International Journal of Mathematical Archive-4(11), 2013, 71-77
Available online through www.ijma.info ISSN 2229 – 5046

A NEW TYPE OF TRANSPORTATION PROBLEM USING OBJECT ORIENTED MODEL

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(Received on: 07-10-13; Revised & Accepted on: 30-10-13)

ABSTRACT

In this paper we introduce the new type of transportation problem called South east corner rule. We solve the transportation problem using OR approach in analysis, design phases and we use the java programming language to model the problem. The results obtain from both solutions are compared to make analysis & prove the object oriented model correctness. We proved that the both results are identical & have the same results when solving the problem using the south east corner rule.

Keywords: *Transportation problem, LPP, optimal solution, south east corner rule, object oriented programming.*

1. INTRODUCTION

The term 'OR' was coined in 1940 by M. C. Closky & T.ref then in a small town of Bawdsey in England. It is a science that came into existence in a military content. During world war II, the military management of UK called an Scientists from various disciplines & organized them into teams to assist it in solving strategic & tactical problems relating to air & land defence of the country.

The transportation problem is a special class of LPP that deals with shipping a product from multiple origins to multiple destinations. The objective of the transportation problem is to find a feasible way of transporting the shipments to meet demand of each destination that minimizes the total transportation cost while satisfying the supply & demand constraints. The two basic steps of the transportation method are

Step 1: Determine the initial basic feasible solution

Step 2: Obtain the optimal solution using the solution obtained from step 1.

In this paper we introduce the new type of transportation problem called South east corner rule. I have presented that the proposed south east corner rule for finding optimal solution of a transportation problem do not reflect optimal solution continuously. Three examples are provided to my claim. Also by the North west corner rule process optimal solutions are showed to illustrate the comparison.

2. MATHEMATICAL STATEMENT OF THE TRANSPORTATION PROBLEM

A. In developing the LP model of the transportation problem the following notations are used
a_i - Amounts to be shipped from shipping origin i ($a_i \geq 0$.
b_j - Amounts to be received at destination j ($b_j \geq 0$).
c_{ij} - Shipping cost per unit from origin i to destination j ($c_{ij} \geq 0$).
x_{ij} - Amounts to be shipped from origin i to destination j to minimize the total cost ($x_{ij} \geq 0$).

We assumed that the total amount shipped is equal to the total amount received, that is,

$$\sum_{i=1}^{m} a_i \geq \sum_{j=1}^{n} b_j .$$

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B. Transportation problem

$$\text{Min } \sum_{i=1}^{m} \sum_{j=1}^{n} c_{ij}\, x_{ij} \ .$$

Subject to $\sum_{j=1}^{n} x_{ij} \leq a_i$, i = 1 , 2 , … , m

$$\sum_{i=1}^{m} x_{ij} = b_j \text{ , j = 1 , 2 , … , n , where } x_{ij} \geq 0 \ \forall \text{ i , j .}$$

Feasible solution: A set of non negative values x_{ij} , i = 1 , 2 , …, n and j = 1 , 2 , …, m that satisfies the constraints is called a feasible solution to the transportation problem .

Optimal solution: A feasible solution is said to be optimal if it minimizes the total transportation cost.

Non degenerate basic feasible solution: A basic feasible solution to a (m × n) transportation problem that contains exactly m + n – 1 allocations in independent positions.

Degenerate basic feasible solution: A basic feasible solution that contains less that m + n – 1 non negative allocations.

Balanced and Unbalanced Transportation problem: A Transportation problem is said to be balanced if the total supply from all sources equals the total demand in the destinations and is called unbalanced otherwise.

Thus, for a balanced problem, $\sum_{i=1}^{m} a_i = \sum_{j=1}^{n} b_j$ and for unbalanced problem, $\sum_{i=1}^{m} a_i \neq \sum_{j=1}^{n} b_j$.

3. SOUTH EAST CORNER RULE

In this section, we introduce a new method called the south east corner rule for finding an optimal solution to a transportation problem. This method is similar to that of north west corner rule. The south east corner rule proceeds as follows.

This method starts at the south east corner cell (route) of the table variable (x_{43}).

Step 1: Construct the transportation table for the given TPP.

Step 2: Allocate as much as possible to the selected cell and adjust the associated amounts of supply and demand by subtracting the allocated amount.

Step 3: Cross out the row or column with zero supply or demand to indicate that no further assignments can be made in that row or column. I both a row and column net to zero simultaneously, cross out one only and leave a zero supply (demand in the uncrossed out row - column).

Step 4: If exactly one row or column is left uncrossed out, stop. Otherwise, move to the cell to the right if a column has just been crossed out. Go to step 2 [8].

