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To obtain IBFS of transportation problem through coefficient of variation

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Abstract
The transportation problem is a linear programming problem in which cost of transportation is reduced. We have developed the new method of finding initial basic feasible solution by calculating the coefficient of variation row or column wise and the result is compared with VAM, LCM and MODI method.

Keywords: Transportation problem, initial basic feasible solution, coefficient of variation

Introduction

The transportation problem, a widely recognized optimization dilemma in operations research and logistics, aims to efficiently transport goods from sources to destinations while minimizing costs or maximizing profits.

The basic transportation problem was originally developed by Hitchcock in 1941 [4]. Efficient methods for obtaining solution were developed, primarily by Dantzig in 1951 [3], followed by Charnes *et al*, in 1953 [2]. To tackle the transportation problem, it can be mathematically formulated as a linear programming model. Several solution techniques, such as the North-West Corner Method, Least Cost Method, Vogel's Approximation Method, and Modified Distribution Method, utilize iterative allocation rules to assign goods efficiently and reach an optimal solution.

In a separate context, the coefficient of variation (CV) measures the dispersion of a dataset compared to its arithmetic mean. CV is calculated by dividing the standard deviation (σ) by the mean (μ) and expressing it as a percentage. The coefficient of variation is valuable for comparing variability between datasets, especially when their means differ significantly or when variables are measured on different scales. It aids in understanding the dispersion of data, identifying consistency, and making statistical inferences or predictions. The incorporation of the coefficient of variation (CV) in solving a transportation problem can produce favourable outcomes that are comparable to those achieved by methods like Vogel's Approximation Method (VAM) and the Modified Distribution Method (MODI).

Algorithm for Coefficient of Variation Method (CVM)

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 standard deviation $\sigma = \sqrt{\frac{\sum_{i=1}^{n}(x_i-\bar{x})^2}{n}}$ and the mean $\bar{x}_i = \frac{\sum_{i=1}^{n} x_i}{n}$ for each row. Then obtain the respective coefficient of variation, CV= $\frac{\sigma}{\bar{x}_i}$

Step 3: Determine the standard deviation $\sigma = \sqrt{\frac{\sum_{i=1}^{n}(x_i-\bar{x})^2}{n}}$ and the mean $\bar{x}_i = \frac{\sum_{i=1}^{n} x_i}{n}$ for each column. Then obtain the respective coefficient of variation, CV= $\frac{\sigma}{\bar{x}_i}$

Step 4: Determine the row or column that exhibits the highest coefficient of variation (CV) among all the rows and columns, resolving ties arbitrarily. Find the cell within the chosen row or column that has the lowest cost 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 coefficients of variation (CV), do not include any column or row with zero demand or supply.

Step 6: Recompute the coefficient of variation (CV) 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, compute the total transportation cost of the Transportation Table (TT). This calculation involves summing the product of the cost and the corresponding assigned value for each cell in the TT.

Numerical Example with Illustration

	D1	D2	D3	D4	Supply
S1	3	1	7	4	300
S2	2	6	5	9	400
S3	8	3	3	2	500
Demand	250	350	400	200	

	D1	D2	D3	D4	Supply	CV
S1	3	[300]1	7	4	300/0	0.67
S2	2	6	5	9	400	0.52
S3	8	3	3	2	500	0.68
Demand	250	350/50	400	200		
CV	0.74	0.75	0.40	0.72		

The maximum CV is 0.75 which is present in 2nd column. The least cost in this column is 1.
We allocate the minimum supply/demand to the corresponding cost in the 2nd column, which has the highest coefficient of variation (CV) of 0.75. Among the costs in this column, we select the lowest cost of 1 and allocate 300 units. Row 1 is identified as satisfied and subsequently crossed out.

	D1	D2	D3	D4	Supply	CV
S2	[250] 2	6	5	9	400/150	0.52
S3	8	3	3	2	500	0.68
Demand	250/0	350	400	200		
CV	0.85	0.47	0.35	0.90		

The maximum CV is 0.85 which is present in 1st column. The least cost in this column is 2.
We allocate the minimum supply/demand to the corresponding cost in the 2nd column, which has the highest coefficient of variation (CV) of 0.85. Among the costs in this column, we select the lowest cost of 2 and allocate 250 units. Column 1 is identified as satisfied and subsequently crossed out.

	D2	D3	D4	Supply	CV
S2	6	5	9	150	0.31
S3	3	3	[200]2	500/300	0.22
Demand	350/50	400	200/0		
CV	0.47	0.35	0.90		

The maximum CV is 0.90 which is present in 3rd column. The least cost in this column is 2.
We allocate the minimum supply/demand to the corresponding cost in the 2nd column, which has the highest coefficient of variation (CV) of 0.90 Among the costs in this column, we select the lowest cost of 2 and allocate 200 units. Column 3rd is identified as satisfied and subsequently crossed out.

	D2	D3	Supply	CV
S2	6	5	150	0.13
S3	[50]3	3	300/250	0.00
Demand	50/0	400		
CV	0.47	0.35		

The maximum CV is 0.47 which is present in 1st column. The least cost in this column is 3.
We allocate the minimum supply/demand to the corresponding cost in the 1nd column, which has the highest coefficient of variation (CV) of 0.90 Among the costs in this column, we select the lowest cost of 2 and allocate 200 units. Column 1st is identified as satisfied and subsequently crossed out.

