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An initial basic feasible transportation solution based on the north-west corner rule programming in c

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Abstract

Transportation is one of the most important problems in operations research because it is involved in our daily activities and is primarily concerned with logistics. It is a very important class of linear programming model that deals with the condition of transporting commodities or resources from sources to destinations. The problem's primary goal is to save transportation time and steps by using minimal transformation costs. The solution to this problem is classified into two types: the Initial Basic Feasible Solution (IBFS) and the Optimal Solution (OS).

The purpose of this research is to develop a programme that employs the North West Corner Rule to determine the Initial Basic Feasible solution to the transportation problem (NWCR). This programme was written in C# and can handle both balanced and unbalanced situations. Furthermore, the North West Corner Rule has a broader application than other methods for solving transportation problems. Finally, the proposed programme is more useful for decision makers who deal with unbalanced supply and demand quantities on a regular basis.

Keywords: Transportation, Optimal Solution, Initial Basic Feasible Solution.

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Introduction

Introduction to *c* programming:

Computers are essentially electronic devices. They do not accept instructions in natural languages such as Telugu, Hindi, English, and so on; instead, they only follow instructions in computer languages. It was sometimes performed using low-level languages such as machine language, assembly language, and so on. C-programming and other high-level languages were used solely for automating human tasks. There was no language that could perform both tasks.Because the C compiler combines the capabilities of an assembly language with the features of a high level language, it is well suited for writing both systems software and business packages. C programmes are efficient and fast.[1][2][4][5]

Operational research:

Operations research is a problem-solving and decision-making analytical method used in organisational management. [3]

Linear programming:

Linear programming is one of the most widely used optimization (maximization/minimization) techniques in operational research.

Linear programming problems:

The general Linear Programming Problem (LPP) asks you to optimise (maximize/minimize) a linear function of variables called the objective function, which is subject to a set of linear equations and/or inequalities called the constraints or restrictions.[6][7]

TRANSPORTATION PROBLEM:

The transportation problem is a subclass of linear programming problems in which the goal is to transport a homogeneous commodity from various origins to various destinations while keeping the total transportation cost to a minimum.

General mathematical problem model of transportation problem:

Let there be m sources of supply S1,S2,...,Sm with ai (i=1,2,...m) units of supply or capacity to be transported to n destinations, D1,D2,...,Dn with bj (j=1,2,...,n) units of demand or requirement.

The problem is to determine the transportation schedule if Cij represents the cost of shipping one unit of the commodity from source I to destination j and Xij represents the number of units shipped from source I to destination j. In order to reduce transportation costs while meeting supply and demand conditions.[1]-[6]

Mathematically, the transportation problem, in general may be stated as follows:

$Minimize\ (total\ cost)\ z = \sum_{i=1}^{m}\sum_{j=1}^{n} C_{ij} X_{ij}$ __________ (1)

Subjected to the constraints

$\sum_{j=1}^{n} X_{ij} = a_i, i = 1,2,\dots,m$ (Supply constraints) __________ (2)

$\sum_{i=1}^{m} X_{ij} = b_j, j = 1,2,\dots,n$ (Demand constraints) ___________ (3)

And $X_{ij} \geq 0\ for\ all\ i\ \&j$___________ (4)

Existence of feasible solution:-

A necessary and sufficient condition for the feasible solution to the transportation problem is: [3]-[5]

Total supply = Total demand

$\sum_{i=1}^{m} a_i \sum_{j=1}^{n} b_j$ (Also called RIM conditions)

To / From	D_1	D_2	...	D_n	supply (a_i)
S_1	C_{11} X_{11}	C_{12} X_{12}	...	C_{14} X_{1n}	a_1
S_2	C_{21} X_{21}	C_{22} X_{22}	...	C_{2n} X_{2n}	a_2
⋮	⋮	⋮		⋮	⋮
S_m	C_{m1} X_{m1}	C_{m2} X_{m2}	...	C_{mn} X_{mn}	a_m
Demand (b_j)	b_1	b_2	...	b_n	$\sum_{i=1}^{m} a_i = \sum_{j=1}^{n} b_j$

There are (m+n-1) constraints in this problem, one for each source of supply and destination, and mn. One of these equations is extra because all m+n constraints or equations. The additional constraint (equation) can be derived from other constraints without affecting the solution's feasibility. As a result, any feasible solution to a transportation problem must have exactly (m+n-1) non-negative basic variables (or allocations) Xij..

