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Application of incline matrix theory in linear systems problem involving some decision-making factors: study on medical diagonosis

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Abstract
In This paper we have found mathematical technique to detect disease and various aspects of medical diagnosis using incline matrix theory and presented illustration of this technique with the help of hypothetical case study. Our approach involves the construction and application of incline matrices represent symptoms and diseases, allowing for precise medical diagonosis. The method leverages incline algebra properties to handle uncertainty and provisional data, offer improved accuracy in diagonosis. The case study demonstrate the effectiveness of the technique in identify diseases based on patient symptoms.
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Keywords: Incline algebra, incline matrix, medical knowledge, disease symptoms etc.

Introduction

In our real life various problems related with medical sciences, engineering, political, financial, social disciplines and numerous different arenas involve provisional data which are not always necessarily in crisp, appropriate and conclusive forms due to uncertainty associated with these problems. Such problems are usually being handled with the help of the topics like probability theory, fuzzy set theory, intuitionistic fuzzy sets, interval mathematics and rough sets.

M.N Jafar *et al*. [3] studied Sanchez's approach to disease identification using trapezoidal fuzzy number. Method of medical diagnosis using intuitionistic fuzzy set, Saikia extended the method [6] using intuitionistic fuzzy soft set. Chetia and Das [2] studied Sanchez's approach of medical diagnosis through interval valued fuzzy soft set *IVFSS* an improvement. Sangodapo, Onasanya and Hoskova [5] made the same decision making with fuzzy soft matrix. Meenakshi [4] provided the techniques to study Sanchez's approach of medical diagnosis of interval valued fuzzy matrix. In this paper, we purposes to discuss general case for the application of Sanchez's *IVFM* technique using incline matrix theory for detection of disease. We take the basic notion and definitions based on Cao, Kim and Rough [1].

Prelimniries

Definition: An incline is an algebraic structure $(\Im,+,*)$ having a non-empty set $\Im$ and two binary operations + and * such that for all x,y,z in $\Im$, if the following laws hold

[K1] Associative laws
(i) $x + (y + z) = (x + y) + z$,
(ii) $x * (y * z) = (x * y) * z$.

[K2] Commutative laws
(i) $x + y = y + x$,
(ii) $x * y = y * x$.

[K3] Distributive laws
(i) $x * (y + z) = (x * y) + (x * z)$,
(ii) $(y + z) * x = (y * x) + (z * x)$.

[K4] Idempotent law: $x + x = x$.
[K5] Incline law
(i) $x + (x * y) = x$,

(ii) y + (x * y) = y.

We shall also use the following definitions and properties in our further investigations.

Definition: Let x, y ϵ ℑ. The incline order relation denoted as "≤" and is defined as x ≤ y ↔ x + y = y.
From the incline axiom (K5) obiviously, we have
1. x + y ≥ x and x + y ≥ y for x,y ϵ ℑ,
2. xy ≤ x and xy ≤ y for x,y ϵ ℑ.

Which are known as incline properties.

Definition: Incline matrices are those matrices whose elements belong to [0,1] and operations performed on them are subjected to following incline operations
1. A+B = sup (a_{ij} + b_i); Matrix addition in incline,
2. A⨀B = $a_{ij}b_{ij}$; Matrix product in inline,
3. AB =max ($\sum a_{ij}b_{ij}$); Matrix multiplication over an incline.

Application of incline matrix to detect disease
Methodology
For a particular pathology lab, let us suppose that the set of patients P with the set of symptoms S associated with the set of diseases D.
Now we built up strategy to detect patients experiencing what sickness using incline set i.e. $A(d_1)$ and $A(d_2)$ which is the symptoms values related to particular diseases.
Now we have a single Incline matrix representation I_1 with respect to incline set $A(d_i)$ for $i=1,2$. Called symptoms-disease Incline relation matrix.
The complement of Incline set $A(d_i)$ and its incline matrix representation I_1^c is called non-symptoms disease incline matrix. Again we construct a incline relation matrix Q called patients symptoms incline relation matrix and its complement Q^c called patients-non symptoms incline relation matrix.
Now using the of incline operation matrix multiplication we obtain two new $E_2 = Q\ I_1^c$ called patients-symptoms non disease incline relation matrix respectively.
Similarly, we obtain two new incline relation matrix $E_3 = Q^c\ I_1$ called patients non-symptoms disease incline relation matrix and $E_4 = Q^c\ I_1^c$ called patients non-symptoms non-disease incline relation matrix respectively as

i.e $E_1 = Q\ I_1, E_2 = Q\ I_1^c, E_3 = Q^c\ I_1\ and\ E_4 = Q^c\ I_1^c$. (1)

