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A study on application in selecting a school using Fuzzy matrices and Hungarian method

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Abstract **This paper focuses its attention on fuzzy matrices combined with Hungarian method. In this paper, a new method is proposed to find the fuzzy optimal solution of fuzzy matrix problem. For the application of proposed approach, school situation in Tamil Nadu is studied and a problem is solved.**

***Keywords* —Fuzzy matrices, Hungarian method, Max-min composition, Maximum product composition.**

I. INTRODUCTION

Most of our real life problems often involve data which are not necessarily crisp, precise and deterministic in character due to various uncertainties associated with these problems. Usually these uncertainties are handled with the help of topics like probability, fuzzy sets, intuitionistic fuzzy sets, interval mathematics and rough sets etc. De et.al (2001) studied the Sanchez's approach for medical diagnosis and extended this concept with the notion of intuitionistic fuzzy set theory which is a generalization of fuzzy set theory. Chetia and Das (2010) extended Sanchez's approach for medical diagnosis by considering the set of patients with symptoms using interval-valued soft sets. Meenakshi and Kaliraja (2011) extended Sanchez's approach for medical diagnosis using an interval valued fuzzy matrix and an interval matrix. They introduced arithmetic mean of an interval valued fuzzy matrix and proposed a method through the arithmetic mean of an interval to study Sanchez's approach of medical diagnosis. Samuel and Balamurugan (2012) proposed fuzzy max–min composition to study the Sanchez's approach for medical diagnosis and with the notion of intuitionistic fuzzy sets. Banu (2013) developed Sanchez's approach using incline matrix for medical diagnosis technique and exhibited the technique with a hypothetical case study. Praveen Prakash (2014) surveyed the utilization of the max-min composition of binary fuzzy relations in analyzing the possible health issues.

Venkatesan (2017) used the ranking order to deal with the vagueness in imprecise determination of preference. Geetha and Usha (2017) applied Circulant fuzzy matrix in Sanchez's approach for medical diagnosis. Beaula and Mallika (2017) defined fuzzy matrices and developed an algorithm for medical diagnosis. In this paper, a new algorithm is proposed using Sanchez's method of medical diagnosis as a base. With the help of proposed algorithm, an application of a school situation is demonstrated and solved. The paper is organized as follows: Following the introduction, section 2 gives an overview of basic definitions on fuzzy sets and fuzzy matrices. In section 3, we have developed an algorithm using Sanchez's approach for medical diagnosis; also an application is demonstrated and solved. The conclusion is included in section 4.

II. PRELIMINARIES

In this section, we present some of the basic definitions of fuzzy matrices and their composite functions.

Definition 2.1. (Fuzzy matrix): An $m \times n$ matrix $A = (a_{ij})$ whose components are unit interval $[0,1]$ is called a fuzzy matrix.

Definition 2.2. (Fuzzy relations): A fuzzy relation Q in $U_1 \times U_2 \times \ldots \times U_n$ is defined as

$\{(u_1 \times u_2 \times \ldots \times u_n), \mu_Q(u_1 \times u_2 \times \ldots \times u_n) | (u_1 \times u_2 \times \ldots \times u_n) \epsilon\, U_1 \times U_2 \times \ldots \times U_n\}$

where $\mu_Q : (u_1 \times u_2 \times \ldots \times u_n) \to [0,1]$.

*Definition 2.3. (Fuzzy complement):*Let $A = (a_{ij})$be a fuzzy matrix of order $m \times n$ then the complement of A is denoted by, $A^c = (c_{ij})$ where $c_{ij} = 1 - a_{ij}$ for all i and j.

Definition 2.4.(Max-Min composition): Let R be a fuzzy relation in $X \times Y$ and S be a fuzzy relation in $Y \times Z$. The max-min composition of R and S is a fuzzy relation in $X \times Z$,such that, $RoS = Max\{\min\{\mu_R(x,y), \mu_S(y,z)\}\}/(X,Z)$.

Definition 2.5. (Maximum product composition): Let R be a fuzzy relation in $X \times Y$ and S be a fuzzy relation in $Y \times Z$.

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The maximum product composition of R and S denoted by RoS is a fuzzy relation in $X \times Z$, such that, $RoS = Max\{\mu_R(x,y).\mu_s(y,z)\}/(X,Z)$

III. PROPOSED ALGORITHM

In this section, we elaborated a decision making method using fuzzy composite matrix discussed by Samuel and Balamurugan (2012) and the detailed procedure is as follows:

Step 1. Input the fuzzy matrix value of criteria over alternative-1 and denote it as A.
Step 2. Input the fuzzy matrix value of alternative-2 over criteria and denote it as B.
Step 3. Compute the complement of both matrices A and B. Let it be A^c and B^c.
Step 4. Compute the relational matrix under the maximum product composition ($\circ$).

$$C = A \circ B \,,\, D = A^c \circ B^c$$

Step 5. Compute $W = C - D$ where"–" is the maximum of C and D.
Step 6. Use Hungarian method on W-matrix and this gives the solution of the problem.

