Assignment 1
Linear Algebra

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I. Problem

Find the area of a rectangle $ABCD$ with vertices $A = \begin{pmatrix} -1 \\ \frac{1}{2} \\ 4 \end{pmatrix}$, $B = \begin{pmatrix} 1 \\ \frac{1}{2} \\ 4 \end{pmatrix}$, $C = \begin{pmatrix} 1 \\ -\frac{1}{2} \\ 4 \end{pmatrix}$, $D = \begin{pmatrix} -1 \\ -\frac{1}{2} \\ 4 \end{pmatrix}$.

II. Solution

Method 1: The adjacent sides of the rectangle are BA and AD (i.e. length and breadth). Area of a rectangle = length * breadth = AD*BA.

$$AD = \|\mathbf{A} - \mathbf{D}\| = \begin{pmatrix} -1 \\ \frac{1}{2} \\ 4 \end{pmatrix} - \begin{pmatrix} -1 \\ -\frac{1}{2} \\ 4 \end{pmatrix} = 1 \quad (1)$$

Similarly,

$$BA = \|\mathbf{B} - \mathbf{A}\| = 2 \quad (2)$$

.
Thus, area = 1*2 = 2 sq.units

Method 2: Area of rectangle = cross product of vectors of adjacent sides

$$\mathbf{A} - \mathbf{D} = \begin{pmatrix} 0 \\ -1 \\ 0 \end{pmatrix} \quad (3)$$

$$\mathbf{B} - \mathbf{A} = \begin{pmatrix} 2 \\ 0 \\ 0 \end{pmatrix} \quad (4)$$

Area = cross product of vectors

$$\|(\mathbf{A} - \mathbf{D}) \times (\mathbf{B} - \mathbf{A})\| \quad (5)$$

$$= \left\| \begin{pmatrix} 0 \\ -1 \\ 0 \end{pmatrix} \times \begin{pmatrix} 2 \\ 0 \\ 0 \end{pmatrix} \right\| \quad (6)$$

$$= \begin{pmatrix} 0 & -0 & 1 \\ 0 & 0 & 0 \\ -1 & 0 & 0 \end{pmatrix} \times \begin{pmatrix} 2 \\ 0 \\ 0 \end{pmatrix} \quad (7)$$

$$= 2 \quad (8)$$

Area = 2

Python code link

https://github.com/Swati-Mohanty/EE5600/blob/master/Assignment1/Code/quad_area.py