

Assignment 1
Of
Modelling & Simulation Lab (CS1052)

Masters of Technology in Computer Science And Engineering

submitted by
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Problem statement 1

A firm manufactures two products A and B on which the profits earned per unit are ₹ 3 and ₹ 4 respectively. Each product is processed on two machines M_1 and M_2 .

Product A requires one minute of processing time on M_1 and two minutes on M_2 , while B requires one minute on M_1 and one minute on M_2 . Machine M_1 is available for not more than 1 hr 30 min while machine M_2 is available for 10 hr during any working day. Find the number of units of products A and B to be manufactured to get maximum profit.

Problem formulation:-

Let x and y be no. of productⁿ of product A and B respectively

the profit of product A is ₹ 3 and the profit of product B is ₹ 4

the total profit over the product is

$$Z = 3x + 4y$$

objective of the function is to maximize the profit

$$\text{i.e. Maximise } (Z) = 3x + 4y$$

if M_1 machine is used,

$$x + y \leq 450 \quad \text{--- (1)}$$

if M_2 machine is used,

$$2x + y \leq 600 \quad \text{--- (2)}$$

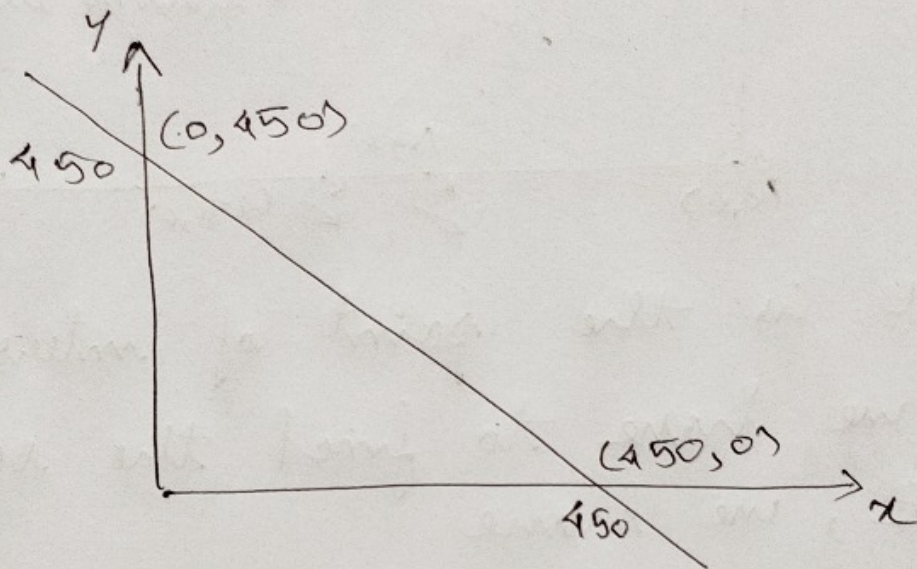
Solutions:-

co-ordinates for line $x + y = 450$

when $x = 450$, $y = 0$

