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Mathematics

STATISTICAL METHOD FOR SOLVING TRANSPORTATION PROBLEMS OF USING THE PROGRAMMING LANGUAGE MATLAB

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ABSTRACT *I*n Linear Programming, the transportation problem is a special class of model. 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. In this paper, we present an alternative method to North West Corner method by using Statistical tool called arithmetic mean (***AM***) it's one measures of central tendency. Numerical examples are explained to justify the results, and we found that the total transportation cost by using the arithmetic mean (***AM***) method is optimal as compared to the all other classical for solve the problem under investigated.

KEYWORDS : Statistical Method, Arithmetic Mean (AM), Initial Basic Feasible Solution (IBFS), Transportation Problem, Matlab Language .

1- Introduction :

In the light of the progress and rapid development of the applications of research in applications fields, the need to rely on scientific tools and cleaner for data processing has become a prominent role in the resolution of decisions in industrial and service institutions according to the real need of these methods to make them scientific methods to solve the problem Making decisions for the purpose of making the departments succeed in performing their planning and executive tasks. Therefore, we found it necessary to know the transport model in general and to use statistical methods to reach the optimal solution with the lowest possible costs in particular.

And you know The Transportation Problem (also called Hitchcock Problem and denoted by TP) is one of the classic problems in operation research, a special type of linear programming problem(2):

$$Min\ z = \sum_{i=}^{m}\sum_{j}^{n} cij\ xij$$

$$\sum_{j=1}^{n} xij = ai\ , i = 1, \ldots, m\ /$$

$$\sum_{i=1}^{m} xij = bj, j = 1, \ldots, n$$

$$xij \geq 0\ for\ all\ i, j$$

Where :

cij = unit transportation cost for each source i to destination j.
xij = number of units from source to destination.
ai = supply from sources ; bj= demand from destination

W*e have to determine the optimal shipments from a given set of origins to a given set of destinations in such a way as to minimize the total transportation costs*[7].

H*ave been widely studied in computer science and operations research. It is one of the fundamental problems of network flow problem which is usually use to minimize the transportation cost for industries with number of sources and number of destination while satisfying the supply limit and demand requirement.*[1]

T*he problem is constrained by known upper limits on the supply at the various origins and by the necessity to satisfy the known demand at each destination. The classical transportation model assumes that the per unit cost for each potential origin destination pair is known a priori.*[2]

I*t was first studied by F. L. Hitchcock in 1941, then separately by T. C. Koopmans in 1947, and finally placed in the framework of linear programming and solved by simplex method by G. B. Dantzig in 1951*[3][4]*.The first step of the simplex method for the transportation problem is to determine an initial basic feasible solution. The simplest procedure for finding an initial basic feasible solution was proposed by Dantzig (1951) and was termed the northwest corner rule by charnes and cooper (1954)*[5].

S*ince the Northwest Corner rule does not take into account costs when allocating to the variables, it may yield an initial solution that gives an objective function value far from the optimum. Many researchers have provided alternate methods to find the Initial Basic Feasible Solution (IBFS) as well as optimal solution. In 2012, authors S. I. Ansari and A. P. Bhadane proposed a statistical techniques based approach to find IBFS*[6].

2- Proposed Statistical Methodology

I*n Statistics, measures of central tendency play a vital role in explaining the nature of the distribution, and is defined as "the statistical measure that identifies a single value as representative of an entire distribution. it aims to provide an accurate representation of the entire data. it is the single value that is most typical representative of the collected data. the term "number crunching" is used to illustrate this aspect of data description. the arithmetic mean, median and mode are the three commonly used measures of central tendency*[8].

One of such measure is Arithmetic Mean (AM) is defined as being equal to the sum of the numerical values of each and every observation divided by the total number of observations. It can be calculated by the following formula:

$$\bar{c} = \frac{\sum_{i=}^{m}\sum_{j}^{n} cij}{n}$$

Where:
c ̄ : cost–bar (arithmetic mean)
Cij : cost per unit to transport units from origin i to destination j
n: the total number of observations

And to find the initial basic Feasible solution Using the statistical tool Follow these steps :

1- Find the Arithmetic Mean (AM) for each Row as well as Column and find the one with maximum value.
2- Identify the row or column having maximum (AM) and also 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 fresh (AM) for the remaining sub-matrix as in step 1 and allocate following the procedure of previous step. Continue the process until all rows and columns are satisfied.
6- Compute total transportation cost for the feasible cost for the feasible allocations using the original balanced transportation cost matrix.

The merit in using the measures of central tendency and the use of one of the measures in calculating the cost of transferring goods from sources to the requesting destinations is based entirely on the cost of transferring the unit, contrary to the method of the Northwest corner which does not depend on allocating the quantities transferred to the costs, The statistics on many of the applied examples and you have been tested by Matlab for many examples have yielded better results than the Northwest Corner method, the least cost method and have yielded results similar to the Vogel approximation results.

Thus, we adopted the alternative method of the north-west corner

3- Programing Code For All method By Using Matlab Language

Matlab is a fourth-generation programming language and numerical analysis environment, Uses for MATLAB include matrix calculations, developing and running algorithms, creating User Interfaces (UI) and data visualization. The multi-paradigm numerical computing environment allows developers to interface with programs developed in different languages, which makes it possible to harness the unique strengths of each language for various purposes [10].

We will review the steps of programming the statistical method proposed by the researcher & programming that method using programming language (matlab), with the classical methods ((North West Corner Rule(NWCR), Least Cost Method(LCM), Vogel's Approximation Method (VAM)), used in finding the best solution, and compare those results to arrive at the optimal solution that leads to reduced transportation costs.

