

MATGEO Presentation: 1.6.5

Subhodeep Chakraborty
ee25btech11055,
IIT Hyderabad.

August 29, 2025

1 Problem

2 Solution

- Theory
- Calculations
- Plot

3 C Code

4 Python Code

- Using C shared objects
- Plot
- In Pure Python
- Plot

Problem Statement

Show that the points $(2, 3, 4)$, $(-1, -2, 1)$, $(5, 8, 7)$ are collinear.

Theory

For three points **A**, **B** and **C** to be collinear:

$$\text{rank}(\mathbf{B} - \mathbf{A} \quad \mathbf{C} - \mathbf{A}) = \text{rank}(\mathbf{B} - \mathbf{A} \quad \mathbf{C} - \mathbf{A})^{\top} = 1 \quad (3.1)$$

Given:

$$\mathbf{A} \equiv (2, 3, 4) \quad (3.2)$$

$$\mathbf{B} \equiv (-1, -2, 1) \quad (3.3)$$

$$\mathbf{C} \equiv (5, 8, 7) \quad (3.4)$$

Calculations

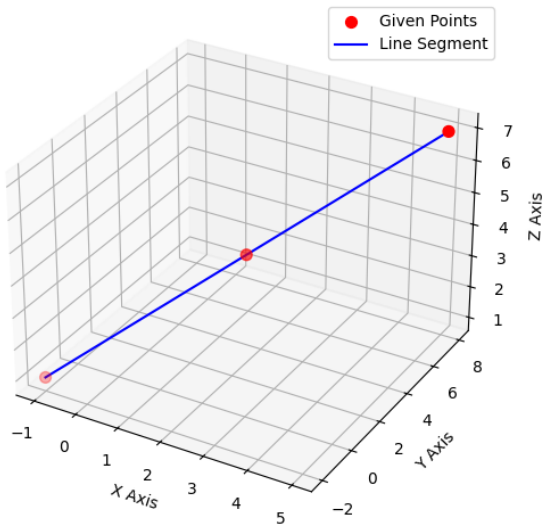
The transpose of the collinearity matrix can be expressed as:

$$\begin{aligned} (\mathbf{B} - \mathbf{A} \quad \mathbf{C} - \mathbf{A})^{\top} &= \begin{pmatrix} -3 & -5 & -3 \\ 3 & 5 & 3 \end{pmatrix} \\ &\xleftrightarrow{R_2 = R_2 + R_1} \begin{pmatrix} -3 & -5 & -3 \\ 0 & 0 & 0 \end{pmatrix} \end{aligned}$$

which has rank 1. Using 3.1, we conclude that the given points are collinear.

Plot

1.6.5



C code for generating points on line

```
void point_gen(const double* P1, const double* P2, double t, double*  
    result_point) {  
    result_point[0] = P1[0] + t * (P2[0] - P1[0]);  
    result_point[1] = P1[1] + t * (P2[1] - P1[1]);  
    result_point[2] = P1[2] + t * (P2[2] - P1[2]);  
}
```

Python code for plotting using C

```
import ctypes
import numpy as np
import matplotlib.pyplot as plt
from mpl_toolkits.mplot3d import Axes3D

lib = ctypes.CDLL("./line.so")

get_point = lib.point_gen
get_point.argtypes = [
    ctypes.POINTER(ctypes.c_double), # P1
    ctypes.POINTER(ctypes.c_double), # P2
    ctypes.c_double, # t
    ctypes.POINTER(ctypes.c_double), # result_point
]
get_point.restype = None
```


Python code for plotting using C

```
DoubleArray3 = ctypes.c_double * 3
P1_arr = DoubleArray3(-1, -2, 1)
P2_arr = DoubleArray3(5, 8, 7)

t_values = np.linspace(0, 1, 100)
line_points_x, line_points_y, line_points_z = [], [], []

for t in t_values:
    result_arr = DoubleArray3()

    get_point(P1_arr, P2_arr, t, result_arr)

    line_points_x.append(result_arr[0])
    line_points_y.append(result_arr[1])
    line_points_z.append(result_arr[2])

original_points = np.array([[ -1, -2, 1], [2, 3, 4], [5, 8, 7]])
```

Python code for plotting using C

```
fig = plt.figure(figsize=(8, 6))
ax = fig.add_subplot(111, projection="3d")

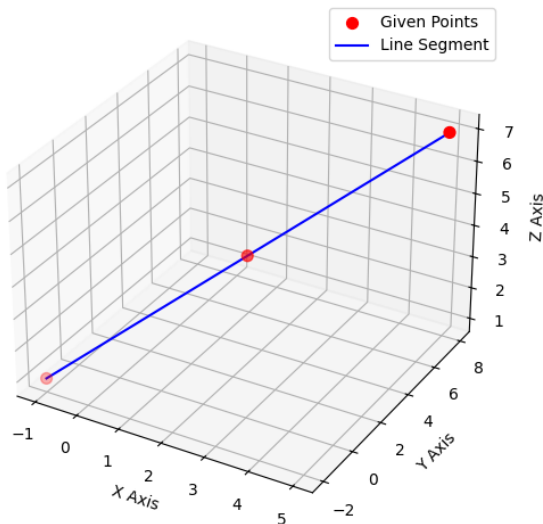
ax.scatter(
    original_points[:, 0],
    original_points[:, 1],
    original_points[:, 2],
    color="red",
    s=50,
    label="Given Points",
)
```

Python code for plotting using C

```
ax.plot(  
    line_points_x,  
    line_points_y,  
    line_points_z,  
    color="blue",  
    label="Line-Segment",  
)  
  
ax.set_xlabel("X-Axis")  
ax.set_ylabel("Y-Axis")  
ax.set_zlabel("Z-Axis")  
ax.set_title("1.6.5")  
ax.legend()  
ax.grid(True)  
  
plt.savefig("../figs/plot.png")  
plt.show()
```

Plot

1.6.5



Pure Python Code for Plotting

```
import numpy as np
import matplotlib.pyplot as plt
from mpl_toolkits.mplot3d import Axes3D

points = np.array([[−1, −2, 1], [2, 3, 4], [5, 8, 7]])

x_coords = points[:, 0]
y_coords = points[:, 1]
z_coords = points[:, 2]

fig = plt.figure(figsize=(8, 6))
ax = fig.add_subplot(111, projection="3d")

ax.scatter(x_coords, y_coords, z_coords, color="red", s=50, label="Given
          Points")
ax.plot(x_coords, y_coords, z_coords, color="blue", label="Line-Segment"
        )
```

Pure Python Code for Plotting

```
ax.set_xlabel("X-Axis")
ax.set_ylabel("Y-Axis")
ax.set_zlabel("Z-Axis")
ax.set_title("1.6.5")
ax.legend()
ax.grid(True)

plt.savefig("../figs/python.png")
plt.show()
```

Pure Python Plot

1.6.5

