Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin

BU7150 Business Decision Optimization Group Assignment
Mathematical Modelling & Simulation

Due Date: April 24 2023, 23:59

This assignment contributes 60% to the overall grade for students taking this module.

Submission Package:

- Group Assignment Cover Sheet
- PowerPoint presentation with voice-over to present and explain the modelling approach and the formulations for Question 1 and Question 2
- Excel files uploaded as a single zip file
- Report on the open-ended Question 3

Question 1 (40 points out of 100)
Mathematical Modelling

Please read this case study in detail, especially Section 3 Problem Description and Section 4 Mathematical Description of the Optimization Model: https://optimization-online.org/wp-content/uploads/2016/12/5789.pdf

Please apply these corrections:

1) Page 7, line 1: Could be better if w_i : measures the weight a vehicle has delivered *when* it reaches customer i
2) Equation (16): Instead of $\forall i \in \{1, 2, \dots, N\}$, $please\ arrange\ for\ \forall i \in V_c$
3) Page 8, line 11: Instead of "…plus the weight of the order of center i", use "…plus the weight of the order of center j"

Then please provide solutions to the below problems listed in Part A) and Part B). Please provide slides with voice-over to explain your model (similar to the explanations for the Landhills Winery case) and provide two separate Excel files (workbooks) for part A) and part B).

A) Please set-up and solve the model in Section 4 with respect to the data set below (with two customers only). Your model should be configured to allow all numerical parameters (which are not represented as subscripts) to be changed easily. After obtaining the solution, please explain the actions/implementation in practice to be applied such as describe the optimal route(s) for vehicle(s) and the arrival times to the customers and comment on whether the optimal routing allows for breaks for the driver(s).

n = 2
T = 120 mins

N = 2 vehicles
D_1 = 25 doses
D_2 = 15 doses
F = 30 Euros

c_ij	0	1	2
0	0	8.84	9.35
1	8.84	0	4.42
2	9.35	4.42	0

t_ij	0	1	2
0	0	21.46	22.7
1	21.46	0	10.73
2	22.7	10.73	0

s_1 = 15 mins
s_2 = 15 mins

W_{VEH} = 300 kgs
W_{CON} = 6 kgs

W_1 = 150 kgs
W_2 = 90 kgs

$[e_1, l_1]$ = [30, 40]; e. g. earliest arrival is at 30th minute after the starting time
$[e_2, l_2]$ = [40, 60]

B) Please set-up and solve the model in Section 4 with respect to the data set below (with three customers). Your model should be configured to allow all numerical parameters (which are not represented as subscripts) to be changed easily. After obtaining the solution, please explain the actions/implementation in practice to be applied such as describe the optimal route(s) for vehicle(s) and the arrival times to the customers and comment on whether the optimal routing allows for breaks for the driver(s).

n = 3
T = 120 mins
N = 2 vehicles
D_1 = 25 doses
D_2 = 15 doses
D_3 = 10 doses

F = 30 Euros

c_ij	0	1	2	3
0	0	8.84	9.35	14.79
1	8.84	0	4.42	6.97
2	9.35	4.42	0	5.44
3	14.79	6.97	5.44	0

t_ij	0	1	2	3
0	0	21.46	22.7	35.9
1	21.46	0	10.73	16.92
2	22.7	10.73	0	13.21
3	35.9	16.92	13.21	0

s_1 = 15 mins
s_2 = 15 mins
s_3 = 15 mins

W_{VEH} = 300 kgs
W_{CON} = 6 kgs

W_1 = 150 kgs
W_2 = 90 kgs
W_3 = 60 kgs

$[e_1, l_1]$ = [30, 40]; e. g. earliest arrival is at 30th minute after the starting time
$[e_2, l_2]$ = [40, 60]
$[e_3, l_3]$ = [30, 60]

Question 2 (30 points out of 100)
Simulation

Please read carefully the Example 16.7 at pp. 810-812 at our textbook Albright, S. C., & Winston, W. L. (2020). Business analytics: Data analysis & decision making. Cengage Learning..

Please also review the materials uploaded on Blackboard related with this example thoroughly (at "Lecture 6, Simulation continued" tab). Then, please re-configure the Big Picture diagram and the Excel file based on the extension to the problem described below and provide PowerPoint slides with voice-over to explain your model along with the Excel file for the re-configured solution obtained via @RISK add-in.

The customer loyalty model in Example 16.7 assumes that once a customer leaves (becomes disloyal), that customer never becomes loyal again. Assume instead that there are two probabilities that drive the model, the retention rate and the *rejoin* rate, with values 0.75 and 0.15, respectively. The simulation should follow a customer who starts as a loyal customer in year 1. From then on, at the end of any year when the customer was loyal, this customer remains loyal for the next year with probability equal to the retention rate. But at the end of any year the customer is disloyal, this customer becomes loyal the next year with probability equal to the rejoin rate. During the customer's *n*th loyal year with the company, the company's mean profit from this customer is the *n*th value in the mean profit list in column B. Keep track of the same two outputs as in the example, and also keep track of the number of times the customer rejoins.

Question 3 (30 out of 100)
Simulation Open-ended Question

Please provide a report on the use of simulation in business analytics. One example of use of simulation for business purposes is described here in detail for supply chain analytics (https://nicolas-vandeput.medium.com/the-perfect-inventory-competition-a5a6e0d958d3).

The word limit for the report is 2500 words, excluding bibliography and any figures appendices that may be added if preferred.

Please use the Harvard referencing system. This requires you to state the surname of the author(s) in the text of your report, followed by a comma and year of publication e.g.: "Smith (1983) states that…." If you use direct quotes, then the page number should follow e.g.: Smith (1983: 112) "The profit … business growth". Failure to reference properly constitutes a violation of university regulations i.e. plagiarism and is a serious offence. In your bibliography you provide the following full details of each reference:

Smith, J. (1983) Title of the work, *Harvard Business Review*, Sept. – Oct., pp. 109-117.

Grading criteria for the report:

- Relevance to module material (e. g. textbooks) – 10 points
- Educational insight and richness of the further examples – 15 points
- Clarity of writing and referencing – 5 points