

# Application of Fuzzy Matrix in the Study of Yoga on Sciatica

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**ABSTRACT:** In this paper, an occurrence relation  $R_0$  and conformability relation  $R_c$  are determined from expert medical documentation and observation of the related patient with sciatica. Fuzzy relation  $R_0$  and  $R_c$  we will try to draw different types of diagnostic conclusion about sciatica.

**KEYWORDS:** Fuzzy set, fuzzy matrix, max – min relations, Sciatica.

## I. INDRODUCTIONS

In recent years, computational intelligence has been used to solve many complex problem by developing intelligent systems. And fuzzy logic has proved to be a powerful tool for decision – making systems, such as expert systems and pattern classification systems. Fuzzy set theory has already been used in some medical expert systems. Sanchez formulated the diagnostic models involving fuzzy matrices representing the medical knowledge between symptoms and diseases. Esogbue and Elder utilized fuzzy cluster analysis to model medical diagnostic. Meenakshi and kaliraja (7) have extended sanchez's approach for medical diagnosis using the representation of a interval valued fuzzy matrix. They have also introduced the arithmetic mean matrix of an interval valued fuzzy matrix and directly applied Sanchez's method of medical diagnosis on it. Fuzzy set theory also plays a vital role in the field of decision making. Decision making is a most important scientific, social and economic endeavor. In classical crisp decision making theory decisions are made under conditions of certainty but in real life situations that is not possible which gives rise to fuzzy decision making theories.

Some models to understand and teach process of medical diagnosis using fuzzy set theory vary in the degree, to which they attempt to deal with different complicating aspects as below,

- Relative importance of symptoms.
- Symptom patterns of diseases stage
- Relation between diseases themselves.
- Stage of hypothesis formation
- Preliminary and final diagnosis within diagnostic process.

These models also form the basis or computerized medical expert system. Which is useful for physician in the diagnosis of some specified category of diseases. This inspires us to make a model related to disease **SCIATICA**, Which commonly observed in India.

This model proposes two types of relations to exist between symptoms and diseases.

An, occurrence relation  $R_0$  provides knowledge about the tendency or frequency of appearance of symptoms when the specific diseases is present. i.e how often does the symptoms occur with diseased.

A conformability relation  $R_c$  describes the discriminating power of the symptoms to confirm the presence of the disease. i.e. how, strongly does the symptoms confirm diseased.

The distinction between occurrence and conformability is important because a symptom may occur with given disease may be commonly occur with several other diseases.

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## II. PRELIMINARIES

### Definition 2.1

#### Addition of Fuzzy Matrix :

We add two fuzzy matrices A and B and get the sum of them to be fuzzy matrix as follows.

Let  $X = [X_{ij}]$

$$X = \begin{pmatrix} 0.4 & 0.2 & 0.3 & 0.5 & 1.0 & 0.4 \\ 0.6 & 0.1 & 0.4 & 0.8 & 0.0 & 0.5 \\ 0.9 & 0.4 & 0.6 & 1.0 & 0.3 & 0.2 \\ 0.3 & 0.7 & 0.8 & 1.0 & 0.8 & 0.5 \end{pmatrix}$$

And  $Y = [Y_{ij}]$

$$Y = \begin{pmatrix} 0.2 & 0.7 & 0.8 & 1.0 & 0.0 & 0.3 \\ 0.5 & 1.0 & 0.8 & 1.0 & 0.0 & 0.3 \\ 0.2 & 0.7 & 1.0 & 0.5 & 0.6 & 0.3 \\ 1.0 & 0.2 & 0.3 & 0.4 & 0.5 & 0.0 \end{pmatrix}$$

Be any two 4 x 6 fuzzy matrices. To find  $\max \{x,y\} = [C_{ij}]$ , where  $C_{ij} = X_{ij} + Y_{ij}$  and  $\max \{x,y\}$

$$= \begin{pmatrix} 0.4 & 0.7 & 0.8 & 1.0 & 0.0 & 0.4 \\ 0.6 & 1.0 & 0.8 & 1.0 & 0.0 & 0.5 \\ 0.9 & 0.7 & 0.6 & 1.0 & 0.6 & 0.3 \\ 1.0 & 0.7 & 0.8 & 1.0 & 0.8 & 0.5 \end{pmatrix}$$

Similarly  $\min \{X,Y\}$  can be obtained.

