2.7.8

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Question

Find $|\mathbf{a}-\mathbf{b}|$, if two vectors $\mathbf{a}$ and $\mathbf{b}$ are such that $|\mathbf{a}|=2,|\mathbf{b}|=3$ and $\mathbf{a}.\mathbf{b}=4$.

Theoretical Solution

According to the question,

$$|\mathbf{a}| = 2 \;\; ; \;\; |\mathbf{b}| = 3 \;\; ; \;\; \mathbf{a}^T\mathbf{b} = 4 \tag{1}$$

Equation

The value of $\|\mathbf{a}-\mathbf{b}\|$ can be computed by the following formula,

$$\|\mathbf{a}-\mathbf{b}\|^2 = \|\mathbf{a}\|^2 + \|\mathbf{b}\|^2 - 2\mathbf{a}^T\mathbf{b} \tag{2}$$

Theoretical Solution

$$\therefore \|\mathbf{a}-\mathbf{b}\|^2 = 2^2 + 3^2 - 2 \times 4 \tag{3}$$

$$\|\mathbf{a}-\mathbf{b}\|^2 = 5 \tag{4}$$

$$\implies \|\mathbf{a}-\mathbf{b}\| = \sqrt{5} = 2.2361 \textit{units} \tag{5}$$

C Code - Cross product and magnitude of vector

```c
#include<stdio.h>

double find_mag_diffvector(double a, double b ,double dot)
//Here dot is the dot product of a and b
{
        double val=a*a+b*b-2*dot;
        if(val<0) val=0;
        return sqrt(val);
}
```

Python+C Code

```
import ctypes

lib = ctypes.CDLL('./libdiff.so')

lib.find_mag_diffvector.argtypes = [ctypes.c_double, ctypes.
    c_double, ctypes.c_double]
lib.find_mag_diffvector.restype = ctypes.c_double

a = 2.0
b = 3.0
dot = 4.0

diff = lib.find_mag_diffvector(a, b, dot)
print(f"The magnitude of difference vector of a and b is: {diff
    :.4f}")
```

Python+C Code

```
#taking an example of vectors a and b to prove computationally
A=(2.0,0)
B=(0,3.0)

# Plotting
plt.figure()
plt.quiver(0, 0, A[0], A[1], angles='xy', scale_units='xy', scale
    =1, color='r', label='a')
plt.quiver(0, 0, B[0], B[1], angles='xy', scale_units='xy', scale
    =1, color='b', label='b')
plt.quiver(B[0], B[1], A[0]-B[0], A[1]-B[1],
           angles='xy', scale_units='xy', scale=1, color='g',
               label='a-b')
```

Python+C Code

```
#Annotate magnitudes
plt.text((A[0]+B[0])/2, (A[1]+B[1])/2, f"|a-b|={diff:.4f}", color
    ='g', fontsize=10, ha='center', va='bottom')

plt.xlim(-1, 5)
plt.ylim(-1, 5)
plt.gca().set_aspect('equal', adjustable='box')
plt.grid()
plt.legend()
plt.title("Magnitude of vector difference: a - b")
plt.savefig("/home/user/Matrix/Matgeo_assignments/2.7.8/figs/
    Figure_1.png")
plt.show()
```

Python Code

```
import math as m
import matplotlib as mp
mp.use("TkAgg")
import matplotlib.pyplot as plt
a=2.0
b=3.0
dot=4.0

def find_mag_diffvector(a,b,dot):
    diff=m.sqrt(a**2+b**2-2*dot)
    return diff

mag_diff=find_mag_diffvector(a,b,dot)

print(f"The magnitude of difference of vector a and b is :{
    mag_diff:.4f}")
```

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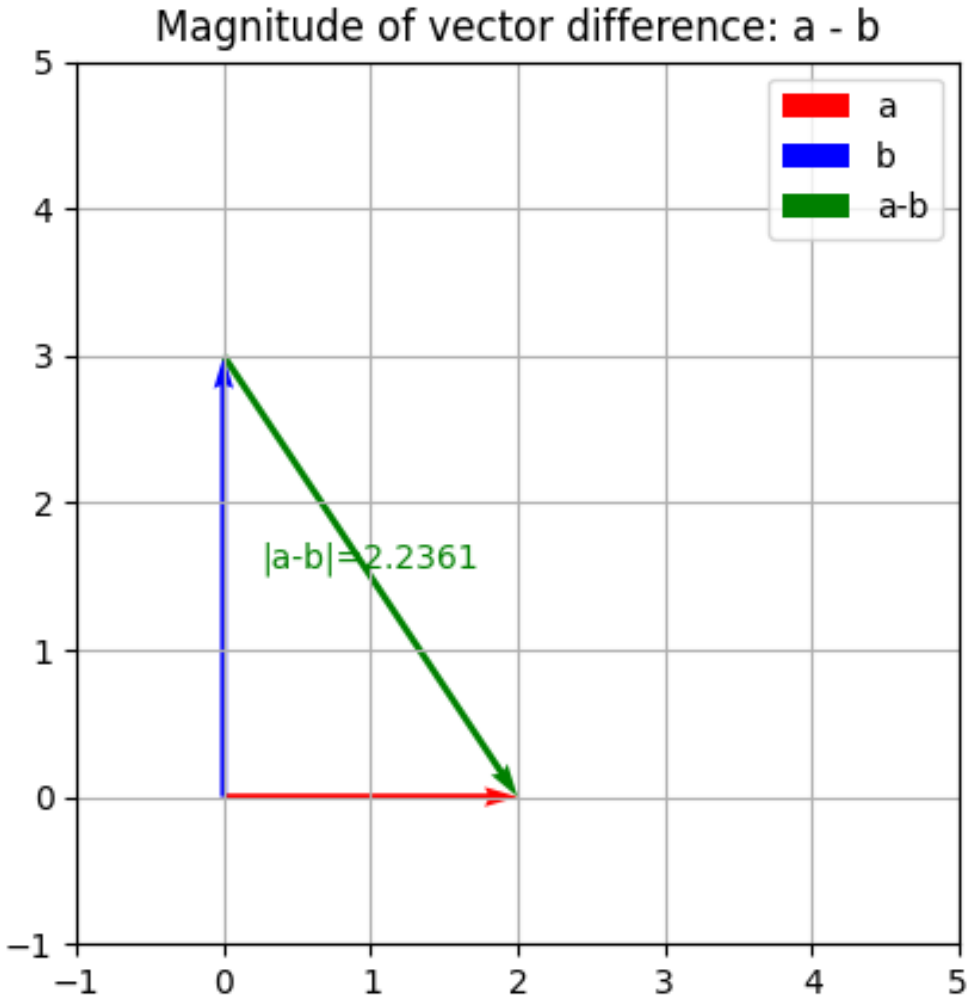
```

Plot


Magnitude of vector difference: a - b
a
b
a-b
|a-b|=2.2361
5
4
3
2
1
0
−1
−1
0
1
2
3
4
5