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Solving Time Minimizing Transportation Problem by Zero Point

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ABSTRACT
In this paper we are study on time minimizing transportation problem for Albert David Company. The object of this problem is minimizing the transportation time of goods which supply from one source to another source. In this paper we are using zero point method [6,7] to solving time minimizing transportation problem and compare the obtained results with the regulars with the regular methods, which is solve by tora software to get feasible solution and we find that zero point method is best from another method.

Introduction

The time minimizing transportation problem is a special case of a transportation problem in which a time associated with each shipping route. Rather than minimizing cost, the objective is to minimize the maximum time to transport all supply to destinations. In a time minimizing transportation problem, the time of the transporting items from origins to destinations is minimized, satisfying certain conditions in respect of availabilities at source and requirement.

The problem of minimizing the total transportation has been studied since long and is well known. In a time transporting goods is minimized to satisfy certain condition in respect of availabilities at source and requirement at destinations. The basic difference between cost minimizing and time minimizing transportation problem is that the cost of transportation change with variations in the quantity but the time involved remains unchanged and irrespective of the quantities. The time minimizing transportation problem has been studied by Hammer [5], Garfinkel and Rao [3], Szware [9], Bhatia et al [1], seshan and Tikekar [6]. Most of the models developed for solving the time transportation problem are with the assumption that the supply, the demand and the cost per unit values are exactly known. But real world applications, the supply, the demand and the cost per unit of quantities are generally not specified precisely i.e. the parameter are not complete. But even with incomplete, But even with incomplete information, the model user is normally able to give a realistic interval for the parameters.

zero Point method used by P Pandian and G Natrajan [6,7] to finding the optimal solution and fuzzy optimal solution to reduced transportation cost of transportation problem and fuzzy transportation problem respectively. In this we are using zero point method to solve time minimizing transportation to reduced transportation time for Albert David Company which is situated in Mandideep. Here our object is comparing the zero point method with regular method [4] of solving time minimizing transportation problem and we are using different – 2 method to get feasible solution which is solve by tora software.

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Mathematical Time Minimizing Transportation Problem:

In a time transportation problem, the time of transporting goods from m origins to n destinations is minimized, satisfying certain condition in respect of availability at sources and requirements at the destinations.

Thus the time minimizing transportation problem is:

Minimize $Z = [Max_{(i,j)}\, t_{ij} : x_{ij} > 0]$

Subject to $\sum_{j=1}^{n} x_{ij} = a_i \qquad i = 1, 2, 3, \ldots\ldots\ldots m$

$\sum_{i=1}^{m} x_{ij} = b_j, \qquad j = 1, 2, 3, \ldots\ldots\ldots n$

$x_{ij} \geq 0$

Here t_{ij} is the time of transporting goods from the ith origin, where availability is a_i to the j^{th} destination, where the requirement is b_j. For any given feasible solution, $X = [x_{ij}]$ satisfying (1), the time of transportation is the maximum of t_{ij}'s among the cells in which there are positive allocations, i.e., corresponding to the solution X, the time of transportation is $[Max_{(i,j)} = t_{ij} : x_{ij} > 0]$

The aim is to minimize the time of transportation. Such problems arise when it is required to transport perishable goods during war days, it is required to transport food and armament in the shortest possible time and in so many other similar situations.

Zero Point Method

The Zero Point Method proceeds as follows:

Step 1. Construct the transportation table for the given transportation problem and then, convert into a balanced one if not.

Step 2. Subtract each row entries of the transportation table from the row minimum

Step 3. Subtract each column entries of the transportation table after using Step 2 from the column minimum.

Step 4. Check if each column demand is less then to the sum of the supplies whose reduced costs in that column are zero. Also check if each row supply is less than to sum of the column demands whose reduced costs in that row are zero. If so, go to Step 7 (Such reduced table is called the allotment table).

If not go to Step 5

Table 4.1

	W1	W2	W3	W4	Supply
F1	1	10	12	11	23
F2	15	21	22	09	41
F3	22	16	32	15	48
Demand	25	16	30	41	112

Table 4.2

	W1	W2	W3	W4	Supply
F1	23 1	10	12	11	23
F2	2 15	21	30 22	9 09	41
F3	22	16 16	32	32 15	48
Demand	25	16	30	41	112

Table 4.3

	W1	W2	W3	W4	Supply
F1	18 1	10	5 12	11	23
F2	15	16 21	25 22	09	41
F3	7 22	16	32	41 15	48
Demand	25	16	30	41	112

Table 4.4

	W1	W2	W3	W4	Supply
F1	23 1	10	12	11	23
F2	15	21	30 22	11 09	41
F3	2 22	16 16	32	30 15	48
Demand	25	16	30	41	112

Table 4.5

	W1	W2	W3	W4	Supply
F1	23 1	10	12	11	23
F2	2 15	21	30 22	9 09	41
F3	22	16 16	32	32 15	48
Demand	25	16	30	41	112

Table 5.1

Name of Methods	Number of iteration	Allocations	Optimal Solution
North West Corner	3	$x_{11} = 18$; $x_{13} = 5$; $x_{22} = 16$ $x_{23} = 22$; $x_{31} = 7$; $x_{34} = 41$	22
Least Cost	2	$x_{11} = 23$; $x_{23} = 30$; $x_{24} = 11$ $x_{31} = 2$; $x_{32} = 6$; $x_{34} = 30$	22
Vogel Approximation	1	$x_{11} = 23$; $x_{21} = 2$; $x_{23} = 30$ $x_{24} = 09$; $x_{32} = 16$; $x_{34} = 32$	22
Zero Point	1	$x_{11} = 23$; $x_{21} = 2$; $x_{23} = 30$ $x_{24} = 9$; $x_{32} = 16$; $x_{34} = 32$	22

