MSBA7003 Quantitative Analysis Methods

Assignment 2 (Due September 25 at 23:55; Please submit your solutions with the template)

Q1.

Dumoor Appliance Center sells and services several brands of major appliances. Past sales for a particular model of refrigerator have resulted in the following probability distribution for demand:

Demand per Week	0	1	2	3	4
Probability	0.10	0.20	0.30	0.35	0.05

The replenishment lead time, in weeks, is described by the following distribution:

Lead Time (weeks)	1	2	3
Probability	0.25	0. 40	0.35

Based on cost considerations as well as storage space, the company has decided to order 15 units each time. The shipping cost for each order is $30. The holding cost is $5 per week per unit that is left in inventory at the end of the week. The stock-out cost is $40 per unit. The company has decided to place an order whenever there are only two or fewer refrigerators left at the end of the week. No order can be placed when refrigerators are being shipped on the way. Simulate 10 weeks of operation for Dumoor Appliance by hand assuming that there are currently 5 units in inventory. You must use the random numbers listed in the table below to generate demand and lead time values, respectively.

Week	Order Received	Total Available	R.N.	Demand	Sales	Lost Sales	Ending Inventory	Place Order	R.N.	Lead Time
1	0	5	0.52						0.56	
2			0.37						0.45	
3			0.82						0.07	
4			0.98						0.16	
5			0.96						0.48	
6			0.33						0.61	
7			0.50						0.31	
8			0.88						0.43	

9			0.90						0.28	
10			0.06						0.31	

Which of the following statement(s) is(are) true?

A) The total sales during this 10-week period is 15.

B) The total lost sales during this 10-week period is 6.

C) The total number of orders placed during this 10-week period is 2.

D) The total (not average) cost of inventory holding, ordering, and stock-out costs during this 10-week period is $485.

E) None of the above.

Note: Please refer to "Assignment_2_solutions.xlsx".

Q2.

Three Hills provides power to a large city through a series of 200 electric generators. The company is concerned about generator failures because a breakdown costs about $75 per generator per hour. (The breakdown cost of $75 will be incurred for an hour as long as a generator is not working at the beginning of the hour, regardless of whether it is fixed in the hour or not.) There is one repairperson onsite at any time and the hourly wage is $30. (The hourly wage should be paid whenever the worker is onsite, regardless of he or she is working on a failed generator or not.) Management team wants to evaluate the service maintenance cost and the machine breakdown cost. There are two important uncertain factors. On the one hand, time between successive breakdowns for any single generator follows an exponential distribution with a rate of once every 400 hours or $\lambda = 1/400$. In theory, if there are n working generators, the total number of breakdowns in one hour follows a Binomial distribution with maximum number n and success probability $1 - \exp(-\lambda)$. On the other hand, the number of broken-down generators that can be repaired by a repairperson in one hour ranges from zero to two according to the following distribution.

# of generators repaired	Probability	Cumulative Probability
0	0.28	0.28
1	0.52	0.80
2	0.20	1.00

Simulate the operations of the system for at least 10000 hours. Which of the following is(are) true? (Assume the default setting if not otherwise stated.)

A) The average hourly total cost with a single repairperson is about $110 ~ $124.

B) The average hourly total cost with two workers with the same skills is about $120 ~ $130.

C) It is better to replace the repairperson with another one who receives the same salary and whose hourly repair rate is constantly one.

D) Consider a second worker with the same skill. He can report for duty immediately when he is called and will get the same hourly wage only when he is working. Once he is called, he must work for 4 hours in a row and take a 2-hour break before he can be called again. Whenever there are 2 or more broken generators remaining unfixed at the beginning of an hour, the company calls him if he is available. The average hourly total cost will be about $95 ~ $100.

E) None of the above.

Note: Please refer to “Assignment_2_solutions.xlsx”.

Q3.

We are solving a dynamic decision-making problem for a project, for which the final outcome is either success or failure. In the process to build a search tree with the Monte Carlo Tree Search algorithm to maximize the success rate (V), after the 22nd round of selection-expansion-simulation-backpropagation is finished, the first 4 rows of the table that stores the search tree is given below. The UCB1 selection strategy is used, and the constant C = 1/2.

Index	Parent	Child	Type	Note	n	V	UCB
1	–	{2, 3, 4}	Decision	Root	22	0.2727	–
2	1	{5, …}	State	Option1-1	6	0.1667	0.8844
3	1	{…}	State	Option1-2	4	0.0000	0.8791
4	1	{…}	State	Option1-3	12	0.4167	0.9242

Which of the following statement(s) is(are) true?

A) The 22nd search surely started from node 3.

B) The 23rd search will surely start from node 4.

C) If the 23rd search is successful, then the UCB values for nodes 2, 3, and 4 will all increase.

D) The 24th search may start from node 2.

E) None of the above.

Note:

We cannot make sure the V_i of nodes 2, 3, and 4 before updated. Therefore, A) is wrong.

The upper confidence bound (UCB) for node i (an option) is given by

$$B_i = V_i + \sqrt{\frac{\ln N_i}{n_i}}.$$

To better understand and calculate, we can transform the decimals of V_i in the table to 6/22, 1/6, 0/4, and 5/12, respectively.

According to the given search tree table, the UCB value of node 4 is the highest. Hence the 23rd search will surely start from node 4. Therefore, B) is True.

According to the information given by the table, we can obtain that if the 23rd research is successful, then n_i of node 4 would increase to 13, the V value of node 4 would increase, the of nodes 2 and 3 would remain the same, and the value of N_i would increase to 23, then UCB values of node 2 and 3 increase to 0.8896 and 0.8853, and the UCB value of node 4 equal to 0.9527, which is increased too. Therefore, C) is True.

after the 23nd round	C =	1					success	
	Index	Parent	Child	Type	Note	n	V	UCB
	1	-	{2, 3, 4}	Decision	Root	23	0.3043	-
	2	1	{5, ⋯}	State	Option1-1	6	0.1667	0.8896
	3	1	{⋯}	State	Option1-2	4	0.0000	0.8854
	4	1	{⋯}	State	Option1-3	13	0.4615	0.9527

But if the 23 research is not successful, we can obtain the updated UBC values of nodes 2, 3, and 4 equal to 0.8896, 0.8853, and 0.8757, respectively. Therefore, D) is True.

C =	1					Failure	
Index	Parent	Child	Type	Note	n	V	UCB
1	-	{2, 3, 4}	Decision	Root	23	0.2609	-
2	1	{5, ⋯}	State	Option1-1	6	0.1667	0.8896
3	1	{⋯}	State	Option1-2	4	0.0000	0.8854
4	1	{⋯}	State	Option1-3	13	0.3846	0.8757

Please refer to “Assignment_2_solutions.xlsx”.