# 2.6.22

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# Question

Given vectors $\mathbf{a} = 2\overrightarrow{i} + \overrightarrow{j} + 3\overrightarrow{k}$ and $\mathbf{b} = 3\overrightarrow{i} + 5\overrightarrow{j} - 2\overrightarrow{k}$, find $|\mathbf{a} \times \mathbf{b}|$.

# Theoretical Solution

The cross product or vector product of two vectors $\mathbf{A} = \begin{pmatrix} A_1 \\ A_2 \\ A_3 \end{pmatrix}$ and $\mathbf{B} = \begin{pmatrix} B_1 \\ B_2 \\ B_3 \end{pmatrix}$ is defined as:

$$\mathbf{A} \times \mathbf{B} = \begin{pmatrix} A_2 B_3 - A_3 B_2 \\ A_3 B_1 - A_1 B_3 \\ A_1 B_2 - A_2 B_1 \end{pmatrix} \tag{1}$$

Now, given

$$\mathbf{a} = \begin{pmatrix} 2 \\ 1 \\ 3 \end{pmatrix}, \quad \mathbf{b} = \begin{pmatrix} 3 \\ 5 \\ -2 \end{pmatrix} \tag{2}$$

# Theoretical Solution

Using the formula for cross product,

$$\mathbf{a} \times \mathbf{b} = \begin{pmatrix} 1 \times (-2) - 3 \times 5 \\ 3 \times 3 - 2 \times (-2) \\ 2 \times 5 - 1 \times 3 \end{pmatrix} \tag{3}$$

$$= \begin{pmatrix} -2 - 15 \\ 9 + 4 \\ 10 - 3 \end{pmatrix} \tag{4}$$

$$= \begin{pmatrix} -17 \\ 13 \\ 7 \end{pmatrix} \tag{5}$$

Finally, the magnitude of the cross product is:

$$||\mathbf{a} \times \mathbf{b}|| = \sqrt{(-17)^2 + 13^2 + 7^2} \tag{6}$$

$$= \sqrt{289 + 169 + 49} \tag{7}$$

$$= \sqrt{507} \tag{8}$$

# C Code

```c
#include <stdio.h>

void crossProduct(int a[3], int b[3], int result[3]) {
    result[0] = a[1]*b[2] - a[2]*b[1];
    result[1] = a[2]*b[0] - a[0]*b[2];
    result[2] = a[0]*b[1] - a[1]*b[0];
}
```

# C-Python Code

```
import numpy as np
import matplotlib.pyplot as plt
import ctypes
import numpy.linalg as linalg
from mpl_toolkits.mplot3d import Axes3D
lib = ctypes.CDLL('./func.so')

lib.crossProduct.argtypes = [
    ctypes.POINTER(ctypes.c_int),
    ctypes.POINTER(ctypes.c_int),
    ctypes.POINTER(ctypes.c_int)
]
lib.crossProduct.restype = None
```

# C-Python Code

```
A = (ctypes.c_int * 3)(2, 1, 3)
B = (ctypes.c_int * 3)(3, 5, -2)
C = (ctypes.c_int * 3)()
lib.crossProduct(A,B,C)
normC=linalg.norm(C)
print(normC)
fig=plt.figure()
ax = fig.add_subplot(111, projection='3d')
O= [0, 0, 0]
ax.quiver(*O, *A, color='r', label='a', linewidth=2)
ax.quiver(*O, *B, color='g', label='b', linewidth=2)
ax.quiver(*O, *C, color='b', label='a * b', linewidth=2)
```

# C-Python Code

```
ax.text(A[0], A[1], A[2], 'a', color='r', fontsize=12)
ax.text(B[0], B[1], B[2], 'b', color='g', fontsize=12)
ax.text(C[0], C[1], C[2], 'a * b', color='b', fontsize=12)
ax.set_xlabel('X')
ax.set_ylabel('Y')
ax.set_zlabel('Z')
ax.set_xlim([-20,5])
ax.set_ylim([0,15])
ax.set_zlim([-5,10])
ax.set_title('plotting a,b,a*b')
plt.savefig("/home/gauthamp/ee1030-2025/ai25btech11013/matgeo
    /2.6.22/figs/plotc.png")
plt.show()
```

# Python Code

```
import numpy as np
import numpy.linalg as linalg
import matplotlib.pyplot as plt
from mpl_toolkits.mplot3d import Axes3D
A=np.array([2,1,3])
B=np.array([3,5,-2])
C=np.cross(A,B)
normC=linalg.norm(C)
fig=plt.figure()
ax = fig.add_subplot(111, projection='3d')
O= [0, 0, 0]
ax.quiver(*O, *A, color='r', label='a', linewidth=2)
ax.quiver(*O, *B, color='g', label='b', linewidth=2)
ax.quiver(*O, *C, color='b', label='a * b', linewidth=2)
```

# Python Code

```
ax.text(A[0], A[1], A[2], 'a', color='r', fontsize=12)
ax.text(B[0], B[1], B[2], 'b', color='g', fontsize=12)
ax.text(C[0], C[1], C[2], 'a * b', color='b', fontsize=12)
ax.set_xlabel('X')
ax.set_ylabel('Y')
ax.set_zlabel('Z')
ax.set_xlim([-20,5])
ax.set_ylim([0,15])
ax.set_zlim([-5,10])
ax.set_title('plotting a,b,a*b')
plt.savefig("/home/gauthamp/ee1030-2025/ai25btech11013/matgeo
    /2.6.22/figs/plot.png")
plt.show()
```

# Plot