3.1 Numerical examples:

Problem 3.1: Obtain the IBFS of a Transportation problem whose cost & rim requirement table is given below

Origin / Destination	D_1	D_2	D_3	Supply
O_1	2	7	4	5
O_2	3	3	1	8
O_3	5	4	7	7
Demand	**7**	**9**	**18**	**34**

Solution: By applying south east corner rule process allocations are obtained as follows:

Since $\sum a_i = \sum b_j$ there exists a feasible solution to the transportation problem.

We obtain initial feasible solution as follows:

Origin / Destination	D_1	D_2	D_3	Supply
O_1	**5** 2	7	4	**5**
O_2	**2** 3	**6** 3	1	**8**
O_3	5	**3** 4	**4** 7	**7**
O_4	1	6	**14** 2	**14**
Demand	**7**	**9**	**18**	**34**

Table 3.1

The initial basic feasible solution is given by

$x_{43} = 14$, $x_{33} = 4$, $x_{32} = 3$, $x_{22} = 6$, $x_{21} = 2$, $x_{11} = 5$.

Total cost = $2 \times 14 + 7 \times 4 + 4 \times 3 + 3 \times 6 + 3 \times 2 + 2 \times 5$
= $28 + 28 + 12 + 18 + 6 + 10$
= $56 + 30 + 16$
= Rs.102.

By applying North west corner rule the allocations are obtained as follows

Origin / Destination	D_1	D_2	D_3	Supply
O_1	**5** 2	7	4	**5**
O_2	**2** 3	**6** 3	1	**8**
O_3	5	**3** 4	**4** 7	**7**
O_4	1	6	**14** 2	**14**
Demand	**7**	**9**	**18**	**34**

The initial basic feasible solution is given by

$x_{11} = 5$, $x_{21} = 2$, $x_{22} = 6$, $x_{32} = 3$, $x_{33} = 4$, $x_{43} = 14$.

Total cost = $2 \times 5 + 2 \times 3 + 6 \times 3 + 3 \times 4 + 4 \times 7 + 2 \times 14$
= Rs. 102.

Commits: The South east corner rule process shows that the optimal solution is Rs. 102 and it is exact and North west corner rule gives the same result.

Problem 3.2: Solve the transportation problem when the unit transportation costs, demands and supplies are as given below.

Origin / Destination	D_1	D_2	D_3	D_4	Supply
O_1	6	1	9	3	70
O_2	11	5	2	8	55
O_3	10	12	4	7	70
Demand	**85**	**35**	**50**	**45**	

Solution: By applying south east corner rule process allocations are obtained as follows:

Since the total demand $\sum b_j$ = 215 is greater than the total supply$\sum a_i$ = 195, the problem is an unbalanced TP.

We convert into a balanced TP by introducing a dummy origin O_4 with cost zero and giving supply equal to 215 – 195 = 20 units. Hence, we have the converted problem as follows:

Origin / Destination	D_1	D_2	D_3	D_4	Supply
O_1	6	1	9	3	**70**
O_2	11	5	2	8	**55**
O_3	10	12	4	7	**70**
O_4	0	0	0	0	**20**
Demand	**85**	**35**	**50**	**45**	**215**

Table 3.2

Origin / Destination	D_1	D_2	D_3	D_4	Supply
O_1	**70** 6	1	9	3	**70**
O_2	**15** 11	**35** 5	**5** 2	8	**55**
O_3	10	12	**45** 4	**25** 7	**70**
O_4	0	0	0	**20** 0	**20**
Demand	**85**	**35**	**50**	**45**	**215**

Table 3.3

Total cost matrix:

70 6	1	9	3
15 11	**35** 5	**5** 2	8
10	12	**45** 4	**25** 7
0	0	0	**20** 0

The initial basic feasible solution is given by

x_{44} = 20, x_{34} = 25, x_{33} = 45, x_{23} = 5, x_{22} = 35, x_{21} = 15, x_{11} = 70.

Total cost = 0× 20 + 7 × 25 + 4 ×45 + 2×5 +5×35 +11×15 + 6 × 70
= Rs.1010.

By applying north west corner rule process allocations are obtained as follows:

65 6	**5** 1	9	3
11	**30** 5	**25** 2	8
10	12	**25** 4	**45** 7
20 0	0	0	0

The initial basic feasible solution is given by

$X_{11} = 65$, $x_{12} = 5$, $x_{22} = 30$, $x_{23} = 25$, $x_{33} = 25$, $x_{34} = 45$, $x_{41} = 20$.