and when we put $y=0$, $x=0$
 $x=450$. $\rightarrow (0, 450)$

the graph is,



from equation 2, similarly
when $x=0$, we get

$$2 \cdot 0 + y = 600$$

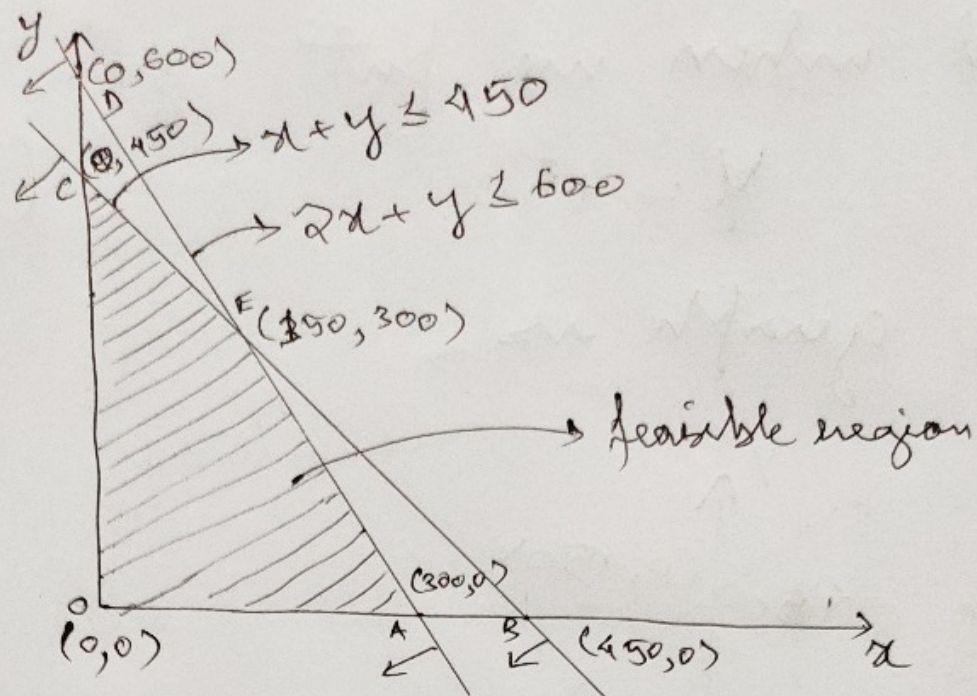
$$y = 600 \rightarrow (0, 600)$$

when $y=0$, we get

$$2 \cdot x + 0 = 600$$

$$x = 300 \rightarrow (300, 0)$$

after making the graph, we
get the feasible region which
is the shaded region.



Here, E is the point of intersection
 Now, we have to find the coordinate
 for E, we have

$$\begin{array}{rcl}
 x + y & = & 450 \\
 2x + y & = & 600 \\
 \hline
 -x & = & -150 \\
 \hline
 100\% x & = & 150
 \end{array}$$

$$\Rightarrow 150 + y = 450$$

$$\therefore y = 300 \rightarrow (150, 300)$$

Now, the value of objective
 function at the corner points
 are :-

$$Z(0) = 3 \times 0 + 4 \times 0 = 0$$

$$Z(A) = 3 \times 300 + 4 \times 0 = 900$$

~~$$Z(B) = 3 \times 450 + 4 \times 0 =$$~~

$$Z(C) = 3 \times 0 + 4 \times 450 = 1800 \leftarrow \text{maximum}$$

$$Z(E) = 3 \times 150 + 4 \times 300 = 1650$$

Therefore Z is maximum at corner points $C(0, 450)$

Hence the firm will earn a maximum profit of ₹1800

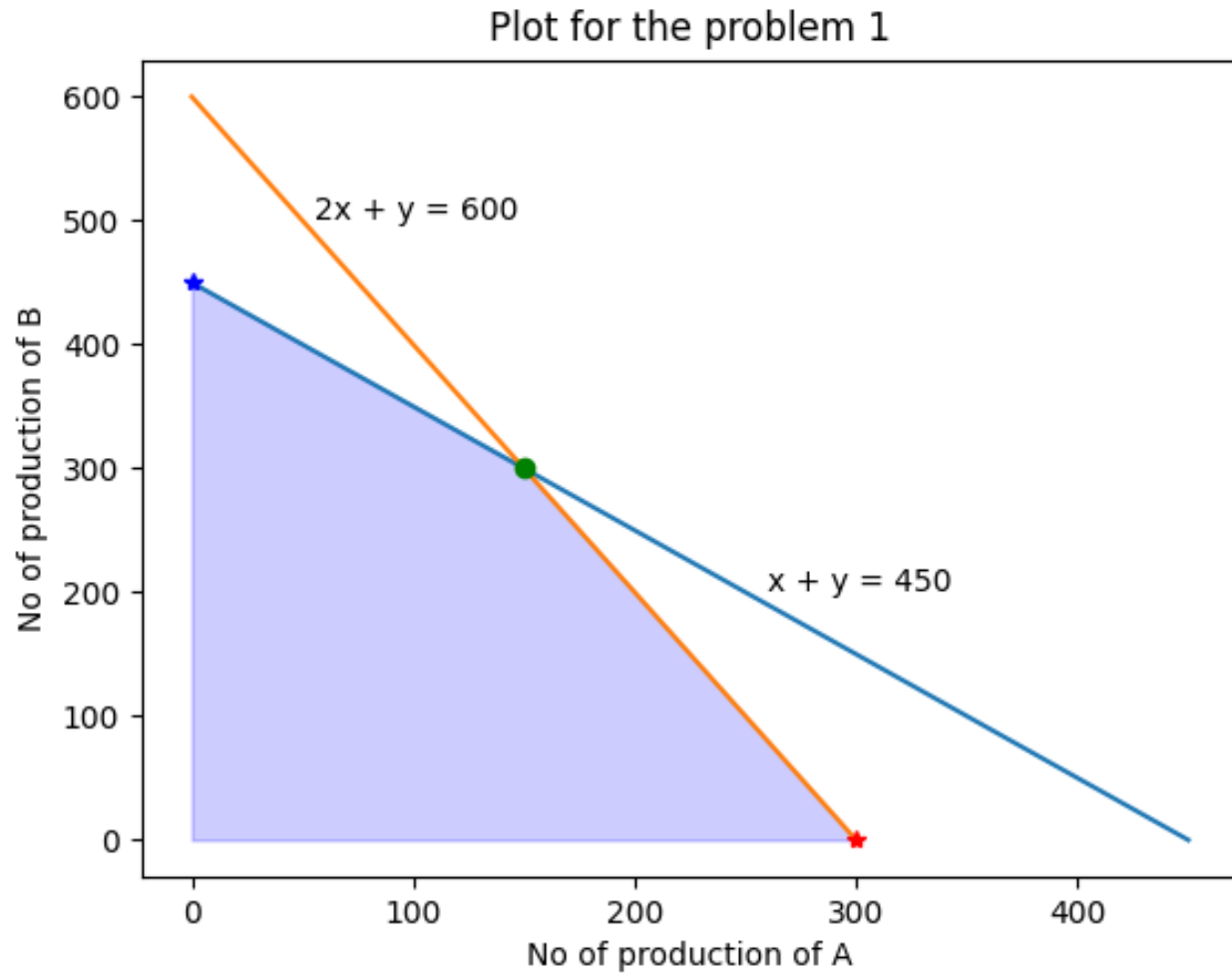
if it manufactures 450 units of product B and 0 units of product A i.e. doesn't manufacture product A at all.

