

ORIE 5380 HW1

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Q1. as Decision Variables:

 X_1 = Amount of Corn. X_2 = Amount of Soybean.

Constraints:

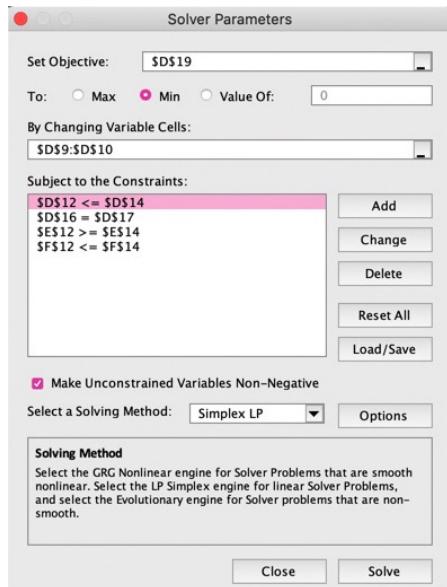
$$\begin{cases} 0.001 X_1 + 0.002 X_2 \leq 90 \times 0.17\% = 0.15 \\ 0.09 X_1 + 0.6 X_2 \geq 90 \times 0.3 = 27 \\ 0.02 X_1 + 0.06 X_2 \leq 90 \times 0.05 = 4.5 \\ X_1 + X_2 = 90 \end{cases}$$

Objective:

b) $\min (0.2 X_1 + 0.6 X_2)$

A	B	C	D	E	F
1					
2					
3	Problem Data		Pounds per Pound of Material		
4		Material	Calcium	Protein	Fiber
5		Corn	0.001	0.09	0.02
6		Soybean	0.002	0.6	0.06
7					
8	Decision Variables		Amount	Cost	
9		Corn	52.94117647	0.2	
10		Soybean	37.05882352	0.6	
11					
12	Constraints	Total material	0.127058824	27	3.282352941
13		Limit sign	<=	>=	<=
14		Bound	0.153	27	4.5
15		Bound %	0.0017	0.3	0.05
16		Total feed require	90		
17		Total feed actual	90		
18					
19	Objective	Min Total cost	32.82352941		

A	B	C	D	E	F
1					
2					
3	Problem Data		Pounds per Pound of Material		
4		Material	Calcium	Protein	Fiber
5		Corn	0.001	0.09	0.02
6		Soybean	0.002	0.6	0.06
7					
8	Decision Variables		Amount	Cost	
9		Corn	52.9411764705882	0.2	
10		Soybean	37.0588235294117	0.6	
11					
12	Constraints	Total material	=SUMPRODUCT(D5:D6,\$D\$9:\$D\$10)	=SUMPRODUCT(E5:E6,\$D\$9:\$D\$10)	=SUMPRODUCT(F5:F6,\$D\$9:\$D\$10)
13		Limit sign	<=	>=	<=
14		Bound	=D15*\$D\$16	=E15*\$D\$16	=F15*\$D\$16
15		Bound %	0.0017	0.3	0.05
16		Total feed require	90		
17		Total feed actual	=SUM(D9:D10)		
18					
19	Objective	Min Total cost	=SUMPRODUCT(D9:D10,E9:E10)		



Optimal Solution:

Corn 52.94 lbs

Soybean 37.06 lbs

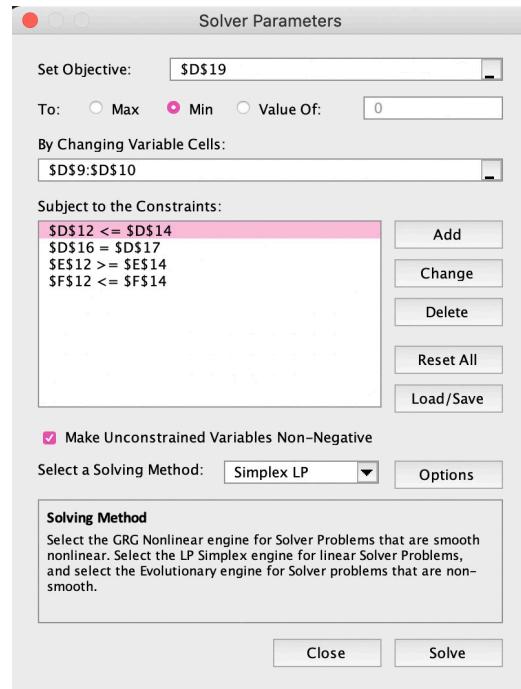
Total cost \$32.82

c) Objective & constraint changes to:

$$\begin{cases} 0.0008 X_1 + 0.0016 X_2 \leq 90 \times 0.17\% = 0.15 \\ 0.09 X_1 + 0.6 X_2 \geq 90 \times 0.3 = 27 \\ 0.02 X_1 + 0.06 X_2 \leq 90 \times 0.05 = 4.5 \\ X_1 + X_2 = 90 \end{cases}$$

