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Assignment - OR

* **Problem statement :-** Transportation Problem :- Milk in Milk shed area is collected on three routes A, B and C. There are four chilling centers P, Q, R and S where milk is kept before transporting it to a milk plant. Each route is able to supply on an average one thousand litres of milk per day. The supply of milk on routes A, B and C are 150, 160 and 190 thousand litres respectively. Daily capacity in thousand litres of chilling ~~centre~~ centers is 140, 120, 90 and 50 respectively. The cost of transportation of 1000l of milk from each route to each chilling center differs accordingly to the distance. These costs (in ₹) are shown in following table :-

Routes	Chilling Center : P	Q	R	S
A	16	18	21	12
B	17	19	14	13
C	32	11	15	10

The problem is to determine how many thousand litres of milk is to be transported from each route on a daily basis in order to maximize the total cost of transportation.

* **Objective :-**
  - Understanding the transportation problem and using different method to find the initial basic feable solution.
  - Finding the basic feasible solution using 3 methods :- Northwest Corner Cell, least cell cell, Vogel's approximation method (VAM).

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* H/W & S/W Requirements :-

⇒ Fedora 20, 8GB RAM.
⇒ Google Colab, Python.

* Theory :-

Transportation Problem is a special kind of linear Programming Problem (LPP) in which goods are transported from a set of sources to a set of destinations subject to the supply and demand of sources and destination respectively such that total cost of transportation is minimized.

Types of transportation Problem:

⇒ Balanced : When both supplies and demands are equal then the problem is said to be a balanced transportation problem.

⇒ Unbalanced :- When supply and demand are not equal then it is said to be unbalanced transportation problem. In this type of problem, either a dummy row or dummy column is added according to the requirement to make it a balance problem.

⇒ Methods to solve :-

To find the initial basic feasible solution, there are 3 methods :-
1) Northwest Corner Cell method
2) Least Cell Cell method.
3) Vogel's Approximation method (VAM).

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Basic structure of transportation Problem:

	Destination				Supply (Si)
	D1	D2	D3	D4	
O1	C_{11}	C_{12}	C_{13}	C_{14}	S1
O2	C_{21}	C_{22}	C_{23}	C_{24}	S2
O3	C_{31}	C_{32}	C_{33}	C_{34}	S3
O4	C_{41}	C_{42}	C_{43}	C_{44}	S4
Demand (di)	d1	d2	d3	d4	

In the above table D1, D2, D3 and D4 are the destinations where the products/goods are to be delivered from different sources S1, S2, S3 and S4. S1 is the supply source Oi. Cij is the cost when the product is delivered from source Si to destination Dj.

1) North West corner cell Method:-

Algorithm:-

Step-1:- select the upper left corner cell of the transportation matrix and allocate min (S1, D1).

Step-2:- a) subtract this value from supply and demand of respective row and column

b) If the supply is 0, then cross that row and move down to next cell.

c) If the demand is 0, then cross the column and move right to next cell.

d) If supply and demand both are 0, then cross both row and column and move diagonally to next cell.

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Step-3:- Repeat these steps until all the supply and demand values are 0.

* Least Cost Method:-

Algorithm:-

Step-1:- Select the cell having minimum unit cost c_{ij} and allocate as much as possible i.e. $\min(s_i, d_j)$

Step-2:- a) Subtract this min value from supply s_i and demand d_j.

b) If this supply s_i is 0, then cross that row and if the demand d_j is 0 then cross that column.

c) If min unit cost cell is not unique, then select the cell where maximum allocation can be possible.

Step-3:- Repeat these steps for uncrossed row and columns until all supply and demand values are 0.

* Vogel's Approximation Method:

This method is preferred over the NWCM and LCM because the initial basic feasible solution obtained by this method is either optimal solution or very nearer to optimal solution.

Algorithm:-

Step-1:- Find the cells having smallest and next to smallest cost in each row with write the difference called penalty along the side of the table in row penalty

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Step-2:- Find the cells having smallest and next to smallest cost in each column and write the difference (called penalty) along the side of the table in each column penalty.

Step-3:- select row or column with maximum penalty and find cell that has least cost in selected row or column. Allocate as much as possible in this cell.

Step-4:- Adjust the supply and demand the cross at the satisfied row or column.

Step-5:- Repeat these steps until all supply & demand values are 0.

* Example & Test case:-

					supply
Input:	16	18	21	12	150
	17	19	14	16	160
	32	11	15	10	90
					400
Demand	140	120	90	50	400

I) Northwest Corner Method.

Output:	140	10	0	0
	0	110	50	0
	0	0	40	50

Final Cost = ₹310.

II) Least Corner Cell Method:-

Output:	140	10	0	0
	0	70	90	0
	0	40	0	50

Final Cost = 5950.

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III) Vogel's Approximation Method :-

Output				
	100	0	0	50
	40	30	90	0
	0	90	0	0

Final cost = 5700.

Hence, Here the VAM gives the least cost for transportation and hence the optimal solution.

* Conclusion :- We successfully understood and implemented : NWR, LCM and VAM method for transportation problem and found that VAM gave the minimum cost.

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