STATISTICAL METHODS FOR SOLVING TRANSPORTATION PROBLEMS

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Abstract: *Transportation problem is one of the models of Linear Programming problem. It deals with the situation in which a commodity from several sources is shipped to different destinations with the main objective to minimize the total shipping cost. There are three well-known methods namely, North West Corner Method Least Cost Method, Vogel's Approximation Method to find the initial basic feasible solution of a transportation problem. In this paper, we present some statistical methods for finding the initial basic feasible solution. We use three statistical tools: arithmetic and harmonic mean and median. We present numerical examples, and we compare these results with other classical methods.*

Keywords: transportation problem, initial basic solution, statistical methods

1. Introduction

Transportation problem is one of the interesting features studied in Operation Research. Transportation problem was first studied by F.L. Hitchcock [2]. 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. There are three well-known methods namely, North West Corner Method, Least Cost Method, Vogel's Approximation Method to find the initial basic feasible solution of a transportation problem. In the last years, several researchers have developed alternative methods for finding initial basic feasible solution.

In this paper, we present some statistical methods for finding the initial basic feasible solution. In Statistics, measures of central tendency play a vital role in explaining the nature of the distribution. The arithmetic mean, median and mode are the three

commonly used measures of central tendency.

In paper [3] the authors present an alternative method to North West Corner method by using arithmetic mean and in papers [4], [5] the authors use another statistical tool called harmonic mean to find the initial basic feasible solution as an alternative method to Matrix Minima Method. We propose another measure of central tendency to find the initial basic solution, namely, the median.

Arithmetic mean is defined as being equal to the sum of the numeric values of each observation, and divided by the total number of observation. Harmonic mean is the total number of observation divided by the sum of the reciprocal of number.

The Median is the middle number in a sequence of numbers. To find the median, we need to organize each number in order by size, and the number in the middle is the median. If there is an odd number of

numbers, the middle one is picked, and if there is an even number of numbers, then there is no single middle value, the median is then usually defined to be the arithmetic mean of the two middle values.

To find the initial basic feasible solution using those statistical tools, follow these steps:

1- Find the statistical tool (arithmetic mean, harmonic mean or median) for each row as well as column and find the one with maximum value (if there is a tie, choose any one arbitrarily).

2- Identify the row or column having maximum statistical tool and identify the boxes with minimum transportation cost in the corresponding row or column.

3- Make maximum allotment to the box having minimum cost of transportation in that row (or column).

4- Delete the row (or column) whose supply (or demand) is fulfilled.

5- Calculate new statistical tool and proceed until the demands and supplies are fulfilled.

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

2. Finding the Initial Solution for a Transportation Problem Using Statistical Methods

In paper [1] we present the optimization of a military action, showing how to solve a practical problem using the transportation problem.

In this paper we will find the initial basic feasible solution for the same example, but using statistical methods and we will compare those results with results of classical methods.

We have the data in Table 1 from the paper [1], regarding the costs to ensure the 3 fighting companies of a motorized infantry battalion of Polish Army with ammunition, fuel, water and food:

Table 1: The data of the problem

SOURCES/DEST.	UNIT1	UNIT2	UNIT3	STOCK (T)
AMMOUNITION	330	280	277	19
FUEL	186	158	156	43
FOOD	330	280	277	2
WATER	126	107	106	5
NEEDED (T)	23	23	23	69 (T)

We use the minimum line method in order to find the initial basic solution:

Table 2: Initial solution using Minimum line method

SOURCES/DEST.	UNIT1	UNIT2	UNIT3	STOCK (T)
AMMOUNITION	330	280	277 19	19
FUEL	186 16	158 23	156 4	43
FOOD	330 2	280	277	2
WATER	126 5	107	106	5
NEEDED (T)	23	23	23	69 (T)

The total transportation cost is
 $(0 \cdot 330 + 0 \cdot 280 + 19 \cdot 277 + 16 \cdot 186 + 23 \cdot 158 + 4 \cdot 156 + 2 \cdot 330 + 0 \cdot 280 + 0 \cdot 277 + 5 \cdot 126 + 0 \cdot 107 + 0 \cdot 106)$
 $= 13787$.

Now we will find the initial basic solution using another classical method, North West Corner Method. We find the follow solution:

Table 3: Initial solution using North West Corner Method

SOURCES/DEST.	UNIT1	UNIT2	UNIT3	STOCK (T)
AMMOUNITION	330 19	280	277	19
FUEL	186 4	158 23	156 16	43
FOOD	330	280	277 2	2
WATER	126	107	106 5	5
NEEDED (T)	23	23	23	69 (T)

The total transportation cost is
 $(19 \cdot 330 + 0 \cdot 280 + 0 \cdot 277 + 4 \cdot 186 + 23 \cdot 158 + 16 \cdot 156 + 0 \cdot 330 + 0 \cdot 280 + 2 \cdot 277 + 0 \cdot 126 + 0 \cdot 107 + 5 \cdot 106)$
 $= 14228$.

Further, we will find the initial basic solution for the data from table1 using statistical tools.

By calculation the arithmetic mean for each row and column, the values are, $R_1 = 295.66$,

$R_2 = 166.66$, $R_3 = 295.66$, $R_4 =$

113 , $C_1 = 243$, $C_2 = 206.25$, $C_3 = 204$.

From the above calculated value $R_1 = 295.66$ and $R_3 = 295.66$ are the maximum arithmetic mean, we choose $R_1 = 295.66$.

In row R_1 the cell with minimum cost value is (1;3). This cell is allocated with maximum supply and remaining cells in the corresponding row are deleted since the supply is fulfilled. The steps are repeated until the demand and supply are fulfilled.

Table 4: Initial solution using Arithmetic Mean/Median

SOURCES/DEST.	UNIT1	UNIT2	UNIT3	STOCK (T)
AMMOUNITION	330	280	277 19	19
FUEL	186 18	158 23	156 2	43
FOOD	330	280	277 2	2
WATER	126 5	107	106	5
NEEDED (T)	23	23	23	69 (T)

The total transportation cost is
 $(0 \cdot 330 + 0 \cdot 280 + 19 \cdot 277 + 18 \cdot 186 + 23 \cdot 158 + 2 \cdot 156 + 0 \cdot 330 + 0 \cdot 280 + 2 \cdot 277 + 5 \cdot 126 + 0 \cdot 107 + 0 \cdot 106)$
 $= 13741$.

Similarly, it is calculated the harmonic mean.

By calculation the Median for each row and column, the values are, $R_1 = 280$, $R_2 = 158$, $R_3 = 280$, $R_4 = 107$, $C_1 = 258$, $C_2 = 219$ and $C_3 = 216.5$. From the above calculated value, $R_1 = 280$ and $R_3 = 280$ are the maximum median value, we choose $R_1 = 280$. In row R_1 the cell with minimum cost value is (1; 3). In the same way as in the

arithmetic mean case, this cell is allocated with maximum supply and remaining cells in the corresponding row are deleted since the supply is fulfilled. The steps are repeated until the demand and supply are fulfilled.

We obtain the same solution as in Table 4, with the same transportation cost.

3. Conclusions

We can observe that the total transportation cost by using statistical tools is less than that of classical methods, North West Corner or Minimum line methods.

References

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