	A	B	C	D	E	F
1						
2						
3	Problem Data		Pounds per Pound of Material			
4		Material	Calcium	Protein	Fiber	
5		Corn	0.0008	0.09	0.02	
6		Soybean	0.0016	0.6	0.06	
7						
8	Decision Variables		Amount	Cost		
9		Corn	52.941764705883	0.2		
10		Soybean	37.0588235294118	0.6		
11						
12	Constraints	Total material	=SUMPRODUCT(D5:D6,\$D\$9:\$D\$10)	=SUMPRODUCT(E5:E6,\$D\$9:\$D\$10)	=SUMPRODUCT(F5:F6,\$D\$9:\$D\$10)	
13		Limit sign	<=	>=	<=	
14		Bound	=D15*\$D\$16	=E15*\$D\$16	=F15*\$D\$16	
15		Bound %	0.0017	0.3	0.05	
16		Total feed require	90			
17		Total feed actual	=SUM(D9:D10)			
18						
19	Objective	Min Total cost	=SUMPRODUCT(D9:D10,E9:E10)			

	A	B	C	D	E	F
1						
2						
3	Problem Data		Pounds per Pound of Material			
4		Material	Calcium	Protein	Fiber	
5		Corn	=0.001*0.8	0.09	0.02	
6		Soybean	=0.002*0.8	0.6	0.06	
7						
8	Decision Variables		Amount	Cost		
9		Corn	52.941764705883	0.2		
10		Soybean	37.0588235294118	0.6		
11						
12	Constraints	Total material	=SUMPRODUCT(D5:D6,\$D\$9:\$D\$10)	=SUMPRODUCT(E5:E6,\$D\$9:\$D\$10)	=SUMPRODUCT(F5:F6,\$D\$9:\$D\$10)	
13		Limit sign	<=	>=	<=	
14		Bound	=D15*\$D\$16	=E15*\$D\$16	=F15*\$D\$16	
15		Bound %	0.0017	0.3	0.05	
16		Total feed require	90			
17		Total feed actual	=SUM(D9:D10)			
18						
19	Objective	Min Total cost	=SUMPRODUCT(D9:D10,E9:E10)			



Optimal Solution after reduce Calcium is still

Corn 52.94 lbs
Soybean 37.06 lbs
Total cost \$32.82

Since the optimal solutions are same b/w Q b) & c), there is no need for purchase the additive.

Q2. Decision Variables.

- x_1 : # of labor worked 1 ~ 5 m (5m)
- x_2 : # of labor worked 1 ~ 4 m (4m)
- x_3 : # of labor worked 2 ~ 5 m (4m)
- x_4 : # of labor worked 1 ~ 3 m (3m)
- x_5 : # of labor worked 2 ~ 4 m (3m)
- x_6 : # of labor worked 3 ~ 5 m (3m)
- x_7 : # of labor worked 1 ~ 2 m (2m)
- x_8 : # of labor worked 2 ~ 3 m (2m)

constraints:

$$\begin{aligned}
 \text{1st M: } x_1 + x_2 + x_4 + x_7 + x_{11} &\geq 110 \\
 \text{2nd M: } x_1 + x_2 + x_3 + x_4 + x_5 + x_7 + x_8 + x_{12} &\geq 130 \\
 \text{3rd M: } x_1 + x_2 + x_3 + x_4 + x_5 + x_6 + x_8 + x_9 + x_{13} &\geq 70 \\
 \text{4th M: } x_1 + x_2 + x_3 + x_5 + x_6 + x_9 + x_{10} + x_{14} &\geq 170 \\
 \text{5th M: } x_1 + x_3 + x_6 + x_{10} + x_{15} &\geq 50
 \end{aligned}$$

