ISE 5123 Software Tools-Dec Support
Spring 2020

Homework 3
Due Date: March 9

There are 4 problems in this homework assignment. Submit the codes for all problems in a single notebook file on Canvas. All problems are from our textbook.

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. What data structure can be used to store number of retailers, warehouses capacity, costs information, and retailers' demand? Create the appropriate data structures in Python. Additionally, formulate the linear programming model for this problem.

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

2. The Metalco company desires to blend a new alloy of 35 percent tin, 35 percent zinc, and 30 percent lead from several available alloys having the following properties:

Property	**Alloy1**	**Alloy2**	**Alloy3**	**Alloy4**	**Alloy5**
Percentage of tin	60	25	45	30	50
Percentage of zinc	20	15	45	40	40
Percentage of lead	20	60	10	30	10
cost ($/lb)	22	26	25	21	27

The objective is to determine the proportion of these alloys that should be blended to produce the new alloy at a minimum cost.

(a) Formulate a linear programming model for this problem.

(b) Solve the model using Python and Gurobi.

3. A Makonsel company is a fully integrated company that both produces goods and sells them at its retail outlets. After production, the goods are stored in the company's two warehouse until needed by the retail outlet. Trucks are used to transport the goods from the two plants to the warehouses, and then from the warehouses to the three retail outlets.
Using units of full truckloads, the following table shows each plants monthly output, its shipping cost per truckload send to each warehouse, and the maximum amount that it can ship per month to each warehouse.

From/To	**Unit shipping cost**		**Shipping capacity**		**Output**
	W1	**W2**	**W1**	**W2**	
Plant 1	\$450	\$560	125	150	225
Plant 2	510	600	175	200	300

For each retail outlet (RO), the next table shows its monthly demand, its shipping costs per truckload from each warehouse, and the maximum amount that can be shipped per month from each warehouse.

From/To	**Unit shipping cost**			**Shipping capacity**		
	RO1	**RO2**	**RO3**	**RO1**	**RO2**	**RO3**
W1	\$470	\$505	\$495	100	150	100
W2	390	415	440	125	150	75
Demand	175	200	150	175	200	150

Management now wants to determine a distribution plan (number of truckloads shipped per month from each plant to each warehouse and from each warehouse to each retail outlet) that will minimize the total shipping cost.

(a) Draw a network that depicts the company's distribution network. Be sure to clearly and neatly label all nodes.

(b) Formulate this problem as a network (minimum cost flow) problem.

(c) Solve the model using Python and Gurobi.

4. A company will be producing the same new product at two different factories, and then the product might be shipped to two warehouses. Factory 1 can send an unlimited amount by rail to warehouse 1 only, whereas factory 2 can send an unlimited amount by rail to warehouse 2 only. However, independent truckers can be used to ship up to 50 units from each factory to a distribution center, from which up to 50 units can be shipped to each warehouse. The shipping cost per unit for each alternative is shown in the following table, along with the amounts to be produced at the factories and the amounts needed at the warehouses.

From/To	Distribution Center	Warehouse		Output
		1	**2**	
Factory 1	2	6	–	80
Factory 2	4	–	9	70
Distribution Center		3	4	
Allocation		60	90	

(a) Draw a network that depicts the company's distribution network. Be sure to clearly and neatly label all nodes.

(b) Formulate the network representation of this problem as a minimum cost flow problem.

(c) Solve the model using Python and Gurobi.