Now we calculate the digonosis scores X_{E1} and X_{E2} with and against disease respectively as

$$X_{E_1} = \max\{E_1(p_i, d_j),\ E_3(p_i, d_j)\}; i = 1,2,3; j = 1,2 \quad (2)$$

$$X_{E_2} = \max\{E_2(p_i, d_j),\ E_4(p_i, d_j)\}; i = 1,2,3; j = 1,2. \quad (3)$$

Now we find $X_k = \max\{X_{E_1}(p_i, d_j) - X_{E_2}(p_i, d_j)\}; i = 1,2,3; j = 1,2.$ (4)

Thus we conclude that the patients p_i is suffering from the disease d_k.

All the above steps can be summerised in algorithm as follows:

Step I: Select the parameter sets.

Step II: Construct the incline matrix I_1 and I_1^c associated with the incline set $A(d_i)$ and $A(d_i)^c$.

Step-III: Now construct the Incline relation matrix Q and Q^c associated with set $B(s_i)$ and $B(s_i)^c$.

Step IV: Compute the incline matrices

i.e. $E_1 = Q\ I_1, E_2 = Q\ I_1^c, E_3 = Q^c\ I_1\ and\ E_4 = Q^c\ I_1^c$ (5)

Step V: Compute the diagonosis scores $X_{E_1} and\ X_{E_2}$.

Step VI: Find $X_k = \max\{X_{E_1}(p_i, d_j) - X_{E_2}(p_i, d_j)\}; i = 1,2,3; j = 1,2.$

We conclude that the patients p_i is suffering from disease d_k.

Case Study

Let us suppose that Raj, steave and Kane are three patients $P=\{ p_1, p_2, p_3 \}$ goes for pathology for laboratory test with symptoms $S=\{s_1, s_2, s_3, s_4\}$ where s_1, s_2, s_3, s_4 represent Temperature, Headache, Cough and body pain, symptoms related to disease $D=\{d_1, d_2\}$ where d_1, d_2 represent Viral Fever and Corona respectively.

$$A(d_1) = \{ (s_1, 0.85), (s_2, 0.25), (s_3, 0.55), (s_4, 0.30) \}, \tag{6}$$

$$A(d_2) = \{ (s_1, 0.75), (s_2, 0.50), (s_3, 0.45), (s_4, 0.45) \}. \tag{7}$$

There Incline relation matrix $A(d_i); i=1,2$ represented by a single incline matrix I_1 called symptoms disease incline matrix

$d_1\ d_2$

$$I_1 = \begin{matrix} s_1 \\ s_2 \\ s_3 \\ s_4 \end{matrix} \begin{pmatrix} 0.85 & 0.75 \\ 0.25 & 0.50 \\ 0.55 & 0.45 \\ 0.30 & 0.45 \end{pmatrix}. \tag{8}$$

$d_1\ d_2$

$$\text{Now, } I_1^c = \begin{matrix} s_1 \\ s_2 \\ s_3 \\ s_4 \end{matrix} \begin{pmatrix} 0.15 & 0.25 \\ 0.75 & 0.50 \\ 0.45 & 0.55 \\ 0.70 & 0.55 \end{pmatrix} \tag{9}$$

4×2

Again, Incline matrix *(B, S)* over *P* given as appropriate explanation of patients symptoms in pathology.

$$(B, s) = \begin{cases} B(s_1) = \{(p_1, 0.75), (p_2, 0.40), (p_3, 0.70)\} \\ B(s_2) = \{(p_1, 0.40), (p_2, 0.50), (p_3, 040)\} \\ B(s_3) = \{(p_{1,}, 0.90), (p_2, 0.30), (p_3, 0.60)\} \\ B(s_4) = \{(p_1, 0.75), (p_2, 0.40), (p_3, 0.30)\}. \end{cases} \tag{10}$$

Now construct the incline matrix relation with the above set represented by Q (called patient symptoms incline relation matrix) and its complement Q^c (Called non-patients symptoms incline relation matrix).

