1.10.19

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Question : If a line has direction ratios $2, -1, -2$, determine its direction cosines.
Solution :

Symbol	Value	Description
a	$\begin{pmatrix} 2 \\ -1 \\ -2 \end{pmatrix}$	vector

Table : Vector

The direction vector of the line is

$$\mathbf{a} = \begin{pmatrix} 2 \\ -1 \\ -2 \end{pmatrix}$$

The length of **A** is

$$\begin{aligned} a^\top a &= \begin{pmatrix} 2 & -1 & -2 \end{pmatrix} \begin{pmatrix} 2 \\ -1 \\ -2 \end{pmatrix} \\ &= 2^2 + (-1)^2 + (-2)^2 \\ &= 4 + 1 + 4 = 9 \end{aligned}$$

Therefore, the norm of a is

$$\|a\| \overset{\Delta}{=} \sqrt{a^\top a} = \sqrt{9} = 3$$

The unit vector in the direction of **a** is

$$\frac{\mathbf{a}}{\|\mathbf{a}\|} = \frac{1}{3} \begin{pmatrix} 2 \\ -1 \\ -2 \end{pmatrix}$$

Let α, β, γ be the angles made by the line with the x, y, z axes respectively.Then, the direction cosines are the elements of the above direction vector

$$\cos\alpha = \frac{2}{3}, \quad \cos\beta = -\frac{1}{3}, \quad \cos\gamma = -\frac{2}{3}$$

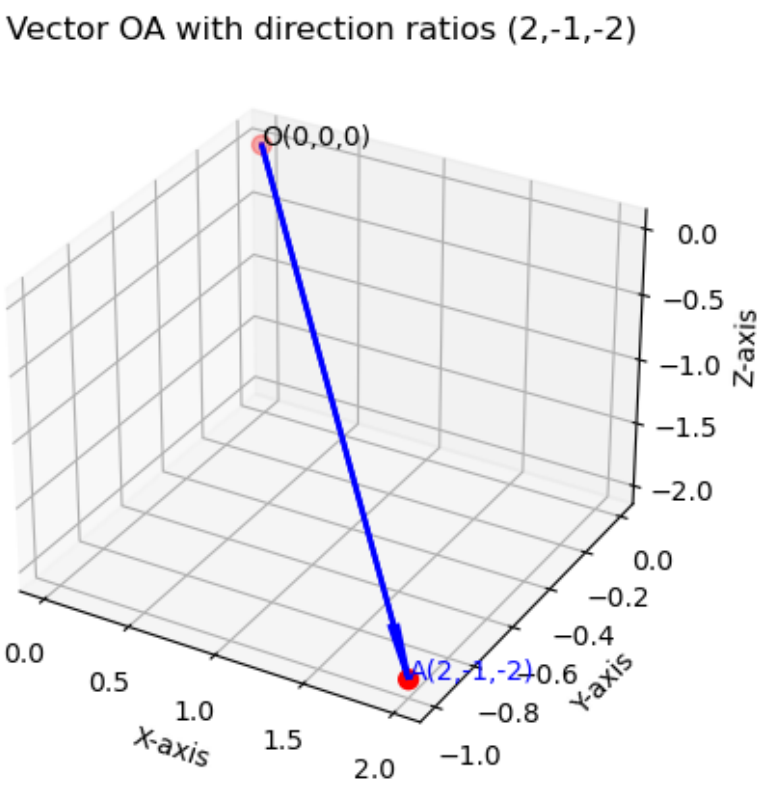
Vector OA with direction ratios (2,-1,-2)
O(0,0,0)
A(2,-1,-2)
X-axis
Y-axis
Z-axis
0.0
0.5
1.0
1.5
2.0
−1.0
−0.8
−0.6
−0.4
−0.2
0.0
−0.5
−1.0
−1.5
−2.0

Fig : Vector a