### Definition 2.2

#### Fuzzy Matrix :-

Multiplication of fuzzy matrix :-

We see the product of two fuzzy matrices under usual matrix multiplication is not a fuzzy matrix. So we need to define a compatible operation analogous to product the product again happens to be a fuzzy matrix. However even for this new operation the product  $XY$  is to defined we need the number of columns of X is equal to the number of rows of Y. The two types of operations which we can have are Max – Min operations.

$$\text{Let } X = \begin{pmatrix} 0.3 & 1.0 & 0.7 & 0.2 & 0.5 \\ 1.0 & 0.9 & 0 & 0.8 & 0.1 \\ 0.8 & 0.0 & 0.3 & 1.0 & 0.4 \\ 0.5 & 1.0 & 0.6 & 0.7 & 0.8 \end{pmatrix}$$

Be a 4 x 5 fuzzy matrices

$X * Y$  defined using Max – Min function

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$$\text{Thus } X * Y = \begin{pmatrix} 0.7 & 0.7 & 0.7 \\ 0.8 & 0.4 & 1.0 \\ 0.8 & 0.4 & 0.8 \\ 0.7 & 0.6 & 0.7 \end{pmatrix} \text{ is a } 4 \times 3 \text{ Matrix}$$

### Definition 2.3

#### Sciatica :

Sciatica is the name given to pain Caused by irritation of the Sciatic nerve. Any thing from mild to serve sciatic is usually caused by a compressed nerve in the lower spine.

#### Sciatica Overview :

The term “Sciatica” is confused with general back pain. However sciatica is not just limited to the back. The sciatic nerve is the longest and widest nerve in the human body. It runs from the lower back through the buttocks and down the legs, ending just below the knee. This nerve controls several muscles in the lower legs and supplies sensation toe the skin of the foot and the majority of the lower leg sciatica is not a condition, but rather a symptom of another problem involving the sciatica nerve. Some experts estimate that up to 40 percent of people will experience sciatica atleast once in their life.

#### Causes of sciatica :

Sciatica is common symptom of several different medical conditions, however and estimated 90 percent of cases are due to herniated (slipped) disk. The Spinal column is made up of three parts.

- Vertebra (individual bones in the space that protect underlying nerves)
- Nerves
- Disks

Disks are made of Cartilage, which is a strong and resilient material ; the cartilage acts as a cushion between each vertebra and allows the spine to be flexible

**A herniated disk** occurs when a disk is pushed out of place, putting pressure on the sciatic nerve.

Other causes of sciatica include

- **Lumbar spinal stenosis**  
Narrowing of the spinal cord in the lower back
- **Spondylolisthesis**  
A condition where a disk slips forward over the vertebra below
- **Tumors within the spine**  
These may compress the root of the sciatic nerve
- **Infection**  
Ultimately affecting the spine
- **Cauda equina syndrom**  
A rare but serious condition that affects the nerves in the lower part of the spinal cord.

### III. ALGORITHM

#### Case (i) :

Input the fuzzy matrix  $R_0$  refers to occurrence of symptoms and diseases.

#### Case (ii) :

Input the fuzzy matrix  $R_c$  referes to confirmative relation is  $R_c = S \times D$

#### Case (iii) :

Input the fuzzy matrix  $R_s$  refers to symptoms and diseases matrix.

#### Case (iv) :

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Calculate occurrence indication relation  $R_1 = R_s * R_0$ .

Case (v) :

Calculate conformability Indication relation  $R_2 = R_s * R_c$ .

