Matrix Assignment

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Problem Statement:

Two godowns A and B have grain capacity of 100 quintals and 50 quintals respectively. They supply to 3 ration shops, D, E and F whose requirements are 60, 50 and 40 quintals respectively. The cost of transportation per quintal from the godowns to the shops are given in the following table:

From/to	A	B
D	6	4
E	3	2
F	2.5	3

How should the supplies be transported in order that the transportation cost is minimum? What is the minimum cost?

Solution

Let's assume that

1. A supplies x quintals grain to ration shop D.
2. A supplies y quintals grain to ration shop E.
3. A will supply remaining grains 100-x-y quintals to F.
4. B will supply 60-x quintals grain to ration shop D.
5. B will supply 50-y quintals grain to ration shop E.
6. B will supply x+y-60 quintals grain to ration shop F.

Total transportation cost is given by :

$$P = 2.5 * x + 1.5 * y + 410 \tag{1}$$

Now, Since godown A can supply maximum 60 quintals to ration shop D and 50 quintals to ration shop E and have maximum 100 quintals capacity to supply.

Also, if godown A supplies all 40 quintals to ration shop F, then remaining 60 quintals will be supplied to ration shop D and E and x and y is amount of grains. It can never be negative.

$$x + y \leq 100 \tag{2}$$
$$x \leq 60 \tag{3}$$
$$y \leq 50 \tag{4}$$
$$-x - y \leq -60 \tag{5}$$
$$x \geq 0 \tag{6}$$
$$y \geq 0 \tag{7}$$

The above equations in vector form is :

$$\mathbf{A_1} = \begin{pmatrix} 1 \\ 1 \end{pmatrix} \tag{8}$$
$$\mathbf{A_2} = \begin{pmatrix} 1 \\ 1 \end{pmatrix} \tag{9}$$
$$\mathbf{A_3} = \begin{pmatrix} 1 \\ 0 \end{pmatrix} \tag{10}$$
$$\mathbf{A_4} = \begin{pmatrix} 0 \\ 1 \end{pmatrix} \tag{11}$$
$$\mathbf{x} = \begin{pmatrix} x \\ y \end{pmatrix} \tag{12}$$

$$\mathbf{A_1 x} \leq 100 \tag{13}$$

$$\mathbf{A_2 x} \geq 60 \tag{14}$$

$$\mathbf{A_3 x} \leq 60 \tag{15}$$

$$\mathbf{A_4 x} \leq 50 \tag{16}$$

which can be expressed in vector form as

$$\begin{pmatrix} 1 & 1 \\ -1 & -1 \\ -1 & 0 \\ 0 & -1 \end{pmatrix} \mathbf{x} \preceq \begin{pmatrix} 100 \\ -60 \\ -60 \\ -50 \end{pmatrix} \tag{17}$$

The optimization is done by using cvxpy packges in python language:
The minimum value of P is : 510
By solving the above inequalities in python using cvxpy packages the value of **x** is :

$$\mathbf{x} = \begin{pmatrix} 10 \\ 50 \end{pmatrix} \tag{18}$$

Hence,

1. The minimum transportation cost is : 510 /-
2. A supplies 10 quintals grain to ration shop D.
3. A supplies 50 quintals grain to ration shop E.
4. A supplies 40 quintals grain to ration shop F.
5. A supplies 50 quintals grain to ration shop D.
6. A supplies 0 quintals grain to ration shop E.
7. A supplies 0 quintals grain to ration shop F.