DAILY MATH - DAY 5

PHANIE'S MOM (DG)
Uploaded via @myeloidcell on GitHub

15 NOVEMBER 2025

Geometry of Hyperplanes and Lines in $\mathbb{R}^n$

① $3x-4y+2z=5$ ⟨ $P(2,-1,0)$, $Q(5,2,3)$

$$v = \overline{PQ} = \begin{bmatrix}5\\2\\3\end{bmatrix} - \begin{bmatrix}2\\-1\\0\end{bmatrix} = \begin{bmatrix}3\\3\\3\end{bmatrix}$$

$$u = \begin{bmatrix}3\\-4\\2\end{bmatrix} \rightarrow \text{normal vector of the plane.}$$

verify : $u \cdot v = 0$

$3\times3 + (-4)\times3 + (2)\times3 = 9-12+6 \neq 0$

u is not a normal vector of v

② $P(2,1,-3,4)$

$u = [7,-1,5,-2]$

$7x_1 - x_2 + 5x_3 - 2x_4 = k.$

$7(2) - 1 + 5(-3) - 2(4) = k$

$14 - 1 - 15 - 8 = k$

$-10 = k$ //

③ Parametric eq.

$P(-1,3,0,2)$ $u = [-4,6,1,9]$

$$L(t) = \begin{bmatrix}-1\\3\\0\\2\end{bmatrix} + \begin{bmatrix}-4\\6\\1\\9\end{bmatrix} t$$

$L(t) = [(-1-4t), (3+6t), t, 2+9t]$

$Q, t=2 \rightarrow Q = (-9, 15, 2, 20)$

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(a) Let H be the plane in R^3 corresponding to the linear equation:

$$3x - 4y + 2z = 5 \qquad \begin{cases} P(2, -1, 0) \\ Q(5, 2, 3) \end{cases}$$

$$v = \overrightarrow{PQ} = \begin{bmatrix} 5 \\ 2 \\ 3 \end{bmatrix} - \begin{bmatrix} 2 \\ -1 \\ 0 \end{bmatrix} = \begin{bmatrix} 3 \\ 3 \\ 3 \end{bmatrix}$$

$$u = \begin{bmatrix} 3 \\ -4 \\ 2 \end{bmatrix} \rightarrow \text{normal vector of the plane}$$

Verify: $u \cdot v = 0$

$$3 \times 3 + (-4) \times 3 + (2) \times 3 = 9 - 12 + 6 \neq 0$$

u is not a normal vector of v

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(b) Equation of a Hyperplane in R^4

$$P(2, 1, -3, 4)$$

$$u = [7, -1, 5, -2]$$

$$7x_1 - x_2 + 5x_3 - 2x_4 = k$$

$$7(2) - 1 + 5(-3) - 2(4) = k$$

$$14 - 1 - 15 - 8 = k$$

$$-10 = k$$

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(c) Parametric Representation of a Line in R^4

$$P(-1, 3, 0, 2) \quad u = [-4, 6, 1, 9]$$

$$L(t) = \begin{bmatrix} -1 \\ 3 \\ 0 \\ 2 \end{bmatrix} + \begin{bmatrix} -4 \\ 6 \\ 1 \\ 9 \end{bmatrix} t$$

$$L(t) = [(-1 - 4t), (3 + 6t), t, (2 + 9t)]$$

$$Q, t = 2 \rightarrow Q = (-9, 15, 2, 20)$$