Step 5. Draw the minimum number of horizontal lines and verticals line to cover all the Zeros of the reduced transportation table such that some entries of rows(s) or / column(s) which do not satisfy the condition of the step 4, are not covered.
Step 6. Develop the new revised reduced transportation table as follows:
(i) Find the smallest entry of the reduced cost matrices not covered by any lines.
(ii) Subtract this entry from all the uncovered entries and the same to all entries lying at the intersection of any two lines, and then, go to step 4.
Step 7. Select a cell in the α – row or / and β- column of the reduced transportation table which is the only cell whose reduced time is zero and then allot the maximum possible to that cell. If such a cell does not occur for the maximum value, find the next maximum so that such a cell occurs. If such cell does not occur for any value, we select any cell in the reduced transportation table whose reduced time is zero.
Step 8. Reform the reduced transportation table after deleting the fully used supply point and the received demand points and also, modify it to include the not fully used supply point and not received demand points.
Step 9. Repeat Step 7 to Step 9 until all supply points are used and all demand points are fully received.
Step 10. This allotment yields a solution to the time transportation problem.

Numerical Example

Now, $\Sigma a_i = \Sigma b_j = 112$, the given transportation problem is balanced.

Zero point method:

In this section we are applying zero point method to get optimum solution of time minimizing transportation problem.
by solving zero point method we get the following allotment
$x_{11} = 23$ with $t_{11} = 01$ $x_{21} = 2$ with $t_{21} = 15$
$x_{23} = 30$ with $t_{23} = 22$ $x_{24} = 9$ with $t_{24} = 09$
$x_{32} = 16$ with $t_{32} = 16$ $x_{34} = 32$ with $t_{34} = 15$
We get the optimal time of transportation problem is 22.

Regular Method:

In this section we are using regular method [4] to solve time minimization problem to get optimum time, here we are using North West Corner Method (NWCR), Least Cost Method (LCM) and Vogel Approximation Method (VAM) to get feasible solution and other step using same as. In this section we are using Tora software to solve NWCR, LCM and VAM.

North West Corner Method:

In this section we are using Tora software to solve North West corner method to get feasible solution, and after feasible solution we apply stepping stone method and after three iterations we get the following allotment
$x_{11} = 18$ with $t_{11} = 01$ $x_{13} = 5$ with $t_{13} = 12$
$x_{22} = 16$ with $t_{22} = 22$ $x_{23} = 22$ with $t_{23} = 25$
$x_{31} = 7$ with $t_{31} = 2$ $x_{34} = 41$ with $t_{34} = 15$
We get the optimal time of transportation problem is 22.

Least Cost Method:

In this section we are using Tora software for Least Cost Method to get feasible solution, and after feasible solution we apply stepping stone method and after Two iteration we get the following allotment
$x_{11} = 23$ with $t_{11} = 1$ $x_{23} = 30$ with $t_{23} = 22$
$x_{24} = 11$ with $t_{24} = 09$ $x_{31} = 2$ with $t_{31} = 22$
$x_{32} = 6$ with $t_{32} = 16$ $x_{34} = 30$ with $t_{34} = 15$
We get the optimal transportation of time is 22

Vogel Approximation Method:

In this section we are using Tora software for solving VAM to get feasible optimal time, we get the following allotment
$x_{11} = 23$ with $t_{11} = 01$ $x_{21} = 2$ with $t_{13} = 15$
$x_{23} = 30$ with $t_{23} = 22$ $x_{24} = 09$ with $t_{24} = 09$
$x_{32} = 16$ with $t_{32} = 16$ $x_{34} = 32$ with $t_{34} = 15$
We get the optimal transportation of time is 22.
Table 4.5

Results and Discussion:

After using zero point method and NWCM, LCM and VAM for feasible solution of regular method to solve time minimizing transportation problem to reduced transportation time for Albert David Company for essential commodity and show the results in following table 5.1 and comparison show in fig 1. We observe that NWCM and LCM required the stepping stone method to get the optimal solution but VAM given the directly optimum solution with using stepping stone method and zero point method also given the optimum solution and we also observe zero point method and VAM both are giving the optimum solution of our problem with the same allocations of shipping units.

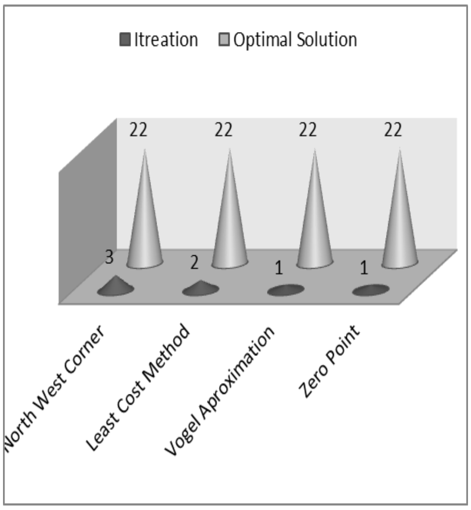

Fig 1. comparison between all method

Conclusion:

The zero point method is a systematic procedure to solve the all type transportation problem because its easy to apply and utilized for all types of transportation problem. This an important tool for the decision makers when they are handling various types of logistic problems because other methods gives an optimal solution but zero point method gives optimal solution without help of any other modified method. In our problem we have get directly optimum solution by zero point method but other method NWCR and LCM also given the optimum solution but they required other supporting method.

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