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A New Algorithm Using Ranking Function to Solve Fuzzy Transportation Problem

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Abstract

In this paper a new algorithm is used which depending on ranking function for conclusion an optimal solution when transportation cost, sources to destination are fuzzy and were represented by abnormal triangular fuzzy numbers. A numerical example is given to display the efficiency of this algorithm.

Keywords: Fuzzy numbers, Fuzzy transportation problem, Triangular membership function, Ranking function.

خوارزمية جديدة بأستخدام دالة الرتب لحل مشكلة النقل الضبابية

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الخلاصة

في هذا البحث، يتم استخدام خوارزمية جديدة تعتمد على دالة الرتب للحصول على الحل الأمثل عندما تكون تكلفة النقل والعرض والطلب ضبابية ويتم تمثيلها بأرقام غير طبيعية مثلثية.و يتم إعطاء مثال عددي لإظهار كفاءة هذه الخوارزمية.

الكلمات المفتاحية: الارقام الضبابية، مسألة النقل الضبابية، دالة المثلثية العضويه و دالة الرتب.

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Introduction

The transportation problem (TP) is a distinctive category of linear programing problem which deals with shipping a commodity from sources to destinations. The purpose is to set the shipping schedule that minimizes the total shipping cost while sufficient supply and demand border. In real life, there are many problems deal with uncertainty in parameters, then cannot applied the traditional approach to solve (TP), but we can solve it by using fuzzy methods which depend on ranking function to find the optimal solution for transportation problems (TP). The fuzzy transportation problems (FTP) connect between fuzzy set theory and transportation problems, which mean that the sources, destinations and total cost are fuzzy numbers. Let $M \neq \emptyset$. A fuzzy set S in M is defined by its membership function $\Psi_S: M \rightarrow [0,1]$ and Ψ_S is interpreted as the degree of membership of element in fuzzy S for each $m \in M$ [2]. A fuzzy number $\tilde{\pi}$ is a fuzzy set on the real line that satisfies the condition of normality and convexity [5].

A fuzzy number $\tilde{\pi}$ in R is said to be a triangular fuzzy number and denoted by $\tilde{\pi} = (\delta, \beta, \gamma)$ if its membership function $\Psi_{\pi} : R \rightarrow [0,1]$ has the following characteristics: [4]

$$\Psi_{\pi}(m) = \begin{cases} \frac{m-\delta}{\beta-\delta} & \delta \leq m \leq \beta \\ 1 & m = \beta \\ \frac{\gamma-m}{\gamma-\beta} & \beta \leq m \leq \gamma \end{cases} .$$

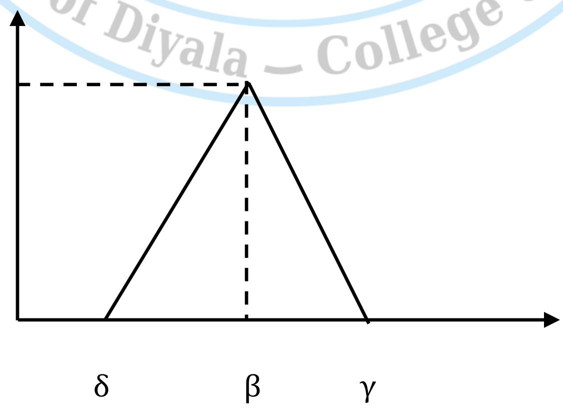

Figure 1: Represents fuzzy number

Fuzzy Tansportation Problem (FTP)

The FTP is the TP with sources, destinations and the total cost are fuzzy quantities [1].

Now formulate the fully fuzzy transportation problem by

Minimize $R=\sum_{n=1}^{s}\sum_{m=1}^{t}\widetilde{c_{nm}}\; x_{nm}$

$$\sum_{m=1}^{t} x_{nm} = \widetilde{a_n} \qquad , n = 1, \dots, s$$

$$\sum_{n=1}^{s} x_{nm} = \widetilde{b_m} \qquad , m = 1, \dots, t$$

$$x_{nm} \geq 0$$

Ranking of Triangular Fuzzy Number

The raking function defined as, R: F (Ψ)→ R which maps each fuzzy number into the real line; F (Ψ) represents the set of triangular fuzzy number [6]. There are many properties for ranking function, any two triangular fuzzy numbers N and M we have the following comparison [4].

1. $N < M \Leftrightarrow R(N) < R(M)$.
2. $N > M \Leftrightarrow R(N) > R(M)$.
3. $N \approx M \Leftrightarrow R(N) \approx R(M)$.
4. $N - M = 0 \Leftrightarrow R(N) - R(M) = 0$.

