International Journal of Mathematics And its Applications
Volume 4, Issue 4 (2016), 323–329. (Special Issue)
ISSN: 2347-1557
Available Online: http://ijmaa.in/

International Journal of Mathematics And its Applications

A Study on the Medical Diagnosis using Hexagonal Intuitionistic Fuzzy Relation

Research Article*

A.Virgin Raj[1] and R.Muthamizhselvan[1]

1 Department of Mathematics, St. Joseph's College of Arts & Science, Manjakuppam, Cuddalore (Tamil Nadu), India.

Abstract: In this paper, we propose Intuitionistic Hexagonal Fuzzy Relation through the well known Sanchezs approach for medical diagnosis using fuzzy max-min composition and score, accuracy function. We extend our approach in application of these Intuitionistic Hexagonal Fuzzy Relation in medical diagnosis decision making method. Finally given a numerical example to verify the proposed approach.

Keywords: Medical Diagnosis, Intuitionistic Hexagonal Fuzzy Relation.

1. Introduction

In this paper, a system for medical diagnosis based on Hexagonal Valued Instuitionistic Fuzzy Relation is proposed. The Intuitionstic Fuzzy Sets [IFSs] were first introduces Atanassov (1986) which is a generalization of the concept of fuzzy set zadeh (1965). Shannon et.al were the first to develop an approach using IFS for decision making in medical diagnosis. In this paper Hexagonal Valued Intuitionistic Fuzzy Relation is used to solve medical diagnosis decision making problem. We study Sanchez's method of medical diagnosis with the notion of HVIFS. Numerical example is provided to illustrate this approaches.

2. Preliminaries

Definition 2.1 (Fuzzy Number)**.** *A fuzzy number A is a fuzzy set on the real line R, must satisfy the following conditions;*

1. *$\mu_A(x_0)$ is piecewise continuous*
2. *There exist at least one $x_0 \in R$ with $\mu_A(x_0) = 1$*
3. *μ_A must be normal and convex.*

Definition 2.2 (Hexagonal fuzzy number [HFN)**.** *A hexagonal fuzzy number [1, 0] $\tilde{A}_H$ is specified by 6-tuples $\tilde{A}_H = (a_1, a_2, a_3, a_4, a_5, a_6)$ where a_1, a_2, a_3, a_4, a_5 and a_6 are real numbers and $a_1 \leq a_2 \leq a_3 \leq a_4 \leq a_5 \leq a_6$ is membership*

* *Proceedings : National Conference on* `Recent Trends in Applied Mathematics` *held on 22 & 23.07.2016, organized by Department of Mathematics, St. Joseph's College of Arts & Science, Manjakuppam, Cuddalore (Tamil Nadu), India.*

function is given below,

$$\mu_{\tilde{A}}(x)=\begin{cases}\frac{1}{2}\left(\frac{x-a_1}{a_2-a_1}\right), & \text{for } a_1\le x\le a_2\\ \frac{1}{2}+\frac{1}{2}\left(\frac{x-a_2}{a_3-a_2}\right), & \text{for } a_2\le x\le a_3\\ 1, & \text{for } a_3\le x\le a_4\\ 1-\frac{1}{2}\left(\frac{x-a_4}{a_5-a_4}\right), & \text{for } a_4\le x\le a_5\\ \frac{1}{2}\left(\frac{a_6-x}{a_6-a_5}\right), & \text{for } a_5\le x\le a_6\\ 0, & \text{otherwise.}\end{cases}$$

Definition 2.3 (Operations on Hexagonal Fuzzy Number)**.** *Let* $A=(a_1,b_1,c_1,d_1,e_1,f_1)$ *and* $B=(a_2,b_2,c_2,d_2,e_2,f_2)$ *be two HFN (Hexagonal Fuzzy Number) then 'min' and 'max' operator for any two HFNs are defined as,*

$$\min(A,B)=(\min(a_1,a_2),\min(b_1,b_2),\min(c_1,c_2),\min(d_1,d_2),\min(e_1,e_2),\min(f_1,f_2))$$
$$\max(A,B)=(\max(a_1,a_2),\max(b_1,b_2),\max(c_1,c_2),\max(d_1,d_2),\max(e_1,e_2),\max(f_1,f_2))$$

Supremum of HFN: Let $A=(x_1,x_2,x_3,x_4,x_5,x_6)$ *be a HFN, then* $\sup(A)$ *is defined as* $\sup(A)=x_6$.

