

Question 1:

a) Convert to linear program problem:

Decision variables:

x = # of pounds of corn

y = # of pounds of soybean

Objective:

$$\min (0.2x + 0.6y)$$

Constraints:

$$x + y = 90$$

$$0.001x + 0.002y \leq 90 \cdot 1\%$$

$$0.09x + 0.6y \geq 90 \cdot 30\%$$

$$0.02x + 0.06y \leq 90 \cdot 5\%$$

$$x, y \geq 0$$

b) Find the solution with Excel's Solver.

	B	C
1	x	y
2	1	1
3	=0.2*B2+0.6*C2	
4	=B2+C2	90
5	=0.001*B2+0.002*C2	=C4*1%
6	=0.09*B2+0.6*C2	=C4*30%
7	=0.02*B2+0.06*C2	=C4*5%
8		
9		
10		
11		
12		
13		
14		
15		

	B	C
1	x	y
2	52.9411764705882	37.0588235294118
3	=0.2*B2+0.6*C2	
4	=B2+C2	90
5	=0.001*B2+0.002*C2	=C4*1%
6	=0.09*B2+0.6*C2	=C4*30%
7	=0.02*B2+0.06*C2	=C4*5%
8		
9		
10		
11		
12		
13		
14		
15		

Solver Parameters

Set Objective:

To: ☐ Max ☒ Min ☐ Value Of: 0

By Changing Variable Cells:

Subject to the Constraints:

-
-
-
-

☒ Make Unconstrained Variables Non-Negative

Select a Solving Method: Simplex LP

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.

Buttons: Help, Solve, Close

Solver Parameters

Set Objective:

To: ☐ Max ☒ Min ☐ Value Of: 0

By Changing Variable Cells:

Subject to the Constraints:

-
-
-
-

☒ Make Unconstrained Variables Non-Negative

Select a Solving Method: Simplex LP

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.

Buttons: Help, Solve, Close

The optimal solution to our optimization problem is $(x,y)=(52.94, 37.06)$ providing the objective value of $0.2x+0.6y = 32.82$

Question 2:

a) Convert to linear program problem:

a. Decision variables:

x11: # of labors with 1 month of employment recruited in the 1st month

x12: # of labors with 2 month of employment recruited in the 1st month

x13: # of labors with 3 month of employment recruited in the 1st month

x14: # of labors with 4 month of employment recruited in the 1st month

x15: # of labors with 5 month of employment recruited in the 1st month

x21: # of labors with 1 month of employment recruited in the 2nd month

x22: # of labors with 2 month of employment recruited in the 2nd month

x23: # of labors with 3 month of employment recruited in the 2nd month

x24: # of labors with 4 month of employment recruited in the 2nd month

x31: # of labors with 1 month of employment recruited in the 3rd month

x32: # of labors with 2 month of employment recruited in the 3rd month

x33: # of labors with 3 month of employment recruited in the 3rd month

x41: # of labors with 1 month of employment recruited in the 4th month

x42: # of labors with 2 month of employment recruited in the 4th month

x51: # of labors with 1 month of employment recruited in the 5th month

b. Objective:

min

$$(110*(x_{11}+x_{21}+x_{31}+x_{41}+x_{51})+140*(x_{12}+x_{22}+x_{32}+x_{42})+170*(x_{13}+x_{23}+x_{33})+230*(x_{14}+x_{24})+250*x_{15})$$

c. Constraints:

$$x_{11}+x_{12}+x_{13}+x_{14}+x_{15} \geq 110$$

$$x_{12}+x_{13}+x_{14}+x_{15}+x_{21}+x_{22}+x_{23}+x_{24} \geq 130$$

$$x_{13}+x_{14}+x_{15}+x_{22}+x_{23}+x_{24}+x_{31}+x_{32}+x_{33} \geq 70$$

$$x_{14}+x_{15}+x_{23}+x_{24}+x_{32}+x_{33}+x_{41}+x_{42} \geq 165$$

$$x_{15}+x_{24}+x_{33}+x_{42}+x_{51} \geq 50$$

$$x_{11}, x_{12}, x_{13}, x_{14}, x_{15}, x_{21}, x_{22}, x_{23}, x_{24}, x_{31}, x_{32}, x_{33}, x_{41}, x_{42}, x_{51} \geq 0$$

