

# Assignment 2 : Question 15 (b)

Abhay Shankar K : cs21btech11001

## Question:

Find the length of the perpendicular from the origin to the plane

$$\mathbf{r} \cdot (3\mathbf{i} - 4\mathbf{j} - 12\mathbf{k}) + 39 = 0 \quad (1)$$

## Solution:

Clearly, the length of the perpendicular from a plane passing through some point is the distance of that point from the plane. The normal form of a plane is an equation of the form:

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

Where :

$$\mathbf{n} = \begin{pmatrix} p \\ q \\ r \end{pmatrix}, \mathbf{x} = \begin{pmatrix} x \\ y \\ z \end{pmatrix} \quad (3)$$

We can represent the given plane (*equation (1)*) using normal form (*equation (2)*) thus :

$$(3 \quad -4 \quad -12) \mathbf{x} = -39 \quad (4)$$

The formula for the distance of a point from a plane is :

$$Distance = \frac{|\mathbf{n}^\top \mathbf{x} - c|}{\|\mathbf{n}\|} \quad (5)$$

The input parameters are :

$$\mathbf{n} = \begin{pmatrix} 3 \\ -4 \\ -12 \end{pmatrix}, \mathbf{x} = \begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix}, c = -39 \quad (6)$$

Substituting (6) in (5),

$$Distance = \frac{\left| (3 \quad -4 \quad -12) \begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix} + 39 \right|}{\|(3 \quad -4 \quad -12)\|} \quad (7)$$

$$= \frac{39}{13} \quad (8)$$

$$= 3 \quad (9)$$

$\therefore$  The length of the perpendicular from the origin to the plane (*equation (1)*) is 3 units.

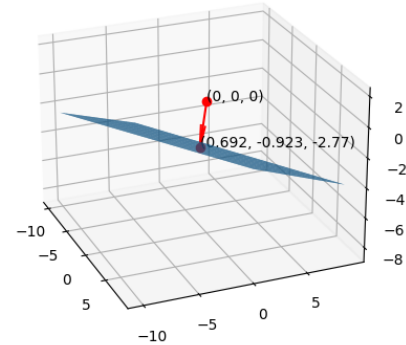


Fig. 1. Graph of the given plane