5.8.25

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Question

One says, "Give me a hundred, Friend! I shall then become twice as rich as you ". The other "if you give me ten, i shall be six times as rich as you ". Tell me What is the amount of their (respective) capital? [From the bijaganita of Bhaskara II].

Equation I

Let an amount with Friend 1 be a and amount with Friend 2 be b
From given information:

$$a + 100 = 2(b - 100) \tag{1}$$

$$a - 2b = -300 \tag{2}$$

And

$$b + 10 = 6(a - 10) \tag{3}$$

$$b + 10 = 6a - 60; \tag{4}$$

$$6a - b = 70 \tag{5}$$

Theoretical Solution

By combining the Eq.2 and Eq.5 we get

$$\begin{pmatrix} 1 & -2 \\ 6 & -1 \end{pmatrix} \mathbf{x} = \begin{pmatrix} -300 \\ 70 \end{pmatrix} \tag{6}$$

Where

$$\mathbf{x} = \begin{pmatrix} a \\ b \end{pmatrix} \tag{7}$$

$$\left(\begin{array}{cc|c} 1 & -2 & -300 \\ 6 & -1 & 70 \end{array}\right) \xleftrightarrow{R_2 \leftarrow R_2 - 6R_1} \left(\begin{array}{cc|c} 1 & -2 & -300 \\ 0 & 11 & 1870 \end{array}\right) \tag{8}$$

$$\left(\begin{array}{cc|c} 1 & -2 & -300 \\ 0 & 11 & 1870 \end{array}\right) \xleftrightarrow{R_2 \leftarrow \frac{1}{11} R_2} \left(\begin{array}{cc|c} 1 & -2 & -300 \\ 0 & 1 & 170 \end{array}\right) \tag{9}$$

Theoretical solution

$$\left(\begin{array}{cc|c} 1 & -2 & -300 \\ 0 & 1 & 170 \end{array}\right) \xleftrightarrow{R_1 \leftarrow R_1 + 2R_2} \left(\begin{array}{cc|c} 1 & 0 & 40 \\ 0 & 1 & 170 \end{array}\right) \tag{10}$$

$$\mathbf{x} = \begin{pmatrix} 40 \\ 170 \end{pmatrix} \tag{11}$$

$$a = 40 \quad \textit{and} \quad b = 170 \tag{12}$$

The amount with Friend 1 = 40
The amount with Friend 2 = 170

C Code

```c
  typedef struct {
    double a;
    double b;
} Solution;

Solution solve_equations(double a1, double b1, double c1, double
    a2, double b2, double c2) {
    Solution sol;
    double determinant = a1 * b2 - a2 * b1;

    // Use Cramer's rule to find 'a' and 'b'
    if (determinant != 0) {
        sol.a = (c1 * b2 - c2 * b1) / determinant;
        sol.b = (a1 * c2 - a2 * c1) / determinant;
    }
```

C Code

```
 else {
        // Fallback for singular matrix
        sol.a = 0.0;
        sol.b = 0.0;
    }
    return sol;
}
```

Python Code

```
import os
import ctypes
import numpy as np
import matplotlib.pyplot as plt

# --- Hardcoded inputs from the question ---
a1, b1, c1 = 1, -2, -300
a2, b2, c2 = 6, -1, 70

# --- Compile and Load C Library ---
if os.system(gcc -shared -o word.so -fPIC word.c) != 0:
    print(\nC compilation failed. Exiting.)
    exit()

class Solution(ctypes.Structure):
    _fields_ = [(a, ctypes.c_double), (b, ctypes.c_double)]
```

Python Code

```
c_lib = ctypes.CDLL(os.path.abspath(word.so))
c_lib.solve_equations.argtypes = [ctypes.c_double] * 6
c_lib.solve_equations.restype = Solution

# --- Solve by Calling C Function ---
solution = c_lib.solve_equations(a1, b1, c1, a2, b2, c2)
a_sol, b_sol = solution.a, solution.b
print(fSolution from C: a = {a_sol:.2f}, b = {b_sol:.2f})

# --- Plot the Graph ---
a_vals = np.linspace(a_sol - 50, a_sol + 50, 400)
b1_vals = (c1 - a1 * a_vals) / b1
b2_vals = (c2 - a2 * a_vals) / b2

plt.figure(figsize=(10, 8))
plt.plot(a_vals, b1_vals, label=f'{a1}a + {b1}b = {c1}')
plt.plot(a_vals, b2_vals, label=f'{a2}a + {b2}b = {c2}')
```