A New Algorithm Ranking Function

The idea of this algorithm depends on the idea for Nagoor Gani and Abbas at (2013), in this algorithm we take fully fuzzy numbers.[3]

Now, by using the following triangular membership:

$$\Psi_{\pi}(m) = \begin{cases} \frac{\lambda(m-\delta)}{\beta-\delta} & \delta \leq m \leq \beta \\ \lambda & m = \beta \\ \frac{\lambda(\gamma-m)}{\gamma-\beta} & \beta \leq m \leq \gamma \end{cases} \qquad \textbf{(1)}$$

By using α-cut, where $\alpha \in [0,1]$ and $0 \le \alpha \le \lambda$ and $0 \le \lambda \le 1$, then

$$\alpha = \frac{\lambda(m-\delta)}{\beta-\delta} \qquad \alpha = \frac{\lambda(\gamma-m)}{\gamma-\beta}$$

$$m = \delta + \frac{\alpha}{\lambda}(\beta-\delta) \qquad m = \beta - \frac{\alpha}{\lambda}(\gamma-\beta)$$

$$\widetilde{B}^{l}{}_{(\alpha)} = \delta + \frac{\alpha}{\lambda}(\beta-\delta) \tag{2}$$

$$\widetilde{B}^{u}{}_{(\alpha)} = \beta - \frac{\alpha}{\lambda}(\gamma-\beta) \tag{3}$$

Where $\widetilde{B}^{l}{}_{(\alpha)}$ is lower bound and $\widetilde{B}^{u}{}_{(\alpha)}$ be an upper, then presented for arbitrary fuzzy numbers be an ordered pair of function $[\widetilde{B}^{l}{}_{(\alpha)},\ \widetilde{B}^{u}{}_{(\alpha)}]$ where $\widetilde{B}^{l}{}_{(\alpha)} \le \widetilde{B}^{u}{}_{(\alpha)}$, suppose ρ is weight for $\widetilde{B}^{l}{}_{(\alpha)}$ and (1-ρ) is weight for $\widetilde{B}^{u}{}_{(\alpha)}$.

$$R(\widetilde{B}_{(m)}) = \frac{\int_0^\lambda \alpha^2\,[\rho\,\widetilde{B}^{l}{}_{(\alpha)} + (1-\rho)\widetilde{B}^{u}{}_{(\alpha)}]d\alpha}{\int_0^\lambda \alpha^2 d\alpha}$$

$$R(\widetilde{B}_{(m)}) = \frac{\int_0^\lambda \alpha^2\left[\rho m + \frac{\rho\alpha}{\lambda}(\beta-\delta) + (1-\rho)\gamma - \frac{(1-\rho)\alpha}{\lambda}(\gamma-\beta)\right]d\alpha}{\int_0^\lambda \alpha^2 d\alpha}$$

$$R(\widetilde{B}_{(m)}) = \frac{\int_0^\lambda [\alpha^2\rho m + \frac{\alpha^3\rho}{\lambda}(\beta-\delta) + \alpha^2(1-\rho)\gamma - \frac{\alpha^3(1-\rho)}{\lambda}(\gamma-\beta)]}{\int_0^\lambda \alpha^2 d\alpha}$$

$$R(\widetilde{B}_{(m)}) = \frac{\frac{\lambda^3\rho m}{3} + \frac{\lambda^4\rho(\beta-\delta)}{4\lambda} + \frac{\lambda^3(1-\rho)\gamma}{3} - \frac{\lambda^4(1-\rho)(\gamma-\beta)}{4\lambda}}{\frac{\lambda^3}{3}}$$

$$R(\widetilde{B}_{(m)}) = \frac{\frac{\lambda^3[4\rho m + 3\rho(\beta-\delta) + 4(1-\rho)\gamma - 3(1-\rho)(\gamma-\beta)}{12}}{\frac{\lambda^3}{3}}$$

$$R(\widetilde{B}_{(m)}) = \frac{1}{4}[\rho(m-\gamma) + 3\beta + \gamma].$$

Numerical Example

A company has three sources A_1, A_2 and A_3, also three destinations F_1, F_2 and F_3. All the data in this example are triangular fuzzy.

	F_1	F_2	F_3	Supply
A_1	((0.3,1,2)	((-0.7,0,1)	((1.3,2,3)	(5.3 ,6,7)
A_2	((2.3,3,4)	((5.3,6 ,7)	(4.3,5,6)	(7.3,8,9)
A_3	((2.3,3,4)	((1.3,2,3)	((5.3,6,7)	((9.3,10,11)
Demand	(3.3,4,5)	(7.3,8,9)	((11.3,12,13)	

apply the proposed algorithm of ranking function, we get the following optimal solution

	D_1	D_2	D_3	supply
S_1	((1.0375)	((0.0375)	((2.0375) 6.0375	((6.0375)
S_2	((3.0375) 4.0375	((6.0375)	((5.0375) 4	((8.0375)
S_3	((3.0375)	((2.0375) 8.0375	((6.0375) 2	((10.0375)
Demand	(4.0375)	(8.0375)	(12.0375))	

we find that the total cost is 73.17

Conclusion

When we solve the fuzzy problem by using a new algorithm with ranking function the total cost is (73.17). The new algorithm will be helpful for decision makers when they deal with fuzzy transportation problem.

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