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Solving of transportation problem by various methods of cardinal directions

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Abstract - *The transportation problem is one of the special class of linear programming problems. It is concerned with the transportation of the commodity from 'm' sources to 'n' destinations. The main objective of the transportation problem is to minimize the distribution cost while satisfying both the limits of supply and demand. In this paper we have tried to reveal that the projected methods such as north-west, north-east, south-east and south -west, for finding initial basic feasible solution of a transportation problem, do not always provide initial basic feasible solution at all times.*

Keywords *- sources; destinations; transportation problem; basic feasible solution cardinal directions*

I. INTRODUCTION

Transportation problem has been widely studied in the Operations Research. It is a tool widely utilized to determine and minimize the transportation cost with the number of sources and destinations to satisfy certain parameters of the supply and demand constraints. Transportation models play a vital role in the logistics and supply for the reduction of cost. It is assumed that the balanced conditions for the Transportation problem is that total demand is equal to the total supply and unbalanced conditions is that total demand is not equal to the total supply. Finding an initial basic feasible solution of the commodity with the satisfaction of demands at each destination is the main aim of solving the problem. In the year 1941, F.L.Hitchcock[1] developed the basic Transportation problem in his paper "The Distribution of a Product from several sources to numerous localities" and later in 1949 Koopmans[2] presented in his historic paper "Optimum Utilization of the Transportation system" in detail. S. Kalavathy[3] and Prof. V. Sundaresan et al [4] have also discussed it. The main objective of the transportation problem is to minimize the deviation of the transportation which has been studied by many researchers, some of which are Sharma and Swarup, Seshan and Tikekar, Prakash and Papmanthou and Sonia. Sonia et al. studied the transportation problem on time. Many methods have been introduced for finding the initial basic feasible solution. Among them some methods directly attain the objective such as SWCR, NWCR, and SECR methods. Two numerical examples have been provided below. Also through the NWCR method we have attempted to show initial basic feasible solutions to illustrate the comparison.

II. DEFINITIONS

2.1. Feasible Solution

A feasible solution is that it should satisfy the set of non-negative values xij, where i,j = 1,2,…n, of the constraints.

2.2. Basic Feasible Solution (BFS)

A Basic Feasible Solution (BFS) is that it contains not more than m+n-1 non-negative allocations. where 'm' is the rows and 'n' is the columns.

2.3. Balanced and Unbalanced Transportation problem

If the total of supply and demand are equal then it is said to be a balanced transportation problem

(i.e.) $\sum_{i=1}^{m} ai = \sum_{j=1}^{n} bj$. (i=1,2…m) (j =1,2…n)

For unbalanced problem, if the total of supply and demand is not equal then it is said to be an unbalanced transportation problem

(i.e.) $\sum_{i=1}^{m} ai \neq \sum_{j=1}^{n} bj$. (i=1,2…m) (j=1,2…n)

2.4. Standard transportation table

Transportation problem is clearly represented by the following transportation table:

Table 1. Destination

Sources	D_1	D_2	D_3	..	D_m	..	D_n	Supply
s_1	c_{11}	c_{12}	c_{13}		c_{1j}		c_{1n}	a_1
s_2	c_{21}	c_{21}	c_{21}		c_{2j}		c_{21}	a_2
	:	:	:		:		:	:
s_i	c_{i1}	c_{i2}	c_{i3}		c_{ij}		c_{in}	a_i
s_m	c_{m1}	c_{m2}	c_{m3}		c_{mj}		c_{mn}	a_m
Demand	b_1	b_2	b_3		b_m		b_n	$\sum_{i=1}^{m} ai = \sum_{j=1}^{n} bj$

III. PROCEDURE

3.1. North-West Corner method or NWCR

The algorithm for this method is as follows:

Step 1: As a first step, check the values of demand and supply. If they are equal then treat it as a balanced problem, else it is an unbalanced one.

Step 2: Since it is a North-West Corner method, start from the top-left corner i.e., c_{11} of the transportation matrix. Then compare demand and supply.

