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Fuzzy Assignment problem in Icosikaitetragonal Fuzzy Number

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Abstract

An Assignment problem is very important type of linear programming problem which is used for allocating resources in an optimal way. Assignment problem has various applications in real world. Strategy of fuzzy assignment problem is more appropriate than the conventional assignment problem. An Icosikaitetragonal fuzzy assignment problem is changed into crisp valued problem using ranking method. We have applied Hungarian method to find an optimal solution and illustrated by an example.

Keywords: Fuzzy number, Icosagonal fuzzy number, Fuzzy assignment problem, ranking method, Icosikaitetragonal fuzzy number.

1. Introduction:

Fuzzy set concepts are developed by Zadeh[1]. It was enlarged most and used vast in almost all the fields of engineering and Computational Mathematics. Fuzzy is to deal with inexactness, vagueness in our circumstances. Since the introduction of fuzzy set, noteworthy advances have been made for the development of many methodologies by many researchers. Fuzzy applications are most useful in various decision making problems. Raju and Jayagopal [2] introduced the Icosagonal fuzzy number which has twenty points. Raju and Jayagopal [3] again

has introduced the Icosikaitetragonal fuzzy number. Here we are making use of an Icosikaitetragonal fuzzy number to solve the assignment problem. Assignment problems are largely used in manufacturing and service system. Project management is designed to control organization resources on a given set of activities, within time, cost and quality. Therefore, the limited resources must be used efficiently such that the optimal available resources can be assigned to the most needed tasks so as to maximize and minimize the profit and cost respectively. In this paper, fuzzy assignment problem is transformed into crisp valued problem using ranking technique for Icosikaitetragonal fuzzy number. We have used Hungarian method to find the optimal solution and the examples are given and explained.

2. PRELIMINARIES

In this section, we give the preliminaries that are required for this study.

Definition 2.1. *A fuzzy set A is defined by* $A = \{(x, \mu_A(x)) : x \in A, \mu_A(x) \in [0,1]\}$. *Here* x *is crisp set A and* $\mu_A(x)$ *is membership function in the interval* $[0,1]$.

Definition 2.2. *The fuzzy number A is a fuzzy set whose membership function must satisfy the following conditions.*

(i) A fuzzy set A of the universe of discourse X is convex

(ii) A fuzzy set A of the universe of discourse X is a normal fuzzy set if $x_i \in X$ exists

(iii) $\mu_A(x)$ is piecewise continuous

Definition 2.3*An* α*-cut of fuzzy set A is classical set defined as* ${}^{\alpha}[A] = \{x \in X | \mu_A(x) \geq \alpha\}$

Definition 2.4*A fuzzy set A is a convex fuzzy set iff each of its* α*-cut* ${}^{\alpha}A$ *is a convex set.*

Definition 2.5 Mathematical model of an assignment problem:

The general form of Fuzzy assignment problem is

Minimize $z = \sum_{i=1}^{n}\sum_{j=1}^{n} C_{ij} X_{ij}$

Subject to the constraints $\sum_{j=1}^{n} x_{ij} = 1 \quad for\ i = 1,2,.....n$

$\sum_{i=1}^{n} x_{ij} = 1,\ j = 1,2,3.....n$

$$where \quad x_{ij} = \begin{cases} 1, \text{if the } i^{th} \text{ person is assigned the } j^{th} \text{ job} \\ 0, otherwise \end{cases}$$

