Task 2: Solve an Optimization Problem

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Optimization — D605

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A: IDENTIFY OPTIMIZATION PROBLEM

The optimization problem is to minimize the total shipping costs for Amazon Air while ensuring each fulfillment center receives the required amount of cargo, and no hub or focus city exceeds its capacity.

B: CREATE MATHEMATICAL REPRESENTATION OF OPTIMIZATION PROBLEM

This section outlines the mathematical components of the optimization model.

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

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

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

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

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

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

4. **Center Requirement:** The total amount sent to each center must meet the requirement through shipments from hubs and focus cities:

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

B1: OBJECTIVE FUNCTION EXPRESSION

The goal is to minimize the total cost of shipping from hubs to focus cities, from hubs to centers, and from focus cities to centers:

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

Where:

- c_{ij} is the cost per ton from hub i to focus city j
- c_{ik} is the cost per ton from hub i to center k
- c_{jk} is the cost per ton from focus city j to center k

B2: OPTIMIZATION CONSTRAINTS

1. **Hub Capacity:**

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

2. **Focus City Capacity (Inbound):**

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

3. **Focus City Flow Conservation:**

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

4. **Center Demand:**

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

B3: IDENTIFY DECISION VARIABLES

- x_{ij}: quantity of cargo sent from hub i to focus city j

- Y_{ik}: quantity of cargo sent from hub i to center k
- z_{jk}: quantity of cargo sent from focus city j to center k

C: APPROACH FOR SOLVING THE OPTIMIZATION

This is a linear programming problem. The objective function and all constraints are linear. I will use the Simplex method to solve this problem. It is an efficient method for solving linear programming models and is supported by many optimization tools.

C1: IDENTIFICATION OF OPTIMIZATION METHOD OR ALGORITHM

The optimization method I will use is the Simplex method. It is well-suited for linear programming problems like this one, where the objective and constraints are all linear.

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.

References

No sources were used except for official WGU course materials.