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Computation the Optimal Solution of Octagonal Fuzzy Numbers

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ABSTRACT

In this work, we suggested a novel algorithm to computation the optimal Solution for the fuzzy octagonal fractional programming problems (FOFPP) were transformed to crisp value (CV), through the ranking function (RF), and then solved a crisp value by graphical method. Finally, numerical examples are presented to display the efficacy of the computational procedure.

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Introduction:

Many research have proposed new methods of solving various fuzzy numbers (FN) with fractional programming problems (FPP) [10,28,16,1,21,17,22,23].One of the most important ordering functions in decision making, optimization, and prediction of fuzzy number (FN) ordering function, Several other works have used the fuzzy number ordering function approach to solve it [5,18,4,19].
Several studies have suggested many algorithms to find the optimal solution for octagonal fuzzy numbers (OFN) [8, 25, 13]. Authors used the octagonal fuzzy numbers (OFN) have implemented many ranking methods [15, 3, 6]. Some approaches to the optimal solution are octagonal fuzzy numbers (OFN) with a transportation problem ranking function (RF) [12, 2, 20].
the FFPP has been studied through the use of many types of fuzzy numbers, but in this paper we will study FFPP via the use of octagonal fuzzy numbers (OFN) as well as the rank function used previously

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[24,27] to determine the critical path in the fuzzy project network and fuzzy game theory with pure strategies by maximin-minimax.

This paper is attention as follows, In Section 2, the Knowledge of octagonal fuzzy numbers (OFN) is recalled with introduces the ranking of octagonal fuzzy numbers (ROFN). In Section 3, explain the mathematically formulated of Fractional Programming Problem (FPP) in Section 4,Concluding the method to convert fractional programming (FP) to crisp programming (CP) in Section 5, we give the algorithm to solve OFFP problems in Section 6.The numerical examples in Section 7. finally, Conclusion.

1- Basic Definitions [7,14, 27,24] :

Some fundamental concepts that this paper will introduce

Definition 2.1: Octagonal Fuzzy Numbers [OFN]: A Fuzzy Number (FN) $\ddot{A}_o = (\, a_1, a_2, a_3, a_4, a_5, a_6, a_7\,, a_8)$ in R is said to be a **OFN** its membership function as following:

$$\mu\ddot{A}_o(j) = \begin{cases} 0 & for \quad j < a_1 \\ k\left(\dfrac{j - a_1}{a_2 - a_1}\right) & for \quad a_1 \le j \le a_2 \\ k & for \quad a_2 \le j \le a_3 \\ k + (1-k)\left(\dfrac{j - a_3}{a_4 - a_3}\right) & for \quad a_3 \le j \le a_4 \\ 1 & for \quad a_4 \le j \le a_5 \\ k + (1-k)\left(\dfrac{a_6 - j}{a_6 - a_5}\right) & for \quad a_5 \le j \le a_6 \\ k & for \quad a_6 \le j \le a_7 \\ k\left(\dfrac{a_8 - j}{a_8 - a_7}\right) & for \quad a_7 \le j \le a_8 \\ 0 & for \quad j > a_8 \end{cases}$$

Where $0 < k < 1$.

Definition 2.2: Ranking of octagonal fuzzy numbers (ROFN): Let $\ddot{A}_o$ be **OFN**. The value $M_o^{oc}(\ddot{A}_o)$ called the measure of $\ddot{A}_o$ which computed as bellow:

$$M_o^{oc}(\ddot{A}_o) = \frac{1}{2}\int_{\varrho}^{k}(\dot{\rho}_1(r) + \dot{\rho}_2(r))\,dr + \frac{1}{2}\int_{k}^{w}(\acute{s}_1(t) + \acute{s}_2(t))\,dt \quad where\ 0 \le k \le 1$$

$$= \frac{1}{4}[(a_1 + a_2 + a_7 + a_8)\,k + (a_3 + a_4 + a_5 + a_6)(1 - k)] \; where\ 0 \le k \le 1 \quad .... (1)$$

2- Fractional Programming Problem (FPP) [9]:

The problem with LFP can be mathematically formulated as follows:

$$Maximize\ \dot{F}(j) = \frac{c^t\ j+\alpha}{d^t j+\beta}$$

Subject to the constraints

$A\,J \leq \underline{b}$

$J \geq 0$

Where j $J(\epsilon R^n)$, A is (m*n) matrix R^{n*m} , also c^t, d^t are n-vectors, $\underline{b}$$R^m$ α, β are scalar.

3- The Method to Convert Fractional Programming Problem(FPP) to Crisp Programming (CP) [11,26] :

Proposed [11, 26] transformation method FP to formulation CP as below:

$Max\ z(x) = e^t\ n + v$

$Subject\ to\ Qn \leq u$

$n \geq 0$

Where, $e^t = (c^t - d^t * \frac{\alpha}{\beta})$, $n = \frac{x}{d^t x+\beta}$, $v = \frac{\alpha}{\beta}$, $Q = \left(A + d^t * \frac{b}{\beta}\right)$, $u = \left(\frac{b}{\beta}\right)$

Where $(*)$ is multiplication, α, β, c are scalar.

