Assignment 1

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- **Subject Name:** Modelling and Simulation Lab
- **Subject Code:** CSS752

Problem 1

A person requires 10, 12 and 12 units of chemicals A, B and C respectively for his gardens. A liquid product contains 5, 2 and 1 units of A, B and C respectively per jar. A dry product contains 1, 2 and 4 units of A, B and C per carton. If the liquid product sells for | 3 per jar and the dry product sells for | 2 per carton, how many of each should be purchased to optimize the cost and meet the requirements? Formulate the problem as a LPP and solve it by graphical method.

Solution:

Assignment - 1.

Name: Diptangshu Dey.

1) Given Data about Chemicals

⇒

Chemicals ↓	Liquid Prod.(x)	Dry Prod (y)	Demand
A	5	1	10
B	2	2	12
C	1	4	12
Cost	₹3	₹2	

Objective function:

$$\text{Min } z = 3x + 2y.$$

Constraints:

$$5x + y = 10$$
$$2x + 2y = 12 \Rightarrow x + y = 6$$
$$x + 4y = 12.$$
$$x, y \geq 0.$$

Solutions found with graphical method $\Rightarrow$

$A(1, 5)$, $B(4, 2)$
$C(0, 10)$, $D(12, 0)$.

Values of objective function

$A \Rightarrow 3(1) + 2(5) = 13.$ (min).
$B \Rightarrow 3(4) + 2(2) = 16$
$C \Rightarrow 3(0) + 2(10) = 20$
$D \Rightarrow 3(12) + 2(0) = 36$

$\therefore$ The number of cartons to be purchased for the liquid solution and the dry powder is 1, 5 cartons respectively.

Code:

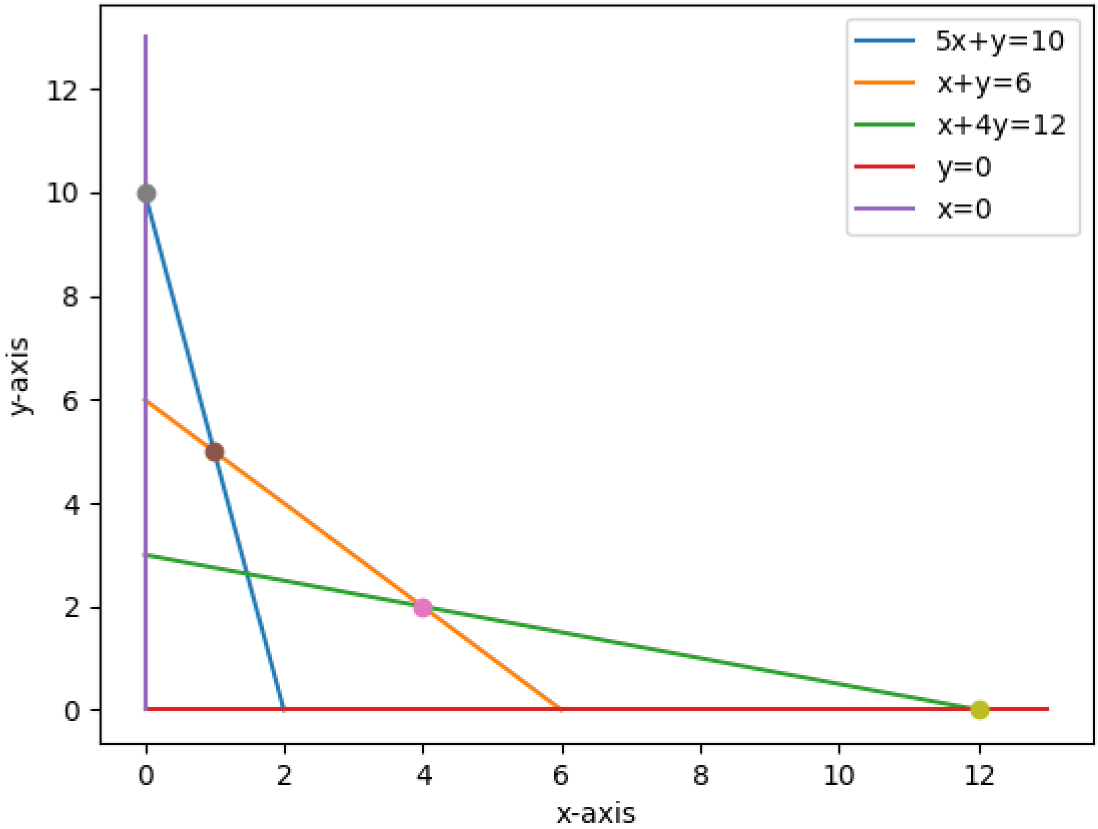
```
from shapely.geometry import LineString
from matplotlib import pyplot as plt
import numpy as np

# Plot lines
```

```
x = [0, 2]
y = [10, 0]

plt.plot(x, y)

x = [0, 6]
y = [6, 0]

plt.plot(x, y)

x = [0, 12]
y = [3, 0]

plt.plot(x, y)

x = [0, 13]
y = [0, 0]

plt.plot(x, y)

x = [0, 0]
y = [0, 13]

plt.plot(x, y)

# Labels
plt.legend(["5x+y=10", "x+y=6", "x+4y=12", "y=0", "x=0"])
plt.xlabel('x-axis')
plt.ylabel('y-axis')
plt.title('Prob 1')

# define lines calculate inersection points
l1 = LineString([(2, 0), (0, 10)])
l2 = LineString([(6, 0), (0, 6)])
l3 = LineString([(12, 0), (0, 3)])
i1 = l1.intersection(l2)
i2 = l2.intersection(l3)

# plot and print intersection points
plt.plot(*i1.xy, 'o')
plt.plot(*i2.xy, 'o')
plt.plot(0, 10, 'o')
plt.plot(12, 0, 'o')

prn = f"Intersection points are: \nA({i1.xy[0][0]}, {i1.xy[1][0]})
\nB({i2.xy[0][0]}, {i2.xy[1][0]}) \nC(0, 10) \nD(12, 0)"
print(prn)

# Show result
plt.show()
```

