Assignment 6

Maryam Heidari

ALY 6050 Introduction to Enterprise Analytics CRN: 80802

Spring quarter of 2019

Instructor: Dr. Ajay Ogirala

submission date: 28 June 2019

question 1:

Chapter 14, question 1: Explain the difference between general integer variables and binary variables.

Mathematically, a binary variable *x* is simply a general integer variable that is restricted to being between 0 and 1. Binary variables enable us to model logical decisions in optimization models. So the difference between general integer and binary variables is the binary variables can get certain range amount and it usually is equal to zero or one

---

Chapter 14, question 2: What is the difference between linear and nonlinear optimization models?

The difference between linear and nonlinear optimization models is the relationship among variables in a model is not linear. Whenever either the objective function or a constraint is not linear, the model becomes a *nonlinear optimization problem.*

Question 2:

Part1: An IT support group at a university has seven projects to complete. The time in days and project deadlines are shown below.

In order to answer this question, I make a table and use the = index for Processing time and due date rows. You can see the result in picture 1.

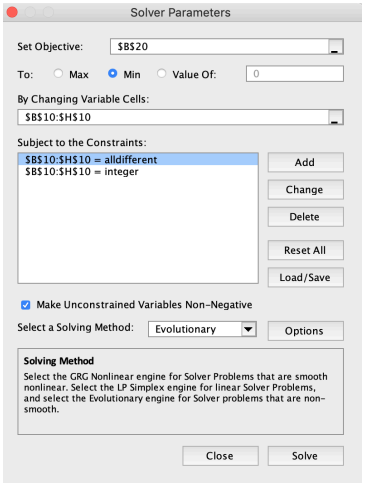
JOB SEQUENCING							
Data							
Project	1	2	3	4	5	6	7
Time	4	9	12	16	9	15	8
deadline	12	24	60	28	24	36	48
Model							
Sequence	1	2	3	4	5	6	7
Job assigned	1	2	3	4	5	6	7
Processing time	4	9	12	16	9	15	8
Completion time	4	13	25	41	50	65	73
Due date	12	24	60	28	24	36	48
Lateness	-8	-11	-35	13	26	29	25
Tardiness	0	0	0	13	26	29	25
average completion time	38.7142857						
Max number of Tardy	7						
Total lateness	39						
Var of Lateness	583.952381						
Total Tardiness	93						
Average Tardiness	13.2857143						
Var of Tardiness	179.238095						

JOB SEQUENCING							
Data							
Project	1	2	3	4	5	6	7
Time	4	9	12	16	9	15	8
deadline	12	24	60	28	24	36	48
Model							
Sequence	1	2	3	4	5	6	7
Job assigned	1	2	3	4	5	6	7
Processing time	=INDEX($B$4:$H$6,2,B10)	=INDEX($B$4:$H$6,2,C10)	=INDEX($B$4:$H$6,2,D10)	=INDEX($B$4:$H$6,2,E10)	=INDEX($B$4:$H$6,2,F10)	=INDEX($B$4:$H$6,2,G10	=INDEX($B$4:$H$6,2,H10)
Completion time	4	13	25	41	50	65	73
Due date	=INDEX($B$4:$H$6,3,B10)	=INDEX($B$4:$H$6,3,C10)	=INDEX($B$4:$H$6,3,D10)	=INDEX($B$4:$H$6,3,E10)	=INDEX($B$4:$H$6,3,F10)	=INDEX($B$4:$H$6,3,G10	=INDEX($B$4:$H$6,3,H10)
Lateness	=B12-B13	=C12-C13	=D12-D13	=E12-E13	=F12-F13	=G12-G13	=H12-H13
Tardiness	=MAX(0,B14)	=MAX(0,C14)	=MAX(0,D14)	=MAX(0,E14)	=MAX(0,F14)	=MAX(0,G14)	=MAX(0,H14)
average completion time	=SUM(B12:H12)/7						
Max number of Tardy	7						
Total lateness	=SUM(B14:H14)						
Var of Lateness	=VAR(B14:H14)						
Total Tardiness	=SUM(B15:H15)						
Average Tardiness	=AVERAGE(B15:H15)						
Var of Tardiness	=VAR(B15:H15)						

picture 1

Sequence the projects to minimize the average lateness.