4- The Algorithm to Solve Octagonal Fuzzy Fractional Programming Problems(OFFPP):

In this work, by using the ranking function, we suggested a new approach for solving OFFP problems. The approach proposed must work as follows:

Step1: The mathematically formulated OFFP problem.

Step2: By using the ranking of octagonal fuzzy numbers (ROFN) in eq.1, we convert OFFP to FPP.

Step3: Applying the previous method convert FPP to CPP.

Step4: In order to get the optimal solution, we solve the problem with CPP by graphic method**.**

6. Numerical Examples:

Suppose the following OFFP problem and solve it by the method proposed:

Example 1: $Max\ Z\ = \dfrac{(4,5,6,7,8,9,10,11)\, j_1 + (2,3,4,5,6,7,8,9)\, j_2}{(4,5,6,7,8,9,10,11)\, j_1 + (1,2,3,4,5,6,7,8)\, j_2 + (0,1,2,3,4,5,6,7)}$

Subject to

$5\, j_1 + 7\, j_2\ \leq 17$

$7\, j_1 + 4\, j_2\ \ \leq 12$

$j_1\ ,\ \ j_2 \geq 0.$

Now by using the (ROFN) in eq. 1 can be converting to FPP.

$R(\acute{Å}) = \frac{1}{4}\left[(\not{a}_1\ +\ \not{a}_2\ +\ \not{a}_7\ +\ \not{a}_8)\,\acute{k}\ +\ (\not{a}_3\ +\ \not{a}_4\ +\ \not{a}_5\ +\ \not{a}_6)(1\ -\ \acute{k})\right]$

Where ḱ =0.5.

$$Max\ z(j) = \frac{7.5\, j_1\ + 5.5\, j_2}{7.5\, j_1\ +\ 4.5\, j_2 + 3.5}$$

Subject to

$5\, j_1 + 7 j_2\ \leq 17$

$7 j_1 + 4\, j_2\ \ \leq 12$

$j_1\ ,\ \ j_2 \geq 0.$

Use the previous method of conversion FPP to CPP.

$Max\ z\ (j) = 7.5\, j_1\ + 5.5\, j_2$

Subject to

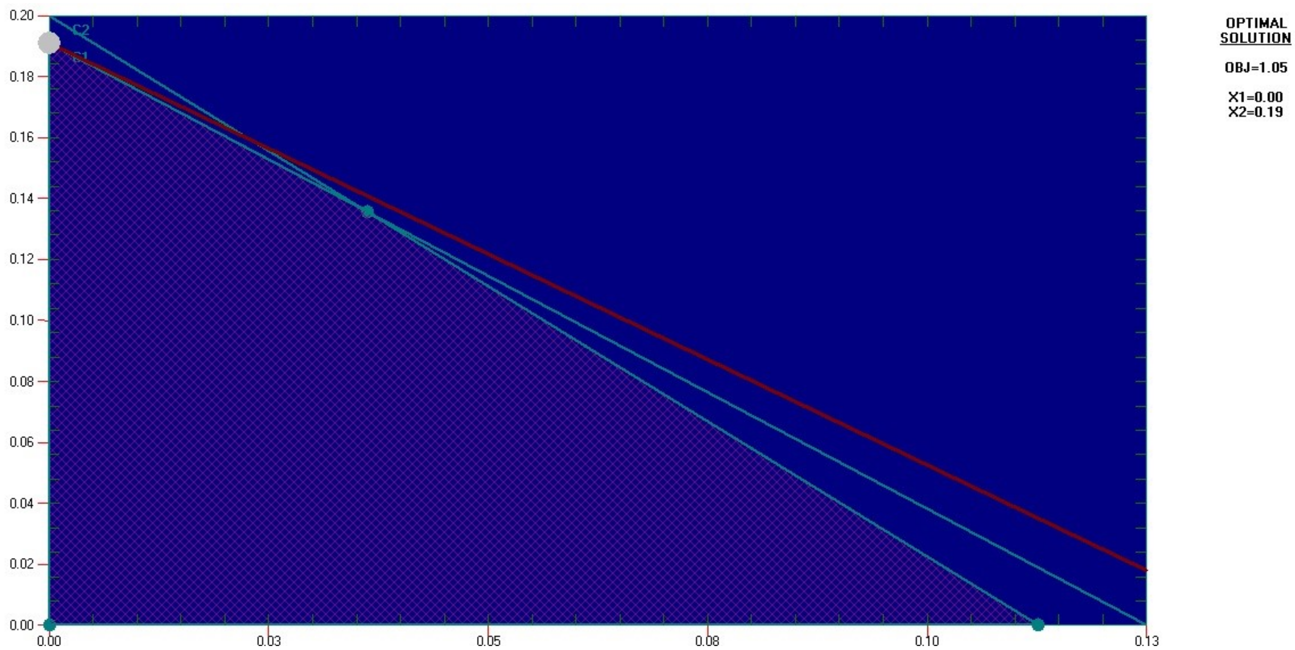
$44.6667\, j_1 + 29.6667\, j_2\ \leq 5.6667$

