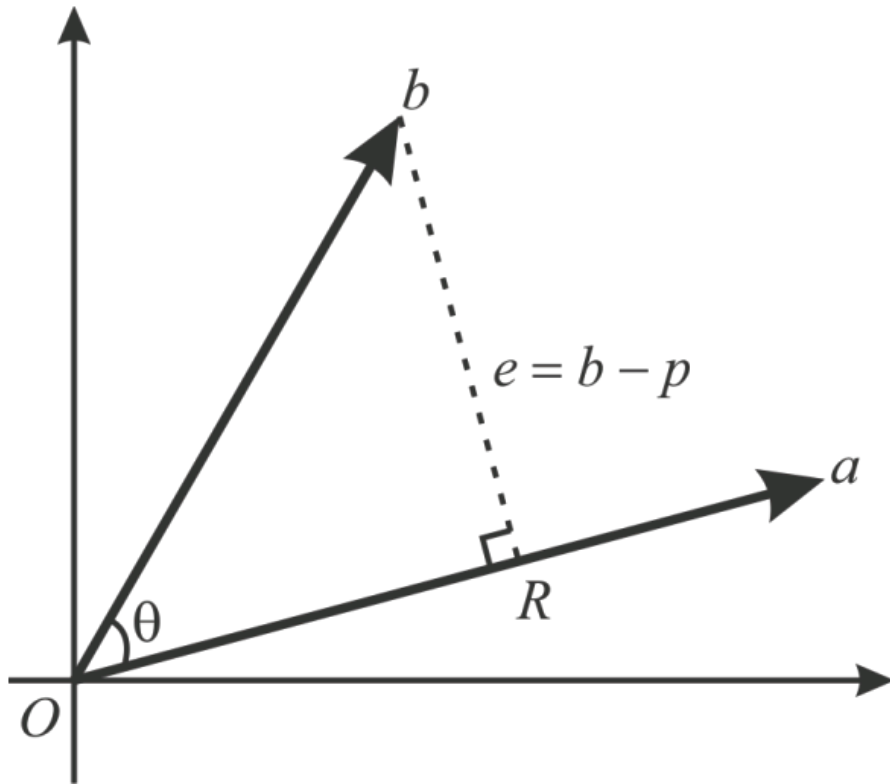


Step-1

Consider this diagram;



The objective is to find norm of p .

Step-2

It is observed that $OR = p$ is the projection of b on a .

This implies;

$$\begin{aligned} p &= \hat{x} a \\ &= \frac{a^T b}{a^T a} a \\ &= \frac{a^T b}{\|a\|^2} a \end{aligned} \quad \text{and } \hat{x} \in \mathbb{R} \quad (1)$$

$$\cos \theta = \frac{a^T b}{\|a\| \|b\|} \quad (2)$$

By definition of norm, $\|p\|^2 = p^T p$

$$\|p\|^2 = \left(\frac{a^T b}{\|a\|^2} a \right)^T \frac{a^T b}{\|a\|^2} a$$

Use (1), and get

$$= \frac{(\|a\| \|b\| \cos \theta) a^T}{\|a\|^2} \frac{(\|a\| \|b\| \cos \theta) a}{\|a\|^2}$$

Use (2), it can be written this as while norm is a scalar

$$\begin{aligned} &= \frac{(\|a\| \|b\| \cos \theta)^2 a^T a}{\|a\|^2 \|a\|^2} \\ &= \frac{(\|a\| \|b\| \cos \theta)^2 \|a\|^2}{\|a\|^2 \|a\|^2} \\ &= \|b\|^2 \cos^2 \theta \end{aligned}$$

Since norm is a non negative quantity, by applying square root on both sides, get $\|p\| = \|b\| \cos \theta$

Hence, norm of p is $\boxed{\|p\| = \|b\| \cos \theta}$