

If a line has the direction ratios  $-18, 12, -4$ , then what are its direction cosines?

# Theoretical solution

Let

$$\mathbf{A} = \begin{pmatrix} -18 \\ 12 \\ -4 \end{pmatrix}.$$

The direction cosines of the line are the components of the unit vector in the direction of  $\mathbf{A}$ . To find this, we first calculate the norm of  $\mathbf{A}$ :

$$\|\mathbf{A}\| = \sqrt{(-18)^2 + 12^2 + (-4)^2} = \sqrt{324 + 144 + 16} = \sqrt{484} = 22.$$

Next, dividing each component of  $\mathbf{A}$  by  $\|\mathbf{A}\|$  gives the unit direction vector:

$$\frac{\mathbf{A}}{\|\mathbf{A}\|} = \frac{1}{22} \begin{pmatrix} -18 \\ 12 \\ -4 \end{pmatrix} = \begin{pmatrix} -\frac{9}{11} \\ \frac{6}{11} \\ -\frac{2}{11} \end{pmatrix}.$$

$$\frac{\mathbf{A}}{\|\mathbf{A}\|} = \frac{1}{\sqrt{a^2 + b^2 + c^2}} \begin{pmatrix} a \\ b \\ c \end{pmatrix}$$

# C code

```
#include <stdio.h>
#include <math.h>
int main() {
    double a = -18, b = 12, c = -4;
    double magnitude;
    double l, m, n;
    // Calculate magnitude of the vector
    magnitude = sqrt(a * a + b * b + c * c);
    // Calculate direction cosines
    l = a / magnitude;
    m = b / magnitude;
    n = c / magnitude;
    // Print direction cosines
    printf("Direction cosines are:\n");
    printf("l = %.6f\n", l);
    printf("m = %.6f\n", m);
    printf("n = %.6f\n", n);
    return 0;
}
```

# Python Plotting Code - Part 1

```
import numpy as np
import matplotlib.pyplot as plt
from mpl_toolkits.mplot3d import Axes3D
a, b, c = -18, 12, -4
magnitude = np.sqrt(a**2 + b**2 + c**2)
alpha, beta, gamma = a/magnitude, b/magnitude, c/magnitude
fig = plt.figure()
ax = fig.add_subplot(111, projection='3d')
ax.quiver(0, 0, 0, 1, 0, 0, color='blue', label='x-axis')
ax.quiver(0, 0, 0, 0, 1, 0, color='red', label='y-axis')
ax.quiver(0, 0, 0, 0, 0, 1, color='green', label='z-axis')
```

## Python Plotting Code - Part 2

```
ax.quiver(0, 0, 0, alpha, beta, gamma, color=skyblue, label='
    Direction Vector')
ax.text(alpha, beta, gamma, f'({alpha:.3f}, {beta:.3f}, {gamma:.3
    f})', fontsize=10)
ax.text2D(0.05, 0.95, f'Direction Cosines:\n = {alpha:.3f}\n= {
    beta:.3f}\n = {gamma:.3f}', transform=ax.transAxes)
ax.set_xlim([-1, 1])
ax.set_ylim([-1, 1])
ax.set_zlim([-1, 1])
ax.set_xlabel('X')
ax.set_ylabel('Y')
ax.set_zlabel('Z')
ax.set_title('Direction Cosines of a Line')
plt.legend()
plt.tightlayout()
plt.show()
```

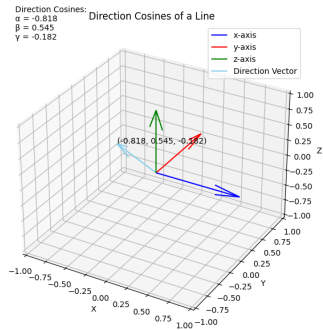


Figure: plot