$35\, j_1 + 20\, j_2\ \ \leq 4$

$j_1\ ,\ \ j_2 \geq 0.$

solve the problem by graphical method to get the optimal solution:

$j_1\ = 0\ ,\ j_2\ = 0.19\ ,\ Max\ \ z\,(j) =\ 1.05.$



Example 2: $Max\ Z\ =\ \dfrac{(8,9,10,11,12,13,14,15)\ j_1\ +(4,5,6,7,8,9,10,11)\ j_2}{(8,9,10,11,12,13,14,15)\ j_1\ +(2,3,4,5,6,7,8,9)\ j_2+\ (0,1,2,3,4,5,6,7)}$

Subject to

$6\ j_1 + 10\ j_2\ \leq 30$

$10\ j_1 + 4\ j_2\ \ \leq 20$

$j_1\ ,\ \ j_2 \geq 0.$

Now by using the (ROFN) in eq. 1 can be converting to FPP.

$$R(\acute{\mathring{A}})\ =\ \frac{1}{4}[(a_1\ +\ a_2\ +\ a_7\ +\ a_8)\ \acute{k}\ +\ (a_3\ +\ a_4\ +\ a_5\ +\ a_6)(1\ -\ \acute{k})]$$

Where $\acute{k}$ =0.5.

$$Max\ z(j) =\ \frac{11.5\ j_1\ + 7.5\ j_2}{11.5\ j_1\ +\ 5.5\ j_2 + 3.5}$$

Subject to

$6\ j_1 + 10\ j_2\ \leq 30$

$10\ j_1 + 4\ j_2\ \ \leq 20$

$j_1\ ,\ \ j_2 \geq 0.$

Use the previous method of conversion FPP to CPP.

$Max\ z\ (j) = 11.5\, j_1\ + 7.5\, j_2$

Subject to

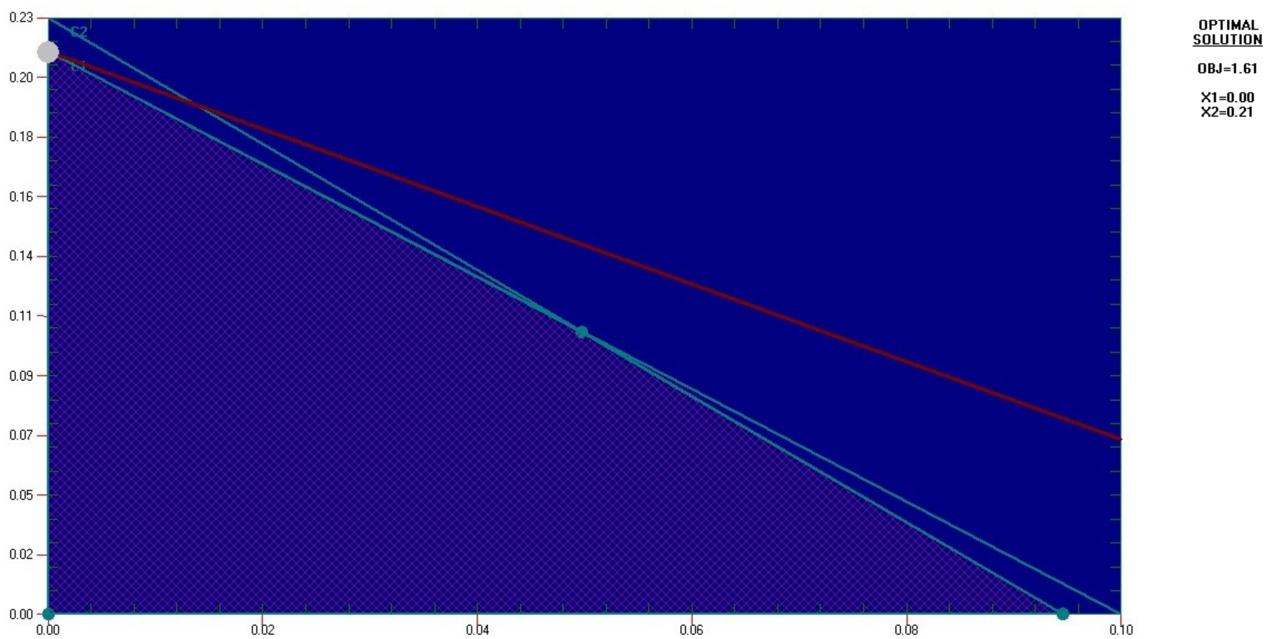
$156\, j_1 + 70\, j_2\ \leq 15$

$110\, j_1 + 44\, j_2\ \ \leq 10$

$j_1\ ,\ \ j_2 \geq 0.$

solve the problem by graphical method to get the optimal solution:

$j_1\ = 0\ ,\ j_2\ = 0.21,\ \ Max\ \ z\,(j) =\ 1.60.$



6. Conclusion:

A new technique is suggested to find the crisp optimal solution of the FP problem with octagonal fuzzy numbers (OFN) the OFFP problem is translated into FP problem by ranking function, then FP can be converted to CPP and solved. To evaluate the proposed model, numerical examples were given. The technique is beneficial in Actual world problems where the product is inaccurate.

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