12.27

Bhargav - EE25BTECH11013

September 29, 2025

Question

Question:
1200 men and 500 women can build a bridge in 2 weeks. 900 men and 250 women will take 3 weeks to build the same bridge. How many men will be needed to build the bridge in one week?

Solution

Let one man complete work in x weeks and one woman complete work in y weeks

In one week a man can complete $\frac{1}{x}$ work and woman can complete $\frac{1}{y}$

$$\frac{1200}{x} + \frac{500}{y} = \frac{1}{2} \tag{1}$$

$$\frac{900}{x} + \frac{250}{y} = \frac{1}{3} \tag{2}$$

$$\begin{pmatrix} 1200 & 500 \\ 900 & 250 \end{pmatrix} \begin{pmatrix} \frac{1}{x} \\ \frac{1}{y} \end{pmatrix} = \begin{pmatrix} \frac{1}{2} \\ \frac{1}{3} \end{pmatrix} \tag{3}$$

Solution

This can be converted into an augmented matrix and can be solved by Gaussian elimination:

$$\left(\begin{array}{cc|c} 1200 & 500 & \frac{1}{2} \\ 900 & 250 & \frac{1}{3} \end{array}\right) \xleftrightarrow[R_2 \leftarrow R_2/125]{R_2 \leftarrow R_2 - 3R_1/4} \left(\begin{array}{cc|c} 1200 & 500 & \frac{1}{2} \\ 0 & 1 & \frac{1}{3000} \end{array}\right) \tag{4}$$

$$\xleftarrow[R_1 \leftarrow R_1 - 500R_2]{R_1 \leftarrow R_1/1200} \left(\begin{array}{cc|c} 1 & 0 & \frac{1}{3600} \\ 0 & 1 & \frac{1}{3000} \end{array}\right) \tag{5}$$

$$\begin{pmatrix} \frac{1}{x} \\ \frac{1}{y} \end{pmatrix} = \begin{pmatrix} \frac{1}{3600} \\ \frac{1}{3000} \end{pmatrix} \tag{6}$$

A man can finish the work in 3600 weeks, a woman can finish the work in 3000 weeks

C Code

```c
void mat_vec_mult(double* a, double* x, double* result) {
    result[0] = a[0] * x[0] + a[1] * x[1];
    result[1] = a[2] * x[0] + a[3] * x[1];
}
```

Python + C Code

```
import numpy as np
import ctypes
lib_path = "./libcode.so"
c_lib = ctypes.CDLL(lib_path)
c_lib.mat_vec_mult.argtypes = [
    ctypes.POINTER(ctypes.c_double),
    ctypes.POINTER(ctypes.c_double),
    ctypes.POINTER(ctypes.c_double)
]
c_lib.mat_vec_mult.restype = None

a = np.array([[1200, 500], [900, 250]], dtype=np.float64)
b = np.array([[1/2], [1/3]], dtype=np.float64)

x = np.linalg.solve(a, b)
result_from_c = np.zeros_like(b)
a_ptr = a.ctypes.data_as(ctypes.POINTER(ctypes.c_double))
```

Python + C Code

```
x_ptr = x.ctypes.data_as(ctypes.POINTER(ctypes.c_double))
result_ptr = result_from_c.ctypes.data_as(ctypes.POINTER(ctypes.
    c_double))

c_lib.mat_vec_mult(a_ptr, x_ptr, result_ptr)

print("Numpy result:")
print(1/x[0])
print(1/x[1])
print("\nResult of A*x from C code (for verification):")
print(result_from_c[0])
print(result_from_c[1])
if np.allclose(result_from_c, b):
    print("\nVerification successful: The C result matches 'b'.")
```

Python Code

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

a = np.array([[1200, 500], [900, 250]])
b = np.array([[1/2], [1/3]])
x = np.linalg.solve(a, b)
print("Man can finish the task in ", 1/x[0], " weeks")
print("Woman can finish the task in ", 1/x[1], " weeks")
```