Step 3: If the values of both are equal then assign either of the values to the first element and the remaining is set to zero irrespective of row or column. If the values are not equal then assign the lesser value to the first element. Then strike out the corresponding row or column.

Step 4: Repeat the same method for the remaining rows and columns until the supply and demand values are zero.

Step 5: Attain the initial basic feasible solution.

3.2. North-East Corner method or NECR

Now, a new logic called the North-East Corner method is introduced. The method proceeds as follows:

Step 1: As a first step, check the values of demand and supply. If they are equal then treat it as a balanced problem, else it is an unbalanced one.

Step 2: Since it is a North-East Corner method, start from the top-right corner, i.e., c_{1n} of the transportation matrix. Then compare demand and supply.

Step 3: If the values of both are equal then assign either of the values to the first element and the remaining is set to zero irrespective of row or column. If the values are not equal then assign the lesser value to the first element. Then strike out the corresponding row or column

Step 4: Repeat the same method for the remaining rows and columns until the supply and demand values are zero

Step 5: Attain the initial basic feasible solution

3.3. South-East Corner method or SECR

Next we introduce a technique called the South-East Corner method. Following are the steps:

Step 1: As a first step, check the values of demand and supply. If they are equal then treat it as balanced problem, else it is an unbalanced one.

Step 2: Since it is a South-East corner method, start from the bottom-right corner i.e., c_{mn} of the transportation matrix. Then compare demand and supply.

Step 3: If the values of both are equal then assign either of the values to the first element and the remaining is set to zero irrespective of row or column. If the values are not equal then assign the lesser value to the first element. Then strike out the corresponding row or column

Step 4: Repeat the same method for the remaining rows and columns until the supply and demand values are zero

Step 5: Attain the initial basic feasible solution

3.4. South-West Corner method or SWCR

We next present the South-West Corner method. The steps are as follows:

Step 1: As a first step, check the values of demand and supply. If they are equal then treat it as balanced problem, else it is an unbalanced one.

Step 2: Since it is a South-West corner method, start from the bottom-left corner i.e., c_{m1} of the transportation matrix. Then compare demand and supply.

Step 3: If the values of both are equal then assign either of the values to the first element and the remaining is set to zero irrespective of row or column. If the values are not equal then assign the lesser value to the first element. Then strike out the corresponding row or column

Step 4: Repeat the same method for the remaining rows and columns until the supply and demand values are zero

Step 5: Attain the initial basic feasible solution

IV. NUMERICAL EXAMPLES

4.1. Problem 1

Determine the initial basic feasible solution of the following transportation problem with 3 companies and 3 retailers

Table 2

Company	R_1	R_2	R_3	**Supply**
p_1	**1**	**2**	**6**	**7**
p_2	**0**	**4**	**2**	**12**
p_3	**3**	**1**	**5**	**11**
Demand	**10**	**10**	**10**	**30**

Solution

Since $\sum_{i=1}^{m} ai = \sum_{j=1}^{n} bj$ the given problem is balanced

Solution by NWCR method: $c_{11} = 7$; $c_{21} = 3$; $c_{22} = 9$; $c_{32} = 1$; $c_{33} = 10$

Total initial transportation Cost=(7*1)+(0*3)+(9*4)+(1*1)+(10*5)=94

Solution by NECR method: $c_{13} = 7$; $c_{22} = 9$; $c_{23} = 3$; $c_{31} = 10$; $c_{32} = 1$

Total initial transportation Cost=(6*7)+(9*4)+(3*2)+(10*3)+(1*1)=115

Solution by SWCR method: $c_{13} = \mathbf{7}$; $c_{22} = \mathbf{9}$; $c_{23} = \mathbf{3}$; $c_{31} = \mathbf{10}$; $c_{32} = \mathbf{1}$

Total initial transportation Cost=(6*7)+(9*4)+(3*2)+(10*3)+(1*1)=115

Solution by SECR method: $c_{11} = \mathbf{7}$; $c_{21} = \mathbf{3}$; $c_{22} = \mathbf{9}$; $c_{32} = \mathbf{1}$; $c_{33} = \mathbf{10}$

Total initial transportation Cost=(7*1)+(0*3)+(9*4)+(1*1)+(10*5)=94

Inference: The NWCR method shows that the initial basic feasible solution is $94 and it is exact and SWCR method gives the same result which minimizes the transportation cost . But NECR and SWCR methods give $115 which maximizes the transportation cost.

