1.9.14

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Question

The centroid of triangle $\triangle ABC$ is at $\mathbf{G} = \begin{pmatrix} 1 \\ 1 \\ 1 \end{pmatrix}$. Given: $\mathbf{A} = \begin{pmatrix} 3 \\ -5 \\ 7 \end{pmatrix}$, $\mathbf{B} = \begin{pmatrix} -1 \\ 7 \\ -6 \end{pmatrix}$ Find: Coordinates of point $\mathbf{C}$.

Theoretical Solution

Centroid formula:

$$\mathbf{G} = \frac{1}{3}(\mathbf{A} + \mathbf{B} + \mathbf{C}) \tag{1}$$

Multiply both sides by 3:

$$3\mathbf{G} = \mathbf{A} + \mathbf{B} + \mathbf{C} \tag{2}$$

Rearranged:

$$\mathbf{C} = 3\mathbf{G} - \mathbf{A} - \mathbf{B} \tag{3}$$

Theoretical Solution

Let $\mathbf{A} = \mathbf{a}$, $\mathbf{B} = \mathbf{b}$, $\mathbf{G} = \mathbf{g}$ Then:

$$\mathbf{C} = 3\mathbf{g} - \mathbf{a} - \mathbf{b} \tag{4}$$

Numerical substitution:

$$\mathbf{C} = 3\begin{pmatrix}1\\1\\1\end{pmatrix} - \begin{pmatrix}3\\-5\\7\end{pmatrix} - \begin{pmatrix}-1\\7\\-6\end{pmatrix} \tag{5}$$

Theoretical Solution

Step-by-step:

$$3\mathbf{G} = \begin{pmatrix} 3 \\ 3 \\ 3 \end{pmatrix} \tag{6}$$

$$\mathbf{C} = \begin{pmatrix} 3 \\ 3 \\ 3 \end{pmatrix} - \begin{pmatrix} 3 \\ -5 \\ 7 \end{pmatrix} = \begin{pmatrix} 0 \\ 8 \\ -4 \end{pmatrix} \tag{7}$$

$$\mathbf{C} = \begin{pmatrix} 0 \\ 8 \\ -4 \end{pmatrix} - \begin{pmatrix} -1 \\ 7 \\ -6 \end{pmatrix} = \begin{pmatrix} 1 \\ 1 \\ 2 \end{pmatrix} \tag{8}$$

Answer: $\mathbf{C} = \begin{pmatrix} 1 \\ 1 \\ 2 \end{pmatrix}$

C Code - Direct Solve

```c
#include <stdio.h>

int main() {
    double A[3] = {3, -5, 7};
    double B[3] = {-1, 7, -6};
    double G[3] = {1, 1, 1};
    double C[3];

    for (int i = 0; i < 3; i++)
        C[i] = 3 * G[i] - A[i] - B[i];

    printf("C = (%lf, %lf, %lf)\n", C[0], C[1], C[2]);
}
```

C Code - Function for .so

```c
#include <stdio.h>

void centroid(double* A, double* B,
              double* G, double* C) {
    for (int i = 0; i < 3; i++) {
        C[i] = 3 * G[i] - A[i] - B[i];
    }
}
```

Python Code - Setup

```
import ctypes
import numpy as np

lib = ctypes.CDLL("./libcentroid.so")
lib.centroid.argtypes = [
    ctypes.POINTER(ctypes.c_double)
] * 4
```

Python Code - Execution

```
A = np.array([3.0, -5.0, 7.0])
B = np.array([-1.0, 7.0, -6.0])
G = np.array([1.0, 1.0, 1.0])
C = np.zeros(3)

A_ct = A.ctypes.data_as(
    ctypes.POINTER(ctypes.c_double))
B_ct = B.ctypes.data_as(
    ctypes.POINTER(ctypes.c_double))
```

Python Code - Result

```
G_ct = G.ctypes.data_as(
    ctypes.POINTER(ctypes.c_double))
C_ct = C.ctypes.data_as(
    ctypes.POINTER(ctypes.c_double))

lib.centroid(A_ct, B_ct, G_ct, C_ct)

print("Coordinates of C:", C)
```

Plot

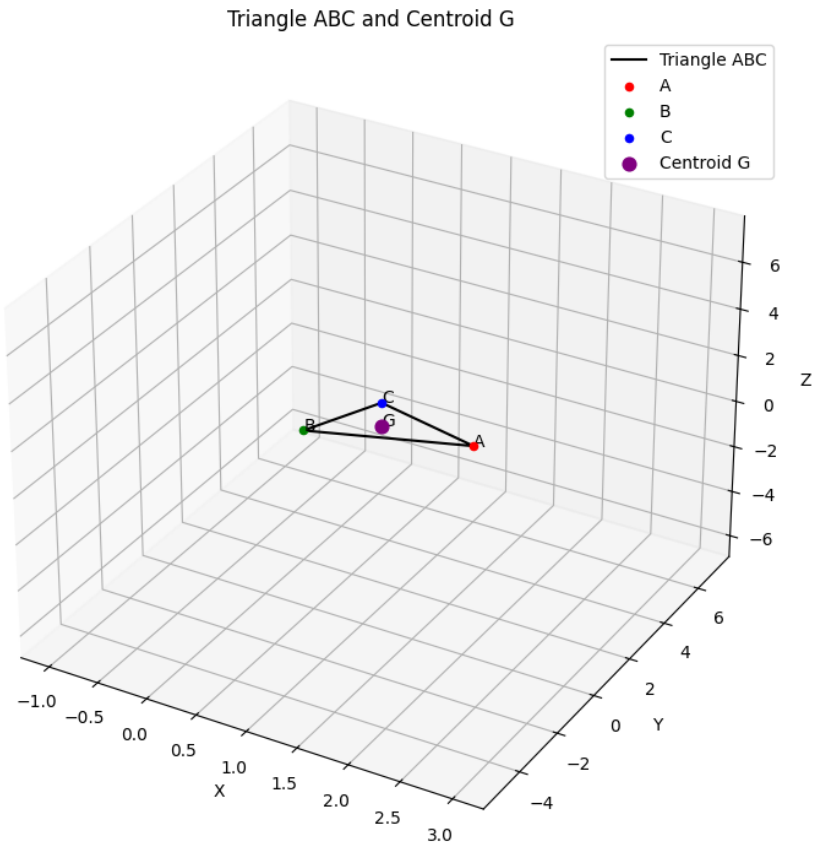

Figure: Plot