Definition 2.4 (Intuitionstic Fuzzy Number)**.** *An Intuitionstic Fuzzy Set* $\tilde{A}_I$ *is called an Intuitionstic Fuzzy Number if it satisfies the following conditions,*

1. $\tilde{A}_I$ *is normal, (i.e) there exists at least two points* $x_0,\ x_1\in X$ *such that* $\mu_{\tilde{A}}(x_0)=1$ *and* $\nu_{\tilde{A}}(x_0)=1$.
2. $\tilde{A}_I$ *is convex, (i.e) its membership function is fuzzy convex and its non membership function is concave.*
3. *Its membership function is upper semicontinuous and its non membership function is lower semicontinuous and the set* $\tilde{A}_I$ *is bounded.*

Definition 2.5 (Intuitionistic Hexagonal Fuzzy Number)**.** *An Intuitionistic Hexagonal Fuzzy Number of a Intuitionistic Fuzzy Number (IFS) is* $\tilde{A}_I$ *is defined as* $\tilde{A}_{IH}=\{(a_1,b_1,c_1,d_1,e_1,f_1)(a_2,b_2,c_2,d_2,e_2,f_2)\}$ *where all* $(a_1,b_1,c_1,d_1,e_1,f_1)(a_2,b_2,c_2,d_2,e_2,f_2)$ *are real number and its membership function* $\mu_{\tilde{A}_{IH}}(x)$*, non-membership function* $\nu_{\tilde{A}_{IH}}(x)$ *are given by*

$$\mu_{\tilde{A}}(x)=\begin{cases}\frac{1}{2}\left(\frac{x-a_1}{a_2-a_1}\right), & \text{for } a_1\le x\le a_2\\ \frac{1}{2}+\frac{1}{2}\left(\frac{x-a_2}{a_3-a_2}\right), & \text{for } a_2\le x\le a_3\\ 1, & \text{for } a_3\le x\le a_4\\ 1-\frac{1}{2}\left(\frac{x-a_4}{a_5-a_4}\right), & \text{for } a_4\le x\le a_5\\ \frac{1}{2}\left(\frac{a_6-x}{a_6-a_5}\right), & \text{for } a_5\le x\le a_6\\ 0, & \text{otherwise.}\end{cases}$$

$$\nu_{\tilde{A}}(x)=\begin{cases}1-\frac{1}{2}\left(\frac{x-a_1'}{a_2'-a_1'}\right), & \text{for } a_1'\le x\le a_2'\\ \frac{1}{2}\left(\frac{a_3-x}{a_3-a_2'}\right), & \text{for } a_2'\le x\le a_3'\\ 0, & \text{for } a_3\le x\le a_4\\ \frac{1}{2}\left(\frac{x-a_4}{a_5'-a_4}\right), & \text{for } a_4\le x\le a_5'\\ \frac{1}{2}+\frac{1}{2}\left(\frac{x-a_5'}{a_6'-a_5'}\right), & \text{for } a_5'\le x\le a_6'\\ 1, & \text{otherwise.}\end{cases}$$

