

# A Comparative Study of Transportation Problem Using C++ and Mat Lab

Prof. Megha A. Janbandhu  
Department of Mathematics  
S.R.P.C.E.  
Nagpur, India  
janbandhu\_megha@yahoo.com

Prof. Madhu S. Palod  
Department of Mathematics  
S.R.P.C.E.  
Nagpur, India  
madhupalod@gmail.com

Prof. B.H. Ganthade  
Department of Mathematics  
S.R.P.C.E.  
Nagpur, India  
ganthade\_b@yahoo.co.in

**Abstract**— This paper is about solving transportation problem using Operation Research (OR) approach in analysis and design phases and we try to use C++ programming language and Mat lab to model the problem. The results obtain from these methods solutions will compared in order to make analysis and prove the object-oriented model correctness. We will try the results obtained from these are identical and have the same results when solving the problem using the five methods northwest corner method, minimum cost method, row minimum cost method, column minimum cost method, and Vogel's approximation method. In future we compare these problem by using C++ and Mat lab for Comparison for Accuracy and Lesser time.

**Keywords**— Transportation problem, Linear Programming (LP), object oriented programming, Mat Lab.

\*\*\*\*\*

## I. INTRODUCTION

Operations research is a statistical tool which was developed during the World War II by the military management of the United Kingdom. A large group of scientists were called from all over the country to give a research plan to analyze the situation and develop a strategy to meet the requirements of the war. After the World War II these techniques were applied to various fields. Operations research was developed as a science. In today's world these techniques are applied in each and every field to meet the requirements to solve a problem. Transportation problem is a special case of Operations research. In Transportation we deal with the problems regarding the shipment of the goods from one place to another i.e. source to the destinations Here we try to minimize the total cost allocated for the transportation of the goods. 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: Finding an Initial Basic Feasible Solution  
Step 2: Testing optimality of the solution taken from Step-1  
The pictorial representation of the transportation model is given in fig.1.

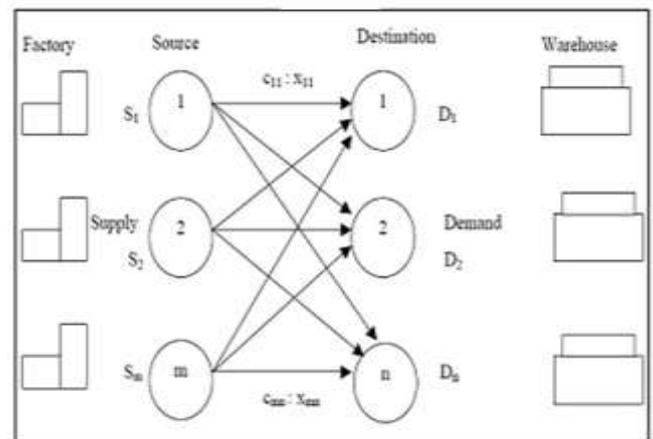


Fig 1: Network representation of the transportation problem

## II. MATHEMATICAL FORMULATION

- In the Transportation algorithm we use the following steps.
- $u_i$  – It Represents the sources from which the goods are to be shipped.
  - $v_j$  – It Represents the destinations to which the goods are to be transported.
  - $a_{ij}$  ---It Represents the cost associated to transfer a good from  $u_i$  to  $v_j$ .
  - We assumed that the supply at the source and the demand at the destination are equal.

### III. INITIAL BASIC FEASIBLE SOLUTION

The solutions obtained it satisfies the initial conditions and it generates  $m+n-1$  occupied cells.

### IV. OPTIMAL SOLUTION

The Initial Basic Feasible Solution is further modified to minimize the total cost and that solution is called as an optimal solution.

The first main purpose is solving transportation problem using five methods of transportation model by Linear Programming (LP). The second main purpose is solving transportation problem by object-oriented programming. C++ programming language and mat lab. The results obtain from these five methods, object oriented programming solutions and Mat lab will be compared. The five methods for solving Transportation problem are:

1. Northwest Corner method
2. Minimum cost method
3. Vogel's approximation method
4. Row Minimum Method
5. Column Minimum Method.

#### 1. North West- Corner Method

The North West corner method is the easy method where we start from the west corner of the give data or cell. The steps are as follows:

(i) Allocate as much as possible to the selected cell and adjust the associated amounts of supply and demand by subtracting the allocated amount.

