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Modified LCM'S Approximation Algorithm for Solving Transportation Problems

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Abstract

In this paper, Modified LCM's Approximation Algorithm for Solving Transportation Problems has been developed in order to gain foremost fundamental capable solution of transportation issues where entity cut down the transportation expensive. The proposed algorithm is correlate with popular presenting methods corralling NWCM, LCM and improved algorithm and purposed algorithm found that yield to better results. Algorithm is quickest and effective. Few examples are tested by using modified algorithm is correlate with open literature.

Key Words: Transportation problem, Initial Basic Feasible Solution, Optimal Solution

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1. Introduction

Transportation problem is extremely important of linear programming issues in the area of applied mathematics and also in operation research of linear programming and also compulsory mathematical tool that cope with the use of limited resources. The type of linear programming problems which may be resolved by applying a classified version of the easier procedure which can be called as transportation issues.

Balanced Transportation in which demand and supply are equal where as demand and supply are different in unbalance transportation problem. The main purpose of transportation problem is to minimize the transportation cost. To reach the feasible and the optimal solution of transportation problems.

The transportation was introduced in 1941 by Hitchcock in order to distribute of production of several numerous localities. In 1947, T.C. Koopmans presented a study called 'Optimum Utilization of the Transportation System'. These two contributions are the fundamentals for the progress of transportation problem. These methods such as LCM, NWCM, IM, VAM and ILCM.

The basic initial solution Methods to solve transportation problems are;

-Northwest Corner Method (NWCM)

This is the first to be solved transportation issues, is simple way to minimize the cost. At beginning northwest corner method, we can count the northwest cell in table of transportation by crossing out the rows with nothing to supply or demand by this procedure, continues till we can minimize obtain cost.

-Least Cost Method (LCM)

In this method we can count low cost in table of transportation by crossing out columns with nothing to supply and demand, we continue this procedure till we can obtain minimize cost.

- Improved Algorithm (IM)

To sum up 1st about penalty by taking difference between lower to next lower cost. Taking difference between the largest and smallest in column and in row. This procedure is continued till get optimal result

Let $X_{nk} \geq 0$ be the quantity shipped from the inception "n" to the emplacement "K". The mathematical formulation of the problem is given below.

Minimize $z - \sum_{n=1}^{0}\sum_{k=1}^{c} m_{nk}x_{nk}(Total\ Transportation\ cost)$

Subject to $\sum_{k=1}^{0} x_{nk} = qn\ (Supply\ from\ inception)$

$\sum_{n=1}^{0} x_{nk} = sk\ (Demand\ from\ implacement)$

$X_{nk} > 0, for\ all\ n\ and\ k$

Where Z: Total transportation cost to be reduced

C_{nk}: Unit transportation cost of the commodity from each inception n to emplacement k

X_{nk}: Number of units of commodity sent from each inception n to emplacement k.

Q_n: level of supply at each inception n.

S_k: level of demand at each emplacement k.

Note: Transportation model is balanced if supply $(\sum_{n=1}^{0} qn) = Demand\ (\sum_{n=1}^{o} Sk)$

Otherwise unbalanced if supply $(\sum_{n=1}^{0} qn) \neq Demand(\sum_{n=1}^{o} Sk)$.

Table of the general transportation Problem

Destinations \ Origins	l_1	l_2	…	l_k	…	ln	Supply: qn
P_1	m_{11}	m_{12}	…	m_{1k}	…	m_{1r}	q_1
P_2	m_{21}	m_{22}	…	m_{2k}	…	m_{2r}	q_2
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
P_n	m_{n1}	m_{n2}	…	m_{nk}	…	m_{nr}	q_n
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
P_o	m_{o1}	m_{o2}	…	m_{ok}	…	m_{or}	q_o
Demand: p_k	p_1	p_2	…	p_k	…	p_r	$\sum_{n=1}^{o} q_n = \sum_{k=1}^{0} S_k$

The total number of variables is O.R. The total number of constraints is (o + r) while the total number of locations (o+ r -1) should be in feasible solution. Here the letter indicates the number of rows and indicate the number of columns.

