

ISE 5123: Software Tools-Dec Support
Assignment #4
Due March 30, 9:00 am

There are four linear programming problems in this assignment focusing on transportation, transshipment, and assignment problems. Please submit (i) a single document demonstrating the mathematical formulation for each problem and (ii) **four Python files** for solving the models using Gurobi optimizer.

Problem 1

A manufacturing company has two warehouses from which it distributes its product to five retailers. At the start of every week, each retailer sends an order to the company’s head office, which is then dispatched from the appropriate warehouse to the retailer. The company would like to have an interactive computer program which they can run week by week to tell them which warehouse should supply which retailer so as to minimize the costs of the whole operation. For example, suppose that at the start of a given week the company has 2000 products at warehouse A, and 3000 products at warehouse B, and that the retailers require 500, 800, 1800, 300, and 700 products respectively.

Transportation Cost of each path is given in the following Table.

Warehouse	Retailer1	Retailer2	Retailer3	Retailer4	Retailer5
W1 (A)	2	4	5	2	1
W2 (B)	3	1	3	2	3

- a) What data structure can be used to store number of retailers, warehouses capacity, costs information, and retailers’ demand?
- b) Create the appropriate data structures in Python (**Note:** It is not required to solve the model for this question)
- c) Formulate the linear programming model for this problem

Problem 2

Oranges are grown, picked, and then stored in warehouses in Tampa, Miami, and Fresno. These warehouses supply oranges to markets in New York, Philadelphia, Chicago, and Boston. The following table shows the shipping costs per truckload (in hundreds of dollars), supply, and demand.

From	To (cost, in \$100s)				Supply
	New York	Philadelphia	Chicago	Boston	
Tampa	\$ 9	\$14	\$12	\$17	200
Miami	11	10	6	10	200
Fresno	12	8	15	7	200
Demand	130	170	100	150	

Because of an agreement between distributors, shipments are prohibited from Miami to Chicago.

- a) Formulate this problem as a linear programming model
- b) Find the optimal solution by using Python and Gurobi optimizer

Problem 3

Walsh's Fruit Company contracts with growers in Ohio, Pennsylvania, and New York to purchase grapes. The grapes are processed into juice at the farms and stored in refrigerated vats. Then the juice is shipped to two plants, where it is processed into bottled grape juice and frozen concentrate. The capacity at each plant were 140,000 tons. The juice and concentrate are then transported to three food warehouses/distribution centers.

The transportation costs per ton from the farms to the plants and from the plants to the distributors, and the supply at the farms and demand at the distribution centers are summarized in the following tables:

Plant			
Farm	4. Indiana	5. Georgia	Supply (1,000 tons)
1. Ohio	\$16	21	72
2. Pennsylvania	18	16	105
3. New York	22	25	83

Distribution Center			
Plant	6. Virginia	7. Kentucky	8. Louisiana
4. Indiana	\$23	\$15	\$29
5. Georgia	20	17	24
Demand (1,000 tons)	90	80	120

- a) Formulate this problem as a linear programming model
- b) Determine the optimal shipments from farms to plants to distribution centers to minimize total transportation costs by using Python and Gurobi optimizer

Problem 4

State University has planned six special catered events for the Saturday of its homecoming football game. The events include an alumni brunch, a parents' brunch, a booster club luncheon, a postgame party for season ticket holders, a lettermen's dinner, and a fund-raising dinner for major contributors. The university wants to use local catering firms as well as the university catering service to cater these events, and it has asked the caterers to bid on each event.

The bids (in thousands of dollars) based on menu guidelines for the events prepared by the university are shown in the following table:

Caterer	Event					
	Alumni Brunch	Parents' Brunch	Booster Club Lunch	Postgame Party	Lettermen's Dinner	Contributors' Dinner
Al's	\$12.6	\$10.3	\$14.0	\$19.5	\$25.0	\$30.0
Bon Apetit	14.5	13.0	16.5	17.0	22.5	32.0
Custom	13.0	14.0	17.6	21.5	23.0	35.0
Divine	11.5	12.6	13.0	18.7	26.2	33.5
Epicurean	10.8	11.9	12.9	17.5	21.9	28.5
Fouchéss	13.5	13.5	15.5	22.3	24.5	36.0
University	12.5	14.3	16.0	22.0	26.7	34.0

The Bon Apetit, Custom, and University caterers can handle two events, whereas each of the other four caterers can handle only one. The university is confident that all the caterers will do a high-quality job, so it wants to select the caterers for the events that will result in the lowest total cost.

- a) Formulate this problem as a linear programming model
- b) Determine the optimal selection of caterers to minimize total cost by using Python and Gurobi optimizer