Case (vi):

Calculate non occurrence indication relation  $R_3 = R_s *(1 - R_0)$ .

Case (vii) :

Calculate non symptoms indication relation  $R_4 = (1- R_s ) * R_0$ .

## IV. CASE STUDY

In this paper five types of sciatic diseases we taken and using the fuzzy matrix relations how a patient can be diagnosed is explained. Here we recall some of the basic properties about fuzzy matrices and operation using them. Through out this article  $[0,1]$  denotes the unit interval. We Say  $X \in [0,1]$  if  $0 \leq x \leq 1$ . We also call the unit interval as a fuzzy interval. We have just defined fuzzy sets and the need of it's in our study. We use.

S = Set of all symptoms  
D = Set of all diseases  
And P = Set of all patient

Here,  $S = \{S_1, S_2, S_3, S_4, S_5, S_6\}$  Where

$S_1$  = numbness in the log along the nerve  
 $S_2$  = Tingling sensation in the feet and toes  
 $S_3$  = Radiating Pair  
 $S_4$  = Difficulty raising the leg.  
 $S_5$  = Constant pain in only inside of the buttock or leg  
 $S_6$  = Pain wersen of standing and sitting

Step i :

D =  $\{d_1, d_2, d_3, d_4, d_5\}$  where  $d_1, d_2, d_3, d_4, d_5$  are represent the diseases.  
 $P = \{P_1, P_2, P_3, P_4, P_5\}$  matrix for occurrence relation is  $R_0 = SXD$ , indicates the frequency of occurrence of symptom with diseased. After result of yoga practice,

$$R_0 = \begin{matrix} & d_1 & d_2 & d_3 & d_4 & d_5 \\ \begin{matrix} S_1 \\ S_2 \\ S_3 \\ S_4 \\ S_5 \\ S_6 \end{matrix} & \begin{pmatrix} 0.3 & 0.0 & 0.1 & 0.6 & 0.4 \\ 0.4 & 0.2 & 0.3 & 0.4 & 0.1 \\ 0.5 & 0.4 & 0.0 & 0.2 & 0.3 \\ 0.7 & 0.6 & 0.5 & 0.4 & 0.2 \\ 0.1 & 0.4 & 0.6 & 0.8 & 0.3 \\ 0.7 & 0.4 & 0.2 & 0.4 & 0.4 \end{pmatrix} \end{matrix}$$

Step ii :

Matrix for confirmative relation is  $R_c = SXD$ , corresponds to the degree to which symptoms confirms the presence of disease d.

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$$R_c = \begin{matrix} & d_1 & d_2 & d_3 & d_4 & d_5 \\ \begin{matrix} S_1 \\ S_2 \\ S_3 \\ S_4 \\ S_5 \\ S_6 \end{matrix} & \begin{pmatrix} 0.6 & 0.4 & 0.4 & 0.7 & 0.8 \\ 0.6 & 0.3 & 0.4 & 0.8 & 0.2 \\ 0.8 & 0.7 & 0.4 & 0.4 & 0.6 \\ 0.9 & 0.9 & 0.7 & 0.7 & 0.3 \\ 0.6 & 0.8 & 0.9 & 0.9 & 0.5 \\ 0.9 & 0.7 & 0.4 & 0.6 & 0.9 \end{pmatrix} \end{matrix}$$

**Step iii :**

Now assume a fuzzy relation  $R_s$  specifying the degree of presence of symptoms  $S_1, S_2, S_3, S_4, S_5$  and  $S_6$  for six patients  $P_1, P_2, P_3, P_4, P_5$  and  $P_6$  as follows. This indicate the degree to which the symptoms in present in Patient P.

