1.5.32

Navya Priya - EE25BTECH11045

August 29,2025

Question

Find the ratio in which the line segment joining the points $(1, 3)$ and $(4, 5)$ is divided by X axis.

Equation

Let $\mathbf{A} = \begin{pmatrix} 1 \\ -3 \end{pmatrix}$, $\mathbf{B} = \begin{pmatrix} x \\ 0 \end{pmatrix}$ and $\mathbf{C} = \begin{pmatrix} 4 \\ 5 \end{pmatrix}$

As the points $\mathbf{A}, \mathbf{B}, \mathbf{C}$ are collinear The matrix

$$\begin{pmatrix} \mathbf{B} - \mathbf{A} & \mathbf{C} - \mathbf{A} \end{pmatrix}^{\top} \textit{ has rank } 1.$$

Equation Used:

$$\mathbf{B} = \frac{\mathbf{A} + k\mathbf{C}}{1 + k}$$

Theoretical Solution

$$\begin{pmatrix} \mathbf{B}-\mathbf{A} & \mathbf{C}-\mathbf{A} \end{pmatrix}^{\top} = \begin{pmatrix} 3 & x-1 \\ 8 & 3 \end{pmatrix}^{\top} \tag{1}$$

$$\begin{pmatrix} \mathbf{B}-\mathbf{A} & \mathbf{C}-\mathbf{A} \end{pmatrix}^{\top} = \begin{pmatrix} 3 & 8 \\ x-1 & 3 \end{pmatrix} \tag{2}$$

$$\begin{pmatrix} 3 & 8 \\ x-1 & 3 \end{pmatrix} R_2 \to 8R_2 - 3R_1 \begin{pmatrix} 3 & 8 \\ 8(x-1)-9 & 0 \end{pmatrix} \tag{3}$$

$$\begin{pmatrix} 3 & 8 \\ 8(x-1)-9 & 0 \end{pmatrix} R_1 \to \frac{R_1}{3} \begin{pmatrix} 1 & \frac{8}{3} \\ 8(x-1)-9 & 0 \end{pmatrix} \tag{4}$$

The matrix is in Row Reduced Echelon Form(RREF). To satisfy collinearity condition, the rank of matrix should be 1. Hence,

$$8(x-1)-9=0 \tag{5}$$

$$x=17/8 \tag{6}$$

Ratio

Assume the ratio **B** divides **A** and **C** be k:1

$$k = \frac{\left(\mathbf{A}-\mathbf{B}\right)^{\top}\left(\mathbf{B}-\mathbf{C}\right)}{\left\|\left(\mathbf{B}-\mathbf{C}\right)\right\|^{2}} \tag{7}$$

$$k = \frac{1095}{1825} \tag{8}$$

$$k = \frac{3}{5} \tag{9}$$

Hence the ratio is 3:5.

C code

```c
#include <stdio.h>
// Structure for a 2D point/vector

typedef struct {
    double x;
    double y;
} Point;

// Function to apply section formula

Point sectionFormula(Point A, Point B, double m, double n) {
   Point P;
     P.x = (m * B.x + n * A.x) / (m + n);
     P.y = (m * B.y + n * A.y) / (m + n);
    return P;
}
```

Call C.py

```
import ctypes

# Load the shared library
ratio_lib = ctypes.CDLL("./ratio.so") # use "ratio.dll" on
    Windows

# Declare function argument & return types
ratio_lib.find_ratio.argtypes = [ctypes.c_double, ctypes.c_double
    ,
                                 ctypes.c_double, ctypes.c_double]
ratio_lib.find_ratio.restype = ctypes.c_double

# Points (1, -3) and (4, 5)
x1, y1 = 1, -3
x2, y2 = 4, 5

# Call C function
ratio = ratio_lib.find_ratio(x1, y1, x2, y2)
```

plot.py

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

# Points
A = (1, -3)
B = (17/8, 0)
C = (4, 5)

# Plot points
plt.figure(figsize=(6,6))
plt.scatter(*A, color="red", label="A(1, -3)")
plt.scatter(*B, color="blue", label="B(17/8, 0)")
plt.scatter(*C, color="green", label="C(4, 5)")

