

Problem 5.4.18

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Problem

Using elementary transformations, find the inverse of the following matrix

$$\begin{pmatrix} 4 & 5 \\ 3 & 4 \end{pmatrix}$$

Augmented Matrix

Given

$$\mathbf{A} = \begin{pmatrix} 4 & 5 \\ 3 & 4 \end{pmatrix} \quad (2.1)$$

Let \mathbf{A}^{-1} be the inverse of \mathbf{A} . Then

$$\mathbf{A}\mathbf{A}^{-1} = \mathbf{I} \quad (2.2)$$

Augmented matrix of $(\mathbf{A} \mid \mathbf{I})$ is given by

$$\left(\begin{array}{cc|cc} 4 & 5 & 1 & 0 \\ 3 & 4 & 0 & 1 \end{array} \right) \xrightarrow{R_2 \rightarrow 4R_2 - 3R_1} \left(\begin{array}{cc|cc} 4 & 5 & 1 & 0 \\ 0 & 1 & -3 & 4 \end{array} \right) \quad (2.3)$$

$$\left(\begin{array}{cc|cc} 4 & 5 & 1 & 0 \\ 0 & 1 & -3 & 4 \end{array} \right) \xrightarrow{R_1 \rightarrow R_1 - 5R_2} \left(\begin{array}{cc|cc} 4 & 0 & 16 & -20 \\ 0 & 1 & -3 & 4 \end{array} \right) \quad (2.4)$$

$$\left(\begin{array}{cc|cc} 4 & 0 & 16 & -20 \\ 0 & 1 & -3 & 4 \end{array} \right) \xrightarrow{R_1 \rightarrow \frac{1}{4}R_1} \left(\begin{array}{cc|cc} 1 & 0 & 4 & -5 \\ 0 & 1 & -3 & 4 \end{array} \right) \quad (2.5)$$

Conclusion

Hence the inverse of the matrix $\begin{pmatrix} 4 & 5 \\ 3 & 4 \end{pmatrix}$ is $\begin{pmatrix} 4 & -5 \\ -3 & 4 \end{pmatrix}$

C Code

```
void get_system_coeffs(double* out_coeffs) {  
  
    out_coeffs[0] = 4.0;  
    out_coeffs[1] = 5.0;  
  
    out_coeffs[2] = 3.0;  
    out_coeffs[3] = 4.0;  
}
```

Python Code for Solving

```
import ctypes
import numpy as np

lib = ctypes.CDLL('./code.so')
double_array_4 = ctypes.c_double * 4
lib.get_system_coeffs.argtypes = [ctypes.POINTER(ctypes.c_double)
    ]
out_data_c = double_array_4()

lib.get_system_coeffs(out_data_c)
coeffs = list(out_data_c)
M = np.linalg.inv([
    [coeffs[0], coeffs[1]],
    [coeffs[2], coeffs[3]],
])

print(M)
```