3.1 An application of the proposed method

Let us consider a set,

$S = \{S_1 = CBSE,\ S_2 = State\ board,\ S_3 = International\}$

$C = \{C_1 = Intelligence,\ C_2 = Memory, C_3 = Knowledge\}$

$F = \{F_1 = Medical\ colleges, F_2 = Engineering\ colleges,$
$F_3 = Arts\ and\ science\ colleges\}$.

Step 1. Defining the fuzzy matrix value of capacities (criteria) over schools (alternative -1)

$$i.e., \quad A = \begin{array}{c c} & \begin{array}{ccc} S_1 & S_2 & S_3 \end{array} \\ \begin{array}{c} C_1 \\ C_2 \\ C_3 \end{array} & \begin{bmatrix} 0.8 & 0.5 & 0.9 \\ 0.5 & 0.8 & 0.6 \\ 0.9 & 0.5 & 0.8 \end{bmatrix} \end{array}$$

*Step 2.*Creating fuzzy matrix for college (alternative-2) over capacities (criteria).

$$i.e., \quad B = \begin{array}{c c} & \begin{array}{ccc} C_1 & C_2 & C_3 \end{array} \\ \begin{array}{c} F_1 \\ F_2 \\ F_3 \end{array} & \begin{bmatrix} 0.8 & 0.7 & 0.9 \\ 0.9 & 0.5 & 0.7 \\ 0.7 & 0.8 & 0.7 \end{bmatrix} \end{array}$$

Step 3. Finding the complement of both matrices of *step1* and *step2*.

$$i.e., \quad A^c = \begin{array}{c c} & \begin{array}{ccc} S_1 & S_2 & S_3 \end{array} \\ \begin{array}{c} C_1 \\ C_2 \\ C_3 \end{array} & \begin{bmatrix} 0.2 & 0.5 & 0.1 \\ 0.5 & 0.2 & 0.4 \\ 0.1 & 0.5 & 0.2 \end{bmatrix} \end{array} \quad \text{and}$$

$$B^c = \begin{array}{c c} & \begin{array}{ccc} C_1 & C_2 & C_3 \end{array} \\ \begin{array}{c} F_1 \\ F_2 \\ F_3 \end{array} & \begin{bmatrix} 0.2 & 0.3 & 0.1 \\ 0.1 & 0.5 & 0.3 \\ 0.3 & 0.2 & 0.3 \end{bmatrix} \end{array}$$

Step 4. Finding the relational matrix under the composition "$\circ$".

$$i.e., \quad C = A \circ B = \begin{array}{c c} & \begin{array}{ccc} S_1 & S_2 & S_3 \end{array} \\ \begin{array}{c} F_1 \\ F_2 \\ F_3 \end{array} & \begin{bmatrix} 0.64 & 0.72 & 0.72 \\ 0.72 & 0.48 & 0.56 \\ 0.72 & 0.64 & 0.81 \end{bmatrix} \end{array} \quad \text{and}$$

$$D = A^c \circ B^c = \begin{array}{c c} & \begin{array}{ccc} S_1 & S_2 & S_3 \end{array} \\ \begin{array}{c} F_1 \\ F_2 \\ F_3 \end{array} & \begin{bmatrix} 0.05 & 0.25 & 0.15 \\ 0.12 & 0.15 & 0.12 \\ 0.06 & 0.25 & 0.15 \end{bmatrix} \end{array}$$

Step 5. Computing $W = C - D$.

$$W = \begin{array}{c c} & \begin{array}{ccc} S_1 & S_2 & S_3 \end{array} \\ \begin{array}{c} F_1 \\ F_2 \\ F_3 \end{array} & \begin{bmatrix} 0.64 & 0.72 & 0.72 \\ 0.72 & 0.48 & 0.56 \\ 0.72 & 0.64 & 0.81 \end{bmatrix} \end{array}$$

Step 6. Using Hungarian Method for *step 5*, we get $F_1 \rightarrow S_1$, $F_2 \rightarrow S_3$, $F_3 \rightarrow S_2$.

Hence, it is suggested that, one who is willing to go for medicine have to move to CBSE School, for engineering have to choose International school and for arts and science can go to state board.

IV. CONCLUSION

Most of the researchers those who used Sanchez's approach applied max-min composition, but in this paper we used maximum product composition. The algorithm proposed in this paper is simple and effective. By observing our proposed algorithm one can assign the solution instead of ranking it.

Conflict of Interests

The authors have declared that no Conflict of Interest exists.

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