Python Code

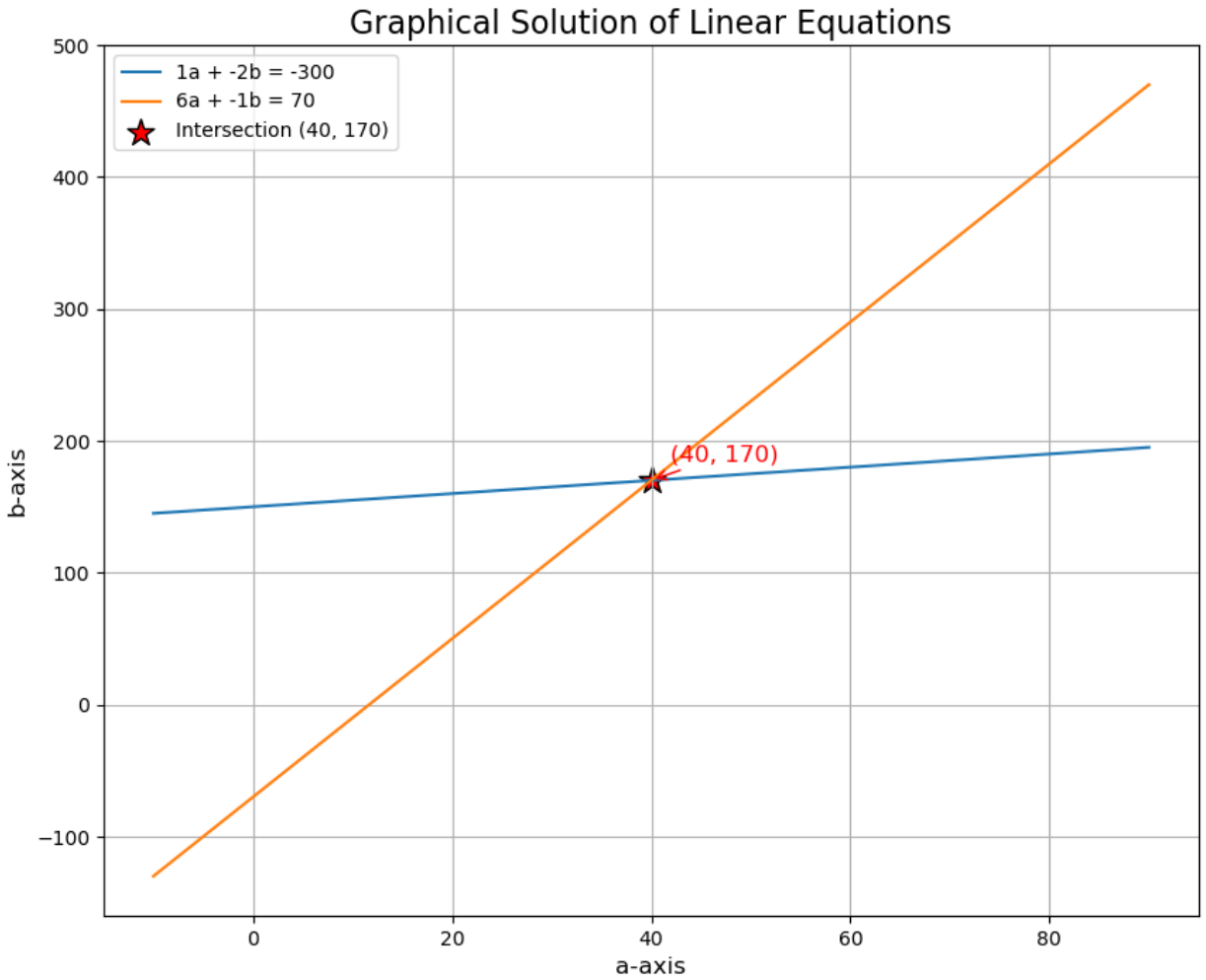
```
    # Mark the intersection
plt.scatter(a_sol, b_sol, color=red, s=200, marker=*, edgecolors=
    black,
            label=f'Intersection ({a_sol:.0f}, {b_sol:.0f})')

# Annotate with arrow
plt.annotate(f({a_sol:.0f}, {b_sol:.0f}),
             (a_sol, b_sol),
             textcoords=offset points,
             xytext=(10,10),
             fontsize=12,
             color=red,
             arrowprops=dict(arrowstyle=->, color=red))
```

Python Code

```
   plt.title(Graphical Solution of Linear Equations, fontsize=16)
plt.xlabel(a-axis, fontsize=12)
plt.ylabel(b-axis, fontsize=12)
plt.grid(True)
plt.legend()
plt.savefig(/media/indhiresh-s/New Volume/Matrix/ee1030-2025/
    ee25btech11027/MATGEO/5.8.25/figs/figure1.png)
plt.show()
```

Plot


Graphical Solution of Linear Equations
1a + -2b = -300
6a + -1b = 70
Intersection (40, 170)
(40, 170)
b-axis
a-axis
500
400
300
200
100
0
−100
0
20
40
60
80