4.2.5

EE25BTECH11002 - Achat Parth Kalpesh

October 6,2025

Question

Find the direction and normal vector for the line;

$$2x = -5y \tag{1}$$

Theoretical Solution

Let $\mathbf{n}$ and $\mathbf{m}$ are the Normal and Direction vectors of the line

$$\mathbf{n_1}^\top \mathbf{x} = c \tag{2}$$

where ,

$$\mathbf{n_1} = \begin{pmatrix} 2 \\ 5 \end{pmatrix} \tag{3}$$

$$c = 0 \tag{4}$$

Theoretical Solution

The $\mathbf{n}$ can be represented as,

$$\mathbf{n} = \begin{pmatrix} -m \\ 1 \end{pmatrix} \tag{5}$$

Where m is the slope of the line,

$$m = \frac{-2}{5} \tag{6}$$

$$\mathbf{n} = \begin{pmatrix} \frac{2}{5} \\ 1 \end{pmatrix} \tag{7}$$

Theoretical Solution

(1) can be represented as,

$$\implies \begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} x \\ \frac{-2}{5}x \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \end{pmatrix} + x \begin{pmatrix} 1 \\ \frac{-2}{5} \end{pmatrix} \tag{8}$$

$$\implies \begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \end{pmatrix} + x \begin{pmatrix} 1 \\ \frac{-2}{5} \end{pmatrix} \tag{9}$$

Comparing it with ,

$$\mathbf{x} = \mathbf{h} + \kappa \mathbf{m} \tag{10}$$

We get,

$$\mathbf{m} = \begin{pmatrix} 1 \\ \frac{-2}{5} \end{pmatrix} \tag{11}$$

C code

```
#include <stdio.h>
void formula(double *a,double *b)
{
   double x, y;
   a[0] = a[0]/a[1];
   a[1] = 1;
   b[0] = 1;
   b[1] = -a[0];
}
```

Python Code

```
import numpy as np
import matplotlib.pyplot as plt
import ctypes
lib_path = ctypes.CDLL('./formula.so')
lib_path.formula.argtypes = [
    ctypes.POINTER(ctypes.c_float)
]
lib_path.formula.restype = ctypes.c_float
# The equation of the line is 2x = -5y, which can be rewritten as
     2x + 5y = 0.

# --- 1. Define the Normal and Direction Vectors ---
# For a line Ax + By + C = 0, the normal vector is (A, B).
normal_vector = np.array([2, 5])

# The direction vector is perpendicular to the normal vector.
# If n = (A, B), the direction vector d can be (-B, A).
direction_vector = np.array([-5, 2])
```

Python Code

```
# --- 2. Generate points to plot the line ---
# From the equation 2x + 5y = 0, we can express y as y = (-2/5)x.
# We will generate a set of x-values to find the corresponding y-
    values.
x_vals = np.linspace(-10, 10, 100)
y_vals = (-2/5) * x_vals

# --- 3. Create the plot ---
plt.figure(figsize=(9, 9))
ax = plt.gca()

# Plot the line itself
plt.plot(x_vals, y_vals, label='Line: 2x + 5y = 0', color='blue',
     zorder=1)

# Plot the normal and direction vectors starting from the origin
    (0,0)
# We use plt.quiver to draw arrows.
```

Python Code: Plotting

```
origin = [0], [0]
plt.quiver(*origin, normal_vector[0], normal_vector[1],
           angles='xy', scale_units='xy', scale=1,
           color='red', label=f'Normal Vector: [0.4 , 1]')
plt.quiver(*origin, direction_vector[0], direction_vector[1],
           angles='xy', scale_units='xy', scale=1,
           color='green', label=f'Direction Vector: [1 , -0.4]')


# --- 4. Format the plot for clarity ---
# Set the limits for the x and y axes
plt.xlim(-10, 10)
plt.ylim(-10, 10)

# Ensure the aspect ratio is equal, so perpendicular lines look
    correct
plt.axis('equal')
```

Python Code: Finalizing Plot

```
# Move the x and y axes to the center to mimic a Cartesian plane
ax.spines['left'].set_position('zero')
ax.spines['bottom'].set_position('zero')
ax.spines['right'].set_color('none')
ax.spines['top'].set_color('none')

# Add labels, a title, a legend, and a grid
plt.xlabel('x-axis', fontsize=12)
plt.ylabel('y-axis', fontsize=12, rotation=0)
ax.xaxis.set_label_coords(1.05, 0.51)
ax.yaxis.set_label_coords(0.51, -0.05)
plt.title('Direction and Normal Vector for the Line 2x = -5y',
    fontsize=14)
plt.legend(loc='best')
plt.grid(True)
plt.savefig('./fig.jpg')
# Display the plot
plt.show()
```

Plot

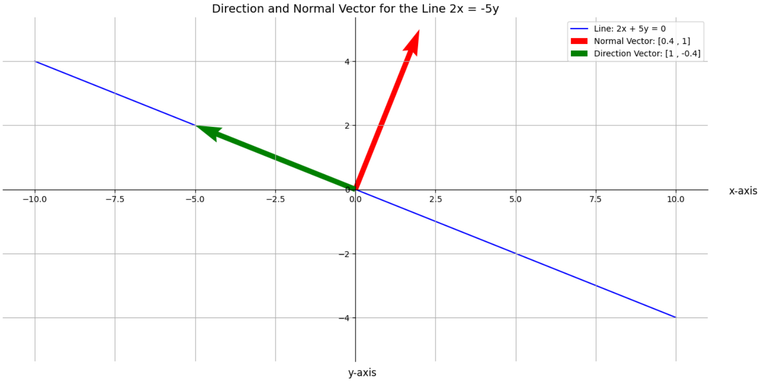

Figure: Direction and Normal Vector for the Line 2x = -5y