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Investigation of Human Diseases with Their symptoms using Fuzzy Relations

Kamalesh Kr. Lal Karn
Patan Multiple Campus,Lalitpur
Email: kkamalesh349@gmail.com

Abstract-The success of treatment depends on proper diagnosis. In the world of medical diagnosis, they frequently deal with vague or imprecise information. Information available is sometimes vague, sometimes inexact or insufficient. In this paper, diagnostic method is evolved for analyzing human diseases with their traits using max-min composition of Fuzzy relations' technique.

Keywords- Fuzzy Relation, Medical Diagnosis, Max-min composition

1. INTRODUCTION

Fuzzy set theory proposed by Lotfi A Zadeh in 1965, has gained successful application in various fields. The field of medicine is one of the most fruitful and interesting areas of applications of fuzzy set theory. The success of treatment depends on proper diagnosis. Sometimes doctors can not start treatment by only considering the information provided by the patient. In order to deal with such problems, Zadeh suggested application of fuzzy sets in medical science in 1969 and Sanchez proposed method of intutionistic medical diagnosis by using the composite fuzzy relation in 1979. In this paper, we present an application of fuzzy relation with fuzzy max-min composition technique in medical diagnosis.

2. PRELIMINARIES

Some basic definitions:

2.1 Definition: A fuzzy relation R from X to Y which is expressed by the membership function.

$\mu_{R:} X \times Y \rightarrow [0,1]$

when A is fuzzy subset of X, the max-min composition of R with A denoted by R ◦ A which is a fuzzy subset of Y defined as

$\mu_{R\circ A}(Y) = \underset{x\in X}{\vee}[(\mu_A(X) \wedge \mu_R(X,Y))]$

It is also written with V(max) & ^(min) operators,

$\mu_{R\circ A}(Y) = \underset{x\in X}{max}[(\mu_A(X) \wedge \mu_R(X,Y))]$ for all y ∈ Y

Where X and Y are finite set.

2.2 Definition: Let Q be a fuzzy relation from X to Y and be a fuzzy relation from Y to Z. The max-min composition of R with Q representing R∘Q which is a fuzzy relation from X to Z defined by

$\mu_{R\circ Q}(X,Z) = \underset{x\in X}{\overset{V}{}}[(\mu_Q(X,Y) \wedge \mu_R(Y,Z)]$ *where* $y \in Y$

for all (X,Z) in X × Z.

In this we present an application of intutionistic fuzzy set theory in Sanchez's approach for medical diagnosis. Suppose S is the set of symptoms, D is the set of diseases and P is the set of patients.

3. MEDICAL DIAGONSIS

Fuzzy medical diagnosis involves:

1. Determination of symptoms,
2. Formulation of medical knowledge based on Fuzzy Relation
3. Determination of diagnosis on the basis of composition of fuzzy relation.

Fuzzy Relation R is from S to D and fuzzy relation Q from P to S. The composition T of fuzzy relation R and Q**.**

3.1 Algorithm

a) Compute T = R∘Q
b) Find min$\{\mu_A(s_i), \mu_R(s_i, d)\}$
c) Find maxim in $\{\mu_A(s_i), \mu_R(s_i, d)\}$, then, we conclude that the patients P_i is suffering from disease d_j where j = 1, 2, 3, 4, 5.

4. CASE STUDY

Let S be the set of common symptoms
S={s_1, s_2, s_3, s_4, s_5 }
S_1 = Temperature; S_2 = Headache; S_3 = Stomach pain; s_4 = cough; S_5 = chest pain
And, D be the set of diseases
D= {d_1, d_2, d_3, d_4, d_5 }
d_1 = Viral fever; d_2 = Dengue; d_3 = Typhoid; d_4 = stomach problem; d_5 = Chest Problem.
Let A be the fuzzy set of S related to patients grading membership in A as follows.

S_1	S_2	S_3	S_4	S_4
0.8	0.6	0.2	0.6	0.1

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By annual report of **Department of health services (DoHs) for fiscal year 2071/72(B.S.) in Nepal**, we arrive at following fuzzy relation R from S to D which can be represented by:

	d_1	**d_2**	**d_3**	**d_4**	**d_5**
S_1	0.4	0.7	0.3	0.1	0.1
S_2	0.3	0.2	0.6	0.2	0
S_3	0.1	0	0.2	0.8	0.2
S_4	0.4	0.7	0.2	0.2	0.2
S_5	0.1	0.1	0.1	0.2	0.8

The maximum-minimum composition R∘A of D expressed by its membership function

First fix d = d_i & vary S
$\mu_A(S_1) \wedge \mu_R(S_1, d_1) = 0.8 \wedge 0.4 = 0.4$
$\mu_A(S_2) \wedge \mu_R(S_2, d_1) = 0.6 \wedge 0.3 = 0.3$
$\mu_A(S_3) \wedge \mu_R(S_3, d_1) = 0.2 \wedge 0.1 = 0.1$
$\mu_A(S_4) \wedge \mu_R(S_4, d_1) = 0.6 \wedge 0.4 = 0.4$
$\mu_A(S_5) \wedge \mu_R(S_5, d_1) = 0.1 \wedge 0.1 = 0.1$
Maximum of all these terms and obtained the value of relation $\mu_{R\circ A}$,(S, d) = 0.4 Similarly, other results are determined.

d_1	**d_2**	**d_3**	**d_4**	**d_5**
0.4	0.7	0.6	0.2	0.2

We observe that high level in d_2 and d_3 so, many people are affected from dengue or Typhoid.
Let P = {p_1, p_2, p_3, p_4} set of people
The grades of membership of P are as follows:

	S_1	**S_2**	**S_3**	**S_4**	**S_5**
P_1	0.8	0.6	0.2	0.6	0.1
P_2	0	0.4	0.6	0.1	0.1
P_3	0.8	0.8	0	0.2	0
P_4	0.6	0.5	0.3	0.7	0.3

The Fuzzy Relation R from S to D and Q from P to S are known to determine T = R∘Q by

$$\mu_T(P, D) = \max_{s \in S} [(\mu_Q(P, S) \wedge \mu_R(S, D))], (P, D) \in P \times D$$

Fix p_1 ,d_1, vary s
$\mu_Q(p_1, s_1) \wedge \mu_R(s_1, d_1) = 0.8 \wedge 0.4 = 0.4$
$\mu_Q(p_1, s_2) \wedge \mu_R(s_2, d_1) = 0.6 \wedge 0.3 = 0.3$
$\mu_Q(p_1, s_3) \wedge \mu_R(s_3, d_1) = 0.2 \wedge 0.1 = 0.1$
$\mu_Q(p_1, s_4) \wedge \mu_R(s_4, d_1) = 0.6 \wedge 0.4 = 0.4$
$\mu_Q(p_1, s_5) \wedge \mu_R(s_5, d_1) = 0.1 \wedge 0.1 = 0.1$

The maximum of all theses terms = 0.4 and, similarly, we can determine by similar manner. Thus, the grade of membership for all pairs and T= R∘Q. The table is as follows:

	d_1	**d_2**	**d_3**	**d_4**	**d_5**
P_1	0.4	**0.7**	0.6	0.2	0.2
P_2	0.3	0.2	0.4	**0.6**	0.2
P_3	0.4	**0.7**	0.6	0.2	0.2
P_4	0.4	**0.7**	0.5	0.3	0.3

5. CONCLUSION

The final result of medical diagnosis problem in last table, we see that the maximum value of P_1, P_3, P_4, is 0.7. This concludes that P_1, P_3, P_4 suffer from dengue. The maximum value of P_2 is 0.6 and therefore, P_2 faces stomach problem.

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