When total supply equals total demand, the problem is called a balanced transportation problem; otherwise, it is called an unbalanced transportation problem. It can be created by adding a dummy supply centre (row) or dummy demand (column) as needed.

The transportation algorithm:

Transportation algorithms aid in reducing the total cost of transporting a homogeneous commodity (product) from supply to demand centres. The steps in the algorithm for solving a transportation problem are as follows:

Step-1:- **Formulate the problem and arrange the data in matrix form:**

The formulation of the transportation problem is similar to the formulation of the linear programming problem. The objective function in a transportation problem is the total transportation cost, and the constraints are the amount of supply and demand available at each source and destination, respectively.[5]

Step-2:- **Obtain the initial basic feasible solution**:

The following three different methods are available to obtain initial solution.

i) North-West Corner method,

1. The solution must feasible, i.e. it must satisfy all the supply and demand constraints [8]

2. The number of positive allocations must be equal to m+n-1, where m is the number of rows and n is the number of columns. [8]

Any solution that satisfies the conditions is called non-degenerate basic feasible solution, otherwise degenerate solution.[8]

There are several types of methods available to obtain an initial basic feasible solution. Now we discuss about the NORTH-WEST CORNER Method.

***NORTH-WEST CORNER METHOD*:**

This method does not take into account the cost of transportation along any route. This technique is also known as the stepping stone method. The procedure is summarised as follows:

Step-1:

Begin with the cell in the upper left (northwest) corner of the transportation table (or matrix) and allocate commodity equal to the rim value for the first row and first column.

i.e. min (a_1,b_1)

Step-2:

a) If the allocation made in step-1 is equal to the supply available at the first source (a1, in the first row), then move vertically down to cell (2,1), second row, and first column. Apply step-1 again, for next allocation.
b) If the allocation made in step-1 equals the demand for the first destination (b1 in the

first column), then move horizontally to cell(1, 2), i.e. first row and second column. Apply step-1 again for next allocation.

c) If $a_1=b_1$, allocate $X_{11}=a_1$ or b_1 and move diagonally to the cell (2,2).

Step-3:

Continue the procedure step by step until an allocation is made in the transportation table's south-east corner cell.

If supply equals demand during the allocation process at a specific cell, the next allocation of magnitude zero can be made in a cell in the next row or column. This is referred to as degeneracy.

1. **Obtain the initial basic feasible solution to the following transportation problem by using North-west corner rule.**

	W_1	W_2	W_3	availability
F_1	2	7	4	5
F_2	3	3	1	8
F_3	5	4	7	7
F_4	1	6	2	14
Requirement	7	9	18	

Solution:

Now applying the North-West corner method,

	W_1	W_2	W_3	availability
F_1	2 (5)	7	4	5
F_2	3 (2)	3 (6)	1	8 6
F_3	5	4 (3)	7 (4)	7 4
F_4	1	6	2 (14)	**14**
Requirement	7 2	9 3	18 **14**	**34**

Hence, the basic feasible solution is

$X_{11}=5$, $X_{12}=0$, $X_{13}=0$,

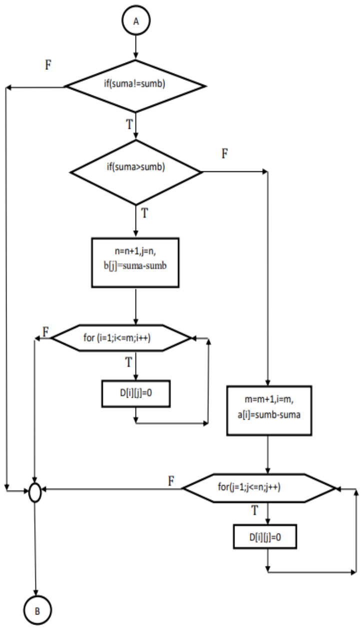
$X_{21}=2$, $X_{22}=6$, $X_{23}=0$,

$X_{31}=0$, $X_{32}=3$, $X_{33}=4$,

$X_{41}=0$, $X_{42}=0$, $X_{43}=14$.

