1.11.16

AI25BTECH11014 - Suhas

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Question

Find the area of a triangle having the points

$$\mathbf{A} = \begin{pmatrix} 1 \\ 1 \\ 1 \end{pmatrix}, \quad \mathbf{B} = \begin{pmatrix} 1 \\ 2 \\ 3 \end{pmatrix}, \quad \mathbf{C} = \begin{pmatrix} 2 \\ 3 \\ 1 \end{pmatrix}$$

as its vertices.

Theoretical Solution

Let the vertices of the triangle be:

$$\mathbf{A} = \begin{pmatrix} 1 \\ 1 \\ 1 \end{pmatrix}, \quad \mathbf{B} = \begin{pmatrix} 1 \\ 2 \\ 3 \end{pmatrix}, \quad \mathbf{C} = \begin{pmatrix} 2 \\ 3 \\ 1 \end{pmatrix}$$

To compute the area of triangle ABC, we use the formula:

$$\text{Area} = \frac{1}{2} \left\| (\mathbf{B} - \mathbf{A}) \times (\mathbf{C} - \mathbf{A}) \right\|$$

Compute the vectors:

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

Theoretical Solution

Now compute the cross product:

$$(\mathbf{B}-\mathbf{A})\times(\mathbf{C}-\mathbf{A}) = \begin{pmatrix}(1)(0)-(2)(2)\\(2)(1)-(0)(0)\\(0)(2)-(1)(1)\end{pmatrix} = \begin{pmatrix}-4\\2\\-1\end{pmatrix}$$

Next, compute the magnitude of the cross product:

$$\left\|\begin{pmatrix}-4\\2\\-1\end{pmatrix}\right\| = \sqrt{(-4)^2+2^2+(-1)^2} = \sqrt{16+4+1} = \sqrt{21}$$

Theoretical Solution

Therefore, the area of triangle ABC is:

$$\text{Area} = \frac{1}{2} \cdot \sqrt{21}$$

$$\boxed{\text{Area} = \frac{\sqrt{21}}{2}}$$

C Code

```c
#include <math.h>
float area() {
  float A[3] = {1,1,1}, B[3] = {1,2,3}, C[3] = {2,3,1};
  float U[3] = {B[0]-A[0],B[1]-A[1],B[2]-A[2]};
  float V[3] = {C[0]-A[0],C[1]-A[1],C[2]-A[2]};
  float CP[3] = {
    U[1]*V[2]-U[2]*V[1],
    U[2]*V[0]-U[0]*V[2],
    U[0]*V[1]-U[1]*V[0]
  };
  return 0.5 * sqrt(CP[0]*CP[0]+CP[1]*CP[1]+CP[2]*CP[2]);
}
```

C Code for .so File

```c
#include <math.h>

float triangle_area(float* U, float* V) {
  float CP[3] = {
    U[1]*V[2] - U[2]*V[1],
    U[2]*V[0] - U[0]*V[2],
    U[0]*V[1] - U[1]*V[0]
  };

  float mag = sqrt(CP[0]*CP[0] + CP[1]*CP[1] + CP[2]*CP[2]);
  return 0.5 * mag;
}
```

Python Code Using .so

```
import ctypes
import numpy as np

lib = ctypes.CDLL('./libtriangle.so')
lib.triangle_area.argtypes = [ctypes.POINTER(ctypes.c_float),
                              ctypes.POINTER(ctypes.c_float)]
lib.triangle_area.restype = ctypes.c_float

U = np.array([0, 1, 2], dtype=np.float32)
V = np.array([1, 2, 0], dtype=np.float32)

area = lib.triangle_area(U.ctypes.data_as(ctypes.POINTER(ctypes.
    c_float)),
                         V.ctypes.data_as(ctypes.POINTER(ctypes.
                             c_float)))
print(f"Area = {area}")
```

Plot

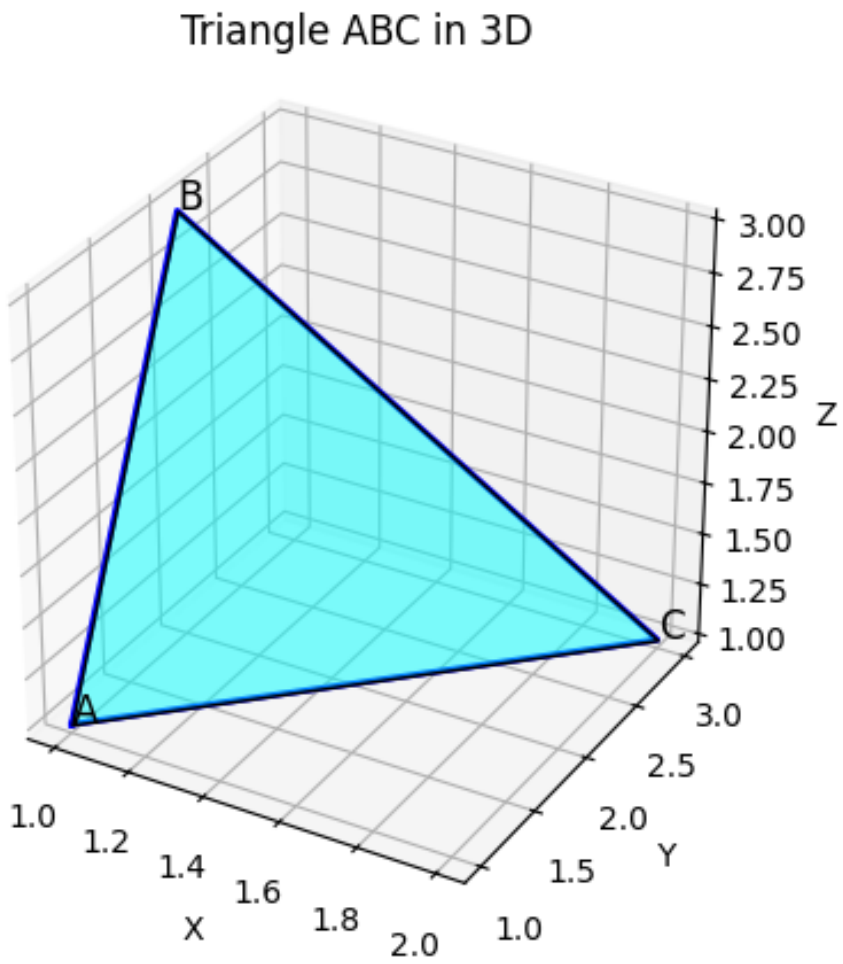

Figure: Triangle ABC