In any research, enormous data is collected and, to describe it meaningfully, Put the data in a matrix or table needs to interpret the data then. The bulkiness of the data can be reduced by organizing it into a frequency table or histogram [9].

4- Numeral Examples & feedback

1-4) Consider the transportation problem in table (1)

	D1	D2	D3	S
S1	(2)	(1)	(5)	10
S2	(7)	(3)	(4)	25
S3	(6)	(5)	(3)	20
D	15	22	18	55/55

Results Of Classical Methods (NWCR,LCM,VAM) And Proposed Statistical Methodology(AM) For Table (1):

Methods	NWCR	LCM	VAM	AM
Allocation	X11 = 10 X21 = 5 X22 = 20 X32 = 2 X33 = 18	*X12 = 10* *X21 = 13* *X22 = 12* *X31 = 2* *X33 = 18*	*X11 = 10* *X21 = 3* *X23 = 22* *X31 = 2* *X33 = 18*	*X11 = 10* *X22 = 22* *X23 = 3* *X31 = 5* *X33 = 15*
Nature Of Solution	Non. Degenerate	Non. Degenerate	Non. Degenerate	Non. Degenerate
Total Cost Min z	179	203	173	173

Through the results obtained in Table(1) above to find the initial basic visible solution (IBVS), for all methods ,We found that the proposed (arithmetic mean ***(AM)***) method gave the best optimal solutions in reducing total transportation costs from (NWCR&LCM) It is similar for (VAM), The final results obtained for the quantities allocated for transport indicate that there are many differences in the optimal allocation from the sources to the requesting destinations as shown in the table above for the proposed method and other methods. Note that the variable x21 included quantities transferred for all roads. this is an indication that the method has a plan in the customization is quite different from the rest of the roads and give non. degenerate solution

2 - 4) Consider the transportation problem in table (2)

	D1	D2	D3	D4	S
S1	(2)	(3)	(11)	(7)	6
S2	(1)	(0)	(6)	(1)	1
S3	(5)	(8)	(15)	(9)	10
D	7	5	3	2	17/17

Results Of Classical Methods(NWCR, LCM, VAM) And Proposed Statistical Methodology(AM) For Table (2):

Method	NWCR	LCM	VAM	AM
Allocation	X11 = 6 X21 = 1 X32 = 5 X33 = 3 X34 = 2	*X11 = 6* *X22 = 1* *X31 = 1* *X32 = 4* *X33 = 3* *X34 = 2*	*X11 = 6* *X12 = 5* *X24 = 1* *X31 = 6* *X33 = 6* *X34 = 1*	*X12 = 2* *X13 = 2* *X14 = 2* *X23 = 1* *X31 = 7* *X32 = 3*
Nature Of Solution	Degenerate	Non. Degenerate	Non. Degenerate	Non. Degenerate
Total Cost Min Z	116	112	102	107

Through the results obtained in Table (2) above to find the initial basic Feasible solution IBFS, for all methods , We found that the proposed (arithmetic mean (***AM***)) method gave the best optimal solutions in reducing total transportation costs from (NWCR,LCM), The solution by NWCR is Degenerate, but by (AM) method it is Non-Degenerate. By comparing the proposed method with the north-west corner, we find that the solution is non. Degenerate for the proposed method. Thus, the methods of improving the solution of this method can be used to achieve the following condition m + n-1, in contrast to the north-west corner method,For not achieving the condition m + n -1.

3 – 4) Consider the transportation problem in table (3)

	D1	D2	D3	D4	S
S1	(19)	(30)	(50)	(10)	7
S2	(70)	(30)	(40)	(60)	9
S3	(40)	(8)	(70)	(20)	18
D	5	8	7	14	34/34

Results Of Classical Methods(NWCR,LCM,VAM) And Proposed Statistical Methodology(AM) For Table (3):

Method	NWCR	LCM	VAM	AM
Allocation	X11 = 5 X12 = 2 X22 = 6 X23 = 3 X33 = 4 X34 = 14	X14 = 7 X21 = 2 X23 = 7 X31 = 3 X32 = 8 X34 = 7	X11 = 5 X14 = 2 X23 = 7 X24 = 2 X32 = 8 X34 = 10	X11 =5 X14 = 2 X22 = 2 X23 = 7 X32 = 6 X34 = 12
Nature Of Solution	Non. Degenerate	Non. Degenerate	Non. Degenerate	Non. Degenerate
Total Cost Min Z	1015	814	779	743

Through the results obtained in Table(3) above to find the initial basic visible solution (IBVS), for all methods ,We found that the proposed (arithmetic mean (AM)) method gave the best optimal solutions in reducing total transportation costs from other methods, we note that the proposed method(AM) gave the best optimal solution results in this example and that the solution it is not degenerate. The above results achieved the best result of reducing transport costs was achieved using the proposed method. The result was significantly different from the previous methods. This is an indication of the quality of this method because it gave the best results in general to all transport matrices whose results were obtained using Matlab. This method replaces the North-West corner method and compares that method with other statistical methods

5- conclusion :

In this paper, we have presented an alternate method to the North-West Corner rule for solving the Transportation method. From the numerical examples, we observed that the total transportation cost by using the arithmetic mean (AM) method is optimal as compared to the all methods (NWCR,LCM,VAM),for example (3 - 4), Also the transportation cost obtained by (AM) method is optimal as compared to the (NWCR,LCM)for example (1-4),(2-4), The solution by NWCR is Degenerate (Ex.2-4) but by AM method it is Non-Degenerate. It was also observed that the initial basic feasible solution is obtained in comparatively very less number of iterations.

So, We can conclude that the arithmetic mean (AM) can be used for finding the IBFS . Further developments can be done for unbalanced transportation problems.

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