Total cost = $6 \times 65 + 5 \times 1 + 5 \times 30 + 2 \times 25 + 4 \times 25 + 7 \times 45 + 0 \times 20$
= Rs.1010.

Commits: The South east corner rule process shows that the optimal solution is Rs. 1010 and it is exact and North west corner rule gives the same result.

4. COMPARISON

In this section we compare the relationship between the transportation problem like south west corner rule and north west corner rule, least cost method. The numerical examples are given below.

Problem 4.1: Obtain initial basic feasible solution to the following transportation problem using south east corner rule and north west corner rule, least cost method, VAM.

Origin	D	E	F	G	Available
A	11	13	17	14	250
B	16	18	14	10	300
C	21	24	13	10	400
Requirements	200	225	275	250	

Solution: By applying North west corner rule the allocations are obtained as follows**:**

Origin	**D**	**E**	**F**	**G**	**Available**
A	**200** 11	**50** 13	17	14	250
B	16	**175** 18	**125** 14	10	300
C	21	24	**150** 13	**250** 10	400
Requirements	200	225	275	250	

The IBFS is

$x_{11} = 200$, $x_{12} = 50$, $x_{22} = 175$, $x_{23} = 125$, $x_{33} = 150$, $x_{34} = 250$.

Total cost = $11 \times 200 + 13 \times 50 + 18 \times 175 + 14 \times 125 + 13 \times 150 + 10 \times 250$
= Rs. 12, 200

By applying Least cost method the allocations are obtained as follows:

Origin	**D**	**E**	**F**	**G**	**Available**
A	**200** 11	**50** 13	17	14	250
B	16	**50** 18	14	**250** 10	300
C	21	**125** 24	**215** 13	10	400
Requirements	200	225	275	250	

The IBFS is

$x_{11} = 200$, $x_{12} = 50$, $x_{22} = 50$, $x_{24} = 250$, $x_{32} = 125$, $x_{33} = 215$.

Total cost = $11 \times 200 + 13 \times 50 + 18 \times 50 + 10 \times 250 + 24 \times 125 + 13 \times 215$
= Rs.12, 825.

By applying Vogels Approximation method the allocations are obtained as follows**:**

200 11	**50** 13	17	14
16	**175** 18	14	**125** 10
21	24	**275** 13	**125** 10

The IBFS (using north west corner rule) is

x_{11} = 200, x_{12} = 50, x_{22} = 175, x_{24} = 125, x_{33} = 275, x_{34} = 215.

Total cost = 11 × 200 + 13 × 50 + 18 × 175 + 10 × 125 + 13 × 275 + 10 × 125
= 12,075

By applying South east corner rule the allocations are obtained as follows:

200 11	**50** 13	17	14
16	**175** 18	**125** 14	**250** 10
21	**125** 24	**150** 13	**125** 10

The IBFS is

x_{11} = 200, x_{12} = 50, x_{22} = 175, x_{23} = 125, x_{24} = 250, x_{32} = 125, x_{34} = 125, x_{33} = 150.

Total cost = 10 × 125 + 13 × 150 + 24×125 + 14×125 + 18 × 175 + 10 × 250 + 11 × 200 +13 ×50.
= Rs.10, 625

Commits: The South east corner rule processes shows that the optimal solution is Rs.10, 625 whereas North west corner rule, least cost method and VAM gives the wrong results which are not optimal.

5. SOLVING TRANSPORTATION PROBLEM USING JAVA LANGUAGE

In this section we solve the transportation problem (south east corner and North West rule) using JAVA language. The main ideas from design Java programs are save time, money and effort.

5.1 JAVA Program me:

In Problem 3.1, we use the java programs to minimize the cost of transportation and determine the number of units transported from source i to destination j.

The results are shown as follows:

The result of south east corner program by JAVA language is the cost of transportation = Rs. 102.

The number of units transported from source i to destination j

We transport
Supply [3] to demand [2] = 14

Supply [2] to demand [2] = 4

Supply [2] to demand [1] = 3

Supply [1] to demand [1] = 6

Supply [1] to demand [0] = 2

Supply [0] to demand [0] = 5

Press any key to continue

The result of north west corner program by JAVA language is the cost of transportation = Rs. 102.

The number of units transported from source i to destination j

We transport

Supply [0] to demand [0] = 5

Supply [1] to demand [0] = 2

Supply [1] to demand [1] = 6

Supply [2] to demand [1] = 3

Supply [2] to demand [2] = 4

Supply [3] to demand [2] = 14

CONCLUSION

Running the above JAVA programs, the result of the programs are equal to LP solution but the solution using JAVA language faster and easier then LP solution. There is scope for further development of these topics.

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Source of support: Nil, Conflict of interest: None Declared