(ii) 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. If both a row and a column net to zero simultaneously, cross out one only and leave a zero supply (demand in the uncrossed-out row (column)).

(iii) 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 or below if a row has been crossed out .Go to step (i) [2].

#### 2. Minimum Cost Method

The minimum-cost method is the method that finds a better starting solution by concentrating on the cheapest routes. The Method starts by choosing as much as possible to the cell with the smallest unit cost .Next, the satisfied row or column is crossed out and the amounts of supply and demand are adjusted accordingly to it. If both a column and a row are satisfied simultaneously, only one is crossed out, the same as we done in the northwest –corner method .Next ,look for the uncrossed-out cell with the smallest unit cost and repeat this procedure until exactly one row or column is left uncrossed out [2].

#### 3. Vogel's Approximation Method(VAM)

*Vogel's Approximation Method* is the method which is an improved version of the minimum-cost method most of the time it gives us or produces better starting solutions.

(i) For each column (row) determine a penalty measure by subtracting the smallest unit cost element in the column (row) from the next smallest unit cost element in the same column (row).

(ii) Identified the row or column with the largest (maximum) penalty. Break it arbitrarily. Allocate as much as possible to the variable with the least unit cost in the selected row or column .Adjust the supply and demand and cross out the row or column. If a row and column are satisfied Simultaneously, only one of the two is crossed out, and the remaining column (row) is assigned zero demand (supply).

(iii) (a) If exactly one row or column with zero supply or demand remains uncrossed out, stop.

(b) If one row (column) with positive supply (demand) remains uncrossed out, determine the Basic variables in the row (column) by the least cost method stop.

(c) If all the uncrossed out rows and columns have (remaining) zero supply and demand determine the zero basic variables by the least-cost method .stop. ). [2]

(d) Otherwise, go to step (i).

#### 4. Row Minimum Method

Row minimum method is the method start with first row and choose the lowest cost cell of first row so that either the demand at  $j$ th distribution or the capacity of the first supply is exhausted is satisfied or both. Three cases arise:

(i) If the capacity of the first supply is completely exhausted, cross off the first row and now proceed to the second row.

(ii) If the demand at  $j$ th distribution center is satisfied, cross off the  $j$ th column and reconsider the first row with the remaining capacity.

(iii) If the capacities of the first supply as well as the demand at  $j$ th distribution center are completely satisfied, make a zero allocation in the second lowest cost cell of the first row .cross off the row as well as the  $j$ th column and move down to the second row .Continue the process for the resulting reduced Transportation table until all the rim conditions (supply and demand condition) are satisfied.

#### 5. Column Minimum Method

Column minimum method is the method where we start from the first column and chooses the lowest cost cell of first column so that

Either the demand of the first distribution center is satisfied or the capacity of the  $i$ th supply is exhausted or both .three cases arise:

(i) If the demand of the first distribution center is satisfied, cross of the first column and move right to the second column.

(ii) If the capacity of  $i$ th supply is satisfied, cross off  $i$ th row and reconsider the first column with the remaining demand.

(iii) If the demands of the first distribution center as well as the capacity of the  $i$ th supply are completely satisfied, make a zero allocation in the second lowest cost cell of the first column. Cross of the column as well as the  $i$ th row and move right to

the second column. [6]Continue the process for the resulting reduce transportation table until all the conditions are satisfied.

6. Illustrative Example(Sunray Transportation)

Sun Ray Transportation Company ships truckloads of grain from three factories to four warehouses. The supply (in truckloads) and the demand (also in truckloads) together with the unit transportation costs per truckload on the different routes are summarized in the transportation model in table.1.

The starting solution (consisting of 6 basic variables) is  $x_{14}=5, x_{21}=65, x_{23}=35, x_{31}=35, x_{32}=3, x_{34}=15$   
 The associated objective function value is  $Z= 7*3+6*5+7*15+6*35+2*35+2*65=566$

c) Vogel's Approximation method

The application of the procedure to the model of the example gives the starting basic solution in table.4.

	W1	W2	W3	W4	Supply
Factory F1	14	25	45	5	6
Factory F2	65	25	35	55	8
Factory F3	35	3	65	15	16
Requirement	4	7	6	13	30(Total)

Table1. Example of Transportation model

a) North West-Corner method

The application of the procedure to the model of the example gives the starting basic solution in table.2.

