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An Initial Basic Feasible Solution for Transportation Problem-South West Corner Method

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Abstract: In this paper, a new method is introduced to find the initial basic feasible solution called south-west corner method. Using the solution from this method, MODI can be applied to find the optimum solution.

Keywords: Transportation problem(TP), Initial Basic Feasible Solution(IBFS), South-west corner method(SWR), North-west corner method(NWC)

I. INTRODUCTION

A. Mathematical Formulation Of Any Transportation Problem

$$\text{Minimize } Z = \sum_{i=1}^m \sum_{j=1}^n x_{ij} C_{ij}$$

$$\text{Subject to constraints } \sum_{j=1}^n x_{ij} = a_i \quad i=1,2,\dots,m$$

$$\sum_{i=1}^m x_{ij} = b_j \quad j=1,2,\dots,n$$

$$x_{ij} \geq 0 \text{ for all } i \text{ and } j$$

where ,

a_i = quantity of commodity available at origin i

b_j =quantity of commodity available at destination j

c_{ij} = cost of transporting one unit of commodity from i^{th} origin to j^{th} destination

x_{ij} = quantity transported from i to j

That is, the objective of any transportation problem is to minimize the transportation cost in such a way that all the demands are satisfied.

B. Transportation table

Any TP can be represented explicitly as a following table: Supply

| | | | | | | | | |
|-------------|----------|----------|-------|----------|-------|-------|-------|-------|
| C_{11} | C_{12} | C_{13} | | C_{1n} | a_1 | | | |
| C_{21} | C_{22} | C_{23} | | C_{2n} | a_2 | | | |
| C_{31} | C_{32} | C_{33} | | C_{3n} | a_3 | | | |
| \vdots | \vdots | \vdots | | \vdots | | | | |
| C_{m1} | C_{m2} | C_{m3} | | C_{mn} | a_m | | | |
| Destination | | | | b_1 | b_2 | b_3 | | b_n |

The 'mn' squares are called cells. C_{ij} is the per unit cost of transporting commodity from i^{th} source to j^{th} destination. Any feasible solution is shown by entering x_{ij} in the $(i,j)^{th}$ cell with a box on its top left corner. The various a 's and b 's are called rim requirements. The feasibility of a solution can be verified by summing the values of x_{ij} along the rows and down the columns.

C. *Necessary and Sufficient Condition For The Existence Of A Feasible Solution*

$$\sum_{i=1}^m a_i = \sum_{j=1}^n b_j \quad \text{i.e Total supply= Total demand}$$

If this condition is satisfied for a TP, it is said to be balanced.

D. *Feasible Solution*

Any set of x_{ij} that minimizes the objective function of the TP is called optimum solution. This can be found by MODI Method.

E. *Basic Feasible solution*

The no. of basic (decision) variables of a general TP at any stage must be $m+n-1$, where m is the no. of origins, n is the no. of destinations.

F. *Initial Basic Feasible Solution*

An IBFS is a solution that satisfies all the supply & demand conditions.

G. *Optimum solution*

Any feasible solution that minimizes the objective function of the TP is called optimum solution. This can be found by MODI Method.

II. SOUTH-WEST CORNER METHOD:

This is one of the methods to find IBFS of any TP. Various steps involved are:

- 1) *Step 1:* If the problem is of maximization type, the problem is to be converted to minimization type by subtracting the other costs from the highest cost available in the table
- 2) *Step 2:* If the necessary and sufficient condition is not satisfied, i.e.
 - a) If the Total demand > Total supply, then include a dummy row with cost as '0' and supply value of that row as "Total demand – Total supply"
 - b) If Total supply > Total demand, then include a dummy column with cost as '0' and demand value of that column as "Total supply – Total demand"

Now, TP becomes balanced.

- 3) *Step 3:* For the above TP, select the south-west (lower-left hand) of the TP and allocate as much as possible so that either capacity of the last row is exhausted or the destination requirement of the first column is satisfied.

i.e., $x_{m1} = \min(a_m, b_1)$

- 4) *Step 4:* If $a_m < b_1$, omit the m^{th} row and fix $b_1 = b_1 - x_{m1}$. Now the table reduces to $(m-1)$ rows and n columns.

If $b_1 < a_m$, omit the first column and fix $a_m = a_m - x_{m1}$ which reduces TP to m rows and $(n-1)$ columns.

- 5) *Step 5:* Repeat the steps 3 and 4 moving up towards upper right corner of the TP until all requirement are satisfied.

- 6) *Step 6:* Finally $\sum_{i=1}^m \sum_{j=1}^n C_{ij} x_{ij}$ will give the transportation cost.

III. EXAMPLES

- 1) *Example 1:* Consider the following TP with cost in ₹

| | | | |
|--------|----|----|----|
| 1 | 2 | 6 | 7 |
| 0 | 4 | 2 | 12 |
| 3 | 1 | 5 | 11 |
| Demand | 10 | 10 | 10 |

This problem is balanced as Total supply = Total demand =30. When south west corner method is used to find IBFS the $m+n-1=5$ solutions becomes,

$$x_{13}=7, x_{22}=9, x_{23}=3, x_{31}=10, x_{32}=1$$

Transportation cost is ₹ 11

When MODI method is applied, it is possible to find the minimized cost.

2) *Example 2:* When south west cost method is applied to the following TP, it gives cheaper cost than NWC Supply

| | | | | |
|--------|----|---|---|-------------|
| 5 | 1 | 3 | 3 | 34 |
| 3 | 3 | 5 | 4 | 15 |
| 6 | 4 | 4 | 3 | 12 |
| 4 | -1 | 4 | 2 | 19 |
| Demand | | | | 21 25 17 17 |

Here Total supply = 80 = Total demand

Hence solution is, when SWC method is used,

$$x_{13}=17, x_{14}=17, x_{22}=15, x_{23}=0, x_{31}=2, x_{32}=10, x_{41}=19$$

Cost= ₹ 259

3) *Example 3:* Consider the following maximized TP cost with cost in \$

SUPPLY

| | | | | |
|--------|----|----|----|-----------------|
| 71 | 13 | 17 | 14 | 200 |
| 16 | 18 | 14 | 10 | 300 |
| 21 | 24 | 13 | 10 | 450 |
| DEMAND | | | | 200 225 275 250 |

The corresponding TP is

| | | | | |
|----|----|----|----|-----------------|
| 13 | 11 | 7 | 10 | 200 |
| 8 | 6 | 10 | 14 | 300 |
| 3 | 0 | 11 | 14 | 450 |
| | | | | 200 225 275 250 |

The solution to the given TP is

$$X_{14}=200, x_{23}=250, x_{24}=50, x_{31}=200, x_{32}=225, x_{33}=25 \text{ using SWC}$$

Cost for given TP is \$ 16525

4) *Example 4:* For the following unbalanced TP solution from south west corner method is $x_{14}=2, x_{23}=4, x_{24}=4, x_{31}=4, x_{32}=2, x_{33}=4$.

Cost= ₹28

| | | | | |
|---|---|---|---|---------|
| 1 | 2 | 3 | 4 | 6 |
| 4 | 3 | 2 | 0 | 8 |
| 0 | 2 | 2 | 1 | 10 |
| | | | | 4 2 8 6 |

IV. CONCLUSION

A new south west corner method is introduced to find the IBFS for any TP which is very simple and provides better transportation cost than NWC at times. It is explained with 4 examples.



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