Tsinghua-Berkeley Shenzhen Institute
Operations Research
Fall 2023

Homework 1

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- **Acknowledgments:** This assignment refers to the textbook: Introduction to Operations Research(10th).
- **Collaborators:** I finish this assignment by myself. 3.4.9 (b) and 3.4.11 (b) were solved with the help of Excel.

The answers below are arranged according to the order of the following questions in the textbook: 3.1-9 (a) (b), 3.1-10 (a) (b), 3.4-9 (a) (b), 3.4-11(a) (b).

1.1. 3.1-9

(a) SOLUTION Let x = the number of Special Risk and y = the number of Mortgage and z = the total profit.
Objective:

$$Maximize \quad z = 5x + 2y, \tag{1}$$

subject to:

$$3x + 2y \leq 2400 \tag{2}$$
$$y \leq 800 \tag{3}$$
$$2x \leq 1200, \tag{4}$$

and $x \geq 0, y \geq 0$.

(b) As Figure 1 shown, $z_{max} = 5 \times 600 + 2 \times 300 = 3600$, when $x = 600, y = -1.5x + 1200 = 300$.

1.2. 3.1-10

(a) SOLUTION Let x = number of hot dogs per week and y = number of hot dog buns per week, and z = the total profit per week.
Objective:

$$Maximize \quad z = 0.88x + 0.33y. \tag{5}$$

subject to:

$$0.1y \leq 200 \tag{6}$$
$$0.25x \leq 800 \tag{7}$$
$$3x + 2y \leq 12000, \tag{8}$$

and $x \geq 0, y \geq 0$.

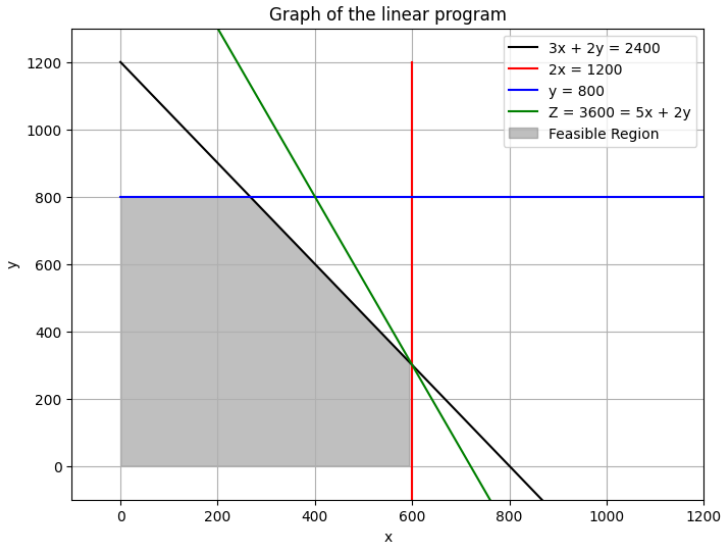

Figure 1: Graphical Solution to Question 3.1-9

(b) As Figure 2 shown, $z_{max} = 0.88 \times 3200 + 0.33 \times 1200 = 3212$, when $x = 3200, y = -1.5x + 6000 = 1200$.

1.3. 3.4-9

(a) SOLUTION Let x_{ij} = the number of space leased in moth i with a period of j (i = 1, 2, j = 1, 2, 3) and z = the total cost.
Objective:

$$Minimize \quad z = 65\sum_{i=1}^{5} x_{i1} + 100\sum_{i=1}^{4} x_{i2} + 135\sum_{i=1}^{3} x_{i3} + 160\sum_{i=1}^{2} x_{i4} + 190x_{15}, \tag{9}$$

subject to:

$$\sum_{j=1}^{5} x_{1j} \geq 30000 \tag{10}$$

$$\sum_{j=1}^{4} x_{2j} + \sum_{j=2}^{5} x_{1j} \geq 20000 \tag{11}$$

$$\sum_{j=1}^{3} x_{3j} + \sum_{j=3}^{5} x_{1j} + \sum_{j=2}^{4} x_{2j} \geq 40000 \tag{12}$$

$$\sum_{j=1}^{2} x_{4j} + \sum_{j=4}^{5} x_{1j} + \sum_{j=3}^{4} x_{2j} + \sum_{j=2}^{3} x_{3j} \geq 10000 \tag{13}$$