	W1	W2	W3	W4	Supply	Row Penalty
Factory F1	4			2		6/2 14-5=9
Factory F2			6	2		8 35-25=10
Factory F3		7		9		16/9 15-3=12
Requirement	4	7	6	13/4/2		
Column penalty	35-14=21	25-3=22	45-35=10	15-5=10		

Table4. The solution using (VAM)

The associated objective function value is  $Z=4*14+2*5+6*35+2*55+7*3+9*15=542$   
 VAM produces a better starting Solution.

d) Row Minimum method

The application of the procedure to the model of the example gives the starting basic solution in table.5.

	W1	W2	W3	W4	Supply
Factory F1	4	2			6/2
Factory F2		5	3		8/3
Factory F3			3	13	16/13
Requirement	4	7/5	6/3	13	30

Table2. The starting solution using North West-Corner Method

The starting basic solution is given as  $X_{11}=14, X_{12}=25, X_{22}=25, X_{23}=35, X_{33}=65, X_{34}=15$   
 The objective function value is  $Z= 4* 14+2*25+5*25+3*35+3*65+13*15=726$

b) Minimum Cost method

The application of the procedure to the model of the example gives the starting basic solution in table.3.

	W1	W2	W3	W4	Supply
Factory F1				6	6
Factory F2	14	25	45	5	8
Factory F3	4		5	7	16
Requirement	4	7	6	13	

Table5. The Final solution using Row Minimum Method

The associated objective function value is  $Z= 6*5+7*25+1*35+4*35+5*65+7*15=810$

e) Column Minimum method

The application of the procedure to the model of the example gives the starting basic solution in table.6.

	W1	W2	W3	W4	Supply
Factory F1				6	6
Factory F2	2		6		8/2
Factory F3	2	7		7	16/9/2
Requirement	4/2	7	6	13/7	30

Table3. The starting solution using minimum-cost method

	W1	W2	W3	W4	Supply
Factory F1	4			2	6/2
Factory F2			6	2	8/2
Factory F3		7		9	16/9
Requirement	4	7	6	13/11/2	30

Table6. The solution using Column Minimum Method

The associated objective function value is  $Z= 4*14+2*5+6*35+2*55+7*3+9*15= 542$

## V. COMPARISON BETWEEN FIVE METHODS

North-west corner method is used when the purpose of completing demand No. 1 (that is from the North West corner) and then the next and is used when the purpose of completing the warehouse No. 1 and then the next. Advantage of this method is it give us quick solution because computations take short time but yields a bad solution because it is very far from optimal solution of Vogel's approximation methods is slow because computations take long time but it give us the best starting basic solution. Column minimum method is used when the purpose of completing demand No. 1 and then the next. Column minimum cost is useful in small number of demand and when the cost of transportation on demand. The cost of transportation is less than North-west corner method. Minimum-cost method takes less time. Row-minimum method is used when the purpose of completing the warehouse No. 1 and then the next. Row minimum cost is useful in small number of supply and when the cost of transportation on supply.

## VI. CONCLUSION

We solve this problem by manually now we will try to solve this problem by using C++ programs and Mat Lab for solving transportation problem. The result come from these methods will compare for accuracy and for lesser time.

## REFERENCES

- [1] Grady Booch, "OBJECT-ORIENTED ANALYSIS AND DESIGN", Addison-Wesley Professional, 2 Editions, USA 1993.
- [2] Hamdy A. Taha. "Operations Research: An Introduction", Prentice Hall, 7 editions 5, USA, 2006.
- [3] John D. McGregor, David A. Sykes "A Practical Guide to Testing Object-Oriented Software", Addison-Wesley Professional, USA, 2001.
- [4] Peretz Shovel. "functional and object-oriented analysis and design", (an integrated methodology), Idea Group Publishing (an imprint of Idea Group Inc.), United States of America, 2006.
- [5] Prem Kumar Gupta, D.S. Hira. "Operations Research", an Introduction, S. Chand and Co., Ltd. New Delhi, 1999.
- [6] Charnes, A. and W.W. Cooper, "The stepping stone method of explaining linear programming calculations in transportation problems", Management Science, 1(1): pp. 49-69, 1954.
- [7] Dantzig, G.B., "Linear Programming and extensions", Princeton, NJ: Princeton University press, 1963.
- [8] Taha Hamdy A. "Operation Research: An introduction", Prentice Hall of India, 8th Edition, 2006.