# Connect points with lines
x_vals = [A[0], B[0], C[0], A[0]]
y_vals = [A[1], B[1], C[1], A[1]]
plt.plot(x_vals, y_vals, linestyle="--", color="black")
```

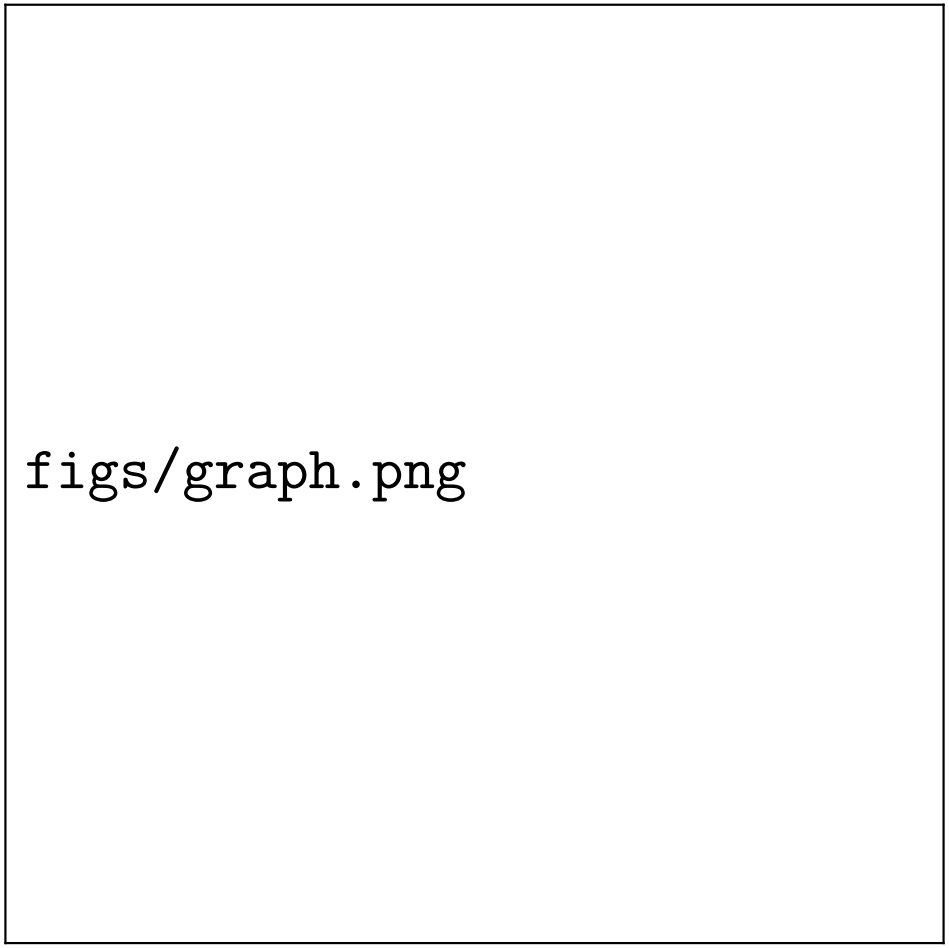
plot.py

```
# Add text labels at coordinates
plt.text(A[0]+0.1, A[1]-0.3, "A(1, -3)", fontsize=10, color="red"
    )
plt.text(B[0]+0.1, B[1]-0.3, "B(17/8, 0)", fontsize=10, color="
    blue")
plt.text(C[0]+0.1, C[1]+0.3, "C(4, 5)", fontsize=10, color="green
    ")

# Labels and grid
plt.xlabel("x-axis")
plt.ylabel("y-axis")
plt.axhline(0, color="black", linewidth=0.5)
plt.axvline(0, color="black", linewidth=0.5)
plt.grid(True, linestyle="--", alpha=0.6)
plt.legend()
plt.title("Triangle ABC with Coordinates")

plt.show()
```

Plot



Plot of Intersection of AB by X-axis