1.5.1

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Question

Find the ratio in which the Y axis divides the line segment joining the points (6, -4) and (-2, -7). Also find the point of intersection.

Given Information

Assume the two points to be position vectors $\mathbf{A} = \begin{pmatrix} 6 \\ -4 \end{pmatrix}$ and $\mathbf{B} = \begin{pmatrix} -2 \\ -7 \end{pmatrix}$

Formula

To find the ratio in which the Y axis divides the line segment. We can use the section formula

$$\mathbf{C} = \left(\frac{\frac{m}{n}A + B}{\frac{m}{n} + 1} \right) \tag{1}$$

Where $\mathbf{C}$ is the point on the Y axis that intersects given line segment

Solution

Here we can assume some constant $k = \frac{m}{n}$. This gives us

$$\mathbf{C} = \left(\frac{kA + B}{k + 1} \right) \tag{2}$$

Continuation

We can write $\mathbf{C}$ as

$$\mathbf{C} = \begin{pmatrix} 0 \\ y \end{pmatrix} \tag{3}$$

Where y is the y coordinate of the point of intersection of the Y axis and the line segment AB.

Continuation

We know that these three points are collinear, so by using rank method we get. Rank of matrix

$$\mathbf{P} = (\mathbf{B} - \mathbf{A}\ \mathbf{C} - \mathbf{A}) = 1 \tag{4}$$

$$\implies \text{Rank of } \begin{pmatrix} -8 & -6 \\ -3 & y+4 \end{pmatrix} = 1 \tag{5}$$

Continuation

On applying row transformations

$$R_2 \to R_2 - \frac{3}{8}R_1$$

$$\mathbf{C} = \begin{pmatrix} -8 & -6 \\ 0 & y + \frac{25}{4} \end{pmatrix} \tag{6}$$

(7)

Continuation

If rank $= 0$

$$\implies y + \frac{25}{4} = 0 \tag{8}$$

$$y = -\frac{25}{4} \tag{9}$$

Python Code

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

def line_gen_num(A,B,num):
  dim = A.shape[0]
  x_AB = np.zeros((dim,num))
  lam_1 = np.linspace(0,1,num)
  for i in range(num):
    temp1 = A + lam_1[i]*(B-A)
    x_AB[:,i]= temp1.T
  return x_AB
```

Python Code

```
# Define 2D points A and B
A = np.array([6, -4])
B = np.array([-2, -7])

k = 1/3 #ratio

C = ((k*A+B)/(k+1))

# Generate line points
x_AB = line_gen_num(A, B, 20)

# Plotting
```

Python Code

```
plt.grid()
plt.title('1.5.1')
plt.plot(x_AB[0, :], x_AB[1, :], 'r--', label='Line from A to B')
     # 'bo-' = blue dots with lines
plt.plot(A[0], A[1], 'go', label='Point A') # green dot
plt.annotate('(6,-4)', xy=(A[0],A[1]), fontsize=12)
plt.plot(B[0], B[1], 'go', label='Point B') # red dot
plt.annotate('(-2,-7)', xy=(B[0],B[1]), fontsize=12)
plt.plot(C[0], C[1], 'bo', label='Intersection Point') #
    intersection point
plt.legend()
```

Python Code

```
plt.xlabel('X-axis')
plt.ylabel('Y-axis')
plt.axis('equal')
plt.savefig('/figs/fig1.png')

plt.show()
```

Plot

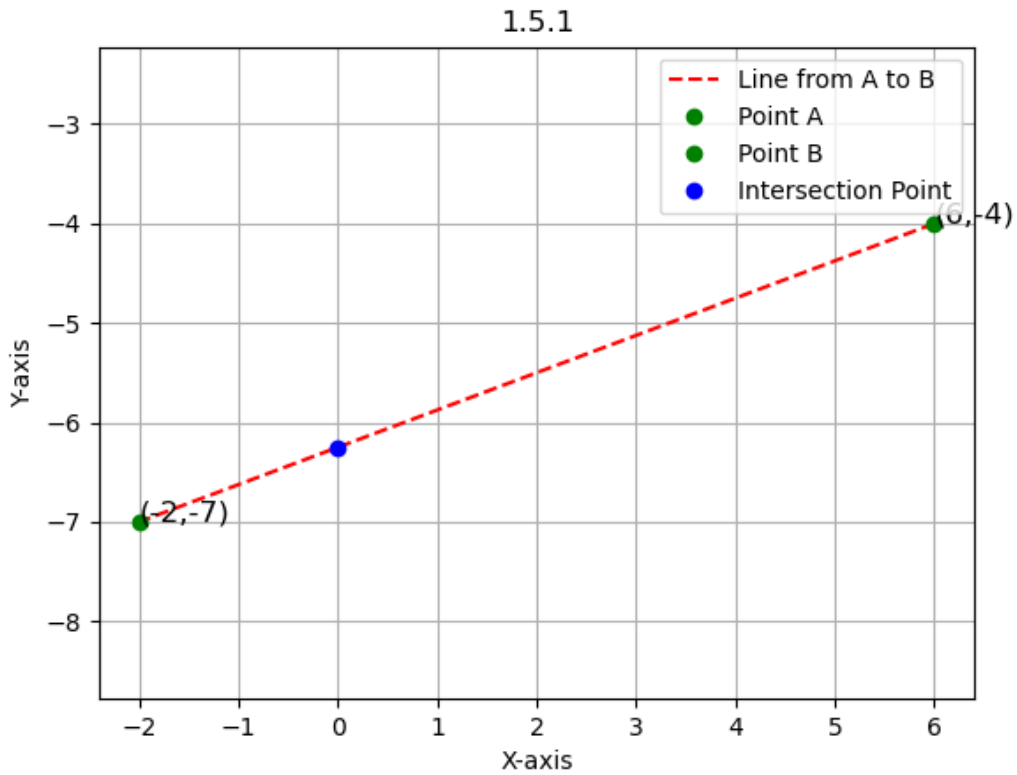

Figure: Intersection of line segment with Y axis