b) Find the solution with Excel's Solver.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1		x11	x12	x13	x14	x15	x21	x22	x23	x24	x31	x32	x33	x41	x42	x51		
2	value	0	0	0	60	50	0	0	20	0	0	0	0	0	35	0	0	
3	objective	=110*(B2+G2+K2+N2+P2)+140*(C2+H2+L2+O2)+170*(D2+I2+M2)+230*(E2+J2)+250*F2																
4	constraints	=SUM(B2:F2)															110	
5		=SUM(C2:J2)															130	
6		=SUM(D2:F2)+SUM(H2:M2)															70	
7		=SUM(E2:F2)+SUM(I2:J2)+SUM(L2:O2)															165	
8		=F2+J2+M2+O2+P2															50	
9																		
10																		
11																		
12																		
13																		
14																		
15																		
16																		
17																		
18																		
19																		
20																		
21																		
22																		
23																		

Solver Parameters

Set Objective:

To: ☐ Max ☒ Min ☐ Value Of:

By Changing Variable Cells:

Subject to the Constraints:

\$B\$4:\$B\$8 >= \$K\$4:\$K\$8

☒ Make Unconstrained Variables Non-Negative

Select a Solving Method:

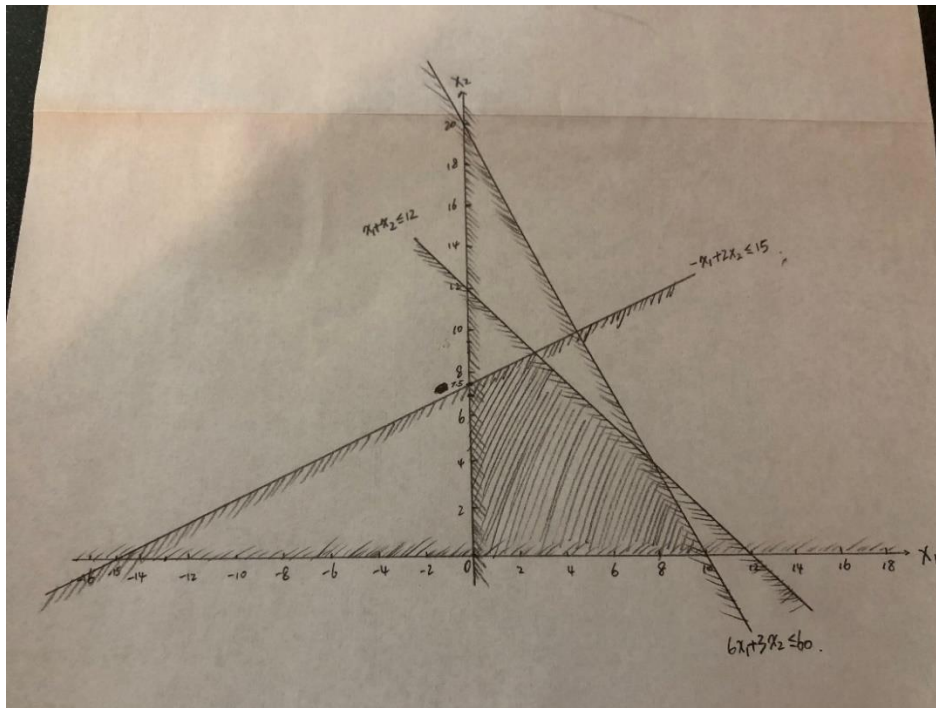
Solving Method

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.

