

4.2.7

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Question

Find the direction and normal vectors of the line $y - 2 = 0$.

Formulae

A line can be expressed in two forms:

$$\begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} 0 \\ c \end{pmatrix} + x \begin{pmatrix} 1 \\ m \end{pmatrix} \quad (1)$$

where $\begin{pmatrix} 1 \\ m \end{pmatrix}$ is the direction vector of the line and m is the **slope** of the line.

$$\mathbf{n}^T \mathbf{x} = c \quad (2)$$

where \mathbf{n} is the normal vector of the line.

$$\mathbf{n}^T \begin{pmatrix} 1 \\ m \end{pmatrix} = 0 \quad (3)$$

Solution

The slope of the line $y - 2 = 0$ is 0, therefore it can be expressed in the first form as:

$$\begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} 0 \\ 2 \end{pmatrix} + x \begin{pmatrix} 1 \\ 0 \end{pmatrix} \quad (4)$$

Let $\begin{pmatrix} x \\ y \end{pmatrix}$ be normal vector. Therefore

$$\begin{pmatrix} x \\ y \end{pmatrix}^T \begin{pmatrix} 1 \\ 0 \end{pmatrix} = 0 \quad (5)$$

$$x = 0 \quad (6)$$

$$\begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} 0 \\ 1 \end{pmatrix} \quad (7)$$

Solution

Therefore the line can be expressed as

$$\begin{pmatrix} 0 \\ 1 \end{pmatrix}^T x = 2 \quad (8)$$

Therefore, the direction vector is $\begin{pmatrix} 0 \\ 1 \end{pmatrix}$, and the normal vector is $\begin{pmatrix} 1 \\ 0 \end{pmatrix}$.

Python Code

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

fig = plt.figure(figsize = (6,6))
ax = plt.subplot(111)

ax.axhline(y=2, color='r', linestyle='--')

ax.set_ylim(0, 4)
ax.set_xlim(0, 10)

ax.set_xlabel(x-axis)
ax.set_ylabel(y-axis)
ax.set_title(Plot of the Equation  $y = 2$ )

ax.grid(True)

plt.show()
```

Plot

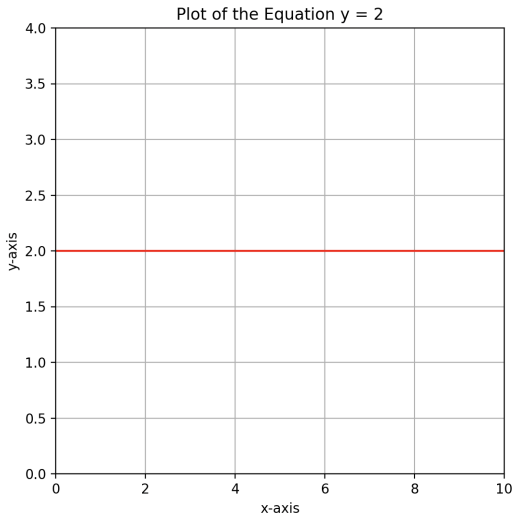


Figure: Plot