

# Assignment One for CS-6648

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## 1 Q1

Solve the following linear programming problem:

Question:

$$\mathbf{Min} \ f(x_1, x_2) : \ x_1 + x_2 \quad (1)$$

$$\mathbf{Subject \ to:} \ 3x_1 - x_2 \leq 3 \quad (2)$$

$$x_1 + 2x_2 \leq 5 \quad (3)$$

$$x_1 + x_2 \leq 4 \quad (4)$$

$$x_1 \geq 0; x_2 \text{ unrestricted in sign.} \quad (8)$$

Answer:

From  $x_2$  is unrestricted, we can let:  $x_2 = x'_2 - x''_2$

Table 1: Formulation

$x_1$	$x'_2$	$x''_2$	$s_1$	$s_2$	$s_3$	b	r
3	-1	1	1	0	0	0	3
1	2	-2	0	1	0	0	5
1	1	-1	0	0	1	1	4
1	1	-1	0	0	0	0	0

Table 2: Find Smallest Positive Number

$x_1$	$x'_2$	$x''_2$	$s_1$	$s_2$	$s_3$	b	r	
3	-1	1	1	0	0	0	3	3
1	2	-2	0	1	0	0	5	-2.5
1	1	-1	0	0	1	1	4	-4
1	1	-1	0	0	0	0	0	

Table 3: Row Operation

$x_1$	$x'_2$	$x''_2$	$s_1$	$s_2$	$s_3$	b	r
3	-1	1	1	0	0	0	3
7	0	0	2	1	0	0	11
4	0	0	1	0	1	1	7
4	0	0	1	0	0	0	3

As the result we know:

$$\mathbf{Min} \ f(x_1, x_2) = -3$$

## 2 Q2

The local community college is planning to grow the biotechnology offering through new federal and state grants. An ambitious program is being planned for recruiting at least 200 students from in and out of state. They are to recruit at least 40 out of state students. They will attempt to recruit at least 30 students who are in the top 20 % of their graduating high school class. Current figures indicate that about 8 % of the applicants from instate, and 6 % of the applicants from out of state belong to this pool. They also plan to recruit at least 40 students who have AP courses in biology. The data suggests that 10 % and 15 % of in state and out of state applicants respectively, belong to this pool. They anticipate that the additional cost per student is 800 *foreach instate student and* 1200 for each out of state student. Find their actual enrollment needed to minimize cost and their actual cost. Hint: Optimal Value= 324,000

Translate question to formula:

$$\mathbf{Min} \ f(x_1, x_2) : 800x_1 + 1200x_2 \quad (6)$$

$$x_1 + x_2 \geq 200 \quad (7)$$

$$x_2 \geq 40 \quad (8)$$

$$0.08x_1 + 0.06x_2 \geq 30 \quad (9)$$

$$0.1x_1 + 0.15x_2 \geq 40 \quad (10)$$

Table 4: Formulation

$x_1$	$x_2$	$s_1$	$s_2$	$s_3$	$s_4$	$a_1$	$a_2$	$a_3$	$a_4$	b
1	1	-1	0	0	0	1	0	0	0	200
0	1	0	-1	0	0	0	1	0	0	40
0.08	0.06	0	0	-1	0	0	0	1	0	30
0.1	0.15	0	0	0	-1	0	0	0	1	40
800	1200	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	1	1	1	1	0

Stage one: Remove the Artifical variables

Table 5: Remove First Artifical Variable

$x_1$	$x_2$	$s_1$	$s_2$	$s_3$	$s_4$	$a_1$	$a_2$	$a_3$	$a_4$	b
1	1	-1	0	0	0	1	0	0	0	200
0	1	0	-1	0	0	0	1	0	0	40
0.08	0.06	0	0	-1	0	0	0	1	0	30
0.1	0.15	0	0	0	-1	0	0	0	1	40
800	1200	0	0	0	0	0	0	0	0	0
-1	-1	1	0	0	0	0	1	1	1	-200

Table 6: Remove Second Artifical Variable

$x_1$	$x_2$	$s_1$	$s_2$	$s_3$	$s_4$	$a_1$	$a_2$	$a_3$	$a_4$	b
1	1	-1	0	0	0	1	0	0	0	200
0	1	0	-1	0	0	0	1	0	0	40
0.08	0.06	0	0	-1	0	0	0	1	0	30
0.1	0.15	0	0	0	-1	0	0	0	1	40
800	1200	0	0	0	0	0	0	0	0	0
-1	-2	1	1	0	0	0	0	1	1	-240

Table 7: Remove Third Artifical Variable

$x_1$	$x_2$	$s_1$	$s_2$	$s_3$	$s_4$	$a_1$	$a_2$	$a_3$	$a_4$	b
1	1	-1	0	0	0	1	0	0	0	200
0	1	0	-1	0	0	0	1	0	0	40
0.08	0.06	0	0	-1	0	0	0	1	0	30
0.1	0.15	0	0	0	-1	0	0	0	1	40
800	1200	0	0	0	0	0	0	0	0	0
-1.08	-2.06	1	1	1	0	0	0	0	1	-270