Python Code:

```
from shapely.geometry import LineString
from matplotlib import pyplot as plt

if __name__ == '__main__':
    x1 = [450, 0]
    y1 = [0, 450]
    plt.plot(x1, y1)
    x2 = [300, 0]
    y2 = [0, 600]
    plt.plot(x2, y2)
    plt.xlabel('No of production of A')
    plt.ylabel('No of production of B')
    plt.title('Plot for the problem 1')
    line1 = LineString([(450, 0), (0, 450)])
    line2 = LineString([(300, 0), (0, 600)])
    intersection = line1.intersection(line2)
    plt.plot(*intersection.xy, 'go')
    plt.plot(0, 450, 'b*')
    plt.plot(300, 0, 'r*')
    p1, q1 = intersection.xy
    x = []
    y = []
    x.append(0)
    x.append(round(p1[0]))
    x.append(300)
    y.append(450)
    y.append(round(q1[0]))
    y.append(0)
    plt.fill_between(x, y, color='blue', alpha=0.2)
    plt.text(260, 200, "x + y = 450")
    plt.text(55, 500, "2x + y = 600")
    plt.show()
    print("Point of Intersection 1: ")
    print(p1[0])
    print(q1[0])
    z = []
    for i in range(len(x)):
        eqn = 3 * x[i] + 4 * y[i]
        z.append(eqn)
        print("Z = ", z)
    max_val = max(z)
    xy_index = z.index(max_val)
    print("The Value of Z ", max_val, " at point (", x[xy_index], ",", y[xy_index], ")")
    )
```

Output :



Point of Intersection 1:

150.0

300.0

Z = [1800]

Z = [1800, 1650]

Z = [1800, 1650, 900]

The Value of Z 1800 at point (0 , 450)

Process finished with exit code 0

Problem statement 2

Egg contains 6 units of vitamin A per gram and 7 units of vitamin B per gram and costs 12 paise per gram.
Milk contains 8 units of vitamin A per gram and 12 units of vitamin B per gram and costs 20 paise per gram.
The daily minimum A & B is 100 unit & 120 units. Formulate the LPP and find the optimal solution by graphical method.

Problem formulation

Amount of vitamin A ≥ 100 unit
Amount of vitamin B ≥ 120 unit

Let's take x gm of egg
and y gm of milk.

Vitamin A content $= 6x + 8y \geq 100$ — (1)

Vitamin B content $= 7x + 12y \geq 120$ — (2)