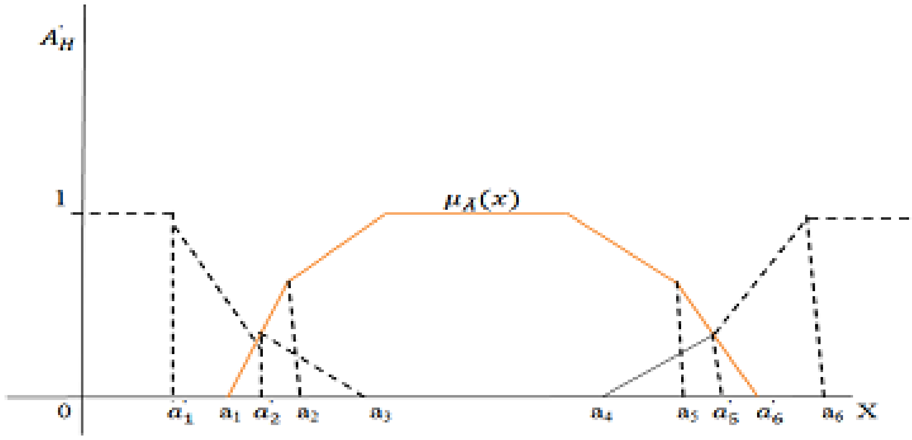

Figure 1. **Graphical representation of Intuitionistic Hexagonal Fuzzy Number (IHFN)**

Definition 2.6 (Score function of an IHFN). *Score function of an Intuitionistic Hexagonal Fuzzy Number* $\tilde{A}_{IH} = \{(a_1, b_1, c_1, d_1, e_1, f_1)(a_2, b_2, c_2, d_2, e_2, f_2)\}$ *is defined as,* $S(\tilde{A}_{IH}) = (a_1 - a_2 + b_1 - b_2 + c_1 - c_2 + d_1 - d_2 + e_1 - e_2 + f_1 - f_2)/6$, *where* $S(\tilde{A}_{IH}) \in [-1, 1]$.

Definition 2.7 (Accuracy Function of an IHFN). *A accuracy function of an Intuitionistic Hexagonal Fuzzy Number* $\tilde{A}_{IH} = \{(a_1, b_1, c_1, d_1, e_1, f_1)(a_2, b_2, c_2, d_2, e_2, f_2)\}$ *is defined as,* $H(\tilde{A}_{IH}) = (a_1 + a_2 + b_1 + b_2 + c_1 + c_2 + d_1 + d_2 + e_1 + e_2 + f_1 + f_2)/6$, *where* $H(\tilde{A}_{IH}) \in [0, 1]$.

The Score function S and the Accuracy function H are respectively, defined as the difference and sum of the membership function $\mu_{\tilde{A}_{IH}}(x)$*, non-membership function* $\mu_{\tilde{A}_{IH}}(x)$.

2.1. Hexagonal Valued Intuitionstic Fuzzy Relation

We defined Hexagonal Valued Intuitionstic Fuzzy Relations and Composition of fuzzy relation

Definition 2.8. *Let X and Y be two sets. A Hexagonal Valued Intuitionstic Fuzzy Relation (HVIFR) R from X to Y is* $_\circ$*a HVIFR of* $X \times Y$ *characterized by the membership function* μ_R *and non-membership function* ν_R *where out put value of* μ_R *and* ν_R *is a Hexagonal fuzzy number. A HVIFR R from X to Y will be denoted by* $R(X \to Y)$.

Definition 2.9. *If A is an HVIFS of X, the Composition of the Hexagonal Valued Intuitionstic Fuzzy Relation* $R(X \to Y)$ *with A is a HVIFS B of Y denoted by* $B = R \circ A$*, and is defined as* $R \circ A(y) = (\mu_{R \circ A}(y), \nu_{R \circ A}(y)) = B(y)$ *where* $\mu_{R \circ A}(y) = \max[\mu_A(x) \ \min \mu_(x, y)]$ *and* $\nu_{R \circ A}(y) = \min[\nu_A(x) \ \max \nu_R(x, y)]$, $y \in Y$.

Definition 2.10. *Let* $V(X \to Y)$ *and* $R(X \to Y)$ *be two HVIFRs. The composition* $R \circ V$ *is the HVIFR from X to Z defined as,* $R \circ V(x, z) = (\mu_{R \circ V}(x, y), \nu_{R \circ V}(y, z))$*, where* $\mu_{R \circ V}(x, z) = \max[\mu_V(x, y) \ \min \mu_R(y, z)]$ *and* $\nu_{R \circ v}(x, z) = \min[\nu_V(x, y) \ \max \nu_R(y, z)]$, $(x, z) \in X \times Z$, $y \in Y$ *and* $z \in Z$.

