IEOR 4004. Project 4, Due March 24

The companion spreadsheet ('project4.xlsx') describes a logistics problem. In this problem, we have a number of orders for material to be shipped to a destination. Each order has a weight and has to be shipped to a 'plant', or warehouse – our goal is to choose which plant to ship it to, and when. Each warehouse is located in a port – see the tab labeled 'Plant location'.

To perform the shipping to we need to rely on carriers (e.g., an air cargo service). The tab labeled 'FreightRates' provides the cost per unit weight for each carrier to each destination. For example, carrier 1 has a per unit weight of \$0.71 to PORT08. That means that if we ship part or all of an order to a plant located within PORT08 then we pay \$0.71 per unit of weight.

Additionally, 'Freight Rates' describes (under 'max_weight') the maximum **daily** capacity for that carrier, which is given on an order/carrier/plant basis. This works out as follows. Consider line 50 of FreightRates. It states a capacity of 249.99 using carrier 49 and PORT04. This means that up to 249.99 units of weight of any given order can be shipped on one day using carrier 49 to any **individual plant located within PORT04**. There are several such plants, e.g. PLANT03.

For example, consider order ID 1447296446.7 (weight: 11155.4). Then at most 249.99 units of weight of this order can be shipped using carrier 49 to plant03 on a given day. However, carrier 49 could also carry up to 249.99 units of the same order to plant08 (another plant within PORT04) on the same day. And carrier 49 could carry other orders on that same day, to plant03 or plant08 – the daily weight limit is on an order/carrier/plant basis.

Additionally, each carrier requires a certain number of days to complete the shipment. So not all the shipments will arrive on day 0. We will add \$0.01 per day per weight to the cost of a shipment as a 'delay cost' – time is measured from time zero (i.e., the start of the first day).

Notes:

1. On any given day, the total shipped for an order can be split among several carriers.
2. And, of course, we may need multiple days and carriers to completely ship an order.

We want to solve the optimization problem described by these features. The objective is to minimize total cost (shipping + delay costs).

Your variables should be the following:

Denote by i the index of an order (i = 1, 2, etc.). Denote by j the index of a carrier. And denote by k the index of a plant (k = 1,…,16). And denote by t the day on which the shipment is sent out (t = 0, 1, …). The variable we want to use is

X(i, j, k, t) = amount of order i sent on carrier j to plant k on day t.

You need to figure out how large t should be, and the constraints for this problem (think of each order as a 'supply', and write an equation saying that you ship everything). The X variables are going to be constrained by the carrier capacities.

Extra credit

Tab 'Plant Capacity' includes information on the daily capacity of each plant, in millions of units of weight. The daily capacity cannot be exceeded. It applies to the all the shipments received by that plant on that day.

Modify the optimization problem so as to account for this feature.