I used the solver and the result is in picture 2



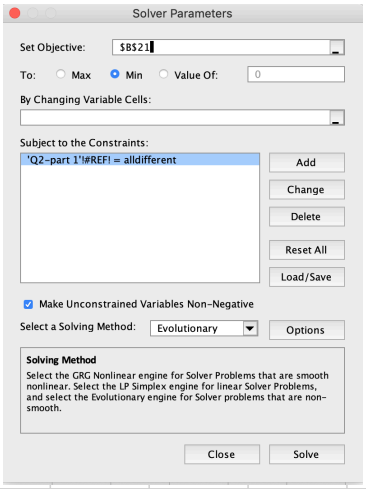
Model							
Sequence	1	2	3	4	5	6	7
Job assigned	1	2	3	4	5	6	7
Processing time	4	9	12	16	9	9	8
Completion time	4	13	25	41	50	59	67
Due date	12	24	60	28	48	36	48
Lateness	-8	-11	-35	13	2	23	19
Tardiness	0	0	0	13	2	23	19
average complet	37						
Max number of T	7						
Total lateness	3						
Var of Lateness	411.952381						
Total Tardiness	57						
Average Tardine	8.14285714						
Var of Tardiness	99.8095238						

Picture 2

Base on the picture 2, the minimum average lateness is 3 and the total tardiness is 57.

And they need to do jobs in this order: 1-2-3-4-5-6-7.

Sequence the projects to minimize the average tardiness.



Model							
Sequence	1	2	3	4	5	6	7
Job assigned	3	1	2	4	7	5	6
Processing time	12	4	9	16	8	9	15
Completion time	12	16	25	41	49	58	73
Due date	60	12	24	28	48	24	36
Lateness	-48	4	1	13	1	34	37
Tardiness	0	4	1	13	1	34	37
average complet	39.1428571						
Max number of	7						
Total lateness	42						
Var of Lateness	794						
Total Tardiness	90						
Average Tardine	12.8571429						
Var of Tardiness	259.142857						

Picture 3

Base on the picture 3, the minimum average lateness is 90, and total lateness is 42.

And they need to do jobs in this order: 3-1-2-4-7-5-6.

Compare these solutions to the SPT and EDD rules.

the result of SPT is

average complet	34.1428571
Max number of	7
Total lateness	7
Var of Lateness	698
Total Tardiness	72
Average Tardine	10.2857143
Var of Tardiness	293.571429

Picture 4

The result of EDD is

average complet	38.7142857
Max number of	7
Total lateness	39
Var of Lateness	131.952381
Total Tardiness	58
Average Tardine	8.28571429
Var of Tardiness	57.2380952

Picture 5

As you can see the results of these two method are between the results of solver.

Part 2: Resolve the problem if Time to complete project 4 is 13 and deadline is 25.

Minimum lateness:

Model							
Sequence	1	2	3	4	5	6	7
Job assigned	1	2	5	4	6	7	3
Processing time	4	9	9	13	15	8	12
Completion time	4	13	22	35	50	58	70
Due date	12	24	24	25	36	48	60
Lateness	-8	-11	-2	10	14	10	10
Tardiness	0	0	0	10	14	10	10
average complet	36						
Max number of	7						
Total lateness	23						
Var of Lateness	101.571429						
Total Tardiness	44						
Average Tardine	6.28571429						
Var of Tardiness	36.5714286						

Picture 6

Minimum Tardiness:

Model							
Sequence	1	2	3	4	5	6	7
Job assigned	1	2	5	4	6	7	3
Processing time	4	9	9	13	15	8	12
Completion time	4	13	22	35	50	58	70
Due date	12	24	24	25	36	48	60
Lateness	-8	-11	-2	10	14	10	10
Tardiness	0	0	0	10	14	10	10
average complet	36						
Max number of	7						
Total lateness	23						
Var of Lateness	101.571429						
Total Tardiness	44						
Average Tardine	6.28571429						
Var of Tardiness	36.5714286						

Picture 7

SPT:

Model							
Sequence	1	2	3	4	5	6	7
Job assigned	1	7	2	5	3	4	6
Processing time	4	8	9	9	12	13	15
Completion time	4	12	21	30	42	55	70
Due date	12	48	24	24	60	25	36
Lateness	-8	-36	-3	6	-18	30	34
Tardiness	0	0	0	6	0	30	34
average complet	33.4285714						
Max number of	7						
Total lateness	5						
Var of Lateness	630.238095						
Total Tardiness	70						
Average Tardine	10						
Var of Tardiness	232						