4.2. Problem 2

Find the basic feasible solution for the following transportation problem

Table 3

Factories	W_1	W_2	W_3	W_4	Supply
F_1	4	6	8	13	50
F_2	13	11	10	8	70
F_3	14	4	10	13	30
F_4	9	11	13	8	50
Demand	25	35	105	20	200 / 185

Solution

Since $\sum_{i=1}^{m} ai \neq \sum_{j=1}^{n} bj$ the given problem is unbalanced. we introduce a dummy column with zero entries and make it balanced. so the given problem becomes

Table 4

Sources	D_1	D_2	D_3	D_4	D_5	Supply
s_1	4	6	8	13	0	50
s_2	13	11	10	8	0	70
s_3	14	4	10	13	0	30
s_4	9	11	13	8	0	50
Demand	25	35	105	20	15	200

Since $\sum_{i=1}^{m} ai = \sum_{j=1}^{n} bj$ the given problem is balanced

Solution by NWCR method: $c_{11} = \mathbf{25}$; $c_{12} = \mathbf{25}$; $c_{22} = \mathbf{10}$; $c_{23} = \mathbf{60}$;

$c_{33} = \mathbf{30;}$ $c_{43} = \mathbf{15}$; $c_{44} = \mathbf{20}$; $c_{45} = \mathbf{15}$

Total initial transportation Cost=(25*4)+(25*6)+(10*11)+(60*10)+(30*10) +(15*13)+(20*8)=1615

Solution by NECR method:

$c_{13} = \mathbf{15}$; $c_{14} = \mathbf{20}$; $c_{15} = \mathbf{15}$; $c_{23} = \mathbf{70}$;

$c_{32} = \mathbf{10;}$ $c_{33} = \mathbf{20}$; $c_{41} = \mathbf{25}$; $c_{42} = \mathbf{25}$

Total initial transportation Cost=(15*8)+(20*13)+(15*0)+(70*10)+(10*4) +(20*10)+(25*9)+(25*11)=1820

Solution by SWCR method:

$c_{13} = \mathbf{15}$; $c_{14} = \mathbf{20}$; $c_{15} = \mathbf{15}$; $c_{23} = \mathbf{70}$;

$c_{32} = \mathbf{10;}$ $c_{33} = \mathbf{20}$; $c_{41} = \mathbf{25}$; $c_{42} = \mathbf{25}$

Total initial transportation Cost=(15*8)+(20*13)+(15*0)+(70*10)+(10*4) +(20*10)+(25*9)+(25*11)=1820

Solution by SECR method:

$c_{11} = \mathbf{25}$; $c_{12} = \mathbf{25}$; $c_{22} = \mathbf{10}$; $c_{23} = \mathbf{60}$;

$c_{33} = \mathbf{30;}$ $c_{43} = \mathbf{15}$; $c_{44} = \mathbf{20}$; $c_{45} = \mathbf{15}$

Total initial transportation Cost=(25*4)+(25*6)+(10*11)+(60*10)+(30*10) +(15*13)+(20*8)=1615

Inference: The NWCR method shows that the initial basic feasible solution is $1615 and it is precise and SWCR gives the same result which minimizes the transportation cost. But NECR and SWCR methods give $1820 which maximizes the transportation cost.

V. RESULT

S.no		**NWCR**	**SECR**	**NECR**	**SWCR**
1.	Balanced T.p.	$94	$94	$115	$115
2.	Unbalanced T.p.	$1615	$1615	$1820	$1820

VI. CONCLUSION

In consideration of the above results, we can safely conclude that among the four methods, North-West Corner and South-East Corner methods provide the better solutions by minimizing the transportation cost.

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