1.6.26

AI25BTECH11011-VARUN

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Question

Show that the points P(-2,3,5),Q(1,2,3) and R(7,0,-1) are collinear.

Theoretical Solution

Let the points are $\mathbf{P}\begin{pmatrix}-2\\3\\5\end{pmatrix}$,$\mathbf{Q}\begin{pmatrix}1\\2\\3\end{pmatrix}$ and $\mathbf{R}\begin{pmatrix}7\\0\\-1\end{pmatrix}$.

Theoretical Solution

$$\mathbf{Q}-\mathbf{P}=\begin{pmatrix}1\\2\\3\end{pmatrix}-\begin{pmatrix}-2\\3\\5\end{pmatrix} \tag{1}$$

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

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

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

$$\tag{5}$$

Theoretical Solution

If $\mathbf{P}$, $\mathbf{Q}$ and $\mathbf{R}$ are collinear, then the Rank of matrix $(\mathbf{Q}-\mathbf{P}, \mathbf{R}-\mathbf{P})$ should be 1.

$$\begin{aligned}
(\mathbf{Q}-\mathbf{P}, \mathbf{R}-\mathbf{P}) &= \begin{pmatrix} 3 & 9 \\ -1 & -3 \\ -2 & -6 \end{pmatrix} && (6) \\
R_3 &\rightarrow \left(\frac{R_1}{3} \times 2\right) + R_3 && (7) \\
R_2 &\rightarrow \frac{R_1}{3} + R_2 && (8) \\
&= \begin{pmatrix} 3 & 9 \\ 0 & 0 \\ 0 & 0 \end{pmatrix} && (9) \\
& && (10)
\end{aligned}$$

Theoretical Solution

Since all elements of R_2 and R_3 are 0, The Rank of matrix $(\mathbf{Q}-\mathbf{P}, \mathbf{R}-\mathbf{P})$ is 1.
$\implies$ $\mathbf{P}$, $\mathbf{Q}$ and $\mathbf{R}$ are collinear.

main C Code

```c
// main.c
#include <stdio.h>

// Declare the function from collinear.c
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
 // collinear.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];
    }

    // Check if AB and AC are proportional: AB[i]/AC[i] == AB[0]/AC[0] for all 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

# Load the shared library
lib = ctypes.CDLL('./libcollinear.so')

# Define argument types
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

# Define points
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 Code

```python
# Call the function
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")

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

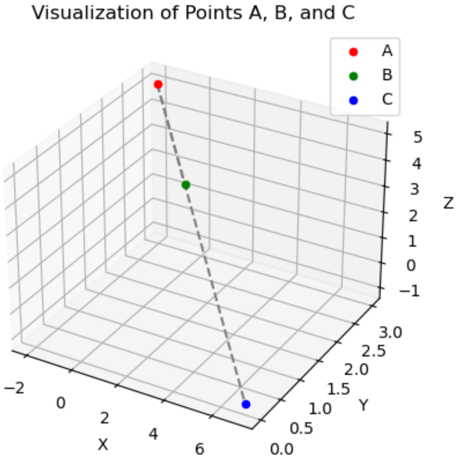
Python Code

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

# Draw lines between points
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/gara-varun-kumar/ee1030-2025/ai25btech11011/
    matgeo/1.6.26/figs/Fig 1.png")
plt.show()
```

Plot


Visualization of Points A, B, and C
A
B
C
5
4
3
2
1
0
−1
Z
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Y
−2
0
2
4
6
X