Objective: $\min [250x_1 + 230 \sum_{i=2,3} x_i + 180 \sum_{i=4,5,6} x_i + 140 \sum_{i=7,8,9,10} x_i + 110 \sum_{i=11,12,13,14,15} x_i]$

A	B	C	D	E	F	G	H	I
1								
2								
3	Problem Data							
4		Total labor amount for each month						
5	Month	1		2	3	4	5	
6	Number of laborers	110		130	70	170	50	
7								
8		Cost of labor regarding different length						
9	Length of employment (# months)	1		2	3	4	5	
10	Cost / laborer	110		140	180	230	250	
11								
12								
13	Decision Variables							
14		1st Month						
15	x1	50						
16	x2	60						
17	x3	0						
18	x4	0						
19	x5	0						
20	x6	0						
21	x7	0						
22	x8							
23	x9							
24	x10							
25	x11	0						
26	x12							
27	x13							
28	x14							
29	x15							
30	Sum	=SUM(D15:D29)						
31	Objective	Total Cost	=D15*I15+D16*I16+E17*I17+D18*I18+E19*I19+F20*I20+D21*I21+E22*I22+F23*I23+G24*I24+D25*I25+E26*I26+F27*I27+G28*I28+H29*I29					

A	B	C	D	E	F	G	H	I
1								
2								
3	Problem Data		Total labor amount for each month					
4	Month	1	2	3	4	5		
5	Number of laborers	110	130	70	170	50		
6								
7		Cost of labor regarding different length						
8	Length of employ	1	2	3	4	5		
9	Cost / laborer	110	140	180	230	250		
10								
11								
12								
13	Decision Variables		1st Month	2nd Month	3rd Month	4th Month	5th Month	Cost
14	x1	50	50	50	50	50	250	
15	x2	60	60	60	60	60	330	
16	x3	0	0	0	0	0	0	230
17	x4	0	0	0	0	0	0	180
18	x5	0	20	20	20	20	180	
19	x6	0	0	0	0	0	0	180
20	x7	0	0	0	0	0	0	140
21	x8	0	0	0	0	0	0	140
22	x9	0	0	0	0	0	0	140
23	x10	0	0	0	0	0	0	140
24	x11	0	0	0	0	0	0	110
25	x12	0	0	0	0	0	0	110
26	x13	0	0	0	0	0	0	110
27	x14	0	0	0	40	0	0	110
28	x15	0	0	0	0	0	0	110
29	Sum	110	130	130	170	50		
30	Objective	Total Cost	34300					

Solver Parameters

Set Objective: \$D\$32

To: Max Min Value Of: 0

By Changing Variable Cells: 6

Subject to the Constraints:

- \$D\$30 >= \$D\$5
- \$E\$30 >= \$E\$5
- \$F\$30 >= \$F\$5
- \$G\$30 >= \$G\$5
- \$H\$30 >= \$H\$5

Add Change Delete Reset All Load/Save

Make Unconstrained Variables Non-Negative

Select a Solving Method: Simplex LP Options

Solving Method
Select the GRG Nonlinear engine for Solver Problems that are smooth nonlinear. Select the LP Simplex engine for linear Solver Problems, and select the Evolutionary engine for Solver problems that are non-smooth.

Optimal Solution: total cost = 34300
 while 110 labors work on 1st month
 130 labors work on 2nd month
 130 labors work on 3rd month
 170 labors work on 4th month
 50 labors work on 5th month
 while 50 labor work for 5 months
 60 labor work for 4 months
 20 labor work for 3 months
 0 labor work for 2 months
 40 labor work for 1 months

Q3. person 1: 1 min person 2: 2 min person 3: 5 min person 4: 8 min

for 1st round, $x(i, j) = 1$ if person who needs $i \& j$ mins to pass the bridge go together, otherwise = 0
 for 2nd round, $x(i, j | k) = 1$ if person who needs $i \& j$ mins to pass the bridge go together
 next while leave person who needs k min to pass the bridge
 stay on the other side, otherwise = 0.

time for each pair is labeled in blue, ✓ torch return

for the 1st round, the time = $\max(i, j) + \min(i, j) = i + j$. max time of

for the 2nd round, the time = $\max(i, j) + \min(i, j, k) + (\text{last pair of people})$
 torch return.

