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An Alternate Method to Matrix Minima Method of Solving Transportation Problem

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Abstract

The article has proposed a method to find the Initial Basic Feasible Solution using a statistical tool 'Harmonic Mean' as an alternate method to Matrix Minima Method for solving the Transportation Problem and illustrated using examples.

Key Words: Operation Research, linear programming, transportation problems, initial basic feasible solution, harmonic mean, alternate method.

1. Introduction

Transportation problem is one of the interesting features studied in Operations Research. It plays a vital role in the field of industries to minimize the transportation cost when the sources and destinations are given and the demand and supply are satisfied. Whenever the exact amount of demand and supply are known for the transportation problem, there are numerous algorithms to solve using it. This approach was first developed by F.L.Hitchcock in 1941[1]. Then Dantzig in 1951[2] developed some of the methods for finding solutions and later by Charnes, Cooper and Henderson in 1953[3]. The foremost step to obtain the solution for transportation problem is to determine the Initial Basic Feasible Solution.

One of the methods for finding Initial Basic Feasible Solution (IBFS) is the Matrix Minima Method. The procedure for this method: The IBFS can be calculated only to the balanced cost matrix. In the cost matrix of the transportation table select the minimum cost cell and allocate the maximum value to the cell. If the supply is satisfied, cross the row with the allocated cell or if the demand is satisfied, cross the column with the allocated cell. Next again select the minimum cost and continue until all demands and supplies are exhausted. Many alternate methods have been provided by researchers to find IBFS. S.I.Ansari and A.P.Bhandava[4] developed an approach for finding IBFS using statistical technique is the best one for finding IBFS. The paper uses a statistical tool called Harmonic Mean to find the IBFS as an alternate method.

2. Proposed Methodology to Find Initial Basic Feasible Solution

In Statistics, Harmonic Mean is one of the several kinds of average.
Harmonic Mean is the ratio of the number of values and the sum of reciprocals of the values

Step 1: Check whether the cost matrix is balanced. If not add corresponding dummy row or column to balance the supply or demand respectively.

Step 2: Find the Harmonic Mean for each row and column.

Step 3: Identify the row or column with the maximum Harmonic Mean value and select the cell with minimum cost in the corresponding row or column.

Step 4: Maximum allocation is made to cell having minimum cost value. Delete the column (or row) whose demand (or supply) is fulfilled.

Step 5: Calculate new Harmonic Mean and proceed until all the demands and supplies are fulfilled.

Step 6: Compute total transportation cost for the allocated cells using cost matrix.

3. Numerical Example

Example 1

Consider the transportation problem in Table 1.

Table 1

	Destination			Supply
	D1	D2	D3	
S1	2	7	4	5
S2	3	3	1	8
S3	5	4	7	7
S4	1	6	2	14
Demand	7	9	18	34

Solution of Example 1 Using Proposed Method

Step 1: In the given transportation problem Supply = Demand, the cost matrix is balanced. Therefore there exists IBFS.

Table 2

2	7	4	5
3	3	1	8
5	4	7	7
1	6	2	14
7	9	18	34

Step 2: By calculating the Harmonic Mean for each row and each column, the values are,

R1 = 3.36, R2 = 1.807, R3 = 4.823, R4 = 1.80, C1 = 1.97, C2 = 4.50, C3 = 2.114

Step 3: From the above calculated values, R3 = 4.823 is the maximum harmonic mean value.

Step 4: In row R3 the cell with minimum cost value is (3, 2). This cell is allocated with maximum supply and remaining cells in the corresponding row are deleted since the supply is fulfilled.

Step 5: The steps are repeated until the demand and supply are fulfilled.

Table 3

	Destination			Supply
	D1	D2	D3	
S1	2 5	7	4	5
S2	3	3 2	1 6	8
S3	5	4 7	7	7
S4	1 2	6	2 14	14
Demand	7	9	18	34

Hence, the total transportation cost is (2 x 5 + 3 x 2 + 1 x 6 + 4 x 7 + 1 x 2 + 2 x 14) = 80.

Solution of Example 1 Using Matrix Minima Method

Table 4

	Destination			Supply
	D1	D2	D3	
S1	2	7 2	4 3	5
S2	3	3	1 8	8
S3	5	4 7	7	7
S4	1 7	6	2 7	14
Demand	7	9	18	34

Hence, the total transportation cost is (7 x 2 + 4 x 3 + 1 x 8 + 4 x 7 + 1 x 7 + 2 x 7) = 83

Example 2

Consider the transportation problem in Table 5.

Table 5

	Destination				Supply
	D1	D2	D3	D4	
S1	6	5	8	8	30
S2	5	11	9	7	40
S3	8	9	7	13	50
Demand	35	28	32	25	120

Solution of Example 2 Using Proposed Method

Step 1: In the given transportation problem Supply = Demand, the cost matrix is balanced. Therefore there exists IBFS.

Table 6

6	5	8	8	30
5	11	9	7	40
8	9	7	13	50
35	28	32	25	120

Step 2: By calculating the Harmonic Mean for each row and each column, the values are

R1 = 6.493, R2 = 7.366, R3 = 8.810, C1 = 6.109, C2 = 7.481, C3 = 7.936, C4 = 8.746

Step 3: From the above calculated values, R3 = 8.810 is the maximum Harmonic Mean value.

Step 4: In row R3 the cell with minimum cost value is (3, 3). This cell is allocated with maximum supply and the remaining cells in the corresponding row are deleted since the supply is fulfilled.

Step 5: The steps are repeated until the demand and supply are fulfilled.

Table 7

	Destination				Supply
	D1	D2	D3	D4	
S1	6 2	5 28	8	8	30
S2	5 15	11	9	7 25	40
S3	8 18	9	7 32	13	50
Demand	35	28	32	25	120

Hence, the total transportation cost is (6 x 2 + 5 x 28 + 5 x 15 + 7 x 25 + 8 x 18 + 7 x 32) = 770

Solution of Example 2 Using Matrix Minima Method

Table 8

	Destination				Supply
	D1	D2	D3	D4	
S1	6	5 28	8	8 2	30
S2	5 35	11	9	7 5	40
S3	8	9	7 32	13 18	50
Demand	35	28	32	25	120

Hence, the total transportation cost is (5 x 28 + 8 x 2 + 5 x 35 + 7 x 5 + 7 x 32 + 13 x 18) = 824

4. Conclusion

This paper presents an alternate method to Matrix Minima Method for finding the IBFS for the transportation problem using Harmonic Mean. The transportation cost obtained by the Harmonic Mean Method is comparatively less than the Matrix Minima Method. Further developments can be done for unbalanced transportation problem.

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