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An efficient approach for finding the IBFS of time minimization transportation problems using mean absolute deviation

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Abstract
The time minimization transportation problem focuses on reducing the total transportation time of goods from origins to destinations. In this research paper, we propose a novel method for achieving minimum transportation time that differs significantly from existing approaches. Our method introduces the use of the mean absolute deviation (MAD) to obtain an initial basic feasible solution. We then compare the results of our proposed method with established techniques, including the Vogel's Approximation Method (VAM), Least Cost Method (LCM), and Modified Distribution Method (MODI). The findings demonstrate the effectiveness of our approach in minimizing transportation time, offering a competitive alternative to conventional methods.

Keywords: Transportation problem, initial basic feasible solution, time minimization, mean absolute deviation

Introduction

This paper presents a new method for minimizing transportation time that differs significantly from existing approaches. The objective is to reduce the time required to transport goods from the source to the destination, assuming that the goods can be delivered in a single trip. The Time-Minimizing Transportation Problem (TMTP) is applicable to a wide range of real-world scenarios, such as military logistics in emergencies, the transportation of perishable food items, firefighting, and hospital services. The paper introduces a simple algorithm designed to solve the TMTP efficiently, offering an optimal solution with minimal iterations. The algorithm is user-friendly and adaptable to various distribution problems with equality constraints.

The TMTP was initially examined by Hammer [1], Garfinkel, and Rao [2], while improved solutions and procedures were provided by Szware [3] and Puri [4]. Further innovative techniques were developed by Swarup [5], Seshan [6] and [8] Nikolic to optimize/reduce transportation time.

Algorithm for Mean absolute Deviation

The algorithm for our proposed approach to determine the initial basic feasible solution for the transportation problem is presented as follows:

Step 1

Verify if the Transportation Problem (TP) is balanced by checking if the total supply is equal to the total demand. If the TP is not balanced, balance it by adding a dummy row or column to adjust the supply and demand values.

Step 2

Determine the mean Deviation $MAD = \frac{1}{n}\sum_{i=1}^{n}|x_i - \bar{x}|$ for each row.

Step 3

Determine the mean Deviation $MAD = \frac{1}{n}\sum_{i=1}^{n}|x_i - \bar{x}|$ for each column.

Step 4

Determine the row or column that exhibits the highest value of mean deviation among all the rows and columns, resolving ties arbitrarily. Find the cell within the chosen row or column that has the lowest time and allocate as many units as feasible to that cell.

Step 5

Subtract the number of units assigned to the cell from the row supply and column demand, and mark the row supply or column demand as satisfied. Create a new tableau based on this adjustment. If both a row and a column are satisfied at the same time, mark only one of them as satisfied, and assign a zero demand (or supply) to the remaining column (or row). Additionally, when calculating subsequent mean deviation, do not include any column or row with zero demand or supply.

Step 6

Recompute the mean deviation for the rows and columns in the reduced transportation tableau, as outlined in steps 2 and 3. Proceed to steps 4 and 5 accordingly. Repeat this iterative process until all the demands and supplies are fulfilled.

Step 7

Lastly, we will determine the transportation time by selecting the basic cell with the largest value that has an allocation.

Numerical Example-I

	D1	D2	D3	D4	Supply
S1	10	0	20	11	15
S2	1	7	9	20	25
S3	12	14	16	18	5
Demand	12	8	15	10	

	D1	D2	D3	D4	Supply	(MAD)
S1	10	0	20	11	15	5.25
S2	1[12]	7	9	20	25/13	5.375
S3	12	14	16	18	5	2
Demand	12/0	8	15	10		
(MAD)	4.44	4.66	4	3.55		

The maximum MD is 5.375 which is present in 2nd row. The least time in this row is 1.

We allocate the minimum supply/demand to the corresponding time in the 2nd row. Column 1 is identified as satisfied and subsequently crossed out.

	D2	D3	D4	Supply	Mean Deviation (MD)
S1	0[8]	20	11	15/7	6.88
S2	7	9	20	25/13	5.33
S3	14	16	18	5	1.33
Demand	8/0	15	10		
Mean Deviation (MD)	4.66	4	3.55		

The maximum MD is 6.88 which is present in 1st row. The least time in this row is 0.

We allocate the minimum supply/demand to the corresponding time in the 2nd row. Column 1 is identified as satisfied and subsequently crossed out.

	D3	D4	Supply	Mean Deviation (MD)
S1	20	11	15/7	4.5
S2	9[13]	20	25/13/0	5.5
S3	16	18	5	1
Demand	15/2	10		
Mean Deviation (MD)	4	3.55		

The maximum MD is 5.5 which is present in 2nd row. The least time in this row is 9.

We allocate the minimum supply/demand to the corresponding time in the 2nd row. Column 1 is identified as satisfied and subsequently crossed out.

	D3	D4	Supply	Mean Deviation (MD)
S1	20	11[7]	15/7/0	4.5
S3	16	18	5	1
Demand	15/2	10/3		
Mean Deviation (MD)	2	3.5		

The maximum MD is 4.5 which is present in 1st row. The least time in this row is 11.

We allocate the minimum supply/demand to the corresponding time in the 1st row. Row 1 is identified as satisfied and subsequently crossed out.

	D3	D4	Supply	Mean Deviation (MD)
S3	16[2]	18[3]	5/3/0	1
Demand	15/2	10/3		
Mean Deviation (MD)	2/0	3.5		

The maximum MD is 1 which is present in 1st row. The least time in this row is 16. We allocate the minimum supply/demand to the corresponding time in the 1st row and the remaining units are allocated to the leftover time cell in TP.

