Matgeo Presentation

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Problem Statement

Consider two points **P** and **Q** with position vectors $\overrightarrow{OP} = 3\overrightarrow{a} - 2\overrightarrow{b}$ and $\overrightarrow{OQ} = \overrightarrow{a} + \overrightarrow{b}$. Find the position vector of a point **R** which divides the line joining **P** and **Q** in the ratio 2 : 1,

i) internally, and

ii) externally

Input Parameters

Symbol	Value	Description
$\overrightarrow{OP}$	$\overrightarrow{3a} - \overrightarrow{2b}$	Position vector of **P**
$\overrightarrow{OQ}$	$\overrightarrow{a} + \overrightarrow{b}$	Position vector of **Q**
m	2	Ratio of division

Linear Equation

For the internal division,

$$\overrightarrow{OR} = \frac{\overrightarrow{OP} + \mathbf{m} \times \overrightarrow{OQ}}{1 + \mathbf{m}} \tag{3.1}$$

For the external division,

$$\overrightarrow{OR} = \frac{\mathbf{m} \times \overrightarrow{OQ} - \overrightarrow{OP}}{\mathbf{m} - 1} \tag{3.2}$$

where

$$\mathbf{m} = 2 \tag{3.3}$$

Calculations

Internal Division:

$$\overrightarrow{OR} = \frac{1 \times \overrightarrow{OP} + 2 \times \overrightarrow{OQ}}{3} \tag{3.4}$$

$$\overrightarrow{OR} = \frac{1 \times (3\overrightarrow{a} - 2\overrightarrow{b}) + 2 \times (\overrightarrow{a} + \overrightarrow{b})}{3} \tag{3.5}$$

$$\overrightarrow{OR} = \frac{3\overrightarrow{a} - 2\overrightarrow{b} + 2\overrightarrow{a} + 2\overrightarrow{b}}{3} \tag{3.6}$$

$$\overrightarrow{OR} = \frac{5\overrightarrow{a}}{3} \tag{3.7}$$

External Division:

$$\overrightarrow{OR} = \frac{2 \times \overrightarrow{OQ} - 1 \times \overrightarrow{OP}}{2 - 1} \tag{3.8}$$

$$\overrightarrow{OR} = \frac{2 \times (\overrightarrow{a} + \overrightarrow{b}) - 1 \times (3\overrightarrow{a} - 2\overrightarrow{b})}{1} \tag{3.9}$$

$$\overrightarrow{OR} = \frac{2\overrightarrow{a} + 2\overrightarrow{b} - 3\overrightarrow{a} + 2\overrightarrow{b}}{1} \tag{3.10}$$

$$\overrightarrow{OR} = \overrightarrow{-a} + 4\overrightarrow{b} \tag{3.11}$$

The codes below verifies the same.

C Code

```c
#include <stdio.h>

int main() {
        FILE *fptr;
        fptr = fopen("division_points.txt", "w");

        if (fptr == NULL) {
                printf("Error opening file!\n");
                return 1;
        }

        // Position vectors for points P and Q
        float Px = 3.0, Py = -2.0; // Point P (3a - 2b)
        float Qx = 1.0, Qy = 1.0; // Point Q (a + b)
```

```
// Internal division ratio m:n (2:1)
int m_internal = 1, n_internal = 2;
float Rx_internal = (m_internal * Px + n_internal * Qx) / (
    m_internal + n_internal);
float Ry_internal = (m_internal * Py + n_internal * Qy) / (
    m_internal + n_internal);
// External division ratio m:n (2:1)
int m_external = 2, n_external = 1;
float Rx_external = (m_external * Qx - n_external * Px) / (
    m_external - n_external);
float Ry_external = (m_external * Qy - n_external * Py) / (
    m_external - n_external);
```

```
// Save the results to the file
fprintf(fptr, "%f%f\n", Rx_internal, Ry_internal); // Internal
    division
fprintf(fptr, "%f%f\n", Rx_external, Ry_external); // External
    division

fclose(fptr);
printf("Division points saved to division_points.txt\n");
return 0;
}
```

Python Code for Plotting

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

# Load the division points from the text file
points = np.loadtxt("division_points.txt")

# Extracting the internal and external division points
R_internal = points[0] # Internal division point
R_external = points[1] # External division point