3. Medical Diagnosis

We present an application of HVIFR in Sanchez's approach for medical diagnosis. Let S be a set of symptoms, D is a set of diseases and P is a set of patients.

Procedure:

Step 1: We define Hexagonal Valued Intuitionstic Fuzzy Relation Q between set of patients P and the set of symptoms S ((i.e) on $P \times S$) which reveals the membership and non-membership between patients and symptoms.

Step 2: We define another Hexagonal Valued Intuitionstic Fuzzy Relation R form the set of symptoms S to the set of diseases D ((i.e) on $S \times D$) which reveals the membership and non-membership between symptoms and diseases.

Step 3: Composition of Hexagonal Valued Intuitionstic Fuzzy Relation to get the HVIFR N $[N = R \circ Q]$ describes the state of patients in terms of the diseases as a HVIFR from P to D.

Step 4: Score and accuracy function is calculated for every of N to medical diagnosis for the patients. Maximum of score value which helps the decision maker to strongly confirm the disease for the patient.

4. Numerical Example

Consider the five patients: P_1 (Murthi), P_2 (Kannan), P_3 (shalini), P_4 (Kala), P_5 (Mathi) and P_6 (suriya). Their symptoms are S_1 (disentry), S_2 (fever), S_3 (vomiting), S_4 (stomach problem) and S_5 (body pain). Let the possible diseases relating to the above symptoms be d_1 (Viral fever), d_2 (Dengue) , d_3 (Malaria) and d_4 (Chiken kuniya).

Step 1: The Hexagonal Valued Intuitionstic Fuzzy Relation (HVIFR) $Q(P \to S)$ is given as in Table 1.

Q	P_1	
S_1	(0.4,0.5,0.55,0.6,0.63,0.65)	(0.2,0.25,0.28,0.3,0.31,0.33)
S_2	(0.7,0.73,0.75,0.78,0.8,0.82)	(0.02,0.05,0.07,0.09,0.1,0.15)
S_3	(0.07,0.9,0.1,0.14,0.18,0.2)	(0.25,0.28,0.3,0.4,0.5,0.6)
S_4	(0.3,0.35,0.4,0.45,0.5,0.55)	(0.17,0.2,0.25,0.3,0.38,0.4)
S_5	(0.09,0.12,0.16,0.18,0.2,0.22)	(0.28,0.32,0.4,0.5,0.6,0.7)
Q	P_2	
S_1	(0.01,0.06,0.08,0.1,0.15,0.18)	(0.3,0.38,0.4,0.45,0.6,0.7)
S_2	(0.17,0.2,0.25,0.3,0.38,0.4)	(0.4,0.45,0.5,0.55,0.58,0.6)
S_3	(0.3,0.35,0.4,0.45,0.5,0.55)	(0.02,0.05,0.07,0.09,0.1,0.15)
S_4	(0.7,0.73,0.75,0.78,0.8,0.82)	(0.01,0.06,0.08,0.1,0.15,0.17)
S_5	(0.2,0.25,0.3,0.33,0.38,0.4)	(0.29,0.31,0.38,0.41,0.46,0.5)
Q	P_3	
S_1	(0.17,0.2,0.25,0.3,0.38,0.4)	(0.4,0.45,0.48,0.5,0.55,0.58)
S_2	(0.7,0.73,0.75,0.78,0.8,0.82)	(0.01,0.06,0.8,0.1,0.15,0.17)
S_3	(0.3,0.35,0.4,0.45,0.5,0.55)	(0.02,0.05,0.07,0.09,0.1,0.15)
S_4	(0.09,0.12,0.16,0.18,0.2,0.22)	(0.28,0.32,0.4,0.5,0.6,0.7)
S_5	(0.4,0.5,0.55,0.6,0.63,0.65)	(0.2,0.25,0.28,0.3,0.31,0.33)
Q	P_4	
S_1	(0.15,0.18,0.2,0.23,0.25,0.28)	(0.28,0.32,0.4,0.5,0.6,0.7)
S_2	(0.01,0.06,0.08,0.1,0.15,0.18)	(0.3,0.38,0.4,0.45,0.6,0.7)
S_3	(0.3,0.35,0.4,0.45,0.5,0.55)	(0.17,0.2,0.25,0.3,0.38,0.4)
S_4	(0.7,0.73,0.75,0.78,0.8,0.82)	(0.01,0.06,0.08,0.1,0.15,0.18)
S_5	(0.13,0.15,0.18,0.2,0.25,0.28)	(0.3,0.35,0.4,0.45,0.5,0.55)
Q	P_5	
S_1	(0.3,0.35,0.4,0.45,0.5,0.55)	(0.09,0.12,0.16,0.18,0.2,0.22)
S_2	(0.01,0.06,0.08,0.1,0.15,0.17)	(0.7,0.73,0.75,0.78,0.8,0.82)
S_3	(0.4,0.5,0.55,0.6,0.63,0.65)	(0.13,0.15,0.18,0.2,0.25,0.28)
S_4	(0.7,0.73,0.75,0.78,0.8,0.82)	(0.03,0.05,0.07,0.08,0.1,0.13)
S_5	(0.2,0.25,0.28,0.3,0.31,0.33)	(0.28,0.33,0.4,0.5,0.6,0.65)
Q	P_6	
S_1	(0.3,0.38,0.4,0.45,0.6,0.7)	(0.13,0.15,0.18,0.2,0.25,0.28)
S_2	(0.01,0.06,0.08,0.1,0.15,0.14)	(0.4,0.45,0.48,0.5,0.55,0.58)
S_3	(0.55,0.58,0.6,0.65,0.68,0.7)	(0.2,0.25,0.25,0.28,0.29,0.3)
S_4	(0.7,0.73,0.75,0.78,0.8,0.82)	(0.03,0.05,0.07,0.08,0.1,0.13)
S_5	(0.4,0.5,0.55,0.6,0.63,0.65)	(0.03,0.05,0.07,0.08,0.1,0.13)