$s_1\ \ s_2\ s_3\ s_4$

$$Q = \begin{matrix} p_1 \\ p_2 \\ p_3 \end{matrix} \begin{bmatrix} 0.75 & 0.40 & 0.90 & 0.75 \\ 0.40 & 0.50 & 0.30 & 0.40 \\ 0.70 & 0.40 & 0.60 & 0.30 \end{bmatrix}. \tag{11}$$

3×4

$$s_1\ s_2\ s_3\ s_4\ Q^c = \begin{matrix} p_1 \\ p_2 \\ p_3 \end{matrix} \begin{bmatrix} 0.25 & 0.60 & 0.10 & 0.25 \\ 0.60 & 0.50 & 0.70 & 0.60 \\ 0.30 & 0.60 & 0.40 & 0.70 \end{bmatrix}. \tag{12}$$

3×4

Now compute $E_1 = Q.I_1$

$s_1\ s_2\ s_3\ s_4\ \ d_1\ d_2$

$$E_1 = \begin{matrix} p_1 \\ p_2 \\ p_3 \end{matrix} \begin{bmatrix} 0.75 & 0.40 & 0.90 & 0.75 \\ 0.40 & 0.50 & 0.30 & 0.40 \\ 0.70 & 0.40 & 0.60 & 0.30 \end{bmatrix} \begin{matrix} s_1 \\ s_2 \\ s_3 \\ s_4 \end{matrix} \begin{bmatrix} 0.85 & 0.75 \\ 0.25 & 0.50 \\ 0.55 & 0.45 \\ 0.30 & 0.45 \end{bmatrix}. \tag{13}$$

$d_1\ \ d_2$

$$i.e\ E_1 = \begin{matrix} p_1 \\ p_2 \\ p_3 \end{matrix} \begin{bmatrix} 0.63 & 0.56 \\ 0.34 & 0.30 \\ 0.59 & 0.52 \end{bmatrix} \tag{14}$$

Patients symptoms disease Incline matrix.

Similarly, we compute $E_2 = Q.I_1^c$

$s_1\ \ s_2\ s_3\ s_4\ d_1\ d_2$

$$E_2 = \begin{matrix} p_1 \\ p_2 \\ p_3 \end{matrix}\begin{bmatrix} 0.75 & 0.40 & 0.90 & 0.75 \\ 0.40 & 0.50 & 0.30 & 0.40 \\ 0.70 & 0.40 & 0.60 & 0.30 \end{bmatrix} \begin{matrix} s_1 \\ s_2 \\ s_3 \\ s_4 \end{matrix}\begin{pmatrix} 0.15 & 0.25 \\ 0.75 & 0.50 \\ 0.45 & 0.55 \\ 0.70 & 0.55 \end{pmatrix} \quad (15)$$

$d_1\ d_2$

$$i.e\ E_2 = \begin{matrix} p_1 \\ p_2 \\ p_3 \end{matrix}\begin{bmatrix} 0.52 & 0.49 \\ 0.52 & 0.25 \\ 0.30 & 0.33 \end{bmatrix} \quad (16)$$

Patients symptoms non-disease Incline matrix.

Also, we have another Incline matrix $E_3 = Q^c.I_1\ and\ E_4 = Q^c.I_1^c$

$s_1\ \ s_2\ s_3\ s_4\ d_1\ d_2$

$$E_3 = \begin{matrix} p_1 \\ p_2 \\ p_3 \end{matrix}\begin{bmatrix} 0.25 & 0.60 & 0.10 & 0.25 \\ 0.60 & 0.50 & 0.70 & 0.60 \\ 0.30 & 0.60 & 0.40 & 0.70 \end{bmatrix} \begin{matrix} s_1 \\ s_2 \\ s_3 \\ s_4 \end{matrix}\begin{pmatrix} 0.85 & 0.75 \\ 0.25 & 0.50 \\ 0.55 & 0.45 \\ 0.30 & 0.45 \end{pmatrix} \quad (17)$$