Decision variable:

$$\begin{array}{lll} \text{1st round: } & x(1, 2)(3) & x(2, 5)(7) \\ & x(3, 8)(13) & \end{array}$$

$$\begin{array}{ll} & x(1, 5)(6) \\ & x(2, 8)(10) \\ & x(1, 8)(9) \end{array}$$

$$\begin{array}{lll} \text{2nd round: } & x(1, 5 | 2)(14) & x(1, 8 | 2)(14) \\ & x(1, 2 | 5)(11) & x(1, 8 | 5)(11) \\ & x(1, 2 | 8)(8) & x(1, 5 | 8)(8) \end{array} \quad \begin{array}{ll} & x(5, 8 | 2)(12) \\ & x(2, 8 | 5)(12) \\ & x(2, 5 | 8)(9) \end{array}$$

Constraints: $x(1, 2) + x(2, 5) + x(5, 8) + x(1, 5) + x(2, 8) + x(1, 8)$

$$1. \quad = 1 \quad \text{while } x(i, j) = 0 \text{ or } 1 \quad \forall i, j \in \{1, 2, 5, 8\}$$

$$2. \quad x(1, 2) = x(1, 5 | 2) + x(1, 8 | 2) + x(5, 8 | 2)$$

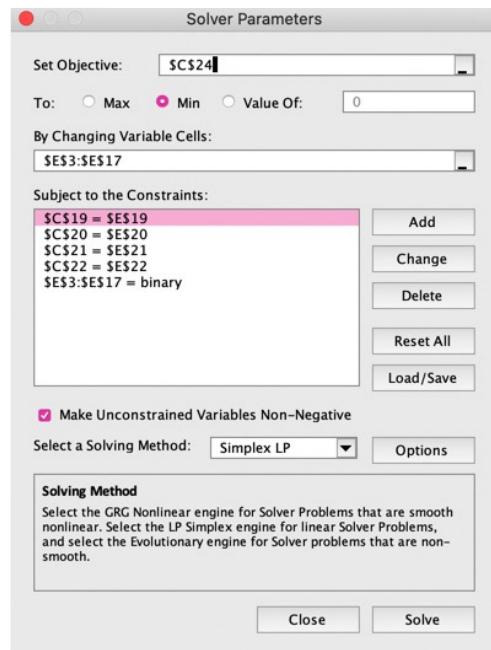
$$3. \quad x(1, 5) + x(2, 5) = x(1, 2 | 5) + x(1, 8 | 5) + x(2, 8 | 5)$$

$$4. \quad x(1, 8) + x(2, 8) + x(1, 8) = x(1, 2 | 8) + x(1, 5 | 8) + x(2, 5 | 8)$$

Objective:

$$\begin{aligned} \min [& 3x(1, 2) + 6x(1, 5) + 9x(1, 8) \\ & + 7x(2, 5) + 10x(2, 8) + 13x(5, 8) \\ & + (14)x(1, 5 | 2) + (14)x(1, 8 | 2) + (12)x(5, 8 | 2) \\ & + (11)x(1, 2 | 5) + (11)x(1, 8 | 5) + (12)x(2, 8 | 5) \\ & + (8)x(1, 2 | 8) + (8)x(1, 5 | 8) + (9)x(2, 5 | 8)] \end{aligned}$$

	A	B	C	D	E
1					
2					
3	Decision Variables	3	x{1,2}	1	
4		6	x{1,5}	0	
5		9	x{1,8}	0	
6		7	x{2,5}	0	
7		10	x{2,8}	0	
8		13	x{5,8}	0	
9		14	x{1,5 2}	0	
10		11	x{1,2 5}	0	
11		8	x{1,2 8}	0	
12		14	x{1,8 2}	0	
13		11	x{1,8 5}	0	
14		8	x{1,5 8}	0	
15		12	x{5,8 2}	1	
16		12	x{2,8 5}	0	
17		9	x{2,5 8}	0	
18					
19	Constrains:	=SUM(E3:E8)	=	1	
20		=E3	=	=E9+E12+E15	
21		=E4+E6	=	=E10+E13+E16	
22		=E5+E7+E8	=	=E11+E14+E17	
23					
24	Objective	Min	=SUMPRODUCT(C3:C17,E3:E17)		



Optimal Result: take 15 mins in total

person 1 & 2 go first , (2 mins)

person 1 returns the torch. (1 mins)

person 5 & 8 go next, person 2 waiting on the other side.

person 2 returns the torch. (2 mins) (8 mins)

person 1 & 2 go finally (2 mins)