Table 1.

Step 2: HVIFR $R(S \rightarrow D)$ is given as in Table 2

R	d_1	
S_1	(0.29,0.31,0.38,0.41,0.46,0.5)	(0.2,0.25,0.28,0.3,0.31,0.33)
S_2	(0.17,0.2,0.25,0.3,0.38,0.4)	(0.3,0.35,0.4,0.45,0.5,0.55)
S_3	(0.09,0.12,0.16,0.18,0.2,0.22)	(0.3,0.38,0.4,0.45,0.6,0.7)
S_4	(0.4,0.5,0.55,0.6,0.63,0.65)	(0.01,0.06,0.08,0.1,0.15,0.17)
S_5	(0.13,0.15,0.18,0.2,0.25,0.28)	(0.4,0.45,0.5,0.55,0.58,0.6)
R	d_2	
S_1	(0.7,0.73,0.75,0.78,0.8,0.82)	(0.02,0.05,0.07,0.09,0.1,0.15)
S_2	(0.4,0.5,0.55,0.6,0.63,0.65)	(0.02,0.05,0.07,0.09,0.1,0.15)
S_3	(0.01,0.06,0.08,0.1,0.15,0.18)	(0.3,0.38,0.4,0.45,0.6,0.7)
S_4	(0.17,0.2,0.25,0.3,0.38,0.4)	(0.4,0.45,0.48,0.5,0.55,0.58)
S_5	(0.2,0.25,0.3,0.33,0.38,0.4)	(03,0.35,0.4,0.45,0.5,0.55)
R	d_3	
S_1	(0.02,0.05,0.07,0.09,0.1,0.15)	(0.7,0.73,0.75,0.78,0.8,0.82)
S_2	(0.15,0.18,0.2,0.23,0.25,0.28)	(0.4,0.45,0.48,0.5,0.55,0.6)
S_3	(0.3,0.35,0.4,0.45,0.5,0.55)	(0.17,0.2,0.25,0.3,0.38,0.4)
S_4	(0.4,0.5,0.55,0.6,0.63,0.65)	(0.09,0.12,0.16,0.18,0.2,0.22)
S_5	(0.7,0.73,0.75,0.78,0.8,0.82)	(0.02,0.05,0.07,0.09,0.1,0.15)
R	d_4	
S_1	(0.55,0.58,0.6,0.65,0.68,0.7)	(0.03,0.05,0.07,0.08,0.1,0.13)
S_2	(0.4,0.5,0.55,0.6,0.63,0.65)	(0.13,0.15,0.18,0.2,0.25,0.28)
S_3	(0.7,0.73,0.75,0.78,0.8,0.82)	(0.01,0.06,0.08,0.1,0.15,0.17)
S_4	(0.2,0.25,0.28,0.3,0.31,0.33)	(0.4,0.45,0.5,0.55,0.58,0.6)
S_5	(0.02,0.05,0.07,0.09,0.1,0.15)	(0.3,0.35,0.4,0.45,0.5,0.55)

