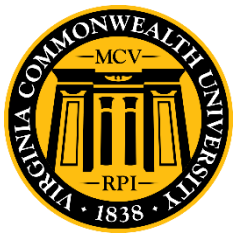

VIRGINIA COMMONWEALTH UNIVERSITY

PRESCRIPTIVE ANALYSIS

ASSIGNMENT 3 PART A

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SUBMITTED TO-

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PROBLEM

A produce company supplies organic apples to four regional specialty stores. The apples are initially gathered from the company's orchard and sent to one of three preparation centers, where they are cleaned and packaged for sale. After preparation, the apples are delivered to the stores. Given the fragile nature of organic apples, transportation costs are high, both from the orchard to the preparation centers and from the centers to the stores. Each preparation center has different transportation, preparation costs, and monthly capacity limits. The company aims to minimize total costs while meeting the monthly demand of each store.

Data

Category	Preparation Center 1	Preparation Center 2	Preparation Center 3
Transportation Cost (Orchard to Center) ($/pound)	$0.45	$1.00	$1.62
Preparation Cost ($/pound)	$0.15	$0.20	$0.18
Monthly Capacity (pounds)	300	500	800
Shipping Cost to Organic Orchard ($/pound)	$0.80	$1.20	$0.20
Shipping Cost to Fresh & Local ($/pound)	$1.10	$1.10	$1.40
Shipping Cost to Healthy Pantry ($/pound)	$0.70	$0.50	$1.30
Shipping Cost to Season's Harvest ($/pound)	$1.40	$1.40	$1.70

Let

P=1,2,3 be the set of preparation centers,

S=Organic Orchard, Fresh Local, Healthy Pantry, Seasons Harvest be the set of stores,

$\text{TransportCostOrchardToPreparation}_i$= the transportation cost per pound from the orchard to preparation center, $i, i \in C$

$preparationcost_i$= the preparation cost per pound at preparation center i , $i \in C$

$capacity_i$ = the monthly capacity (in pounds) of preparation center i, $i \in C$

$Demand_j$= the monthly demand (in pounds) for store j, $j \in R$,

$\text{TransportCostPrepToStore}_{ij}$ = the transportation cost per pound from preparation center, i to store j, $i \in C$ and $j \in R$

Objective in Words:

Decide the number of pounds of apples to transport from the orchard to each preparation center and the number of prepared apples to deliver from each preparation center to the stores, in a way that minimizes the total transportation and preparation costs. This must be done while satisfying the following constraints:

- The total amount of apples transported from the orchard to each preparation center cannot exceed that center's monthly capacity.
- The total amount of apples sent to each store must fulfill its monthly demand.
- The total quantity of apples shipped from the orchard and processed through the preparation centers must not exceed the available supply.

Decision Variables:

Let:

x_i = the number of pounds of apples transported from the orchard to preparation center $i \in C$

y_{ij} = the number of pounds of apples transported from preparation center i to store j $i \in C$ and $j \in R$

Algebraic Formulation

$$min \sum_{i \in C} (\boldsymbol{TransportCostOrchardToPrep_i} * \boldsymbol{x_i} + \boldsymbol{PreparationCost_i} * \boldsymbol{x_i}) + \sum_{i \in C, j \in R} \boldsymbol{TransportCostPrepToStore_{ij}} * \boldsymbol{y_{ij}}$$

such that

$\sum_{j \in R} y_{ij} \geq Demand_j$ (demand_constraint)

$\sum_{j \in R} y_{ij} \leq Capacity y_i, \ i \in C$ (capacity_constriant)

$x_i = \sum_{j \in R} y_{ij}, \ i \in C$ (Flow_balance_constriant)

$x_i \geq 0, i \in C$

$y_{ij} \geq 0, i \in C, j \in R$ (non_negativity_constriant)

Implementation

An implementation and solution of the model using Python, and AMPL is available below,

https://drive.google.com/drive/folders/1VPww1bYJR2PHdtevPRwwtm_qQLHFLEN7

Results

The optimal distribution plan for the produce company minimizes total costs to $3,040. To achieve this, 300 pounds of apples are transported from the orchard to Preparation Center 1, 500 pounds to Preparation Center 2, and 600 pounds to Preparation Center 3. From there, Preparation Center 1 ships 100 pounds to Fresh Local and 200 pounds to Seasons Harvest. Preparation Center 2 sends 100 pounds to Fresh Local and 400 pounds to Healthy Pantry. Finally, Preparation Center 3 delivers 300 pounds to Fresh Local and 300 pounds to Organic Orchard.

AI TRAINING

Model - ChatGPT 4o

https://chatgpt.com/share/66fde62b-47d0-800e-addb-56ef6a27da11