Application of Incline Matrix in Medical Diagnosis

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Abstract- In this paper I extend Sanchez's approach for medical diagnosis using incline matrix and exhibit the technique with a hypothetical case study.

Index Terms- incline matrix, medical knowledge

I. INTRODUCTION

Most of our real life problems in medical sciences, engineering, management, environment and social sciences often involve data which are not necessarily crisp, precise and deterministic in character due to various uncertainties associated with these problems. 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 field of medicine is one of the most fruitful and interesting areas of applications for fuzzy set theory. In the discrimination analysis, the symptoms are ranked according to the grade of discrimination of each disease by a particular symptom and is represented in the form of a matrix called a frequency distribution matrix $F=(f_{ij})$ where f_{ij} is the ratio of the patients with disease 'd_i'. This matrix model may not yield more accurate diagnosis in such cases where several diseases affect a single patient or when a single disease manifests quite differently in different patients and at different disease stages. Moreover, with the increased volume of information available to physicians from new medical technologies, the process of classifying different sets of symptoms under a single name of disease and determining the appropriate therapeutic actions becomes increasingly difficult. Recently, there are varieties of models of medical diagnosis under the general framework of fuzzy sets theory involving fuzzy matrices to deal with different complicating aspects of medical diagnosis.

De et. Al [3] have studied Sanchez's [6] method of medical diagnosis using intuitionistic fuzzy set. Saikia [7] have extended the method in [6] using IFS. In [2], Chetia and Das have studied Sanchez's approach of medical diagnosis through IVFSS obtaining an improvement of the same presented in De [3]. Meenakshi [4] have provided the techniques to study Sanchez's approach of medical diagnosis of IVFM.

In this article, I extend Sanchez's method for medical diagnosis using the notion of incline matrix theory. The notion of inclines and their applications are described comprehensively in Cao, Kim and Rough[1]. The method of incline medical diagnosis involves incline order relations as defined in [5].

II. PRELIMINARIES

Definition 2.1

A non empty set £ with two binary operations' +' and' ·' is called an incline if it satisfy the following conditions:
1. (£,+) is a semilattice
2. (£,·) is a semigroup
3. x(y+z)=xy+xz for all x,y,z ∈ £
4. x+xy=x and y+xy=y for all x,y ∈ £.

Definition 2.2

For x,y ∈ £, the order relation "≤" is defined as x ≤ y ↔ x + y = y. From the incline axiom (4), the order relation "≤" has the following properties:
x + y ≥ x and x + y ≥ y for x,y ∈ £
xy ≤ x and xy ≤ y for x,y ∈ £
which are called as incline properties.

III. APPLICATION OF INCLINE MATRIX IN MEDICAL DIAGNOSIS

In a given pathology, suppose S is a set of symptoms, D a set of diagnosis and P a set of patients. Analogous to Sanchez's notion of medical Knowledge as an incline order relation R from the set of symptoms S to the set of diagnosis D.

The methodology involves mainly the following 3 jobs..
1. Determination of symptoms
2. Formulation of medical knowledge based in incline order relations.
3. Determination of diagnosis on the basis of composition of incline order relations.

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 incline matrix P over D. A relation matrix say ,R_1 is constructed from the incline matrix (£,D) and called symptom-disease matrix. Similarly , write an another relation matrix S over D, say R_2,called non symptom diseases matrix. Analogous to Sanchez's notion of medical knowledge, I refer to each of the matrices R_1 and R_2 as medical knowledge of an incline matrix. Again I construct another incline matrix (£,S) over D, where £ is a mapping given by £:S→£(D). This incline matrix gives another relation matrix Q called patient-symptom matrix. The two new relation matrices $T_1=R_1Q$ and $T_2=R_2Q$ called symptom patient matrix and non symptom patient matrix respectively.

3.1.Algorithm
Step 1:

Input the incline matrix value over the set of patients P over diseases D and write the input value over the set of symptoms S over D denoted by the knowledge matrix R_1 and R_2 respectively.

Step 2:

Input the incline matrix over the set P of patients over D and write its relation Q.