Table 2.

Step 3: The composition $N = R \circ Q$ is as given in Table 3

T	p_1	
d_1	(0.29,0.31,0.38,0.41,0.46,0.5)	(0.17,0.2,0.28,0.3,0.31,0.33)
d_2	(0.4,0.5,0.55,0.6,0.63,0.65)	(0.02,0.05,0.07,0.09,0.1,015)
d_3	(0.3,0.35,0.4,0.45,0.5,0.55)	(0.17,0.2,0.25,0.3,0.38,0.4)
d_4	(0.4,0.5,0.55,0.6,0.63,0.65)	(0.13,0.15,0.18,0.2,0.25,0.28)
T	P_2	
d_1	(0.4,0.5,0.55,0.6,0.63,0.65)	(0.01,0.06,0.08,0.1,0.15,0.17)
d_2	(0.2,0.25,0.3,0.33,0.38,0.4)	(0.3,0.35,0.4,0.45,0.5,0.55)
d_3	(0.4,0.5,0.55,0.6,0.63,0.65)	(0.09,0.12,0.16,0.18,0.2,0.22)
d_4	(0.3,0.35,0.4,0.45,0.5,0.55)	(0.02,0.05,0.07,0.09,0.1,0.15)
T	P_3	
d_1	(0.17,0.2,0.25,0.3,0.38,0.4)	(0.28,0.32,0.4,0.5,0.6,0.7)
d_2	(0.4,0.5,0.55,0.6,0.63,0.65)	(0.02,0.05,0.07,0.09,0.1,0.15)
d_3	(0.4,0.5,0.55,0.6,0.63,0.65)	(0.17,0.2,0.25,0.3,0.38,0.4)
d_4	(0.4,0.5,0.55,0.6,0.63,0.65)	(0.02,0.05,0.07,0.09,0.1,0.15)
T	P_4	
d_1	(0.4,0.5,0.55,0.6,0.63,0.65)	(0.01,0.06,0.08,0.1,0.15,0.17)
d_2	(0.17,0.2,0.25,0.3,0.38,0.4)	(0.28,0.32,0.4,0.45,0.5,055)
d_3	(0.4,0.5,0.55,0.6,0.63,0.65)	(0.09,0.12,0.16,0.18,0.2,0.22)
d_4	(0.3,0.35,0.4,0.45,0.5,0.55)	(0.17,0.2,0.25,0.3,0.38,0.4)
T	P_5	
d_1	(0.4,0.5,0.55,0.6,0.63,0.65)	(0.03,0.05,0.07,0.08,0.1,0.13)
d_2	(0.3,0.35,0.4,0.45,0.5,0.55)	(0.09,0.12,0.16,0.18,0.2,0.22)
d_3	(0.4,0.5,0.55,0.6,0.63,0.65)	(0.09,0.02,0.16,0.18,0.2,0.22)
d_4	(0.4,0.5,0.55,0.6,0.63,0.65)	(0.09,0.02,0.16,0.18,0.2,0.22)