Outputs:

```
❯ python prob_1.py
Intersection points are:
A(1.0, 5.0)
B(4.0, 2.0)
C(0, 10)
D(12, 0)
```

Prob 1



Problem 2

A company produces 2 types of hats. Every hat H1 requires twice as much labor as the second hat H2. If the company produces only hat H2 then it can produce a total of 500 hats a day. The market limits daily sales of hat H1 and H2 to 150 and 250 respectively. The profit on hat H1 and H2 are | 8 and | 5 respectively. Formulate the problem as a LPP and find the optimal solution using graphical method.

Solution:

2) Let,

the no. of H_1 hat produced $= x$.

the no. of H_2 hat produced $= y$.

then,

Objective function:

$$\text{Max } z = 8x + 5y.$$

Constraints:

$2x + y \leq 500$, (Production limit)

$x \leq 150$ (Sale limit).
$y \leq 250$

$x \geq 0$, $y \geq 0$ (non-zero number manufactured.)

By Graphical method, the solution points are
$O(0,0)$, $A(150,200)$, $C((125,250)$,
$D(0,250)$, $E(150,0)$.

Values of Objective function:

$O \Rightarrow z = 0.$
$A \Rightarrow z = 8(150) + 5(200) = 2200$
$C \Rightarrow z = 8(125) + 5(250) = \underline{2250}$ (Max)
$D \Rightarrow z = 8(0) + 5(250) = 1250$
$E \Rightarrow z = 8(150) + 5(0) = 1200$

$\therefore$ The optimal amount of H_1 and H_2 to be produced for maximum profit are 125 and 250 respectively.

Code:

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

# Plot lines
x = [0, 250]
y = [500, 0]

plt.plot(x, y)

x = [150, 150]
y = [0, 500]

plt.plot(x, y)

x = [0, 500]
y = [250, 250]

plt.plot(x, y)

x = [0, 500]
y = [0, 0]

plt.plot(x, y)

x = [0, 0]
y = [0, 500]

plt.plot(x, y)

# Labels
plt.legend(["2x+y <= 500", "x <= 150", "y <= 250", "y = 0", "x = 0"])
plt.xlabel('x-axis')
plt.ylabel('y-axis')
plt.title('Prob 2')

# define lines calculate inersection points
l1 = LineString([(250, 0), (0, 500)])
l2 = LineString([(150, 0), (150, 500)])
l3 = LineString([(0, 250), (500, 250)])
i1 = l1.intersection(l2)
i2 = l2.intersection(l3)
i3 = l3.intersection(l1)

# plot and print intersection points
plt.plot(*i1.xy, 'o')
plt.plot(*i2.xy, 'o')
plt.plot(*i3.xy, 'o')
```

```python
plt.plot(0, 250, 'o')
plt.plot(150, 0, 'o')

prn = f"Intersection points are: \nA({i1.xy[0][0]}, {i1.xy[1][0]})
\nB({i2.xy[0][0]}, {i2.xy[1][0]}) \nC({i3.xy[0][0]}, {i3.xy[1][0]}) \nD(0,
250) \nE(150, 0)"
print(prn)

# shade solution region
x = [0, i3.xy[0][0], i1.xy[0][0], 150]
y = [250, i3.xy[1][0], i1.xy[1][0], 0]
plt.fill_between(x, y, color='blue', alpha=0.2)

# Show result
plt.show()
```

Outputs:

```
❯ python prob_2.py
Intersection points are:
A(150.0, 200.0)
B(150.0, 250.0)
C(125.0, 250.0)
D(0, 250)
E(150, 0)
```