$$x_{15} + x_{24} + x_{33} + x_{42} + x_{51} \geq 50000, \tag{14}$$

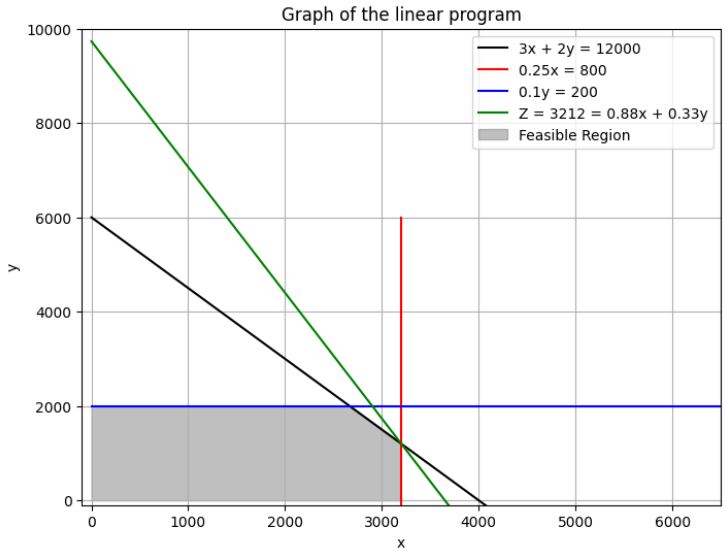

Figure 2: Graphical Solution to Question 3.1-10

and $x_{ij} \geq 0$ for i = 1,...,5 and j = 1,...,6 - i.

(b) The solution solved by Excel is shown in Figure 3, $z_{min} = 7650000$, when $x_{15} = 3000, x_{31} = 10000, x_{51} = 20000$ and $x_{others} = 0$.

	Decisions															Available	
	x11	x12	x13	x14	x15	x21	x22	x23	x24	x31	x32	x33	x41	x42	x51		
Objective	65	100	135	160	190	65	100	135	160	65	100	135	65	100	65	0	Constrains
	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	30000	30000
	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	20000	30000
	0	0	1	1	1	0	1	1	1	1	1	1	0	0	0	40000	40000
	0	0	0	1	1	0	0	1	1	0	1	1	1	1	0	10000	30000
	0	0	0	0	1	0	0	0	1	0	0	1	0	1	1	50000	50000
Decisions	x11	x12	x13	x14	x15	x21	x22	x23	x24	x31	x32	x33	x41	x42	x51		
	0	0	0	0	30000	0	0	0	0	10000	0	0	0	0	20000		
Objective	Z																
	7650000																

Figure 3: Graphical Solution to Question 3.4-9

1.4. 3.4-11

(a) SOLUTION Let x_{ij} = the number of the productions shipped from factory i to customer j, where i = 1, 2 and j = 1, 2, 3.

$$\begin{aligned} Minimize \quad z &= 600x_{11} + 800x_{12} + 700x_{13} \\ &+400x_{21} + 900x_{22} + 600x_{23}, \end{aligned} \tag{15}$$

subject to:

$$x_{11} + x_{12} + x_{13} \leq 400 \tag{16}$$

$$x_{21} + x_{22} + x_{23} \leq 500 \tag{17}$$

$$x_{11} + x_{21} = 300 \tag{18}$$

$$x_{12} + x_{22} = 200 \tag{19}$$

$$x_{13} + x_{23} = 400, \tag{20}$$

and $x_{ij} \geq 0$ for i = 1, 2 and j = 1, 2, 3.

(b) Solution found by Excel is shown in Figure 4, $z_{min} = 540000$, when $x_{11} = 0, x_{12} = 200, x_{13} = 200, x_{21} = 300, x_{22} = 0, x_{23} = 200$.

	Decisions						Available	
	x11	x12	x13	x21	x22	x23		
Objective	600	800	700	400	900	600	0	Constrains
	1	1	1	0	0	0	400	400
	0	0	0	1	1	1	500	500
	1	0	0	1	0	0	300	300
	0	1	0	0	1	0	200	200
	0	0	1	0	0	1	400	400
Decisions	x11	x12	x13	x21	x22	x23		
	0	200	200	300	0	200		
Objective	Z							
	540000							

Figure 4: Graphical Solution to Question 3.4-11

A Relevant files

Relevant files can be found in my GitHub:
`https://github.com/OpenGHz/TBSI-MyHomework.git`.