Step 3:
Compute the relation matrices under the composition $(+,\cdot)$, where the $+$ is Maximum and $\cdot$ is minimum.

i. $T_1 = R_1 Q$
ii. $T_2 = R_2 Q$
iii. $T_3 = (J-R_1) Q$

Where J is the matrix with all its entries 1, which is the greatest element of £.

iv. $T_4 = (J-R_2) Q$

Step 4: Compute the diagnostic scores ST_1 and ST_2
$ST_1 = \max \{T_1(p_i,d_j), T_3(p_i,d_j)\}$ for i=1,2,3 j=1,2
$ST_2 = \max \{T_2(p_i,d_j), T_4(p_i,d_j)\}$ for i=1,2,3 j=1,2

Step 5: Find $S_k = \max [ST_1(p_i,d_j) - ST_2(p_i,d_j)]$ then we conclude the patient p_i is suffering from the disease d_k.

Step 6: If S_k has more than one value then go to step 1 and repeat the process by reassessing the symptoms for the patient.

Case Study
Let us consider 3 patients Balu, Somu and Ramu are denoted by the set P={Balu, Somu, Ramu} and the set of symptoms S={Head ache, stress, acidity}. Let the set of diseases

be D={Vision problem, Ulcer}.

Step 1

$$R_1 = \begin{array}{c} \\ p_1 \\ p_2 \\ p_3 \end{array} \begin{array}{cc} d_1 & d_2 \\ \begin{pmatrix} 1 & 0.2 \\ 0.4 & 1 \\ 0.9 & 0.25 \end{pmatrix} \end{array} \qquad R_2 = \begin{array}{c} \\ s_1 \\ s_2 \\ s_3 \end{array} \begin{array}{cc} d_1 & d_2 \\ \begin{pmatrix} 0.8 & 0 \\ 0.5 & 1 \\ 0.75 & 0.5 \end{pmatrix} \end{array}$$

Step 2

$$Q = \begin{array}{c} \\ p_1 \\ p_2 \\ p_3 \end{array} \begin{array}{ccc} d_1 & d_2 & d_3 \\ \begin{pmatrix} 0.4 & 0.9 & 0.8 \\ 0.7 & 0 & 0.6 \\ 0.8 & 0.7 & 1 \end{pmatrix} \end{array}$$

Step 3

$$T_1 = \begin{array}{c} \\ p_1 \\ p_2 \\ p_3 \end{array} \begin{array}{cc} d_1 & d_2 \\ \begin{pmatrix} 0.72 & 0.9 \\ 0.7 & 0.15 \\ 0.9 & 0.7 \end{pmatrix} \end{array} \qquad T_2 = \begin{array}{c} \\ p_1 \\ p_2 \\ p_3 \end{array} \begin{array}{cc} d_1 & d_2 \\ \begin{pmatrix} 0.6 & 0.9 \\ 0.56 & 0.3 \\ 0.75 & 0.7 \end{pmatrix} \end{array}$$

$$T_3 = \begin{array}{c} \\ p_1 \\ p_2 \\ p_3 \end{array} \begin{array}{cc} d_1 & d_2 \\ \begin{pmatrix} 0.54 & 0.6 \\ 0.06 & 0.56 \\ 0.42 & 0.75 \end{pmatrix} \end{array} \qquad T_2 = \begin{array}{c} \\ p_1 \\ p_2 \\ p_3 \end{array} \begin{array}{cc} d_1 & d_2 \\ \begin{pmatrix} 0.6 & 0.5 \\ 0.4 & 1 \\ 0.12 & 0.3 \end{pmatrix} \end{array}$$

Step 4

$$ST_1 = \begin{array}{c} \\ p_1 \\ p_2 \\ p_3 \end{array} \begin{array}{cc} d_1 & d_2 \\ \begin{pmatrix} 0.72 & 0.9 \\ 0.7 & 0.15 \\ 0.9 & 0.7 \end{pmatrix} \end{array} \qquad ST_2 = \begin{array}{c} \\ p_1 \\ p_2 \\ p_3 \end{array} \begin{array}{cc} d_1 & d_2 \\ \begin{pmatrix} 0.6 & 0.9 \\ 0.4 & 1 \\ 0.42 & 0.75 \end{pmatrix} \end{array}$$

$ST_1 - ST_2$	d_1	d_2
p_1	0.12	**0.3**
P_2	0.3	**0.75**
p_3	**0.48**	-0.05

From the above table, it is obvious that, if the doctor agrees, then Balu (p_1) and Somu (p_2) suffer from Ulcer and Ramu (p_3) suffer from Vision Problem.

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