D605 Task 2
By Eric Williams

A:IDENTIFY OPTIMIZATION PROBLEM

The optimization problem is to minimize shipment costs for Amazon while ensuring the cargo demand is met for all the centers and staying within the limits.

B:CREATE MATHEMATICAL REPRESENTATION OF OPTIMIZATION PROBLEM

Here is a mathematical representation of the variables in this optimization problem:

1. Hub capacities:

$$\sum_{j=1}^{3} x_{ij} + \sum_{k=1}^{65} y_{ik} \leq capacity, i = 1, 2$$

2. Quantity into focus cities:

$$\sum_{i=1}^{2} x_{ij} \leq capacity, j = 1, 2, 3$$

3. Quantity out of focus cities:

$$\sum_{k=1}^{65} z_{jk} = \sum_{i=1}^{2} x_{ij}\ , j = 1, 2, 3$$

4. Center demand:

$$\sum_{i=1}^{2} y_{ik} + \sum_{j=1}^{3} z_{jk} = requirement, k = 1, 2, \ldots 65$$

B1:OBJECTIVE FUNCTION EXPRESSION

The objective function is to minimize the cost of hubs to focus cities, the cost of hubs to centers, and the cost of cities to centers like so:

$$min\left(\sum_{i=1}^{2}\sum_{j=1}^{3} c_{ij}x_{ij} + \sum_{i=1}^{2}\sum_{k=1}^{65} c_{ik}y_{ik} + \sum_{j=1}^{3}\sum_{k=1}^{65} c_{jk}z_{jk}\right)$$

Where:

c_{ij} is the cost per unit of shipping from hub *i* to focus city *j*

c_{ik}Cost per unit of shipping from hub *i* to center *k*

c_{jk}Cost per unit of shipping from focus city *j* to center *k*

B2:OPTIMIZATION CONSTRAINTS

Constraints

1. **Hub Capacity:** The total amount shipped out of each hub cannot exceed its capacity:

$$\sum_{j=1}^{3} x_{ij} + \sum_{k=1}^{65} y_{ik} \leq capacity, i = 1, 2$$

2. **Focus City Capacity (Inbound):** The amount sent into each city cannot exceed its capacity:

$$\sum_{i=1}^{2} x_{ij} \leq capacity, j = 1, 2, 3$$

3. **Flow Conservation for Focus Cities:** The total amount sent into a city must equal the total amount sent out to centers:

$$\sum_{k=1}^{65} z_{jk} = \sum_{i=1}^{2} x_{ij}\ , j = 1, 2, 3$$

4. **Center demand:** The total amount sent to a center must meet the demand requirement by shipments from other cities:

$$\sum_{i=1}^{2} y_{ik} + \sum_{j=1}^{3} z_{jk} = requirement, k = 1, 2, \ldots 65$$

B3:IDENTIFY DECISION VARIABLES

Variables

x_{ij} = quantity sent from hub *i* to focus city *j*, i= 1, 2, j = 1, 2, 3

y_{ik} = quantity sent from hub *i* to center *k*, i=1, 2, k = 1, 2, …65

z_{jk} = quantity sent from focus city *j* to center *k*, j = 1, 2, 3, k = 1, 2, …65

C:APPROACH FOR SOLVING THE OPTIMIZATION

The optimization problem is a linear programming problem. Minimizing shipping costs is linear and the constraints are linear. The Simplex method is great at solving linear programming problems and is easy to implement in python. My plan is to take the data, run the Simplex method, check the results, then share the optimization found by the method.

C1:IDENTIFICATION OF OPTIMIZATION METHOD OR ALGORITHM

The optimization method I will use is the Simplex method because of its ability to solve linear programming problems. In the next task, I will use python to solve it as Python is great at using the Simplex method.

C2:TOOLS AND TECHNOLOGIES

To solve the problem, I will use Python in Jupyter notebook to program the Simplex method. This will allow me to perform the Simplex method with relative ease and no other tools will be required.

Sources

No sources were used except for official WGU course materials.