Definition 2.6

$$\mu_A(x) = \begin{cases} 0, \ for\ x \prec r_1 \\ k_1\left(\frac{x-r_1}{r_2-r_1}\right), \ for\ r_1 \le x \le r_2 \\ k_1, for\ r_2 \le x \le r_3 \\ k_1 + (k_2 - k_1)\left(\frac{x-r_3}{r_4-r_3}\right), \ for\ r_3 \le x \le r_4 \\ k_2, \ for\ r_4 \le x \le r_5 \\ k_2 + (k_3 - k_2)\left(\frac{x-r_5}{r_6-r_5}\right), \ for\ r_5 \le x \le r_6 \\ k_3, \ r_6 \le x \le r_7 \\ k_3 + (k_4 - k_3)\left(\frac{x-r_7}{r_8-r_7}\right), \ for\ r_7 \le x \le r_8 \\ k_4, \ for\ r_8 \le x \le r_9 \\ k_4 + (1 - k_4)\left(\frac{x-r_9}{r_{10}-r_9}\right), \ for\ r_9 \le x \le r_{10} \\ 1, \ for\ r_{10} \le x \le r_{11} \\ k_4 + (1 - k_4)\left(\frac{r_{12}-x}{r_{12}-r_{11}}\right), \ for\ r_{11} \le x \le r_{12} \\ k_4, \ for \quad r_{12} \le x \le r_{13} \\ k_3 + (k_4 - k_3)\left(\frac{r_{14}-x}{r_{14}-r_{13}}\right), \ for\ r_{13} \le x \le r_{14} \\ k_3, \ for\ r_{14} \le x \le r_{15} \\ k_2 + (k_3 - k_2)\left(\frac{r_{16}-x}{r_{16}-r_{15}}\right), \ for\ r_{15} \le x \le r_{16} \\ k_2, \ for\ r_{16} \le x \le r_{17} \\ k_1 + (k_2 - k_1)\left(\frac{r_{18}-x}{r_{18}-r_{17}}\right), \ for\ r_{17} \le x \le r_{18} \\ k_1, \ for\ r_{18} \le x \le r_{19} \\ k_1\left(\frac{r_{20}-x}{r_{20}-r_{19}}\right), \ for\ r_{19} \le x \le r_{20} \\ 0, for\ x > r_{20} \end{cases}$$

A fuzzy number $A = (a, b, c, d)$, where $a \le b \le c \le d$, is trapezoidal fuzzy number and its membership function is given by

$$\mu_A(x) = \begin{cases} 0, for x < a \\ \frac{x-a}{b-a}, for a \le x \le b \\ 1, for b \le x \le c \\ \frac{d-x}{d-c}, for c \le x \le d \\ 0, x > d \end{cases}$$

3. Icosagonal Fuzzy Number: [2]

A fuzzy number is called as Icosagonal fuzzy number and is denoted by

A = ($r_1, r_2, r_3, r_4, r_5, r_6, r_7, r_8, r_9, r_{10}, \ldots\ldots r_{20}$)

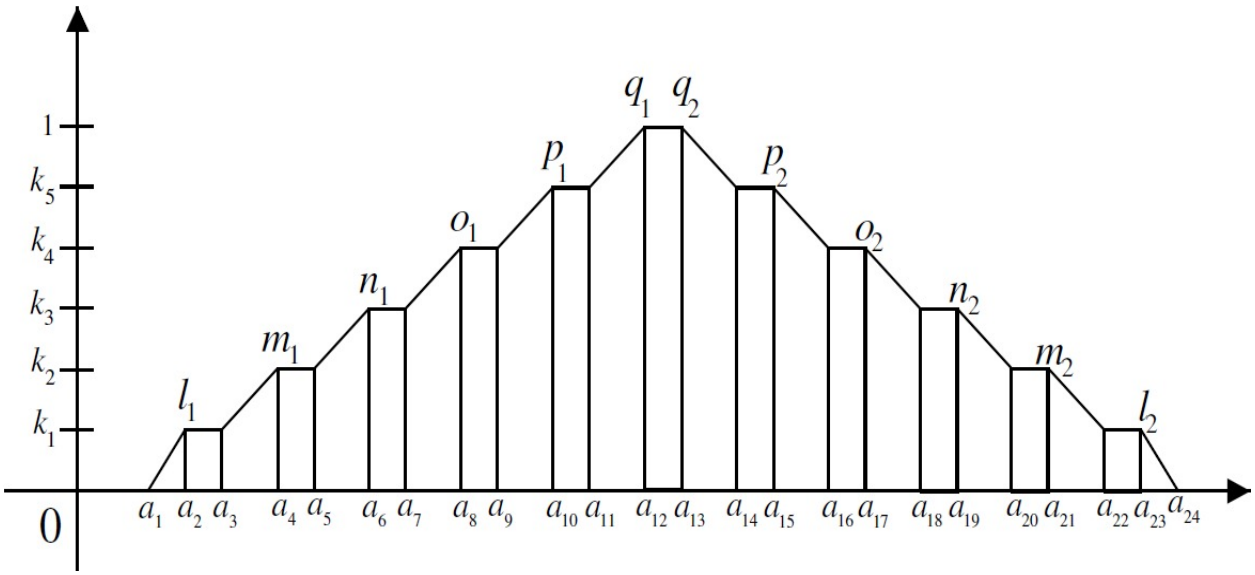
And its membership function is given by

$$where\ \ 0 \le k_1 \le k_2 \le k_3 \le k_4 \le 1$$

Definition : 3.1 [3] A fuzzy number A = $(a_1, a_2, a_3, a_4, a_5, a_6, a_7, a_8, a_9, a_{10}, \ldots\ldots a_{24})$ is Icosikaitetragonal fuzzy number and its membership function is given by

