Assignment 2

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***Abstract*—This document explains the properties of a directional vector and how to find out if the given points are the vertices of a parallelogram, using directional vectors**

Download all python codes from

```
https://github.com/subhasishsaikia22/EE5609−
    Matrix−theory
```

and latex-tikz codes from

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https://github.com/subhasishsaikia22/EE5609−
    Matrix−theory
```

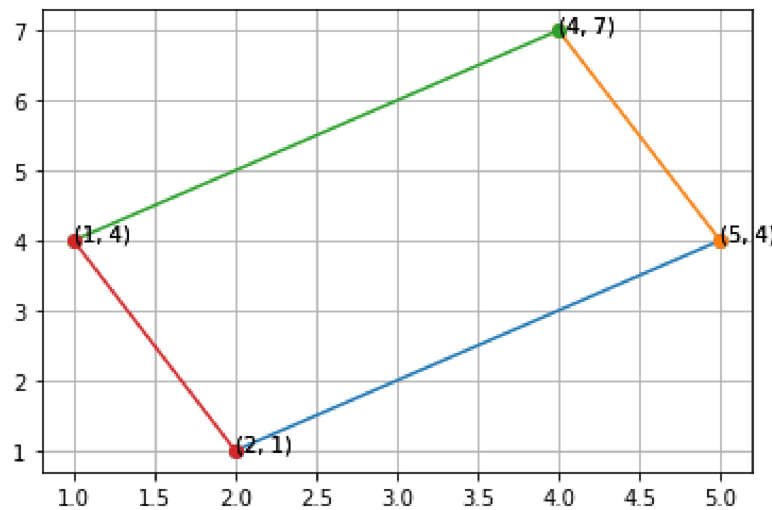

Fig. 1: This is the 2D diagram of the parallelogram with the given vertices

1 Problem

Using directional vectors, show that the points

$$\begin{pmatrix}2\\1\end{pmatrix}, \quad \begin{pmatrix}4\\7\end{pmatrix} \quad \begin{pmatrix}5\\4\end{pmatrix} \quad and \quad \begin{pmatrix}1\\4\end{pmatrix} \tag{1.0.1}$$

are vertices of a parallelogram.

2 Explanation

Two lines are parallel if their respective directional vectors are in the same ratio.
Let the points be denoted by:

$$\mathbf{A} = \begin{pmatrix}2\\1\end{pmatrix} \tag{2.0.1}$$

$$\mathbf{B} = \begin{pmatrix}5\\4\end{pmatrix} \tag{2.0.2}$$

$$\mathbf{C} = \begin{pmatrix}4\\7\end{pmatrix} \tag{2.0.3}$$

$$\mathbf{D} = \begin{pmatrix}1\\4\end{pmatrix} \tag{2.0.4}$$

The directional vector of **AB** is

$$\begin{pmatrix}2-5\\1-4\end{pmatrix} = \begin{pmatrix}-3\\-3\end{pmatrix} \tag{2.0.5}$$

The directional vector of **BC** is

$$\begin{pmatrix}5-4\\4-7\end{pmatrix} = \begin{pmatrix}1\\-3\end{pmatrix} \tag{2.0.6}$$

The directional vector of **CD** is

$$\begin{pmatrix}4-1\\7-4\end{pmatrix} = \begin{pmatrix}3\\3\end{pmatrix} \tag{2.0.7}$$

The directional vector of **AD** is

$$\begin{pmatrix}2-1\\1-4\end{pmatrix} = \begin{pmatrix}1\\-3\end{pmatrix} \tag{2.0.8}$$

The directional vector of **AC** is

$$\begin{pmatrix}2-4\\1-7\end{pmatrix} = \begin{pmatrix}-2\\-6\end{pmatrix} \tag{2.0.9}$$

Since the directional vectors of **AB** and **CD** are in the same ratio, so **AB** and **CD** are parallel and also opposite to each other.
Similarly, the directional vectors of **BC** and **AD** are in the same ratio,hence **BC** and **AD** are parallel and opposite.
Since the two pairs of opposite sides are parallel, the given points are the vertices of the parallelogram.

Moreover the sum of the directional vectors of **AB** and **BC**

$$\begin{pmatrix}-3\\-3\end{pmatrix}+\begin{pmatrix}1\\-3\end{pmatrix}= \begin{pmatrix}-3+1\\-3-3\end{pmatrix}=\begin{pmatrix}-2\\-6\end{pmatrix}$$

Thus **AB** + **BC**= **AC**, which satisfy parallelogram law of vector addition i.e vector sum of two adjacent side of a parallelogram is the diagonal vector of the parallelogram.