2. Methodology

c_{11}	c_{12}	c_{13}	…	c_{1n}
c_{21}	c_{22}	c_{23}	…	c_{2n}
c_{31}	c_{32}	c_{33}	…	c_{3n}
⋮	⋮	⋮	⋮	⋮
c_{m1}	c_{m2}	c_{m3}	…	c_{mn}

c_{ij} are the cost cells where i= 1,2,3…, n and j=1,2, 3, m. they are following steps

1) Transportation problem ought to be $\sum_{n=1}^{0} qn - \sum_{n=1}^{o} S_k$, In case it is not $\sum_{n=1}^{0} qn \neq \sum_{n=1}^{o} S_k$ a dummy variable needs to be added in order to balance it.
2) Select large number from each columns of each cells and subtract that number from each entry of that cell Suppose c_{31} is large number in $C_{11}|c_{31} - c_{21}|$, $|c_{31} - c_{11}|$ …
3) Allocate largest absolute number of each column corresponding column with respect to supply and demand.
4) If there are similar in column $(m_1 = m_2 = m_n)$ then the minimum cell has to selected from the ginen cells finally there to be applied S_k and q_n.
5) If S_k and qn of the current row are completed we shall move towards the next row repeat step 1-4 till all quantities are exhausted.

3. NUMERICAL ILLUSTRATION

In this paper, esteem four dissimilar size cost minimizing transportation problems, chosen form literature. We also describe these examples to perform a comparative study of proposed algorithm with north and west corner and least cost methods. We solve example 1 step-by-step continuous.

Example No: 1

Destination source	D_1	D_2	D_3	Supply
S_1	6	4	1	50
S_2	3	8	7	40
S_3	4	4	2	60
Demand	20	95	35	∑ 150

Table 2: Solve step by step problem 1

Step 1: Count on the different column by receiving large number from each columns of each cells and subtract from each entry of that cell of each columns Table 2.1.

Destination source	D_1	D_2	D3	Supply
S_1	6	4	1 35	50 – 35 = 15
S_2	3	8	7	40
S_3	4	4	2	60
Demand	20	95	35 – 35 = 0	∑ 115

Table 2.1

Step 2: Using table 2.1 Taking largest absolute number in columns

X_{11} = max (6, 3, 4) = 0 , X_{12} = max(4, 8, 4) = 4 , X_{13}= max (1, 7, 2) = 6 Here 6 is largest absolute number and allocated largest absolute number of each row corresponding with respect to supply and demand then remove D_3 column due to its zero demand

Destination source	D_1	D_2	Supply
S_1	6	4 15	15 – 15 = 0
S_2	3	8	40
S_3	4	4	60
Demand	20	95-15 = 80	∑ 100

Table 2.2

Step3: Using table 2.2 Taking largest absolute number in columns

X_{11} = max (6, 3, 4) = 0, X_{12}= max (4, 8, 4) = 4

4 is largest absolute number in column S_1 is 4 allocated supply and demand S_1 is detected because its supply is zero.

Destination source	D_1	D_2	Supply
S_2	3 20	8	40 -20 = 20
S_3	4	4	60
Demand	20 – 20 = 0	80	∑ 80

Table 2.3

Step 4: Using table 2.3 Taking largest absolute number in columns

X_{21} = max (3, 4) = 1, X_{22}= max (8, 4) = 0

1 is largest absolute number then detect

D_1 column because its supply is zero

Destination source	D_2	Supply
S_2	8 20	20 – 20 = 0
S_3	4	60
Demand	80 – 20 = 60	∑ 60

Table 2.4

Step 5: Using table 2.4 Taking largest absolute number in column X_{22} = max {8,4} = 8 so here 8 is largest absolute number in row S_3 is detected because supply is zero

Destination source	D_2	Supply
S_3	4 60	60 – 60
Demand	60 – 60	∑ 0

Table 2.5

In last, we have allocated demand and supply and then detect the exclusive matrix due to nothing to supply and demand.

Steps 6: applying table 1 all allocates hints for gaining minimized cost.

Destination source	D_1	D_2	D_3	Supply
S_1	6	4	1	50
S_2	3	8	7	40
S_3	4	4	2	60
Demand	20	95	35	∑ 150

Z = 1 x 35 + 4 x 15 + 3 x 20 + 4 x 60 = 35 + 60 + 60 + 160 +240 = 555

4. Optimality Test of Example 1

Taking initial basic feasible solution due to proposed method, we now proceed for optimality using modified Distribution methods here calculate u_i and v_j for occupied basic cell using $u_i + v_j = c_{ij}$

