

## MATGEO Presentation: 4.3.45

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- Plot

## Problem Statement

Find the coordinates of the point where the line through  $(5, 1, 6)$  and  $(3, 4, 1)$  crosses the  $YX$ -plane.

## Given data

Given:

$$\mathbf{A} = \begin{pmatrix} 5 \\ 1 \\ 6 \end{pmatrix} \quad (3.1)$$

$$\mathbf{B} = \begin{pmatrix} 3 \\ 4 \\ 1 \end{pmatrix} \quad (3.2)$$

# Formulae

We know:

$$\mathbf{x} = \mathbf{h} + k\mathbf{m} \quad (3.3)$$

$$= \mathbf{A} + k(\mathbf{B} - \mathbf{A}) \quad (3.4)$$

$$\mathbf{e}_3^\top \mathbf{x} = 0 \quad (3.5)$$

# Formulae

Thus

$$\mathbf{e}_3^\top \mathbf{A} + k \mathbf{e}_3^\top (\mathbf{B} - \mathbf{A}) = 0 \quad (3.6)$$

$$k = \frac{\mathbf{e}_3^\top \mathbf{A}}{\mathbf{e}_3^\top \mathbf{A} - \mathbf{e}_3^\top \mathbf{B}} \quad (3.7)$$

$$\mathbf{x} = \mathbf{A} + \frac{\mathbf{e}_3^\top \mathbf{A}}{\mathbf{e}_3^\top \mathbf{A} - \mathbf{e}_3^\top \mathbf{B}} (\mathbf{B} - \mathbf{A}) \quad (3.8)$$

# Solving

Solving

$$\mathbf{e}_3^\top \mathbf{A} = 6 \quad (3.9)$$

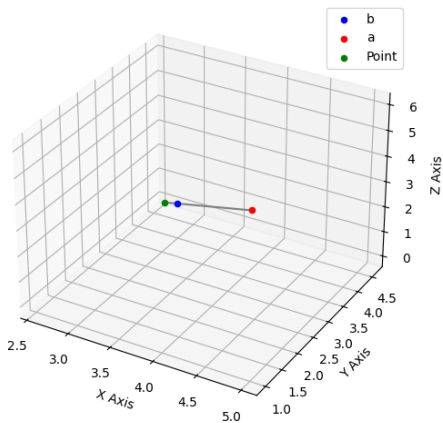
$$\mathbf{e}_3^\top \mathbf{B} = 1 \quad (3.10)$$

$$\mathbf{x} = \begin{pmatrix} 5 - 2 \times \frac{6}{5} \\ 1 + 3 \times \frac{6}{5} \\ 6 - 5 \times \frac{6}{5} \end{pmatrix} \quad (3.11)$$

$$\mathbf{x} = \begin{pmatrix} 13/5 \\ 23/5 \\ 0 \end{pmatrix} \quad (3.12)$$

# Plot

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## 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 numpy.linalg as LA
import matplotlib.pyplot as plt
from mpl_toolkits.mplot3d import Axes3D

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

get_point = libline.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
```

```
DoubleArray3 = ctypes.c_double * 3
a = DoubleArray3(5, 1, 6)
b = DoubleArray3(3, 4, 1)
c = DoubleArray3(13 / 5, 23 / 5, 0)

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

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

for t in t_values:
    result_arr = DoubleArray3()

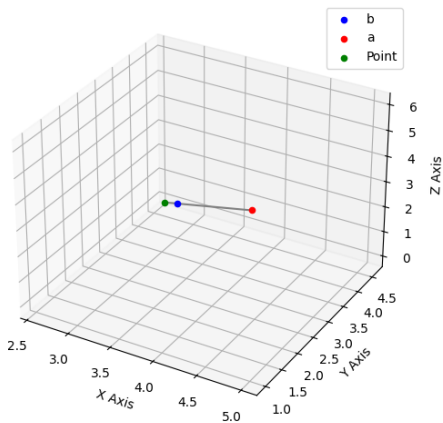
    get_point(a, c, t, result_arr)

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

```
ax.plot(  
    line_points_x,  
    line_points_y,  
    line_points_z,  
    color="gray",  
)  
ax.scatter(b[0], b[1], b[2], color="blue", label="b")  
ax.scatter(a[0], a[1], a[2], color="red", label="a")  
ax.scatter(c[0], c[1], c[2], color="green", label="Point")  
  
ax.set_xlabel("X Axis")  
ax.set_ylabel("Y Axis")  
ax.set_zlabel("Z Axis")  
ax.set_title("2.9.6")  
ax.legend()  
ax.grid(True)  
plt.savefig("../figs/plot.png")  
plt.show()
```

# Plot

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## Pure Python code

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

a = np.array([5, 1, 6]).T
b = np.array([3, 4, 1]).T
c = np.array([13 / 5, 23 / 5, 0])

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

ax.plot([a[0], c[0]], [a[1], c[1]], [a[2], c[2]], color="blue", label="b")

ax.scatter(b[0], b[1], b[2], color="blue", label="b")
ax.scatter(a[0], a[1], a[2], color="red", label="a")
ax.scatter(c[0], c[1], c[2], color="green", label="Point")
```

## Pure Python code

```
ax.text(a[0], a[1], a[2], "A")
ax.text(b[0], b[1], b[2], "B")
ax.text(c[0], c[1], c[2], "Point")

ax.set_xlabel("X-axis")
ax.set_ylabel("Y-axis")
ax.set_zlabel("Z-axis")
ax.set_title("2.9.6")
ax.set_xlim([-5, 5])
ax.set_ylim([-5, 5])
ax.set_zlim([-5, 5])
ax.legend()
ax.grid(True)

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

# Plot

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