Table 8: Remove Forth Artifical Variable

$x_1$	$x_2$	$s_1$	$s_2$	$s_3$	$s_4$	$a_1$	$a_2$	$a_3$	$a_4$	b
1	1	-1	0	0	0	1	0	0	0	200
0	1	0	-1	0	0	0	1	0	0	40
0.08	0.06	0	0	-1	0	0	0	1	0	30
0.1	0.15	0	0	0	-1	0	0	0	1	40
800	1200	0	0	0	0	0	0	0	0	0
-1.18	-2.21	1	1	1	0	0	0	0	1	-310

Stage two:

Table 9: Row operation

$x_1$	$x_2$	$s_1$	$s_2$	$s_3$	$s_4$	$a_1$	$a_2$	$a_3$	$a_4$	b	r
1	1	-1	0	0	0	1	0	0	0	200	200
0	1	0	-1	0	0	0	1	0	0	40	40
0.08	0.06	0	0	-1	0	0	0	1	0	30	500
0.1	0.15	0	0	0	-1	0	0	0	1	40	667
800	1200	0	0	0	0	0	0	0	0	0	0
-1.18	-2.21	1	1	1	-1	0	0	0	0	1	932

Table 10: Row operation

$x_1$	$x_2$	$s_1$	$s_2$	$s_3$	$s_4$	$a_1$	$a_2$	$a_3$	$a_4$	b	r
1	1	-1	0	0	0	1	0	0	0	200	200
0	1	0	-1	0	0	0	1	0	0	40	40
0.08	0.06	0	0	-1	0	0	0	1	0	30	500
0.1	0.15	0	0	0	-1	0	0	0	1	40	667
800	1200	0	0	0	0	0	0	0	0	0	0
-1.18	-2.21	1	1	1	-1	0	0	0	0	1	932

Table 11: Row operation

$x_1$	$x_2$	$s_1$	$s_2$	$s_3$	$s_4$	$a_1$	$a_2$	$a_3$	$a_4$	b	r
1	0	-1	1	0	0	1	-1	0	0	160	160
0	1	0	-1	0	0	0	1	0	0	40	-40
0.08	0	0	0.06	-1	0	0	-0.06	1	0	27.6	460
0.1	0	0	0.15	0	-1	0	-0.15	0	1	34	667
800	0	0	1200	0	0	0	-1200	0	0	-48000	-40
-1.18	0	1	-1.21	1	-1	0	2.21	0	0	-221.6	959

Table 12: Row operation

$x_1$	$x_2$	$s_1$	$s_2$	$s_3$	$s_4$	$a_1$	$a_2$	$a_3$	$a_4$	b	r
1	0	-1	1	0	0	1	-1	0	0	160	160
1	1	-1	0	0	0	1	0	0	0	200	-200
0.02	0	0.06	0	-1	0	-0.06	0	1	0	18	300
-0.05	0	0.15	0	0	-1	-0.15	0	0	1	10	667
-400	0	1200	0	0	0	-1200	0	0	0	-240000	-200
0.03	0	-0.21	0	1	-1	1.21	1	0	0	-28.6	333

Table 13: Row operation

$x_1$	$x_2$	$s_1$	$s_2$	$s_3$	$s_4$	$a_1$	$a_2$	$a_3$	$a_4$	b	r
0.67	0	0	1	0	-6.7	0	-1	0	6.7	222.67	-34
0.67	1	0	0	0	-6.7	0	0	0	6.7	266.67	-40
0.04	0	0	0	-1	0.4	0	0	1	-0.4	14	35
-0.33	0	1	0	0	-6.7	-1	0	0	6.7	66.67	-10
0	0	0	0	0	8000	0	0	0	-8000	-320000	-40
-0.04	0	0	0	1	-0.4	1	1	0	1.4	-14	35

Table 14: Row operation

$x_1$	$x_2$	$s_1$	$s_2$	$s_3$	$s_4$	$a_1$	$a_2$	$a_3$	$a_4$	b	r
1.33	0	0	1	-16.67	0	0	-1	16.67	0	460	345
1.33	1	0	0	-16.67	0	0	0	16.67	0	500	375
0.1	0	0	0	-2.5	1	0	0	2.5	-1	35	350
0.33	0	1	0	-16.67	0	-1	0	16.67	0	300	900
-800	0	0	0	20000	0	0	0	-20000	1	-60000	750
-0.00	0	0	0	0	0	1	1	1	0	0	0

Table 15: Row operation

$x_1$	$x_2$	$s_1$	$s_2$	$s_3$	$s_4$	$a_1$	$a_2$	$a_3$	$a_4$	b
1	0	0	0.75	-12.5	0	0	-0.75	12.5	0	345
0	1	0	-1	0	0	0	1	0	0	40
0	0	0	-0.075	-1.25	1	0	0.075	1.25	-1	0.499
0	0	1	-0.25	-12.5	0	-1	0.25	12.5	0	185
0	0	0	600	10000	0	0	-600	-10000	0	-324000
0	0	0	0	0	0	1	1	1	1	0

$$x_1 = 345, x_2 = 40, \text{Min } f(x_1, x_2) = 800 * 345 + 1200 * 40 = 324000$$