Cost of food (C) $= 12x + 20y$

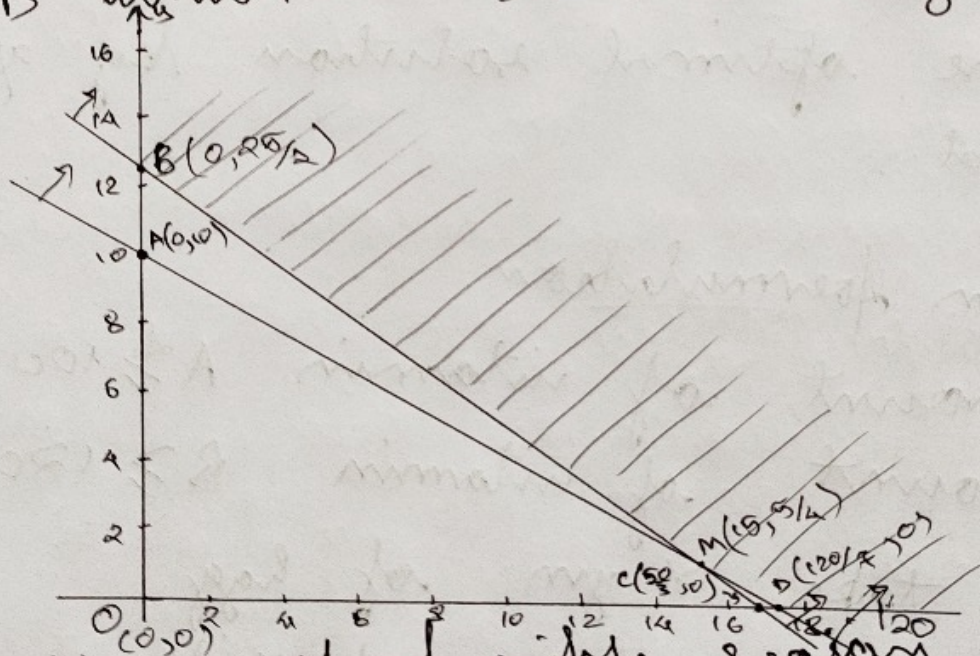
$x \geq 0, y \geq 0$

Solution :-

from eqn (1) \rightarrow
 when $x=0$, $y=100/8=25/2$ $(0, 25/2)$
 for $y=0$, $x=100/6=50/3$ $(50/3, 0)$

from eqn (2) \rightarrow
 when $x=0$, $y=120/12=10$ $(0, 10)$
 when $y=0$, $x=120/7$ $(120/7, 0)$

~~Feasible region~~ Feasible unbounded region is
 BMD which is shaded in graph.



vertices of feasible region

$B(0, 25/2)$, $D(120/7, 0)$

M is point of intersection of
 the lines

$$\begin{array}{rcl}
 6x + 8y & \geq & 100 \quad \times 3 \\
 7x + 12y & \geq & 120 \quad \times 2 \\
 \hline
 18x + 24y & = & 300 \\
 14x + 24y & = & 240 \\
 \hline
 4x & = & 60
 \end{array}$$

$$\text{hence } x \geq 15 \Rightarrow 6x + 8y \geq 100$$

$$y \geq \frac{10}{8} = \frac{5}{4}$$

$$M\left(15, \frac{5}{4}\right)$$

Objective function $z = 12x + 20y$

$$\begin{aligned} \text{cost at } B\left(0, \frac{25}{2}\right) &= 12 \times 0 + \frac{25}{2} \times 20 \\ &= 250 \text{ paise} \end{aligned}$$

$$\begin{aligned} \text{cost at } D\left(\frac{120}{7}, 0\right) &= \frac{120}{7} \times 12 + 20(0) \\ &= 205.7 \text{ paise} \end{aligned}$$

$$\begin{aligned} \text{cost at } M\left(15, \frac{5}{4}\right) &= 12(15) + \frac{20 \times 5}{4} \\ &= 205 \text{ paise} \end{aligned}$$