$$\mu_A(x) = \begin{cases} 0, \ for\ x < a_1 \\ k_1\left(\frac{x-a_1}{a_2-a_1}\right), \ for\ a_1 \le x \le a_2 \\ k_1, for\ a_2 \le x \le a_3 \\ k_1 + (k_2 - k_1)\left(\frac{x-a_3}{a_4-a_3}\right), \ for\ a_3 \le x \le a_4 \\ k_2, \ for\, a_4 \le x \le a_5 \\ k_2 + (k_3 - k_2)\left(\frac{x-a_5}{a_6-a_5}\right), \ for\ a_5 \le x \le a_6 \\ k_3, \ a_6 \le x \le a_7 \\ k_3 + (k_4 - k_3)\left(\frac{x-a_7}{a_8-a_7}\right), \ for\ a_7 \le x \le a_{8/} \\ k_4, \ for\ a_8 \le x \le a_9 \\ k_4 + (k_5 - k_4)\left(\frac{x-a_9}{a_{10}-a_9}\right), \ for\ a_9 \le x \le a_{10} \\ k_5, \ for\ a_{10} \le x \le a_{11} \\ k_5 + (1 - k_5)\left(\frac{x-a_{11}}{a_{12}-a_{11}}\right), \ for\ a_{11} \le x \le a_{12} \\ 1, \ for\ a_{12} \le x \le a_{13} \\ k_5 + (1 - k_5)\left(\frac{a_{14}-x}{a_{14}-a_{13}}\right), \ for\ a_{13} \le x \le a_{14} \\ k_5, \ for\ a_{14} \le x \le a_{15} \\ k_4 + (k_5 - k_4)\left(\frac{a_{16}-x}{a_{16}-a_{15}}\right), \ for\ a_{15} \le x \le a_{16} \\ k_4, \ for\ a_{16} \le x \le a_{17} \\ k_3 + (k_4 - k_3)\left(\frac{a_{18}-x}{a_{18}-a_{17}}\right), \ for\ a_{17} \le x \le a_{18} \\ k_3, \ for\ a_{18} \le x \le a_{19} \\ k_2 + (k_3 - k_2)\left(\frac{a_{20}-x}{a_{20}-a_{19}}\right), \ for\ a_{19} \le x \le a_{20} \\ k_2, \ for \quad a_{20} \le x \le a_{21} \\ k_1 + (k_2 - k_1)\left(\frac{a_{22}-x}{a_{22}-a_{21}}\right), \ for\ a_{21} \le x \le a_{22} \\ k_1, \ for\ a_{22} \le x \le a_{23} \\ k_1\left(\frac{a_{24}-x}{a_{24}-a_{23}}\right), \ for\ a_{23} \le x \le a_{24} \\ 0, \ for\ x > a_{24} \end{cases}$$

3.2 Diagram of Icosikaitetragonal fuzzy number:



3.3: Ranking of Icosikaitetragonal fuzzy number:

Let I be a normal Icosikaitetragonal fuzzy number. The value $M(I)$, called as measure of I is calculated as

$$M(I)=\frac{1}{2}\int_{1}^{k_1}(\ell_1+\ell_2)d\ell+\frac{1}{2}\int_{k_1}^{k_2}(m_1+m_2)dm+\int_{k_2}^{k_3}(n_1+n_2)dn+\int_{k3}^{k_4}(o_1+o_2)do+\int_{k4}^{k_5}(p_1+p_2)dp+\int_{k5}^{1}(q_1+q_2)dq$$

where $0\le k_1\le k_2\le k_3\le k_4\le k_5\le 1$

$$M(L)=\frac{1}{4}\left[\begin{array}{l}(a_1+a_2+a_{23}+a_{24})k_1+(a_3+a_4+a_{21}+a_{22})(k_2-k_1)+(a_5+a_6+a_{19}+a_{20})(k_3-k_2)+\\(a_7+a_8+a_{17}+a_{18})(k_4-k_3)+(a_9+a_{10}+a_{15}+a_{16})(k_5-k_4)+(a_{11}+a_{12}+a_{13}+a_{14})(1-k_5)\end{array}\right]$$

where $0\le k_1\le k_2\le k_3\le k_4\le k_5\le 1$

we take the values for $k_1=\frac{1}{6},k_2=\frac{2}{6},k_3=\frac{3}{6},k_4=\frac{4}{6},k_5=\frac{5}{6}$

