BUSINESS ANALYTICS
MANAGEMENT SCIENCE (QBUS2310)
ASSIGNMENT 2, 2018

Issued: 12 October 2018
Submission date: Monday 29 October 2018 @ 5 pm
Submission –Electronic Submission of Word/PDF document on Canvas. Please save all your Python files.

For each question you should:
a. Define your decision variables.
b. Provide your complete formulation for the problem (objective function, constraints and conditions on the decision variables).
c. Provide the optimal solution obtained using Python. You are required to state the optimal value of the decision variables and, in simple English, the optimal solution with reference to the context (For example, $X_1=2$ and therefore, the company should build 2 5-star hotels...).
d. Provide a screen shot of your code/solution as required in the question.

Question 1 (15 marks): Use Excel for this question

An investor wants to invest $50,000 in two mutual funds, A and B. The rates of return, risks and minimum investment requirements for each fund are:

Fund	Rate of return	Risk	Minimum investment
A	12 %	0.5	$20,000
B	9 %	0.3	$10,000

Note that a low risk rating means a less risky investment. The investor wants to maximize the expected rate of return while minimizing his risk. Any money beyond the minimum investment requirements must be invested in one of the funds (all $50,000 have to be invested). Assume that the risk of a portfolio is equal to the weighted average of the risks of the individual funds.

   a. Find the investment policy that maximizes return. What is the risk and return under this policy?

b. Find the investment policy that minimizes risk. What is the risk and return under this policy?

c. Formulate a goal programming model with a MINIMAX objective function. Assume that maximizing return and minimizing risk are equally important.

d. Solve the problem using EXCEL. Explain your result and provide a screenshot of your Excel sheet.

Question 2 (25 marks): Use Python for this question

You have been put in charge of training new employees (trainees) at a commercial bank. In order to fill the role of an investment consultant each trainee must successfully complete a sub-set of 6 available courses (A, B, C, D, E, F). There are four different sequences of courses that can be taken in order to achieve the required skill level. These sequences are A-E, B, C-F, and A-D-F. The table below provides information on the six courses.

Course	Cost Per Trainee	Min. Num. of Trainees	Max. Num. of Trainees
A	25	15	40
B	55	10	50
C	30	15	50
D	10	15	50
E	20	10	50
F	15	10	50

There are 100 new trainees available for training and a demand for 100 skilled investment consultants. Assume all employees (trainees) pass each course they are allocated to and that you are trying to assign trainees to classes in order to minimize the total cost of training. Assume each course will be held.

In addition to the formulation, solution and Python output you should provide the network flow diagram describing the problem and address the following questions:

What is the expected student load for each course?
Should any course be expanded?
Should any course or sequence be considered for elimination?

Question 3 (30 marks):

Linda has decided to renovate her old shop. She has identified the following activities that must be performed before she can reopen for business:

Activity	Description	Duration (in days)	Predecessor activities
A	New Plumbing	10	--
B	Order/Rec Furniture	20	--
C	Order/Rec Flooring	15	--
D	Construct Partitions	5	--
E	Paint & Wallpaper	5	A, D
F	Install Furniture	3	E, B
G	Install Flooring	4	E, C
H	Move Inventory & Rec's	2	F, G
I	Clean Old Shop	2	H

a. **Draw** the activity network for this problem (AON).

b. Provide the earliest and latest start and finish times, the slack for each activity, and identify the critical activities (either on the network or in a table).

c. What is the duration of the project? Provide the critical paths(s).

d. Suppose that Linda has a binding contract stating that she must complete the renovation within 20 days. The normal and crash times and costs for each activity are summarized in the table below. Is it possible for her to complete the project within 20 days? If it is possible, at what cost? If it is not possible, what is the earliest time she can complete the project and at what cost?

Activity	Normal		Crash	
	Time (days)	Cost (dollars)	Time (days)	Cost (dollars)
A	10	11,000	7	15,000
B	20	5,000	18	6,000
C	15	3,000	12	3,500
D	5	1,500	3	2,000
E	5	750	2	1,200
F	3	600	1	1,200
G	4	1,000	2	1,500
H	2	250	1	450
I	2	200	1	300

Question 4 (30 marks): Use Python for this question

A tour bus company has to decide on the number of small, medium and large buses it will operate during the next tourist season. The company would like to restrict the size of its fleet to 80 buses and ensure that at least 10% of its buses are large (this is a legal requirement since the company must have at least 10% of its fleet accessible to wheelchairs, and only the large buses meet this standard). The number of seats on small, medium and large buses is 30, 40 and 50, respectively. The company wants to ensure that it can accommodate at least 3,000 passengers at any given time.

In the following table, the daily cost (in dollars), the pollution rating and the safety rating of the three bus types is given. The pollution rating is on a scale of 1 to 10 where 1 reflects the lowest levels of pollution and 10 reflects the least environmentally friendly score. The safety rating is also on a scale of 1 to 10 with 10 being the score for the safest bus.

Bus	Cost per day	Pollution rating	Safety score
Large	$490	8	9
Medium	$440	5	8
Small	$400	7	6

a. Find the bus fleet that minimizes costs. What is the cost, the mean pollution rating and the mean safety score for this fleet?

b. Find the bus fleet that minimizes the mean pollution rating. What is the cost, the mean pollution rating and the mean safety score for this fleet?

c. Find the bus fleet that maximizes the mean safety. What is the cost, the mean pollution rating and the mean safety score for this fleet?

d. Formulate a goal programming model with a MINIMAX objective function. Assume that safety is twice as important as both costs and pollution.

e. Solve problem (d) using Python. Explain your result and provide a screenshot of your code.