frame=single, breaklines=true, columns=fullflexible

Matrix 2.10.4

ai25btech11015 – M Sai Rithik

Find the area of the triangle whose vertices are

$$A(1, -1, 2), \quad B(2, 0, -1), \quad C(3, -1, 2),$$

Vectors

$$\mathbf{A} = \begin{pmatrix} 1 \\ -1 \\ 2 \end{pmatrix}, \quad \mathbf{B} = \begin{pmatrix} 2 \\ 0 \\ -1 \end{pmatrix}, \quad \mathbf{C} = \begin{pmatrix} 3 \\ -1 \\ 2 \end{pmatrix} \qquad (1)$$

$$\mathbf{B} - \mathbf{A} = \begin{pmatrix} 2 \\ 0 \\ -1 \end{pmatrix} - \begin{pmatrix} 1 \\ -1 \\ 2 \end{pmatrix} = \begin{pmatrix} 1 \\ 1 \\ -3 \end{pmatrix}, \qquad (2)$$

$$\mathbf{C} - \mathbf{A} = \begin{pmatrix} 3 \\ -1 \\ 2 \end{pmatrix} - \begin{pmatrix} 1 \\ -1 \\ 2 \end{pmatrix} = \begin{pmatrix} 2 \\ 0 \\ 0 \end{pmatrix}. \qquad (3)$$

Cross Product and Area

$$\mathbf{X} \times \mathbf{Y} = \begin{pmatrix} \begin{vmatrix} \mathbf{X}_{23} & \mathbf{Y}_{23} \\ \mathbf{X}_{31} & \mathbf{Y}_{31} \\ \mathbf{X}_{12} & \mathbf{Y}_{12} \end{vmatrix} \end{pmatrix} \tag{4}$$

$$(\mathbf{B} - \mathbf{A}) \times (\mathbf{C} - \mathbf{A}) = \begin{pmatrix} 1 \\ 1 \\ -3 \end{pmatrix} \times \begin{pmatrix} 2 \\ 0 \\ 0 \end{pmatrix} = \begin{pmatrix} 0 \\ -6 \\ -2 \end{pmatrix}. \tag{5}$$

Cross Product and Area

$$\mathbf{X} \times \mathbf{Y} = \begin{pmatrix} \begin{vmatrix} \mathbf{X}_{23} & \mathbf{Y}_{23} \\ \mathbf{X}_{31} & \mathbf{Y}_{31} \\ \mathbf{X}_{12} & \mathbf{Y}_{12} \end{vmatrix} \end{pmatrix} \tag{4}$$

$$(\mathbf{B} - \mathbf{A}) \times (\mathbf{C} - \mathbf{A}) = \begin{pmatrix} 1 \\ 1 \\ -3 \end{pmatrix} \times \begin{pmatrix} 2 \\ 0 \\ 0 \end{pmatrix} = \begin{pmatrix} 0 \\ -6 \\ -2 \end{pmatrix}. \tag{5}$$
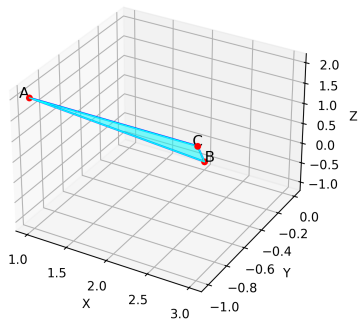
$$\text{Area} = \tfrac{1}{2} \left\| \begin{pmatrix} 0 \\ -6 \\ -2 \end{pmatrix} \right\| = \tfrac{1}{2} \sqrt{0^2 + (-6)^2 + (-2)^2} \tag{6}$$

$$= \tfrac{1}{2} \sqrt{36 + 4} = \tfrac{\sqrt{40}}{2} = \sqrt{10}. \tag{7}$$

$$\boxed{\text{Area} = \sqrt{10}}$$

Figure

Area : 3.1622776601683795

C Code

```c
#include <stdio.h>

int main() {
        int arr1[3] = {1, -1, 2};
        int arr2[3] = {2, 0, -1};
        int arr3[3] = {3, -1, 2};
        FILE *fp = fopen("var.dat", "w");
        if (fp == NULL) {
                printf("Error opening file!\n");
                return 1;
        }
        for (int i = 0; i < 3; i++) fprintf(fp, "%d%c", arr1
            [i], i < 2 ? ' ' : '\n');
        for (int i = 0; i < 3; i++) fprintf(fp, "%d%c", arr2
            [i], i < 2 ? ' ' : '\n');
        for (int i = 0; i < 3; i++) fprintf(fp, "%d%c", arr3
            [i], i < 2 ? ' ' : '\n');
        fclose(fp);
        return 0;
}
```

Python Code (Part 1)

```python
1  import numpy as np
2  import matplotlib.pyplot as plt
3  from mpl_toolkits.mplot3d.art3d import Poly3DCollection
4  import ctypes
5
6  # #Run the C code to generate var.dat
7  # dll = ctypes.CDLL("./get_coordinates.so")
8  # dll.get_coordinates()
9
10 # Read arrays from var.dat
11 with open("var.dat", "r") as f:
12         lines = f.readlines()
13         A = np.array([int(x) for x in lines[0].split()])
14         B = np.array([int(x) for x in lines[1].split()])
15         C = np.array([int(x) for x in lines[2].split()])
16
17 AB = B - A
18 AC = C - A
19 # Area calculation
20 area = 0.5 * np.linalg.norm(np.cross(AB, AC))
21 print("Area of triangle ABC:", area)
22
23 # Create figure
24 fig = plt.figure()
25 ax = fig.add_subplot(111, projection='3d')
```

Python Code (Part 2)

```
1  # Plot triangle edges
2  ax.plot([A[0], B[0]], [A[1], B[1]], [A[2], B[2]], color='
       blue')
3  ax.plot([B[0], C[0]], [B[1], C[1]], [B[2], C[2]], color='
       blue')
4  ax.plot([C[0], A[0]], [C[1], A[1]], [C[2], A[2]], color='
       blue')
5
6  # Fill triangle surface
7  ax.add_collection3d(Poly3DCollection([triangle], color='cyan
       ', alpha=0.5))
8
9  # Scatter vertices
10 ax.scatter(A[0], A[1], A[2], color='red')
11 ax.text(A[0], A[1], A[2], "A", fontsize=12, ha='right')
12 ax.scatter(B[0], B[1], B[2], color='red')
13 ax.text(B[0], B[1], B[2], "B", fontsize=12, ha='left')
14 ax.scatter(C[0], C[1], C[2], color='red')
15 ax.text(C[0], C[1], C[2], "C", fontsize=12, ha='center')
16
17 # Labels
18 ax.set_xlabel("X")
19 ax.set_ylabel("Y")
20 ax.set_zlabel("Z")
21 ax.set_title("Area : " + str(area))
```