4. Numerical Examples:

Consider the following 3×3 fuzzy Assignment problem

$$\begin{pmatrix} \begin{pmatrix} -6,-5,-4,-3,-2,-1,0,1,2,3,4,5, \\ 6,7,8,9,10,11,12,13,14,15,16,17 \end{pmatrix} & \begin{pmatrix} -8,-7,-6,-5,-4,-3,-2,-1,0,1, \\ 2,3,4,5,6,7,8,9,10,11,12,13,14,15 \end{pmatrix} & \begin{pmatrix} 1,2,3,4,5,6,7,8,9,10,11,12,13,14, \\ 15,16,17,18,19,20,21,22,23,24 \end{pmatrix} \\ \begin{pmatrix} -6,-5,-4,-3,-2,-1,0,1,2,3,4,5, \\ 6,7,8,9,10,11,12,13,14,15,16,18 \end{pmatrix} & \begin{pmatrix} -4,-3,-2,-1,0,1,2,3,4,5,6,7,8,9, \\ 10,11,12,13,14,15,16,17,18,19 \end{pmatrix} & \begin{pmatrix} 0,1,2,4,5,6,7,8,9,10,11,12,13,14, \\ 16,18,20,22,24,26,27,28,29,30 \end{pmatrix} \\ \begin{pmatrix} 0,1,2,3,4,5,6,7,9,10,11,13,14,15, \\ 17,19,21,22,24,25,26,27,28,29 \end{pmatrix} & \begin{pmatrix} 1,2,3,6,8,9,10,12,13,15,16,17,19,20, \\ 22,23,25,28,30,32,34,35,37,39 \end{pmatrix} & \begin{pmatrix} -5,-4,-3,-2,-1,0,1,2,3,4,5,67, \\ 8,9,10,11,12,13,14,15,16,17,18 \end{pmatrix} \end{pmatrix}$$

Step 1:

We obtain the values of $\mu_{ICOSIKTETRA}(a_{ij})$ of the given fuzzy assignment problem and convert the fuzzy assignment problem into crisp valued problem which is shown in the given table.

a_{11}	−6,−5,−4,−3,−2,−1,0,1,2,3,4,5, 6,7,8,9,10,11,12,13,14,15,16,17	$\mu_R(a_{11}) = 5.5$
a_{12}	−8,−7,−6,−5,−4,−3,−2,−1,0,1, 2,3,4,5,6,7,8,9,10,11,12,13,14,15	$\mu_R(a_{12}) = 3.5$
a_{13}	1,2,3,4,5,6,7,8,9,10,11,12,13,14, 15,16,17,18,19,20,21,22,23,24	$\mu_R(a_{13}) = 12.5$
a_{21}	−6,−5,−4,−3,−2,−1,0,1,2,3,4,5, 6,7,8,9,10,11,12,13,14,15,16,18	$\mu_R(a_{21}) = 5.54$
a_{22}	−4,−3,−2,−1,0,1,2,3,4,5,6,7,8,9, 10,11,12,13,14,15,16,17,18,19	$\mu_R(a_{22}) = 7.5$
a_{23}	0,1,2,4,5,6,7,8,9,10,11,12,13,14, 16,18,20,22,24,26,27,28,29,30	$\mu_R(a_{23}) = 14.3$
a_{31}	0,1,2,3,4,5,6,7,9,10,11,13,14,15, 17,19,21,22,24,25,26,27,28,29	$\mu_R(a_{31}) = 14.25$
a_{32}	1,2,3,6,8,9,10,12,13,15,16,17,19, 20,22,23,25,28,30,32,34,35,37,39	$\mu_R(a_{32}) = 19$
a_{33}	−5,−4,−3,−2,−1,0,1,2,3,4,5,6 7,8,9,10,11,12,13,14,15,16,17,18	$\mu_R(a_{33}) = 6.5$

After ranking method, we have

$$\begin{bmatrix} 5.5 & 3.5 & 12.5 \\ 5.54 & 7.5 & 14..3 \\ 14.25 & 19 & 6.5 \end{bmatrix}$$

Row wise Subtraction

$$\begin{bmatrix} 2 & 0 & 9 \\ 0 & 1.96 & 8.76 \\ 7.75 & 12.5 & 0 \end{bmatrix}$$

The Assignment cost = 5.54+3.5+6.5 = 15.54

5. Conclusion

In this paper, an Icosikaitetragonal fuzzy number has been used for decision the explication of fuzzy assignment problem using ranking method and transforming fuzzy assignment problem into crisp valued problem. We applied Hungarian method to find the optimal solution for the fuzzy assignment problem and illustrated by a numerical example.

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