DSA/ISE 5113 Advanced Analytics and Metaheuristics
Homework #3

Instructor: Charles Nicholson

Due: See course website for due date

Requirement details

1. Homeworks should be submitted in a clean, clear, concise electronic format. You must show your logic, work, and/or code where appropriate. Note: any code (e.g., AMPL model and/or data files) is a part of your solution (turn in as separate files)
2. For mathematical programming problems, ensure you clearly define the following elements: (i) **necessary assumptions**, (ii) **decision variables**, (iii) **objective and objective function**, and (iv) **constraints**. Points may be deducted if proper definitions/documentation is missing.

Question 1: Norman Electric Cooperative: Generators (30 points)

Each day *Norman Electric Cooperative* (NEC), a power company serving the region, must decide on which power generators to start up and how much power each will generate. NEC has three generators with the characteristics given in Table 1.

Table 1: Generator Characteristics

Generator, i	S_i	F_i	C_i	U_i
A	3000	700	5	2100
B	2000	800	4	1800
C	1000	900	7	3000

where S_i is the fixed startup cost for starting generator i, F_i is the fixed cost per period of operation, C_i is the cost per period per megawatt generated, and U_i is the maximum capacity, in megawatts, that can be generated each period by generator i.

There are two periods in a day. The number of megawatts needed in the first is 2900. In the second period 3900 are needed. A generator started in the first period can be used in the second period without incurring an additional startup cost. All generators are turned off at the end of the day. Formulate and solve the problem.

Question 2: Silos (30 points)

Zimmerman Industries owns 5 types of landscaping and construction products (e.g., cement, sand, etc.) labeled product A, B, C, D, and E which must be stored in 8 different silos. Each silo can contain at most one type of product. Associated with each product and silo combination is a loading cost. Each silo has a finite capacity so some products may have to be split over several silos.

Table 2: Silo data

Product	Silo-Loading Cost per Ton								Amount of Product (tons)
	1	2	3	4	5	6	7	8	
A	1	2	2	1	4	4	5	3	75
B	2	3	3	3	1	4	5	2	50
C	3	4	1	2	1	4	5	1	25
D	1	1	2	2	3	4	5	2	80
E	1	1	1	1	1	1	5	5	20
Silo Capacity (tons)	25	25	30	60	80	85	100	50	

(a) Formulate and solve this problem to find a minimum cost storage plan.

(b) Some of the exceutive management team at Zimmerman Industries has decided they do not like partially filling tanks. Even though that they realize this certainly must happen from time to time, they still just don't like doing it, even if it is more cost effective. Other executives are perfectly fine with partially filled tanks, as long as the storage plan is as inexpensive as possible. Everyone agrees that if all costs were equal, then, for example, it'd be better to store 20 tons in a 25 ton capacity silo instead of using their 100 ton capacity tank. How could you modify your formulation to deal with the management teams wishes? Implement your revised model in AMPL to address this issue and discuss the ramifications.

Question 3: Gadgets and More! (40 points)

You have been hired as a contractor for *Gadgets and More!* and are helping the purchasing manager determine her monthly strategy for buying widgets (a necessary component of the company's gadgets).

She has her choice of five suppliers: *Widgets International Incorporated* (WII), *Widgets 'R Us* (WRS), *Widgets Unlimited* (WU), *World of Widgets* (WOW), and *Widget Emporium* (WE). These suppliers have different price structures and available widgets as seen in the Table 3. She may source the widgets from any combination of these suppliers.

Given the complexity of the price structure, she is concerned that the best cost solution is highly dependent on the specific widget demand values at any given time. Your job is to first formulate an integer linear program (ILP) mathematical model for the problem. Next, solve the problem (using AMPL) for the following possible total widget demand values: 5000, 10000, 25000, 35000, 45000, 50000, and 55000. Provide your results in a summary table as shown in Table 4.

Note: You may wish to look into "Looping" structures for AMPL to make solving several problem instances slightly more convenient, e.g., `https://ampl.com/NEW/loop1.html`

Table 3: Widgets Supplier Info

Supplier	Price structure	Available
WII	\$4.95 per widget	18000
WRS	\$2.30 per widget + fixed fee of \$20,000	14000
WE	\$3.95 per widget, if you also buy from WRS; otherwise, \$4.10 per widget, but you can't buy from WII	7000
WU	\$4.25 per widget, only if you buy at least 15000 (otherwise, no widgets for you!)	22000
WOW	\$9.50 per widget for first 3000; \$4.90 each for the next 6000; \$2.75 each for more	25000

Table 4: Example table of results (fake data)

	Purchased from suppliers					
Demand	WII	WRS	WE	WU	WOW	Total Cost
5,000	1500	9800	2000	3000	1900	\$42,817
10,000	0	12800	5300	850	4210	\$97,302
25,000	1000	8300	0	1850	2210	\$107,302
35,000				...		
45,000				...		
50,000				...		
55,000				...		