

1.9.15

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Question

If a , b , c are position vectors of the points $A(2, 3, -4)$, $B(3, -4, -5)$, and $C(3, 2, -3)$ respectively, then $\|a + b + c\|$ is equal to

Theoretical Solution

Given the position vectors,

$$\mathbf{a} = \begin{pmatrix} 2 \\ 3 \\ 4 \end{pmatrix} \quad \mathbf{b} = \begin{pmatrix} 3 \\ -4 \\ -5 \end{pmatrix} \quad \mathbf{c} = \begin{pmatrix} 3 \\ 2 \\ -3 \end{pmatrix} \quad (1)$$

To find the magnitude of $\|\mathbf{a} + \mathbf{b} + \mathbf{c}\|$, we can add these three vectors to find their sum, say \mathbf{S} , and find their magnitude.

$$\mathbf{S} = \mathbf{a} + \mathbf{b} + \mathbf{c} \quad (2)$$

$$\mathbf{S} = \begin{pmatrix} 2 \\ 3 \\ -4 \end{pmatrix} + \begin{pmatrix} 3 \\ -4 \\ -5 \end{pmatrix} + \begin{pmatrix} 3 \\ 2 \\ -3 \end{pmatrix} \quad (3)$$

$$\therefore \mathbf{S} = \begin{pmatrix} 8 \\ 1 \\ -12 \end{pmatrix} \quad (4)$$

Theoretical Solution

The magnitude of S is given by

$$\|S\|^2 = \mathbf{s}^T \mathbf{s} \quad (5)$$

$$\therefore \|S\|^2 = \begin{pmatrix} 8 & 1 & -12 \end{pmatrix} \begin{pmatrix} 8 \\ 1 \\ -12 \end{pmatrix} \quad (6)$$

$$\|S\|^2 = (209) \quad (7)$$

$$\therefore \|S\| = (14.457) \text{ units} \quad (8)$$

C Code - Sum of vectors and Magnitude of vectors

```
#include<stdio.h>
#include<math.h>

double find_magnitude(int *result)
{
    double mag;
    mag=sqrt(pow(result[0],2)+pow(result[1],2)+pow(result
        [2],2));
    return mag;
}

void sum_of_vectors(int *a, int *b, int *c, int *result)
{
    for(int i = 0; i < 3; i++)
    {
        result[i] = a[i] + b[i] + c[i];
    }
}
```

Python+C Code

```
import ctypes
import numpy as np
import matplotlib as mp
mp.use("TkAgg") # must come before pyplot
import matplotlib.pyplot as plt

# Load C library
lib = ctypes.CDLL('./libmagnitude_sum.so')

# C function signatures
lib.sum_of_vectors.argtypes = [
    ctypes.POINTER(ctypes.c_int),
    ctypes.POINTER(ctypes.c_int),
    ctypes.POINTER(ctypes.c_int),
    ctypes.POINTER(ctypes.c_int)
]
lib.sum_of_vectors.restype = None
```

```
lib.find_magnitude.argtypes = [ctypes.POINTER(ctypes.c_int)]  
lib.find_magnitude.restype = ctypes.c_double
```

```
# Define vectors
```

```
A = np.array([2, 3, -4], dtype=np.int32)  
B = np.array([3, -4, -5], dtype=np.int32)  
C = np.array([3, 2, -3], dtype=np.int32)  
S = np.zeros(3, dtype=np.int32)
```

```
# Sum vectors via C
```

```
lib.sum_of_vectors(  
    A.ctypes.data_as(ctypes.POINTER(ctypes.c_int)),  
    B.ctypes.data_as(ctypes.POINTER(ctypes.c_int)),  
    C.ctypes.data_as(ctypes.POINTER(ctypes.c_int)),  
    S.ctypes.data_as(ctypes.POINTER(ctypes.c_int))  
)
```



```
print("Sum of vectors:", S)

# Magnitude via C
magnitude = lib.find_magnitude(S.ctypes.data_as(ctypes.POINTER(
    ctypes.c_int)))
print("Magnitude of sum vector: {:.3f}".format(magnitude))
```

```
# 3D Plot
origin = np.array([0,0,0])
fig = plt.figure(figsize=(8,8))
ax = fig.add_subplot(111, projection='3d')

ax.quiver(*origin, *A, color='r', label='A')
ax.quiver(*origin, *B, color='g', label='B')
ax.quiver(*origin, *C, color='b', label='C')
ax.quiver(*origin, *S, color='k', linewidth=2, label='Sum (A+B+C)')

max_val = max(np.abs(S)) + 2
ax.set_xlim([0, max_val])
ax.set_ylim([0, max_val])
ax.set_zlim([min(0, np.min(S)) - 2, max_val])
```

```
ax.set_xlabel('X')
ax.set_ylabel('Y')
ax.set_zlabel('Z')
ax.set_title('3D Vectors and their Sum')
ax.legend()

plt.savefig("/home/user/Matrix/Matgeo_assignments/1.9.15/figs/
    Figure_1.png", dpi=300, bbox_inches='tight')
plt.show()
```

```
import numpy as np
import matplotlib as mp
mp.use("TkAgg") # must come before pyplot
import matplotlib.pyplot as plt

# Define vectors
A = np.array([2, 3, -4], dtype=np.int32)
B = np.array([3, -4, -5], dtype=np.int32)
C = np.array([3, 2, -3], dtype=np.int32)

# Sum of vectors
S = A + B + C
print("Sum of vectors:", S)
```

```
# Magnitude of sum vector
magnitude = np.linalg.norm(S)
print("Magnitude of sum vector: {:.3f}".format(magnitude))

# 3D Plot
origin = np.array([0, 0, 0])
fig = plt.figure(figsize=(8, 8))
ax = fig.add_subplot(111, projection='3d')

ax.quiver(*origin, *A, color='r', label='A')
ax.quiver(*origin, *B, color='g', label='B')
ax.quiver(*origin, *C, color='b', label='C')
ax.quiver(*origin, *S, color='k', linewidth=2, label='Sum (A+B+C)')
')
```

Python Code

```
# Axis limits
max_val = max(np.abs(S)) + 2
ax.set_xlim([0, max_val])
ax.set_ylim([0, max_val])
ax.set_zlim([min(0, np.min(S)) - 2, max_val])

# Labels and title
ax.set_xlabel('X')
ax.set_ylabel('Y')
ax.set_zlabel('Z')
ax.set_title('3D Vectors and their Sum')
ax.legend()

# Save and show
plt.savefig("/home/user/Matrix/Matgeo_assignments/1.9.15/figs/
            Figure_1.png",
            dpi=300, bbox_inches='tight')
plt.show()
```

3D Vectors and their Sum

