Solving fuzzy transportation problem using defuzzification methods

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Abstract:

The fuzzy transportation problem is one of the most effective concepts for finding the optimal cost for transporting the required demand and supply. For decision-makers, there will be difficulty in multiple possibilities and outcomes for transporting goods and services. So, the fuzzy methods made it easier to overcome this issue by solving fuzzy transportation problems using defuzzification methods. In this research article, we solve the fuzzy transportation problem by using defuzzification methods, namely, centroid, mean of maximum,$\alpha -$ cut, center of area, weighted average, signed distance, maximum membership principle, and center of sums, and compare the results.

Keywords: Centroid, Defuzzification, Fuzzification, Crisp value, Fuzzy transportation problem (FTP),

Introduction:

The transportation problem is one of the types of linear programming problems, and it is used to find the best optimal solution for transportation goods and services. But in some situations, the required goods are not known accurately, so it causes major trouble for decision-makers. For this problem, we use fuzzy methods to solve and rectify this kind of situation. So fuzzy transportation problems are solved by defuzzification methods. The defuzzification methods are, namely, centroid, mean of maximum, $\alpha -$ cut, center of area, weighted average, signed distance, maximum membership principle, and center of sums, and compare the results with the existing method's results.

Defuzzification:

Defuzzification is the process of converting fuzzy value into crisp value. And in this research article we solve fuzzy transportation problem by following defuzzification methods.

Centroid Method:

If we take $F = (F_1, F_2, F_3)$ as a triangular fuzzy number, then the centroid of F will be

$$\frac{\sum_{i=1}^{3} F_i}{3}$$

Mean of Maximum (MOM) Method:

In this method, we take the middle value from the triangular fuzzy number that is taking F_2 value.

$$F_{MOM} = F_2$$

$\alpha -$ Cut Method:

For the$\alpha -$ Cut Method we sum the first and last parameter and divide by 2, that is

$$F_{\alpha - \text{Cut}} = \frac{F_1 + F_3}{2}$$

Center of Area (COA) Method:

For the center of area method, the defuzzified value will be

$$F_{COA} = \frac{1}{2}\left(\frac{F_1 + F_2}{2} + \frac{F_2 + F_3}{2}\right)$$

Weighted Average Method:

For the weighted average method, the defuzzified value will be

$$F_{WA} = \frac{F_1 + 4F_2 + F_3}{6}$$

Signed Distance Method & Max Membership principle:

Signed distance method and Max membership principle: these two methods are similar to the Mean of Maximum method so that,

$$F_{SD} = F_2 \& F_{MM} = F_2$$

Center of Sums:

The Center of Sums method is similar to $\alpha -$ Cut method, so that

$$F_{CS} = \frac{F_1 + F_3}{2}$$

Numerical example:

Solve this fuzzy transportation problem with all existing defuzzification methods.

Table.1 Fuzzy transportation problem

Destinations / Sources	D1	D2	D3	D4	Supply
S1	[9 9 16]	[1 10 19]	[7 7 13]	[1 3 13]	100
S2	[7 12 16]	[1 5 9]	[3 3 10]	[1 7 9]	75
S3	[10 13 20]	[4 7 14]	[5 5 15]	[2 2 3]	50
S4	[6 16 22]	[8 18 22]	[5 11 14]	[7 10 14]	75
Demand	70	80	120	30	300

Table 1 represents the fuzzy transportation problem; here cost values are given as triangular fuzzy numbers and demand and supply are taken as crisp values.

Table.2 Solving fuzzy transportation problems with all existing defuzzification methods.

Methods / Fuzzy numbers	Centroid Method	Mean of Maximum (MOM) Method	$\alpha -$ Cut Method	Center of Area (COA) Method	Weighted Average Method	Signed Distance Method	Max Membership Principle	Center of Sums
[9 9 16]	11.3	9	12.5	10.75	10.17	9	9	12.5
[1 10 19]	10	10	10	10	10	10	10	10
[7 7 13]	9	7	10	8.5	8	7	7	10
[1 3 13]	5.7	3	7	5	4.3	3	3	7

[7 12 16]	11.67	12	11.5	10.25	10.83	12	12	11.5
[1 5 9]	5	5	5	5	5	5	5	5
[3 3 10]	5.3	3	6.5	4.75	4.17	3	3	6.5
[1 7 9]	5.67	7	5	6	6.3	7	7	5
[10 13 20]	14.3	13	15	14	13.67	13	13	15
[4 7 14]	8.3	7	9	8	7.67	7	7	9
[5 5 15]	8.3	5	10	7.5	6.67	5	5	10
[2 2 3]	2.3	2	2.5	2.25	2.17	2	2	2.5
[6 16 22]	14.67	16	14	15	15.3	16	16	14
[8 18 22]	16	18	15	16.5	17	18	18	15
[5 11 14]	10	11	9.5	10.25	10.5	11	11	9.5
[7 10 14]	10.3	10	10.5	10.25	10.17	10	10	10.5

Table 2 represents all existing defuzzification methods and various solutions to the fuzzy transportation problem.

Table.3 Comparing various solutions of fuzzy transportation problems solved by NWC, LCM, and VAM.

Methods	NWC	LCM	VAM
Centroid Method	2647.5	2586.9	2421
Mean of Maximum (MOM) Method	**2300**	2590	**1640**
$\alpha -$ Cut Method	2830	**2570**	2532.5
Center of Area (COA) Method	2565	2668.75	2412.5
Weighted Average	2477.25	2617.25	2317.9

Method			
Signed Distance Method	**2300**	2590	**1640**
Max Membership Principle	**2300**	2590	**1640**
Center of Sums	2830	**2570**	2532.5

Table 3 represents comparing the optimal solutions of existing methods like NWC, LCM, and VAM by solving using various types of defuzzification methods.

Conclusion:

From Table 3, we can see that for the North West Corner Rule, the Mean of Maximum, Signed Distance, and Max Membership Principle Methods give the best optimal solutions. For the least cost method, the $\alpha -$ Cut method and center of sums give the best optimal solutions. For the Vogel's Approximation Method, the Mean of Maximum, the Signed Distance, and the Max Membership Principle Methods give the best optimal solutions. We already know that the signed distance method and max membership principle are similar to the mean of maximum method, and the center of sums method is similar to the $\alpha -$ Cutmethod. So, we conclude that various defuzzification methods are giving numerous results.

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