostic hypothesis for patient p_i is the disease d_k. In Case there is a tie, the process has to be repeated for patient by reassessing the Symptoms. Let us illustrate the weighted mean method by Considering the Case Study in Illustration (3.2).

Example 4.2:

We shall calculate the Average symptom disease interval matrix am(R_1). Average non Symptom disease interval matrix am(R_2) and average patient Symptom interval matrix am(Q) by using (4.1), (4.2) and (4.3) for the interval incline matrices R_1, R_2 and Q respectively.

$$am(R_1) = \begin{matrix} e_1 \\ e_2 \\ e_3 \\ e_4 \end{matrix}\begin{pmatrix} 0.90 & 0.76 \\ 0.25 & 0.6 \\ 0.55 & 0.46 \\ 0.3 & 0.46 \end{pmatrix} \quad \rightarrow (4.11)$$

$$am(R_2) = \begin{matrix} e_1 \\ e_2 \\ e_3 \\ e_4 \end{matrix}\begin{pmatrix} 0.16 & 0.26 \\ 0.76 & 0.6 \\ 0.46 & 0.56 \\ 0.8 & 0.2 \end{pmatrix} \quad \rightarrow (4.12)$$

$$\text{and } am(Q) = \begin{matrix} p_1 \\ p_2 \\ p_3 \end{matrix}\begin{pmatrix} 0.76 & 0.5 & 1.0 & 0.76 \\ 0.5 & 0.6 & 0.4 & 0.5 \\ 0.8 & 0.5 & 0.7 & 0.4 \end{pmatrix} \quad \rightarrow (4.13)$$

Then combining the relation matrices am(R_1) and am(R_2) separately with am(Q) , we have

$$E_1 = (amQ)(amR_1) = \begin{matrix} p_1 \\ p_2 \\ p_3 \end{matrix}\begin{pmatrix} 0.76 & 0.76 \\ 0.5 & 0.6 \\ 0.8 & 0.8 \end{pmatrix} \quad \rightarrow (4.14)$$

$$E_2 = (amQ)(amR_2) = \begin{matrix} p_1 \\ p_2 \\ p_3 \end{matrix}\begin{pmatrix} 0.8 & 0.56 \\ 0.6 & 0.6 \\ 0.8 & 0.56 \end{pmatrix} \quad \rightarrow (4.15)$$

$$E_3 = (amQ)(H - am(R_1)) = \begin{matrix} p_1 \\ p_2 \\ p_3 \end{matrix}\begin{pmatrix} 0.8 & 0.56 \\ 0.5 & 0.6 \\ 0.8 & 0.8 \end{pmatrix} \quad \rightarrow (4.16)$$

$$E_4 = (amQ)(H - am(R_2)) = \begin{matrix} p_1 \\ p_2 \\ p_3 \end{matrix}\begin{pmatrix} 0.76 & 0.76 \\ 0.5 & 0.6 \\ 0.8 & 0.8 \end{pmatrix} \rightarrow (4.17)$$

Then by equations (4.8) and (4.9) we have,

$$SE_1 = \begin{matrix} p_1 \\ p_2 \\ p_3 \end{matrix}\begin{pmatrix} 0.76 & 0.76 \\ 0.5 & 0.6 \\ 0.8 & 0.8 \end{pmatrix} \text{ and } SE_2 = \begin{matrix} p_1 \\ p_2 \\ p_3 \end{matrix}\begin{pmatrix} 0.8 & 0.56 \\ 0.5 & 0.6 \\ 0.46 & 0.56 \end{pmatrix}$$

Now we calculate from equation (4.10) we have, the difference for and against the diseases by weighted mean formula

SE_1-SE_2	d_1	d_2
p_1	-0.05	0.2
p_2	-0.1	0
p_3	0.34	0.24

Now, we conclude that the patient p_3 is suffering from the disease d_1 and patient p_1 and p_2 both suffering from the disease d_2.

5. Conclusion:

We have applied Sanchez's approach to study medical diagnosis by utilizing the representation of an interval incline matrix as an interval matrix of two incline matrices. In our method the interval matrix operations involved are upper and lower matrices, which is uniform and much simpler than that are found in [1, 2 and 7].

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