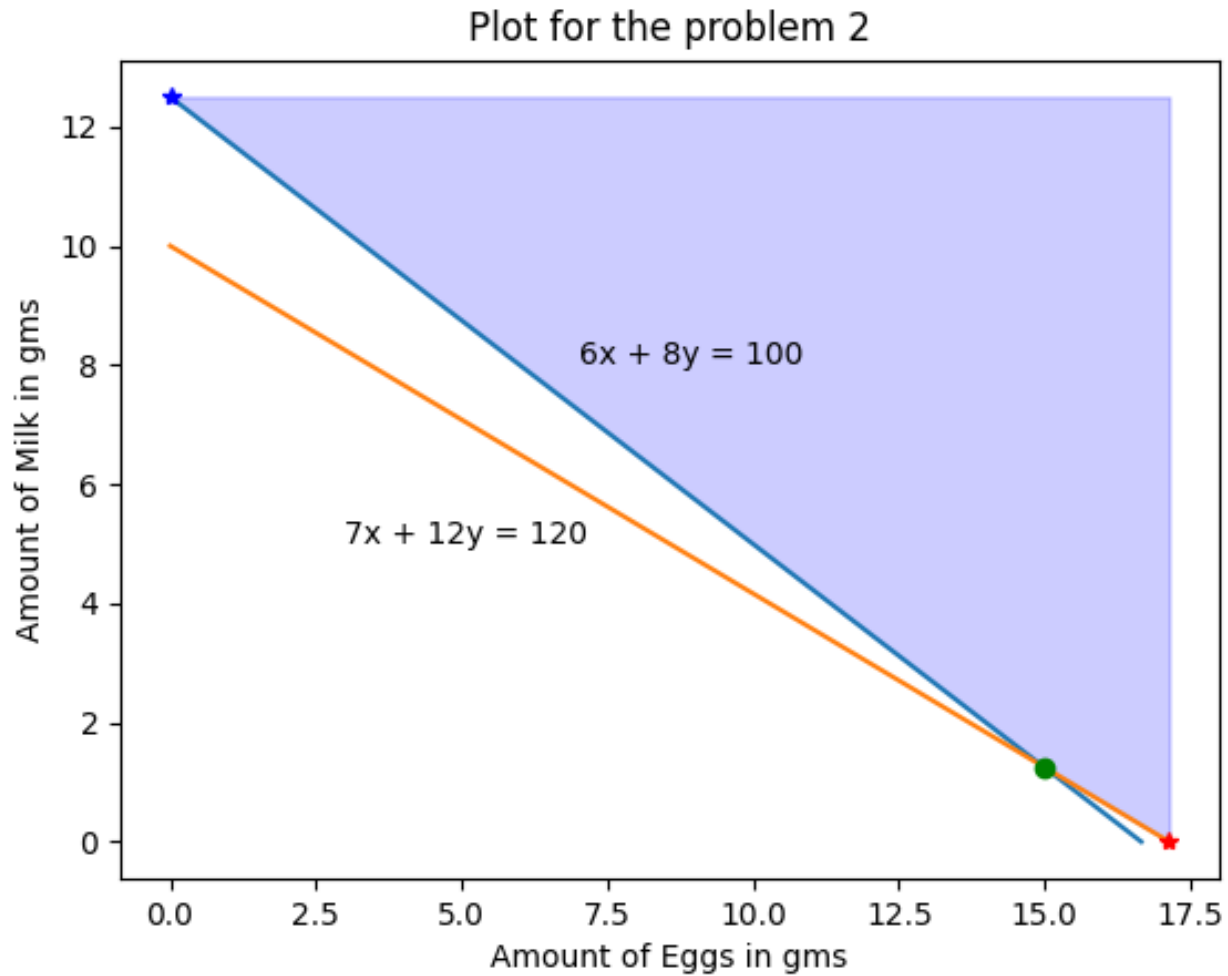
Minimum cost for the diet = 205 paise
in which 15 are eggs and
1.25 of milk.

Python Code:

```
from shapely.geometry import LineString
from matplotlib import pyplot as plt

if __name__ == '__main__':
    x1 = [0,16.66]
    y1 = [12.5,0]
    plt.plot(x1, y1)
    x2 = [17.14,0]
    y2 = [0,10]
    plt.plot(x2, y2)
    plt.xlabel('Amount of Eggs in gms')
    plt.ylabel('Amount of Milk in gms')
    plt.title('Plot for the problem 2')
    line1 = LineString([(16.66,0),(0,12.5)])
    line2 = LineString([(17.14,0),(0,10)])
    intersection = line1.intersection(line2)
    plt.plot(*intersection.xy, 'go')
    plt.plot(0,12.5, 'b*')
    plt.plot(17.14,0, 'r*')
    p1, q1 = intersection.xy
    x = []
    y = []
    x.append(0)
    x.append(round(p1[0],2))
    x.append(17.14)
    y.append(12.5)
    y.append(round(q1[0],2))
    y.append(0)
    plt.fill_between(x,y,max(y),color='blue',alpha=0.2)
    plt.text(7,8,"6x + 8y = 100")
    plt.text(3,5,"7x + 12y = 120")
    plt.show()
    print("Point of Intersection 1: ")
    print(round(p1[0],2))
    print(round(q1[0],2))
    z=[]
    for i in range(len(x)):
        eqn = 12*x[i] + 20*y[i]
        z.append(round(eqn,2))
        print("Z = ",z)
    min_val = min(z)
    xy_index = z.index(min_val)
    print("The Value of Z ",min_val," at point (",x[xy_index],",",y[xy_index],")"
    )
```


Output :



Point of Intersection 1:

14.98

1.26

Z = [250.0]

Z = [250.0, 204.96]

Z = [250.0, 204.96, 205.68]

The Value of Z 204.96 at point (14.98 , 1.26)

Process finished with exit code 0