

MatGeo Assignment - Problem 1.5.12

EE25BTECH11024

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Problem Statement

In what ratio does the point $P(-4, y)$ divide the line segment joining $A(-6, 10)$ and $B(3, -8)$? Hence, find the value of y .

Solution: Using the Rank Criterion

We are given three points:

$$A = \begin{pmatrix} -6 \\ 10 \end{pmatrix}, \quad P = \begin{pmatrix} -4 \\ y \end{pmatrix}, \quad B = \begin{pmatrix} 3 \\ -8 \end{pmatrix} \quad (1)$$

The points A, P, B are collinear if

$$\text{rank} \begin{pmatrix} P - A & B - A \end{pmatrix} = 1 \quad (2)$$

Thus, the matrix is

$$M = \begin{pmatrix} 2 & 9 \\ y - 10 & -18 \end{pmatrix} \quad (3)$$

Perform the row operations: $R_1 \leftarrow R_1/2$ and $R_2 \leftarrow R_2 - R_1(y - 10)$ which results in

Solution:

$$\begin{pmatrix} 1 & 9/2 \\ 0 & -9/2(y-6) \end{pmatrix} \quad (4)$$

If y is not equal to 6, then we perform $R_2 \leftarrow R_2 / (-9/2(y-6))$ to get an identity matrix. But then the rank will be 2

For the rank to be 1, the second row must be all zeros:

$$y - 6 = 0 \quad \Rightarrow \quad y = 6$$

—

Using the vector formula,

$$k = \frac{(\mathbf{A} - \mathbf{P})^\top (\mathbf{P} - \mathbf{B})}{\|\mathbf{P} - \mathbf{B}\|^2} \quad (5)$$

Substitute $y = 6$: Compute the numerator:

$$(\mathbf{A} - \mathbf{P})^\top (\mathbf{P} - \mathbf{B}) = (-2)(-7) + (4)(14) = 14 + 56 = 70 \quad (6)$$

Solution:

Compute the denominator:

$$\|\mathbf{P} - \mathbf{B}\|^2 = (-7)^2 + (14)^2 = 49 + 196 = 245 \quad (7)$$

Thus,

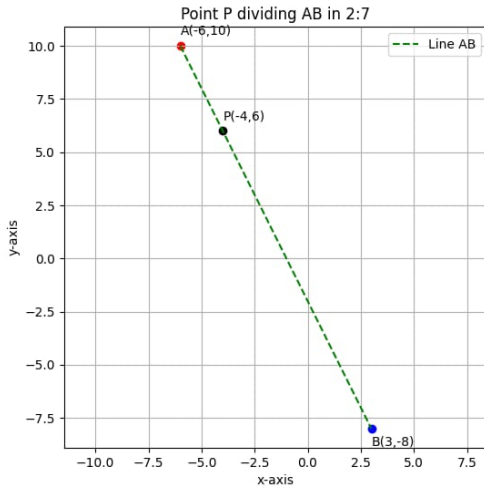
$$k = \frac{70}{245} = \frac{2}{7} \quad (8)$$

Therefore,

$$\boxed{y = 6, \quad k = \frac{2}{7}} \quad (9)$$

See the graphical representation in Figure 1.

Resulting Graph



Python Code: plot.py (Native)

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

# Given points
A = np.array([-6, 10])
B = np.array([3, -8])
P = np.array([-4, 6]) # Found from calculation

# Plotting
plt.figure(figsize=(6,6))
plt.plot([A[0], B[0]], [A[1], B[1]], 'g--', label="Line AB")
plt.scatter(*A, color="red")
plt.scatter(*B, color="blue")
plt.scatter(*P, color="black")

# Labels
plt.text(A[0], A[1]+0.5, "A(-6,10)", fontsize=10)
plt.text(B[0], B[1]-0.8, "B(3,-8)", fontsize=10)
plt.text(P[0], P[1]+0.5, "P(-4,6)", fontsize=10)
```

Python Code (Native Implementation – plot.py)

```
plt.xlabel("x-axis")
plt.ylabel("y-axis")
plt.title("Point P dividing AB in 2:7")
plt.legend()
plt.grid(True)
plt.axis("equal")
plt.savefig("fig.png")
plt.show()
```


C Code (Shared Library – find point.c)

```
#include <stdio.h>

void find_point(double *px, double *py) {
    // A(-6,10), B(3,-8)
    double x1 = -6, y1 = 10, x2 = 3, y2 = -8;
    int m = 2, n = 7; // ratio

    *px = (m*x2 + n*x1) / (m+n);
    *py = (m*y2 + n*y1) / (m+n);
}
```

Python Code: call.py (C + Python)

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

# Load shared object
so = ctypes.CDLL("./find_point.so")

# Prepare arguments
px = ctypes.c_double()
py = ctypes.c_double()

so.find_point(ctypes.byref(px), ctypes.byref(py))

A = np.array([-6, 10])
B = np.array([3, -8])
P = np.array([px.value, py.value])

# Plot
plt.figure(figsize=(6,6))
plt.plot([A[0], B[0]], [A[1], B[1]], 'g--', label="Line AB")
```

Python Code (C Integrated – call.py)

```
plt.scatter(*A, color="red")
plt.scatter(*B, color="blue")
plt.scatter(*P, color="black")

plt.text(A[0], A[1]+0.5, "A(-6,10)", fontsize=10)
plt.text(B[0], B[1]-0.8, "B(3,-8)", fontsize=10)
plt.text(P[0], P[1]+0.5, f"P({px.value:.1f},{py.value:.1f})", fontsize
        =10)

plt.xlabel("x-axis")
plt.ylabel("y-axis")
plt.title("Point P from C code")
plt.legend()
plt.grid(True)
plt.axis("equal")
plt.show()
```