Jacobs University
Fall 2021

October 11, 2021

Operations Research

Homework 6

Due on October 18, 2021

Note: Your homework must be submitted via moodle (see the link on the class website) on the due day BEFORE THE TUTORIAL.

Problem 1 [10 points]

(HL, Problem 8.1-4.) The Versatech Corporation has decided to produce three new products. Five branch plants now have excess product capacity. The unit manufacturing cost of the first product would be \$41, \$39, \$42, \$38, and \$39 in Plants 1, 2, 3, 4, and 5, respectively. The unit manufacturing cost of the second product would be \$55, \$51, \$56, \$52, and \$53 in Plants 1, 2, 3, 4, and 5, respectively. The unit manufacturing cost of the third product would be \$48, \$45, and \$50 in Plants 1, 2, and 3, respectively, whereas Plants 4 and 5 do not have the capability for producing this product. Sales forecasts indicate that 700, 1 000, and 900 units of products 1, 2, and 3, respectively, should be produced per day. Plants 1, 2, 3, 4, and 5 have the capacity to produce 400, 600, 400, 600, and 1 000 units daily, respectively, regardless of the product or combination of products involved. Assume that any plant having the capability and capacity to produce them can produce any combination of the products in any quantity. Management wishes to know how to allocate the new products to the plants to minimize total manufacturing cost.

(a) Formulate this problem as a transportation problem.

(b) Use Pyomo to obtain an optimal solution.

Part (a) should be submitted as a scan or typed into the Ipython notebook using mathematical markup; for part (b) submit your Ipython notebook showing code and output.

Problem 2 [10 points]

(Based on HL, Problem 8.3-2.) Four cargo ships will be used for shipping goods from one port to four other ports (labeled 1, 2, 3, 4). Any ship can be used for making any one of these four trips. However, because of differences in the ships and cargoes, the total cost of loading, transporting, and unloading the goods for the different ship-port combinations varies considerably, as shown in the following table:

	Port			
	1	**2**	**3**	**4**
Ship 1	\$500	\$400	\$600	\$700
Ship 2	\$600	\$600	\$700	\$500
Ship 3	\$700	\$500	\$700	\$600
Ship 4	\$500	\$400	\$600	\$600

The objective is to assign the four ships to four different ports in such a way as to minimize the total cost for all four shipments.

(a) Let $x_{ij} = 1$ if ship i is sent to port j with $x_{ij} = 0$ otherwise. (A problem of this form is called an assignment problem.) Formulate and solve this problem in Pyomo. You should submit a your Ipython notebook, showing code and solution.

Hint: In Pyomo, you can declare a variable to take only values 0 and 1 by using the option `within=Boolean`.

(b) Now suppose you drop the requirement that the x_{ij} are Boolean and replace it with the usual non-negativity requirement. In other words, you are allowing to send "a fraction of a ship" to one port and another fraction to another. Re-solve the problem in Pyomo. What do you see?