Initial we take $u_1 = 0$

$C_{12} = 41 + v_2 = 4 \Rightarrow V_2 = 4$

$C_{13} = 41 + v_3 = 1 \Rightarrow 0 + v_3 = 1 \Rightarrow v_3 = 1$

$C_{21} = u_2 + v_1 = 3 \Rightarrow 4 + v_1 = 3 \Rightarrow v_1 = -1$

$C_{22} = u_2 + v_2 = 8 \Rightarrow u_2 + 4 = 8 \Rightarrow u_2 = 4$

$C_{32} = u_3 + v_2 = 4 \Rightarrow u_3 + 4 \Rightarrow u_3 = 0$

Destination Source	D_1	D_2	D_3	Supply	Ui
S_1	6	4 $_{15}$	1 $_{35}$	50	$4_1 = 0$
S_2	3 $_{20}$	8 $_{20}$	7	40	$4_2 = 4$
S_3	4	4	2	60	$4_3 = 0$
Demand	20	95	35	∑150	
V_j	$V_i = 1$	$V_2 = 4$	$V_3 = 1$		

$D_{11} = c_{11} – (U_1+U_2) = 6 – (0+1) = 6 – 1 = 5$

$D_{23} = C_{23} – (U_2+V_3) = 7 – (4+1) = 7-5 = 2$

$D_{31} = C_{31} – (u_3+v_1) = 4 – (0+1) = 4-1 = 3$

$D_{11} = C_{33} – (u_3+V_3) = 2- (0+1) = 2-1 = 1$

$D_{11} = 5, D_{23} = 2, D_{31} = 3, D_{33} = 1$

Check the all unoccupied cell single

Destination Source	D_1	D_2	D_3	Supply	
S_1	6 $_5$	4 $_{15}$	1 $_{35}$	50	$4_1 = 0$
S_2	3 $_{20}$	8 $_{20}$	7 $_2$	40	$4_2 = 4$
S_3	4 $_3$	4 $_{60}$	2 $_1$	60	$4_3 = 0$
Demand	20	95	35	∑150	
V_j	$V_1 = 1$	$V_2 = 4$	$V_3 = 1$		

All unoccupied Single are $D \geq 0$ then optimal Solution is

Z = 4*5+1*35+3*20+8*20+4*60= 555 Answer.

The same process is adopted on various examples given below.

Example	Destination Source	D1	D2	D3	Supply	Optimal Solution
Example-2	S1	6	8	4	14	143
	S2	4	9	8	12	
	S3	1	2	6	5	
	Demand	5	10	15	Σ^{31}	

Example	Destination Source	D1	D2	D3	D4	D5	Supply	Optimal Solution
Example-3	S1	4	1	2	4	4	60	273
	S2	2	3	2	2	2	35	
	S3	3	5	2	4	4	40	
	Demand	22	45	20	18	30	Σ^{135}	

Example	Destination Source	D1	D2	D3	D4	Supply	Optimal Solution
Example - 4	S1	7	5	9	11	30	430
	S2	4	3	8	6	25	
	S3	3	8	10	5	20	
	S4	2	6	7	3	15	
	Demand	30	30	20	10	Σ^{90}	

Example	Destination Source	D1	D2	D3	D4	Supply	Optimal Solution
Example - 5	S1	3	1	7	4	300	2850
	S2	2	6	5	9	400	
	S3	8	3	3	2	500	
	Demand	250	350	400	200	Σ^{1200}	

5. RESULTS AND DISUCSSION

It has been examined that the performance of proposed Algorithm in comparison to LCM, NWCM and Improved Algorithm by examining five examples the result gained using proposed algorithm in examples 1, 2, 3and 5 was same as the optimal outcome., While in example 4 it is close to the optimal solution. It could be clearly seen that the proposed algorithm gave reliable results which was against with the flourishing methods- NWCM, LCM and Improved Algorithm.

No. of Example	Type of problem	Result of NWCM	Result of LCM	Result of IM	Result of proposed Methods	Optimal Solution
Example-1	**3 * 3**	**730**	**555**	**555**	**555**	**555**
Example-2	**3 * 3**	**228**	**163**	**144**	**143**	**143**
Example-3	**3 * 5**	**363**	**278**	**273**	**273**	**273**
Example-4	**4 * 4**	**540**	**435**	**415**	**430**	**410**
Example-5	**3 * 4**	**4400**	**2900**	**2850**	**2850**	**2850**

6. CONCLUSION

In this paper, for achieving fundamental capable solution of transportation issues, Modified LCM'S approximation Algorithm has been developed. The proposed algorithm has been looked over for optimality. A comparison of proposed algorithm has been made with Least Cost Method, North West Corner Method and An Improved Algorithm by examining 5 numerical examples. It is examined that the proposed algorithm has succumbed capable of outcome which were opposite to the conventional methods.

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