T	P_6	
d_1	(0.4,0.5,0.55,0.6,0.63,0.65)	(0.03,0.05,0.07,0.08,0.1,0.13)
d_2	(0.3,0.38,0.4,0.45,0.6,0.7)	(0.13,0.15,0.18,0.2,0.25,0.28)
d_3	(0.4,0.5,0.55,0.6,0.63,0.65)	(0.09,0.02,0.16,0.18,0.2,0.22)
d_4	(0.4,0.5,0.55,0.6,0.63,0.65)	(0.13,0.15,0.18,0.2,0.25,0.28)

Table 3.

Step 4: We calculate score and accuracy as given in Table 4

	P_1	P_2	P_3
d_1	0.126,0.657	0.46,0.65	-0.183,0.75
d_2	0.475,0.635	-0.115,0.735	0.475,0.635
d_3	0.141,0.708	0.393,0.716	0.283,0.838
d_4	0.356,0.753	0.345,0.505	0.465,0.635

	P_4	P_5	P_6
d_1	0.46,0.65	0.478,0.631	0.478,0.631
d_2	-0.145,0.7	0.28,0.576	0.273,0.67
d_3	0.393,0.716	0.393,0.716	0.393,0.716
d_4	0.141,0.708	0.393,0.716	0.365,0.753

Table 4.

From table 4, the score values it is shows that the patient P_1 (Murthi) and P_3 (Shalini) are suffer from diseases d_2 (Dengue), P_2 (Kannan), P_4 (Kala), P_5 (Mathi) and P_6 (Suriya) suffer from d_1 (Viral fever).

5. Conclusion

The procedures are determinating by using Pentagonal Valued Intuitionstic Fuzzy Relation for medical problems. The result of the numerical example for verify to given the best diagnostic conclusions. Hence Sanchez's approach for medical diagnosis has been made with a generalized notion. And then we apply the score and accuracy function to order Pentagonal Valued Intuitionstic Fuzzy Numbers and its application has been used in may different approaches to model of medical diagnosis process.

References

[1] T.Pathinathan and K.Ponnivalavan, *Reverse order triangular, trapezoidal and pentagonal fuzzy numbers*, Annals of pure and applied mathematics, 9(1)(2015), 107-117.

[2] R.Irene Hepzibah and R.Vidhya, *Modified New Operations For Interval Valued Intuitionistic Fuzzy Number (IVIFNS) Linear Programming Problem with Hexagonal Intuitionistic Fuzzy Numbers*, International journal of Pure and Applied Mathematics, 106(2016), 97-106.

[3] K.Ponnivalavan and T.Pathinathan, *Intuitionistic Pentagonal Fuzzy Number*, ARPN Journal of Engineering and Applied Sciences, 10(12)(2015).

[4] Martin gavalec, *The general trapezoidal algorithm for strongly regular max-min matrics*, Linear Algebra and its Application, 369(2003), 319-338.

[5] A.Edward Samuel and M.Balamurugan, *Application of intuitionistic fuzzy sets in medical diagnosis*, Proceeding of the international conference on mathematical modeling and applied soft computing, 1(2012), 189-194.

[6] A.R.Meenakshi, *Fuzzy Matrix theory and applications*, MJP publishers, (2008).

[7] Ismat Beg and Tabasam Rashid, *A System for medical diagnosis based on Intuitionistic fuzzy relation*, Notes on Intuitionistic Fuzzy Sets, 21(3)(2015), 80-89.

[8] R.Bellman and L.A.Zadeh, *Decision Making in a fuzzy environment*, Management Science, 17(1970), B144-B164.

[9] A.O.Esogbue and R.C.Elder, *Fuzzy diagnosis decision models*, Fuzzy sets and systems, 3(1980), 1-9.

[10] A.R.Meenakshi and M.Kaliraja, *An Application of interval valued fuzzy matrices on medical diagnosis*, International Journal of Mathematical Analysis, 5(36)(2011), 1791-1802.