5.8.29

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Question

2 women and 5 men can together finish an embroidery work in 4 days, while 3 women and 6 men can finish it in 3 days. Find the time taken by 1 women alone to finish the work, and also that taken by 1 man alone.

Theoretical Solution

Let the fraction of work done by a woman in a day be x and the fraction of work done by a man in a day be y, represented as

$$\mathbf{x} = \begin{pmatrix} x \\ y \end{pmatrix} \tag{1}$$

Also, if a days are taken for a work to complete, the fraction of work completed in a single day is $\frac{1}{a}$.

Theoretical Solution

Using the above, we can write the given data into two equations:

$$\begin{pmatrix} 2 & 5 \end{pmatrix} \mathbf{x} = \frac{1}{4} \tag{2}$$

$$\begin{pmatrix} 3 & 6 \end{pmatrix} \mathbf{x} = \frac{1}{3} \tag{3}$$

Theoretical Solution

Converting into Reduced Row Echelon Form:

$$\left(\begin{array}{cc|c} 2 & 5 & \frac{1}{4} \\ 3 & 6 & \frac{1}{3} \end{array}\right) \xleftrightarrow{R_1 \to \frac{1}{2}R_1} \left(\begin{array}{cc|c} 1 & \frac{5}{2} & \frac{1}{4} \\ 3 & 6 & \frac{1}{3} \end{array}\right) \tag{4}$$

$$\left(\begin{array}{cc|c} 1 & \frac{5}{2} & \frac{1}{4} \\ 3 & 6 & \frac{1}{3} \end{array}\right) \xleftrightarrow{R_2 \to R_2 - 3R_1} \left(\begin{array}{cc|c} 1 & \frac{5}{2} & \frac{1}{4} \\ 0 & -\frac{3}{2} & -\frac{1}{24} \end{array}\right) \tag{5}$$

$$\left(\begin{array}{cc|c} 1 & \frac{5}{2} & \frac{1}{4} \\ 0 & -\frac{3}{2} & -\frac{1}{24} \end{array}\right) \xleftrightarrow{R_2 \rightarrow -\frac{2}{3} R_2} \left(\begin{array}{cc|c} 1 & \frac{5}{2} & \frac{1}{4} \\ 0 & 1 & \frac{1}{36} \end{array}\right) \tag{6}$$

$$\left(\begin{array}{cc|c} 1 & \frac{5}{2} & \frac{1}{4} \\ 0 & 1 & \frac{1}{36} \end{array}\right) \xleftrightarrow{R_1 \rightarrow R_1 - \frac{5}{2} R_2} \left(\begin{array}{cc|c} 1 & 0 & \frac{1}{18} \\ 0 & 1 & \frac{1}{36} \end{array}\right) \tag{7}$$

Theoretical Solution

We get

$$\mathbf{x} = \begin{pmatrix} \frac{1}{18} \\ \frac{1}{36} \end{pmatrix} \tag{8}$$

The number of days can be written as

$$\frac{1}{y} = 36 \quad \text{and} \quad \frac{1}{x} = 18 \tag{9}$$

$\therefore$ The time taken by one woman alone to finish the work is 18 days, and the time taken by one man alone to finish the work is 36 days.

C Code - Solving Using Gaussian Elimination

```c
#include <stdio.h>

void Solve_Gaussian(double A[3], double B[3], double sol[2]) {
    // If A[0] == 0, swap rows to avoid division by zero
    //Also covers the case where the matrix is diagonal.
    if (A[0] == 0) {
        for (int i = 0; i < 3; i++) {
            double temp = A[i];
            A[i] = B[i];
            B[i] = temp;
        }
    }
```

C Code - Solving Using Gaussian Elimination

```c

    double factor = B[0] / A[0];
    for (int i = 0; i < 3; i++) {
        B[i] = B[i] - factor * A[i];
    }

    sol[1] = B[2] / B[1];
    sol[0] = (A[2] - A[1] * sol[1]) / A[0];
}
```

Python Code - Using Shared Object

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

c_lib = ctypes.CDLL("./code.so")

c_lib.Gaussian.argtypes = [ctypes.c_double*3, ctypes.c_double*3,
    ctypes.c_double*2]

A = (ctypes.c_double*3)(2,5,1.0/4.0)
B = (ctypes.c_double*3)(3,6,1.0/3.0)

sols = (ctypes.c_double*2)(0.0,0.0)

c_lib.Gaussian(A,B,sols)
```

Python Code - Using Shared Object

```python

sols[0] = np.round(sols[0],3)
sols[1] = np.round(sols[1],3)

plt.plot([-2,2], [0.85,-0.75], c='green', label = r"$2x+5y=\frac{1}{4}$")
plt.plot([-2,2], [19/18,-17/18], c='blue', label = r"$3x+6y=\frac{1}{3}$")

plt.scatter(sols[0],sols[1])

plt.annotate(
        f"{sols[0],sols[1]}",
        xy=(sols[0],sols[1]),
        xytext = (2,2),
        textcoords = "offset points"
        )
```

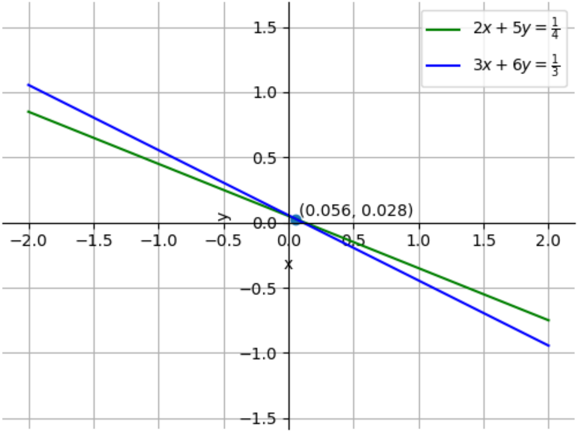
Python Code - Using Shared Object

```python

ax = plt.gca()
ax.spines['top'].set_color('none')
ax.spines['bottom'].set_position('zero')
ax.spines['right'].set_color('none')
ax.spines['left'].set_position('zero')
plt.xlabel('x')
plt.ylabel('y')
plt.legend(loc='best')
plt.grid()
plt.axis('equal')

plt.savefig("../Figs/plot(py+C).png")
plt.show()
```

Plot-Using Both C and Python



Python Code

```
import numpy as np
import matplotlib.pyplot as plt
import numpy.linalg as LA

M = np.array([[2,5],
              [3,6]])
b = np.array([1/4,1/3])
x = LA.solve(M, b)


plt.scatter(x[0],x[1])

x[0]=np.round(x[0],3)
x[1]=np.round(x[1],3)
```

Python Code

```
plt.plot([-2,2], [0.85,-0.75], c='red', label = r'$2x+5y=\frac
    {1}{4}$')
plt.plot([-2,2], [19/18,-17/18], c='black', label = r'$3x+6y=\
    frac{1}{3}$')

plt.annotate(
        f'{x[0],x[1]}',
        xy=(x[0],x[1]),
        xytext = (2,2),
        textcoords = "offset points"
        )
```

Python Code

```

ax = plt.gca()
ax.spines['top'].set_color('none')
ax.spines['bottom'].set_position('zero')
ax.spines['right'].set_color('none')
ax.spines['left'].set_position('zero')
plt.xlabel('x')
plt.ylabel('y')
plt.legend(loc='best')
plt.grid()
plt.axis('equal')

plt.savefig("../Figs/plot(py).png")
plt.show()
```

Plot-Using Python only