Picture 8

EDD:

Model							
Sequence	1	2	3	4	5	6	7
Job assigned	1	2	5	4	6	7	3
Processing time	4	9	9	13	15	8	12
Completion time	4	13	22	35	50	58	70
Due date	12	24	24	25	36	48	60
Lateness	-8	-11	-2	10	14	10	10
Tardiness	0	0	0	10	14	10	10
average complet	33.4285714						
Max number of	7						
Total lateness	23						
Var of Lateness	101.571429						
Total Tardiness	44						
Average Tardine	6.28571429						
Var of Tardiness	36.5714286						

Picture 9

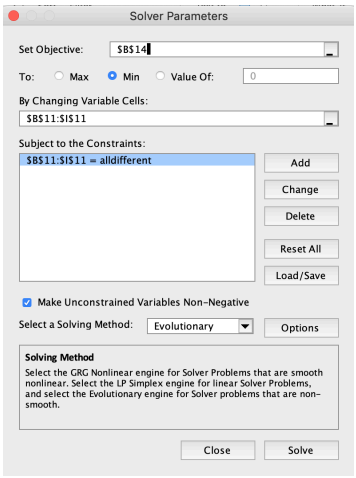
Question 3:

part 1: The *traveling salesperson problem* involves finding an optimal route (called a *tour*) that visits each of *n* cities exactly once and returns to the start. For example, suppose the distances between medical offices for a pharmaceutical representative are: …

Note that the distance from one location to itself is an arbitrarily high number, 999. An example of a tour is 1-4-2-7-8-3-6-5-1. The total distance traveled would be 51+10+80+9+47+30+68+49=344. The objective is to find the minimum distance tour. Set up and solve this problem using *Evolutionary Solver*. (Hint: Use the INDEX function to find the distance between locations and the *alldifferent* constraint in *Solver*. However, ensure that your solution goes back to the starting location.)

	1	2	3	4	5	6	7	8	
1	NAN	19	57	51	49	4	12	92	
2	19	NAN	51	10	53	25	80	53	
3	57	51	NAN	49	18	30	6	47	
4	51	10	49	NAN	50	11	91	38	
5	49	53	18	50	NAN	68	62	9	
6	4	25	30	11	68	NAN	48	94	
7	12	80	6	91	62	48	NAN	9	
8	92	53	47	38	8	94	9	NAN	
squ	3	5	8	7	1	2	4	6	1
dict	18	9	9	12	19	10	11	4	
total	92								

	1	2	3	4	5	6	7	8	
1	NAN	19	57	51	49	4	12	92	
2	19	NAN	51	10	53	25	80	53	
3	57	51	NAN	49	18	30	6	47	
4	51	10	49	NAN	50	11	91	38	
5	49	53	18	50	NAN	68	62	9	
6	4	25	30	11	68	NAN	48	94	
7	12	80	6	91	62	48	NAN	9	
8	92	53	47	38	8	94	9	NAN	
squ	3	5	8	7	1	2	4	6	1
dict	=INDEX($B$2:$I$9,B11,C1	=INDEX($B$2:$I$9,C11,D1	=INDEX($B$2:$I$9,D11,E1	=INDEX($B$2:$I$9,E11,F1	=INDEX($B$2:$I$9,F11,G1	=INDEX($B$2:$I$9,G11,H1	=INDEX($B$2:$I$9,H11,I11	=INDEX($B$2:$I$9,I11,J11	
total	=SUM(B12:I12)								

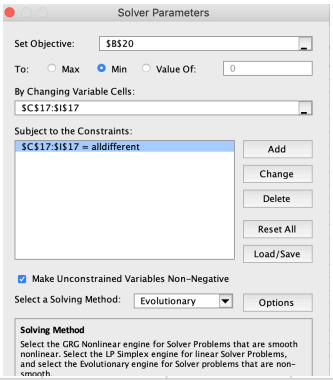


Picture 10

Base on the picture 10 the minimum distance is 92.

part 2: Resolve the problem if you must start from location 8 and end at location 8

for answer this part I did not select the first point as a changing variable which is 8



squ	8	5	3	6	4	2	1	7	8
dict	8	18	30	11	10	19	12	9	
total	117								

picture 11

Base on picture 11 the minimum dictates is 117.