	D3	Supply	CV
S2	5	150	0.00
S3	[250]3	250/0	0.00
Demand	400/150		
CV	0.35		

The maximum CV is 0.35 which is present in 1st column. The least cost in this column is 3.
We allocate the minimum supply/demand to the corresponding cost in the 1nd column, which has the highest coefficient of variation (CV) of 0.35 Among the costs in this column, we select the lowest cost of 3 and allocate 250 units. 2nd row is identified as satisfied and subsequently crossed out.

	D3	Supply	CV
S2	[150]5	150/0	0.00
Demand	400/150/0		
CV	0.00		

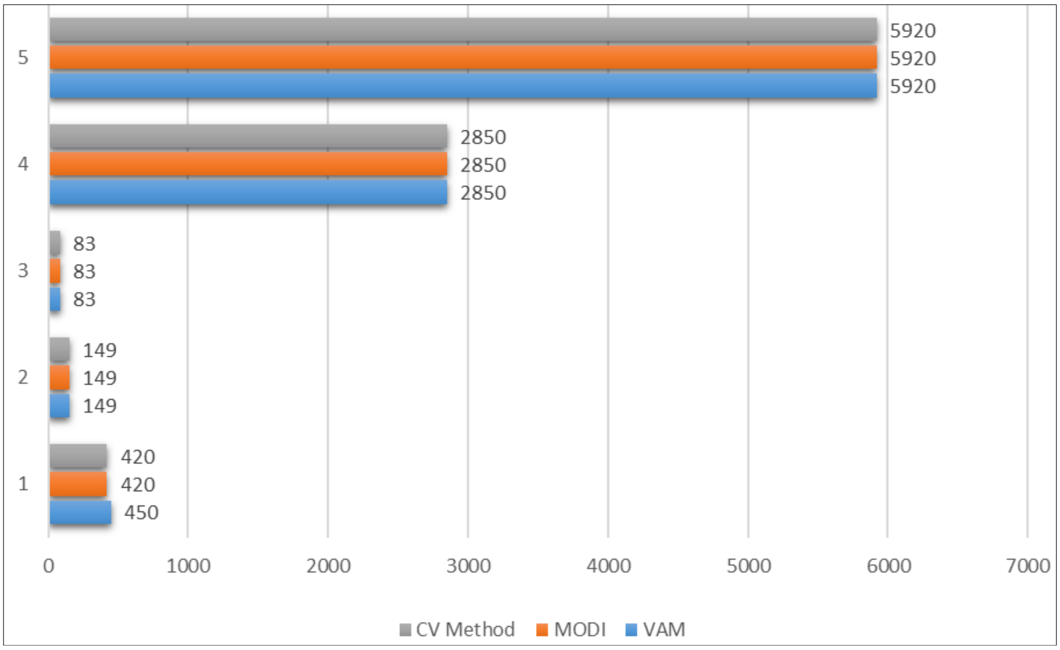
In the end, we allocate 150 units to the leftover cost in TP.

Total cost $= (300 \times 1) + (250 \times 2) + (150 \times 5) + (50 \times 3) + (250 \times 3) + (200 \times 2) = 2850$

By observing that the total number of allocations is 6 in the transportation problem equals to m + n - 1, i.e., 3+4-1=6 we can infer that the solution is non-degenerate.

Comparison

Example	Problem size	VAM	MODI	CV Method
1	3×4	450	420	420
2	3×4	149	149	149
3	4×4	83	83	83
4	3×4	2850	2850	2850
5	3×3	5920	5920	5920



Conclusion

In this paper, we have introduced a new approach named Coefficient of Variation method (CV) to address the transportation problem by proposing a novel approximation method for constructing an efficient IBFS algorithm. CV method has been tested and gives a comparatively better result. In conclusion CV method offers an enhanced Initial Basic Feasible Solution that guarantees minimal transportation costs. The proposed method exhibits a favourable characteristic of producing an optimal or nearly optimal solution in the majority of cases.

References

1. Amaravathy A, Thiagarajan K, Vimala S. Mdma Method- An Optimal Solution For Transportation Problem. Middle-East Journal of Scientific Research. 2016;24(12):3706-3710.
2. Charnes A, Cooper WW, Henderson A. An Introduction to Linear Programming. John Wiley & Sons, New York; c1953.
3. Dantzig GB. Application of the Simplex Method to a Transportation Problem, Activity Analysis of Production and Allocation. In: Koopmans, T.C., Ed., John Wiley and Sons, New York; c1951. p. 359-373.
4. Hitchcock FL. The Distribution of a Product from Several Sources to Numerous Localities. Journal of Mathematics and Physics. 1941;20:224-230.
5. Hamdy A Taha. Operation Research, An Introduction Operation Research 9th Edition.
6. Korukoğlu S, Ballı S. A Improved Vogel's Approximation Method For The Transportation Problem. Mathematical And Computational Applications. 2011;16(2):370-381.
7. Vannam ES, Rekha S. A New Method for Obtaining An Optimal Solution For Transportation Problems. International Journal Of Engineering And Advanced Technology. 2013;2(5):369-371.
8. Bilkour, Henry, Satakshi. Initial Basic Feasible Solution of Transportation Problem by Zero Point Minimum Method. Review of International Geographical Education. 2021;11(7):724-730.