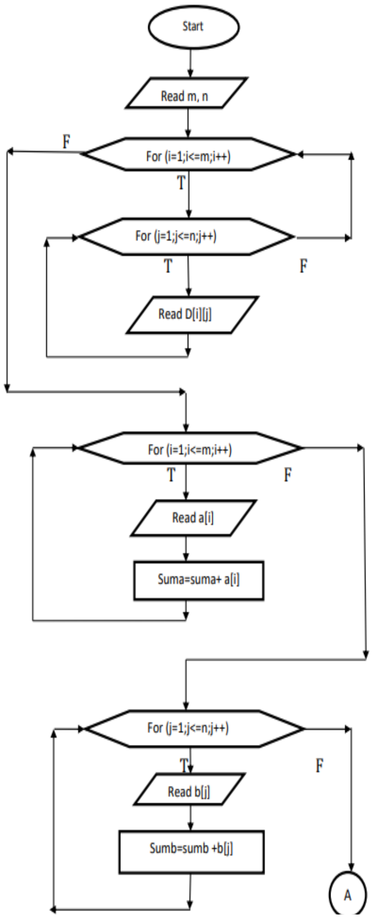
∴The minimum total transportation cost is

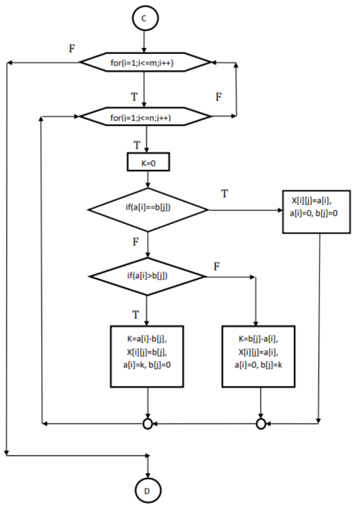
$$5 \times 2 + 3 \times 2 + 3 \times 6 + 4 \times 3 + 7 \times 4 + 2 \times 14$$
$$= 10 + 6 + 18 + 12 + 21 + 28$$
$$= \mathbf{102}$$

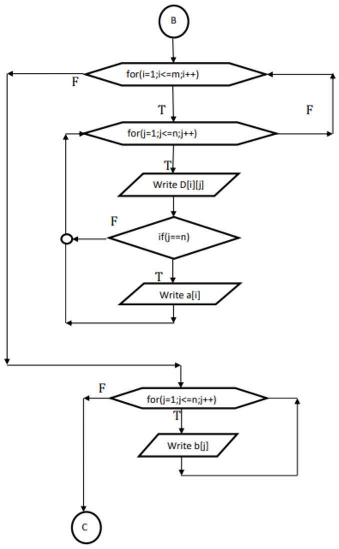


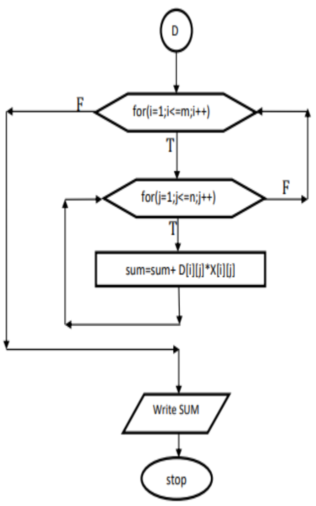
NORTH-WEST CORNER RULE

Flowchart:









Algorithm:

Step-1: Start

Step-2: read m,n

Step-3: for(i=1;i<=m;i++), if it is true goto step-4, otherwise goto step-6

Step-4: for(j=1;j<=n;j++), if it is true goto step-5, otherwise goto step-3

Step-5: Read D[i][j], goto step-4

Step-6: Sum a=0, goto step-7

Step-7: for(i=1;i<=m;i++), if it is true goto step-8, otherwise goto step-10

Step-8: read a[i]

Step-9: Sum a=Sum a+a[i], goto step-7

Step-10: Sum b=0, goto step-11

Step-11: for(j=1;j<=n;j++), if it is true goto step-12 otherwise goto step-14

Step-12: read b[j]

Step-13: Sum b=Sum b+b[j], goto step-11

Step-14: check Sum a!=Sum b,if it is true goto step-15 otherwise goto Step-22

Step-15: check Sum a>Sum b, if it is true goto step-16 otherwise goto Step-19

Step-16: n=n+1, j=n, b[j]=Sum b-Sum a, goto step-17

Step-17: for(j=1;j<=n;j++), if it is true goto step-18 otherwise goto step-22

Step-18: D[i][j]=0, goto step-17

Step-19: m=m+1, i=m, a[i]=Sum a-Sum b, goto step-20

Step-20: for(i=1;i<=m;i++), if it is true goto step-21 otherwise goto step-22

Step-21: D[i][j]=0, goto step-20

Step-22: for(i=1;i<=m;i++), if it is true goto step-23 otherwise goto step-27 [9]

Step-23: for(j=1;j<=n;j++), if it is true goto step-24 otherwise goto step-22

Step-24: write D[i][j]

Step-25: check j=n, if it is true goto step-26 otherwise goto step-23 [9]

Step-26: write a[i],goto step-23

Step-27: for(j=1;j<=n;j++), if it is true goto step-28 otherwise goto step-29

Step-28: write b[j], goto step-27

Step-29: for(i=1;i<=m;i++), if it is true goto step-30 otherwise goto step-37 [9]

Step-30: for(j=1;j<=n;j++), if it is true goto step-31 otherwise goto step-29 [9]

Step-31: k=0, goto step-32 [9]

Step-32: check a[i]=b[j], if it is true goto step-33 otherwise goto step-34

Step-33: X[i][j]=a[i],
a[i]=0, b[j]=k, goto step-30

step-34: check a[i]>b[j], if it is true goto step-35 otherwise goto step-36

Step-35: k=a[i]-b[j],
X[i][j]=b[j],
a[i]=k, b[j]=0, goto step-30

Step-36: k=b[j]-a[i],
X[i][j]=a[i],
a[i]=0, b[j]=k, goto step-30
Step-37: sum=0, goto step-38
Step-38: for(i=1;i<=m;i++), if it is true goto step-39 otherwise goto step-41 [9]
Step-39: for(j=1;j<=n;j++), if it is true goto step-40 otherwise goto step-39 [9]
Step-40: sum=sum+(D[i][j]*X[i][j]), goto step-39
Step-41: write sum, goto step-42
Step-42: stop.

Output-1:

Enter number of rows and number of columns
4
3
Enter cost values
D[1][1]=2
D[1][2]=7
D[1][3]=4
D[2][1]=3
D[2][2]=3
D[2][3]=1
D[3][1]=5
D[3][2]=4
D[3][3]=7
D[4][1]=1
D[4][2]=6
D[4][3]=2
Enter supply
a[1]=5
a[2]=8
a[3]=7
a[4]=14
Enter demand
b[1]=7
b[2]=9
b[3]=18
The balanced transportation problem is

2	7	4	5
3	3	1	8
5	4	7	7
1	6	2	14
7	9	18	**34**

The minimum transportation cost is **102.**

Conclusion:

The transportation problem is a type of linear programming problem with numerous practical applications. There are also several operational areas, such as inventory control, employment scheduling, and personnel assignment. The North West Corner Rule (NWCR) was used in this research work to find an initial basic feasible solution to the transportation problem. The developed programme can be used to solve any transportation problem, whether it is balanced or unbalanced. For all three occasions, the results are clearly displayed with screenshots. In the majority of research publications, the current methods for solving transportation problems are calculated manually.

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