$d_1\ d_2$

$$i.e\ E_3 = \begin{matrix} p_1 \\ p_2 \\ p_3 \end{matrix}\begin{bmatrix} 0.21 & 0.30 \\ 0.51 & 0.45 \\ 0.25 & 0.31 \end{bmatrix}$$ (3.18) Patients non-symptoms disease incline matrix.

$$s_1\ s_2\ s_3\ s_4\ \ d_1\ d_2\ and\ E_4 = \begin{matrix} p_1 \\ p_2 \\ p_3 \end{matrix}\begin{bmatrix} 0.25 & 0.60 & 0.10 & 0.25 \\ 0.60 & 0.50 & 0.70 & 0.60 \\ 0.30 & 0.60 & 0.40 & 0.70 \end{bmatrix} \begin{matrix} s_1 \\ s_2 \\ s_3 \\ s_4 \end{matrix}\begin{pmatrix} 0.15 & 0.25 \\ 0.75 & 0.50 \\ 0.45 & 0.55 \\ 0.70 & 0.55 \end{pmatrix} \quad (19)$$

$d_1\ d_2$

$$i.e\ E_4 = \begin{matrix} p_1 \\ p_2 \\ p_3 \end{matrix}\begin{bmatrix} 0.45 & 0.30 \\ 0.42 & 0.38 \\ 0.49 & 0.38 \end{bmatrix} \quad (20)$$

Patients non-symptoms non-disease incline matrix.
Now $X_{E_1} = \max\{E_1(p_i, d_j), E_3(p_i, d_j)\}\ for\ i = 1,2,3\ and\ j = 1,2\ \ and\ X_{E_2} = \max\{E_2(p_i, d_j), E_4(p_i, d_j)\}for\ i = 1,2,3\ and\ j = 1,2$

$d_1\ d_2\ d_1\ d_2$

$$i.e\ X_{E_1} = \begin{matrix} p_1 \\ p_2 \\ p_3 \end{matrix}\begin{bmatrix} 0.63 & 0.56 \\ 0.51 & 0.45 \\ 0.59 & 0.52 \end{bmatrix} \&\ X_{E_2} = \begin{matrix} p_1 \\ p_2 \\ p_3 \end{matrix}\begin{bmatrix} 0.52 & 0.49 \\ 0.52 & 0.38 \\ 0.49 & 0.38 \end{bmatrix}. \quad (21)$$

Table 1: Diagonosis score difference

$X_{E_1} - X_{E_2}$	d_1	d_2
p_1	0.11	0.07
p_2	−0.01	0.07
p_3	0.10	0.14

Thus, from the above diagonosis score we concluded that the patients suffering from diseases as $p_1 \leftrightarrow d_1, p_2 \leftrightarrow d_2\ and\ p_3 \leftrightarrow d_2$ respectively.

Conclusion

In this paper, we applied the Incline matrix with their respective operation for detection of disease in different patients. we got the more precise and better result from recent previous work with the help fuzzy algebra in medical diagonosis. For the simplicity of technique a case study has been taken to exhibition.

References

1. Cao ZQ, Kim KH, Roush FW. Incline Algebra and Applications. New York: John Wiley & Sons; c1984.
2. Chetia B, Das PK. An application of Interval Valued Fuzzy Soft Set in medical diagnosis. Int. J Contemp Math Sci. 2010;5(38):1887-1894.
3. Jafer MN, Muniba K, Saeed A, Bibi I. Application of Sanchez's Approach to disease identification using TFN. Int. J Latest E R Res. 2019;04(09):51-57. ISSN: 2455-7137.

4. Meenakshi AR, Kaliraja S. An application of Interval Valued Fuzzy Matrices in medical diagnosis. Int. J Math Anal. 2011;5:1791-1801.
5. Sangodapo TO, Onasanya BO, Mayerova-Hoskova S. Decision-making with fuzzy soft matrix using a revised method: A case of medical diagnosis of diseases. MDPI J Math. 2021;09(19):23-27.
6. Saikia BK, Das PK, Borkakati AK. An application of Intuitionistic Fuzzy Soft Sets in medical diagnosis. Bio Sci. Res Bull. 2003;19(2):121-127.