1.6.28

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Show that the points $A(-2\hat{i} + 3\hat{j} + 5\hat{k})$, $B(\hat{i} + 2\hat{j} + 3\hat{k})$ and $C(7\hat{i} - \hat{k})$ are collinear.

Theoretical Solution

Let the points are $\mathbf{A} \begin{pmatrix} -2 \\ 3 \\ 5 \end{pmatrix}$, $\mathbf{B} \begin{pmatrix} 1 \\ 2 \\ 3 \end{pmatrix}$ and $\mathbf{C} \begin{pmatrix} 7 \\ 0 \\ -1 \end{pmatrix}$.

Theoretical Solution

$$\mathbf{B} - \mathbf{A} = \begin{pmatrix} 1 \\ 2 \\ 3 \end{pmatrix} - \begin{pmatrix} -2 \\ 3 \\ 5 \end{pmatrix} \tag{1}$$

$$\mathbf{B} - \mathbf{A} = \begin{pmatrix} 1 - (-2) \\ 2 - 3 \\ 3 - 5 \end{pmatrix} = \begin{pmatrix} 3 \\ -1 \\ -2 \end{pmatrix} \tag{2}$$

$$\mathbf{C} - \mathbf{A} = \begin{pmatrix} 7 \\ 0 \\ -1 \end{pmatrix} - \begin{pmatrix} -2 \\ 3 \\ 5 \end{pmatrix} \tag{3}$$

$$\mathbf{C} - \mathbf{A} = \begin{pmatrix} 7 - (-2) \\ 0 - 3 \\ -1 - 5 \end{pmatrix} = \begin{pmatrix} 9 \\ -3 \\ -6 \end{pmatrix} \tag{4}$$

$$\tag{5}$$

Theoretical Solution

If **A**, **B** and **C** are collinear, then the Rank of matrix $(\mathbf{B} - \mathbf{A}, \mathbf{C} - \mathbf{A})$ should be 1.

$$(\mathbf{B} - \mathbf{A}, \mathbf{C} - \mathbf{A}) = \begin{pmatrix} 3 & 9 \\ -1 & -3 \\ -2 & -6 \end{pmatrix} \tag{6}$$

$$R_3 \rightarrow (\frac{R_1}{3} \times 2) + R_3 \tag{7}$$

$$R_2 \rightarrow \frac{R_1}{3} + R_2 \tag{8}$$

$$= \begin{pmatrix} 3 & 9 \\ 0 & 0 \\ 0 & 0 \end{pmatrix} \tag{9}$$

$$\tag{10}$$

Theoretical Solution

Since all elements of R_2 and R_3 are 0, The Rank of matrix $(\mathbf{B} - \mathbf{A}, \mathbf{C} - \mathbf{A})$ is 1.

$\implies$ $\mathbf{A}$, $\mathbf{B}$ and $\mathbf{C}$ are collinear.

main C Code

```c
#include <stdio.h>

int are_collinear(float A[3], float B[3], float C[3]);

int main() {
    float A[3] = {-2, 3, 5};
    float B[3] = {1, 2, 3};
    float C[3] = {7, 0, -1};

    if (are_collinear(A, B, C)) {
        printf("The points are collinear.\n");
    } else {
        printf("The points are not collinear.\n");
    }

    return 0;
}
```

C Code

```c
#include <stdio.h>

int are_collinear(float A[3], float B[3], float C[3]) {
    float AB[3], AC[3];

    for (int i = 0; i < 3; i++) {
        AB[i] = B[i] - A[i];
        AC[i] = C[i] - A[i];
    }

    float ratio = 0.0;
    int initialized = 0;
```

C Code

```c
for (int i = 0; i < 3; i++) {
    if (AC[i] != 0) {
        float current_ratio = AB[i] / AC[i];
        if (!initialized) {
            ratio = current_ratio;
            initialized = 1;
        } else {
            if (current_ratio != ratio) {
                return 0; // Not collinear
            }
        }
    } else if (AB[i] != 0) {
        return 0; // AC[i] = 0 but AB[i] ≠0 →not proportional
    }
}

return 1; // Collinear
}
```

Python Code

```python
import ctypes
import numpy as np
import matplotlib.pyplot as plt

lib = ctypes.CDLL('./func.so')


lib.are_collinear.argtypes = [ctypes.POINTER(ctypes.c_float),
                              ctypes.POINTER(ctypes.c_float),
                              ctypes.POINTER(ctypes.c_float)]
lib.are_collinear.restype = ctypes.c_int

A = np.array([-2, 3, 5], dtype=np.float32)
B = np.array([1, 2, 3], dtype=np.float32)
C = np.array([7, 0, -1], dtype=np.float32)
```

```python
result = lib.are_collinear(A.ctypes.data_as(ctypes.POINTER(ctypes
    .c_float)),
                            B.ctypes.data_as(ctypes.POINTER(ctypes.
                                c_float)),
                            C.ctypes.data_as(ctypes.POINTER(ctypes.
                                c_float)))

if result == 1:
    print("Points are collinear")
else:
    print("Points are NOT collinear")

fig = plt.figure()
ax = fig.add_subplot(111, projection='3d')
```

Python Code

```python
ax.scatter(*A, color='red', label='A')
ax.scatter(*B, color='green', label='B')
ax.scatter(*C, color='blue', label='C')

ax.plot([A[0], B[0]], [A[1], B[1]], [A[2], B[2]], 'gray',
    linestyle='--')
ax.plot([A[0], C[0]], [A[1], C[1]], [A[2], C[2]], 'gray',
    linestyle='--')

ax.set_xlabel('X')
ax.set_ylabel('Y')
ax.set_zlabel('Z')
ax.legend()
plt.title("Visualization of Points A, B, and C")
plt.savefig("/home/gauthamp/ee1030-2025/ai25btech11013/matgeo
    /1.6.28/figs/Fig 1.png")
plt.show()
```

Plot

Visualization of Points A, B, and C