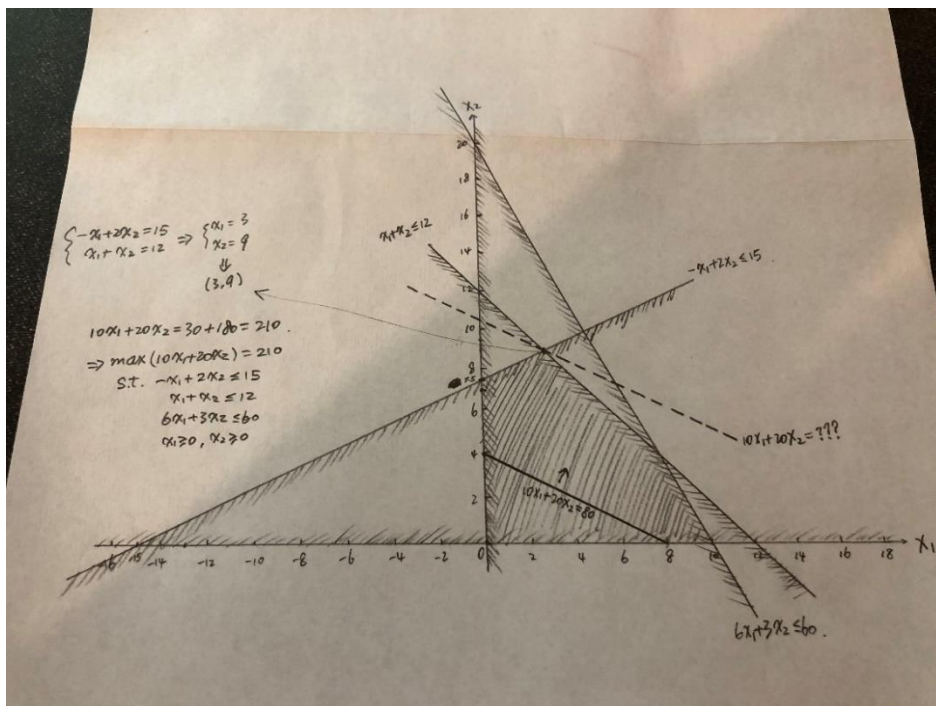
The optimal solution to our optimization problem is $(x_1, x_2) = (60, 50, 20, 35)$, where all the other decision variables = 0, providing the objective value of 33550.

Question 3:

(a)



(b)



Solution: The optimal values of the decision variables are $(x_1, x_2) = (3, 9)$. The optimal value of the objective function is 210.

Question 4:

a) Convert to linear program problem:

a. Decision variables:

x11: # of units shipped from factory 1 to Customer 1
 x12: # of units shipped from factory 1 to Customer 2
 x13: # of units shipped from factory 1 to Customer 3
 x21: # of units shipped from factory 2 to Customer 1
 x22: # of units shipped from factory 2 to Customer 2
 x23: # of units shipped from factory 2 to Customer 3

b. Objective:

$\min (600 \cdot x_{11} + 800 \cdot x_{12} + 700 \cdot x_{13} + 400 \cdot x_{21} + 900 \cdot x_{22} + 600 \cdot x_{23})$

c. Constraints:

$x_{11} + x_{12} + x_{13} \leq 400$
 $x_{21} + x_{22} + x_{23} \leq 500$
 $x_{11} + x_{21} = 300$
 $x_{12} + x_{22} = 200$
 $x_{13} + x_{23} = 400$
 $x_{11}, x_{12}, x_{13}, x_{21}, x_{22}, x_{23} \geq 0$

b) Find the solution with Excel's Solver:

The screenshot shows an Excel spreadsheet with the following data:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1		x11	x12	x13	x21	x22	x23											
2	value	0	200	200	300	0	200											
3	objective	=600*B2+800*C2+700*D2+400*E2+900*F2+600*G2																
4	constraints	=B2+C2+D2	<=		400													
5		=E2+F2+G2	<=		500													
6		=B2+E2	=		300													
7		=C2+F2	=		200													
8		=D2+G2	=		400													

The Solver Parameters dialog box is open, showing the following settings:

- Set Objective: \$B\$3
- To: ☐ Max ☒ Min ☐ Value Of: 0
- By Changing Variable Cells: \$B\$2:\$G\$2
- Subject to the Constraints:
 - \$B\$4:\$B\$5 <= \$F\$4:\$F\$5
 - \$B\$6:\$B\$8 = \$E\$6:\$E\$8
- ☒ Make Unconstrained Variables Non-Negative
- Select a Solving Method: Simplex LP
- 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 values of the decision variables are $(x_{11}, x_{12}, x_{13}, x_{21}, x_{22}, x_{23}) = (0, 200, 200, 300, 0, 200)$.

Optimal values of the objective function is 540000.