$$R_s = \begin{matrix} & S_1 & S_2 & S_3 & S_4 & S_5 & S_6 \\ \begin{matrix} P_1 \\ P_2 \\ P_3 \\ P_4 \\ P_5 \end{matrix} & \begin{pmatrix} 0.7 & 0.2 & 0.0 & 0.1 & 0.3 & 0.4 \\ 0.6 & 0.6 & 0.5 & 0.9 & 0.9 & 0.4 \\ 0.9 & 0.8 & 0.6 & 0.5 & 0.4 & 0.9 \\ 0.1 & 0.4 & 1.0 & 0.9 & 0.6 & 0.4 \\ 1.0 & 0.8 & 0.7 & 0.5 & 0.4 & 1.0 \end{pmatrix} \end{matrix}$$

Using relation  $R_s$ ,  $R_0$  and  $R_c$  we can now calculate four different indication relation as bellows.

**Step iv:**

**The occurrence indication relation**

$R_1$  calculate by  $R_1 = R_s * R_0$

$$R_1 = \begin{matrix} & d_1 & d_2 & d_3 & d_4 & d_5 \\ \begin{matrix} P_1 \\ P_2 \\ P_3 \\ P_4 \\ P_5 \end{matrix} & \begin{pmatrix} 0.4 & 0.4 & 0.3 & 0.6 & 0.4 \\ 0.5 & 0.6 & 0.6 & 0.8 & 0.4 \\ 0.9 & 0.5 & 0.4 & 0.6 & 0.4 \\ 0.7 & 0.6 & 0.6 & 0.6 & 0.6 \\ 0.7 & 0.4 & 0.4 & 0.6 & 0.4 \end{pmatrix} \end{matrix}$$

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**Step v :**

The conformability indication relation  $R_2$  is calculated by  $R_2 = R_S * R_C$

$$R_2 = \begin{matrix} & d_1 & d_2 & d_3 & d_4 & d_5 \\ \begin{matrix} P_1 \\ P_2 \\ P_3 \\ P_4 \\ P_5 \end{matrix} & \begin{pmatrix} 0.6 & 0.4 & 0.4 & 0.7 & 0.7 \\ 0.9 & 0.9 & 0.9 & 0.9 & 0.6 \\ 0.9 & 0.7 & 0.5 & 0.8 & 0.9 \\ 0.9 & 0.9 & 0.7 & 0.7 & 0.7 \\ 0.9 & 0.7 & 0.5 & 0.8 & 0.9 \end{pmatrix} \end{matrix}$$

**Step vi :**

The non occurrence indication relation  $R_3$  calculated by  $R_3 = R_S * (1 - R_0)$

$$R_3 = \begin{matrix} & S_1 & S_2 & S_3 & S_4 & S_5 & S_6 & & d_1 & d_2 & d_3 & d_4 & d_5 \\ \begin{matrix} P_1 \\ P_2 \\ P_3 \\ P_4 \\ P_5 \end{matrix} & \begin{pmatrix} 0.7 & 0.2 & 0.0 & 0.1 & 0.3 & 0.4 \\ 0.6 & 0.6 & 0.5 & 0.9 & 0.9 & 0.4 \\ 0.9 & 0.8 & 0.6 & 0.5 & 0.4 & 0.9 \\ 0.1 & 0.4 & 1.0 & 0.9 & 0.6 & 0.4 \\ 1.0 & 0.8 & 0.7 & 0.5 & 0.4 & 1.0 \end{pmatrix} & * & \begin{matrix} S_1 \\ S_2 \\ S_3 \\ S_4 \\ S_5 \\ S_6 \end{matrix} & \begin{pmatrix} 0.7 & 1.0 & 0.9 & 0.4 & 0.6 \\ 0.6 & 0.8 & 0.7 & 0.6 & 0.9 \\ 0.5 & 0.6 & 1.0 & 0.8 & 0.7 \\ 0.3 & 0.4 & 0.5 & 0.6 & 0.8 \\ 0.9 & 0.6 & 0.4 & 0.2 & 0.7 \\ 0.3 & 0.6 & 0.8 & 0.6 & 0.6 \end{pmatrix} \\ & & & & & & & & d_1 & d_2 & d_3 & d_4 & d_5 \\ \begin{matrix} P_1 \\ P_2 \\ P_3 \\ P_4 \\ P_5 \end{matrix} & \begin{pmatrix} 0.7 & 0.7 & 0.7 & 0.4 & 0.6 \\ 0.9 & 0.6 & 0.6 & 0.6 & 0.8 \\ 0.7 & 0.9 & 0.9 & 0.6 & 0.8 \\ 0.7 & 0.7 & 1.0 & 0.8 & 0.8 \\ 0.7 & 1.0 & 0.9 & 0.7 & 0.8 \end{pmatrix} \end{matrix}$$