	D1	D2	D3	D4	Supply
S1	10	0[8]	20	11[7]	15
S2	1[12]	7	9[13]	20	25
S3	12	14	16[2]	18[3]	5
Demand	12	8	15	10	

The obtained solution $x_{12} = 8$, $x_{14} = 7$, $x_{21} = 12$, $x_{23} = 13$, $x_{33} = 2$, $x_{34} = 3$ and the time of shipment is max {0,11,1,9,16,18} = 18-time units.

Numerical Example-II

	D1	D2	D3	Supply
S1	4	15	3	80
S2	27	23	6	120
S3	7	26	5	300
Demand	140	90	270	

	D1	D2	D3	Supply	MAD
S1	4[80]	15	3	80/0	5.11
S2	27	23	6	120	8.44
S3	7	26	5	300	8.88
Demand	140/60	90	270		
MAD	9.55	4.22	1.11		

The maximum MAD is 9.55 which is present in 1ST column. The least time in this row is 4.

We allocate the minimum supply/demand to the corresponding time in the 1st column. 1st row is identified as satisfied and subsequently crossed out.

	D1	D2	D3	Supply	MAD
S2	27	23	6	120	8.44
S3	7[60]	26	5	300/240	8.88
Demand	140/60/0	90	270		
MAD	10	1.5	0.5		

The maximum MAD is 10 which is present in 1^{ST} column. The least time in this row is 7.

We allocate the minimum supply/demand to the corresponding time in the 1^{st} column. 1^{st} Column is identified as satisfied and subsequently crossed out.

	D2	D3	Supply	MAD
S2	23	6	120	8.5
S3	26	5[240]	300/240/0	10.5
Demand	90	270/30		
MAD	1.5	0.5		

The maximum MAD is 10.5 which is present in 2^{nd} row. The least time in this row is 5.

We allocate the minimum supply/demand to the corresponding time in the 2^{nd} row. 2^{nd} row is identified as satisfied and subsequently crossed out.

	D2	D3	Supply	MAD
S2	23	6[30]	120/90	8.5
Demand	90	270/30/0		
MAD	0	0		

The maximum MAD is 8.5 which is present in 1st row. The least time in this row is 6.

We allocate the minimum supply/demand to the corresponding time in the 1st row.

	D2	Supply	MAD
S2	23[90]	120/90/0	8.5
Demand	90/0		
MAD	0		

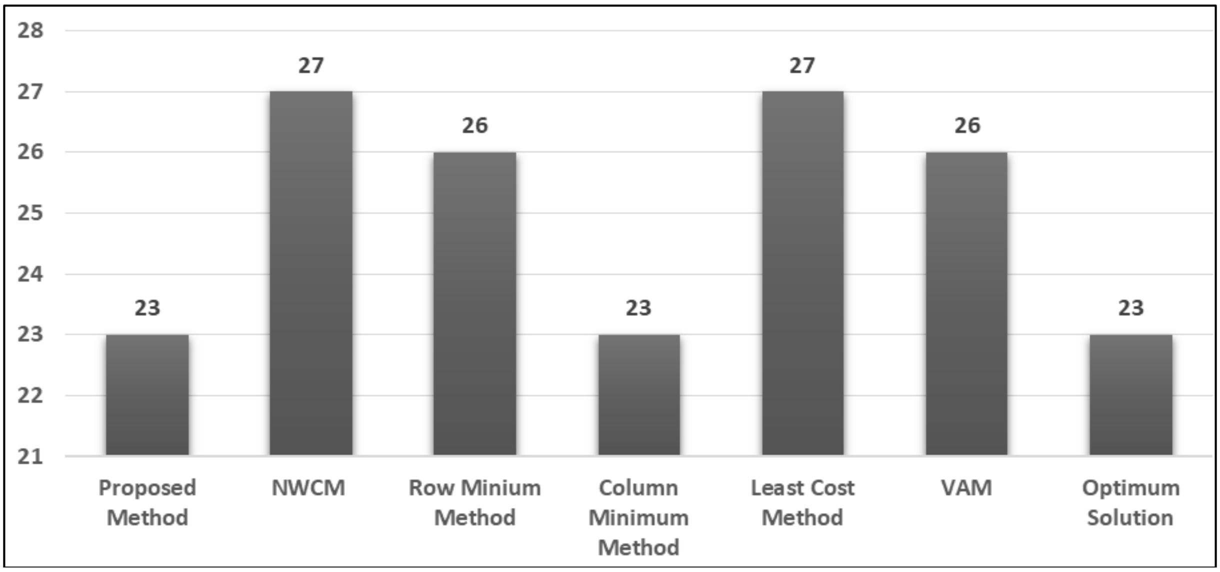
The remaining units are allocated to the leftover time cell in TP.

	D1	D2	D3	Supply
S1	4[80]	15	3	80
S2	27	23[90]	6[30]	120
S3	7[60]	26	5[240]	300
Demand	140	90	270	

The obtained solution $x_{11} = 80$, $x_{22} = 90$, $x_{23} = 30$, $x_{31} = 60$, $x_{33} = 240$ and the time of shipment is max {4,23,6,7,5} = 23-time units.

Comparison

Sr. No.	Method name	Time
1	Proposed Method	23
2	NWCM	27
3	Row Minium Method	26
4	Column Minimum Method	23
5	Least Cost Method	27
6	VAM	26
7	Optimum Solution	23



Conclusion

In this research paper we have introduced a novel methodology based on the concept of mean deviation, specifically tailored for TMTP. The mean deviation method aims to provide an efficient and effective procedure for determining the IBFS. By concentrating on the average deviations in transportation times, this method ensures a more balanced and practical initial solution, which is essential for the subsequent optimization process. In most instances, the proposed method demonstrates a beneficial quality of generating an optimal or nearly optimal solution.

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