# Define points P and Q
P = np.array([3, -2]) # Point P
Q = np.array([1, 1]) # Point Q

plt.figure(figsize=(10, 5))
```

```
# Plotting Internal Division
plt.subplot(1, 2, 1)
plt.plot([P[0], Q[0]], [P[1], Q[1]], 'bo-', label="Line PQ")
plt.plot(R_internal[0], R_internal[1], 'ro', label="Internal Division R")
plt.text(P[0], P[1], 'P', fontsize=12, ha='right')
plt.text(Q[0], Q[1], 'Q', fontsize=12, ha='right')
plt.text(R_internal[0], R_internal[1], 'R', fontsize=12, ha='right')
plt.title('Internal Division of Line Segment')
plt.grid(True)
plt.axhline(0, color='black', linewidth=0.5)
plt.axvline(0, color='black', linewidth=0.5)
plt.legend()
```

```
# Plotting External Division
plt.subplot(1, 2, 2)
plt.plot([P[0], Q[0]], [P[1], Q[1]], 'bo-', label="Line PQ")
plt.plot(R_external[0], R_external[1], 'ro', label="External Division R")
plt.text(P[0], P[1], 'P', fontsize=12, ha='right')
plt.text(Q[0], Q[1], 'Q', fontsize=12, ha='right')
plt.text(R_external[0], R_external[1], 'R', fontsize=12, ha='right')
plt.title('External Division of Line Segment')
plt.grid(True)
plt.axhline(0, color='black', linewidth=0.5)
plt.axvline(0, color='black', linewidth=0.5)
plt.legend()

plt.tight_layout()
plt.show()
```

Plot of the division

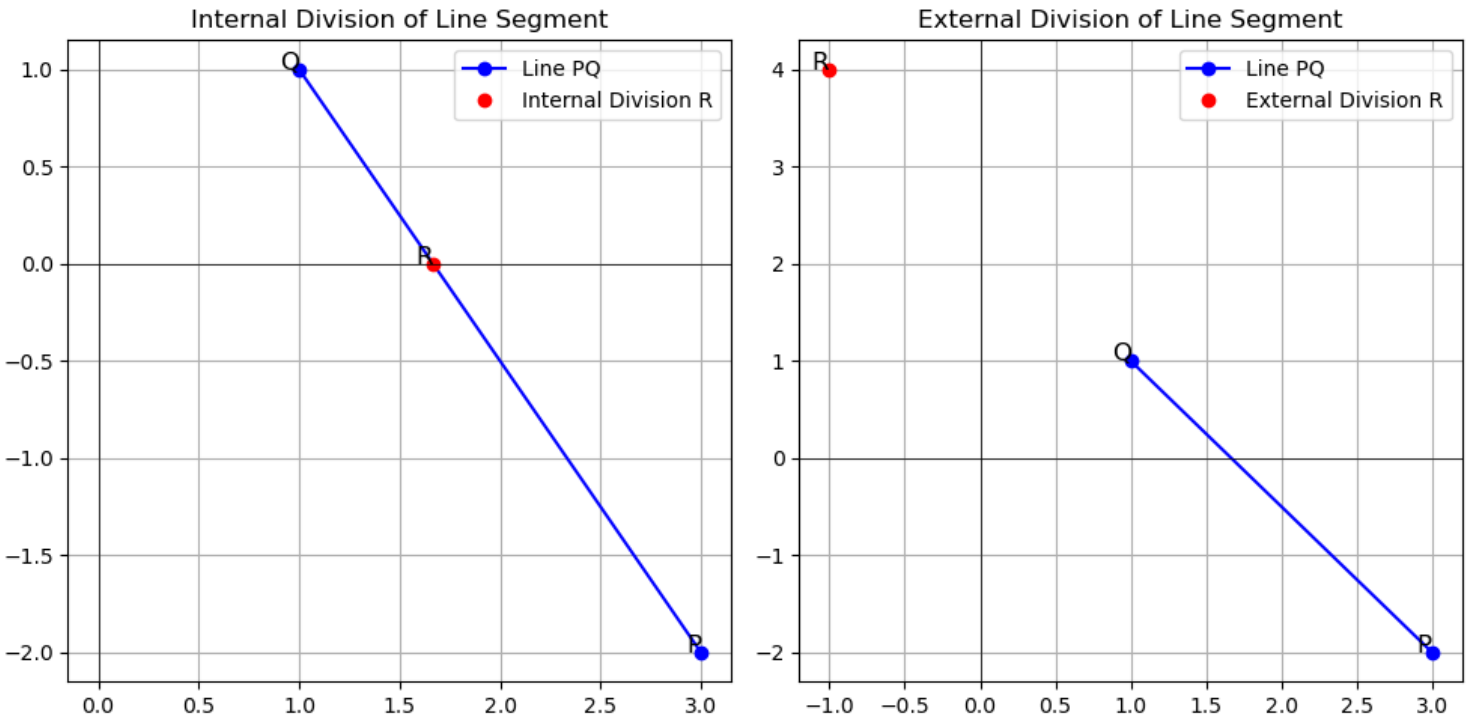

Figure: Internal and External division by point R