**Step vii :**

Finally,

The non – symptom indication relation  $R_4$  calculated by  $R_4 = (1 - R_S) * R_0$

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$$R_4 = \begin{matrix} & \begin{matrix} S_1 & S_2 & S_3 & S_4 & S_5 & S_6 \end{matrix} \\ \begin{matrix} P_1 \\ P_2 \\ P_3 \\ P_4 \\ P_5 \end{matrix} & \begin{pmatrix} 0.3 & 0.8 & 1.0 & 0.9 & 0.7 & 0.6 \\ 0.4 & 0.4 & 0.5 & 0.1 & 0.1 & 0.6 \\ 0.1 & 0.2 & 0.4 & 0.5 & 0.6 & 0.1 \\ 0.3 & 0.6 & 0.0 & 0.1 & 0.4 & 0.6 \\ 0.0 & 0.2 & 0.3 & 0.5 & 0.6 & 0.0 \end{pmatrix} \end{matrix} * \begin{matrix} \begin{matrix} d_1 & d_2 & d_3 & d_4 & d_5 \end{matrix} \\ \begin{matrix} S_1 \\ S_2 \\ S_3 \\ S_4 \\ S_5 \\ S_6 \end{matrix} \\ \begin{pmatrix} 0.3 & 0.0 & 0.1 & 0.6 & 0.4 \\ 0.4 & 0.2 & 0.3 & 0.4 & 0.1 \\ 0.5 & 0.4 & 0.0 & 0.2 & 0.3 \\ 0.7 & 0.6 & 0.5 & 0.4 & 0.2 \\ 0.1 & 0.4 & 0.6 & 0.8 & 0.3 \\ 0.7 & 0.4 & 0.2 & 0.4 & 0.4 \end{pmatrix} \end{matrix}$$
  
  

$$R_4 = \begin{matrix} \begin{matrix} d_1 & d_2 & d_3 & d_4 & d_5 \end{matrix} \\ \begin{matrix} P_1 \\ P_2 \\ P_3 \\ P_4 \\ P_5 \end{matrix} \\ \begin{pmatrix} 0.7 & 0.6 & 0.6 & 0.7 & 0.4 \\ 0.6 & 0.4 & 0.3 & 0.4 & 0.4 \\ 0.5 & 0.5 & 0.6 & 0.6 & 0.3 \\ 0.6 & 0.4 & 0.4 & 0.4 & 0.4 \\ 0.3 & 0.5 & 0.6 & 0.6 & 0.3 \end{pmatrix} \end{matrix}$$

## IV.CONCLUSION

From these indication relations  $R_1$  and  $R_2$  indicate the both disease  $d_1$  and  $d_4$  are suitable diagnostic for patient  $P_3$  and  $P_1$  respectively. Whereas  $R_4$  indicates patient  $P_1$  is having disease  $d_1$  and  $d_4$ . Finally, we may include in our set of diagnostic hypothesis for Patient  $P$  any disease  $d$  such that  $0.5 < \max (R_1 (p,d), R_2 (p,d))$  is satisfied. Yoga study intervention in a predominantly minority population with chronic sciatica (lower back pain) was moderately feasible and its more effective than usual care for reducing pain and medication use.

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