Assignment 1

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Area of Triangle

Abstract—**This document contains the solution to find the area of a triangle, from the given coordinates of the vertices.**

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1 Problem

1.1 Vector2, Example-2,6

Find the area of the triangle the coordinates of whose angular points are respectively: $A(-1, 2)$, $B(2, 3)$ and $C(4, -3)$.

2 Solution

We will be using vectors for calculating the area of the triangle formed by above three points.

$$(\mathbf{B} - \mathbf{A}) = \begin{pmatrix} 2 \\ 3 \end{pmatrix} - \begin{pmatrix} -1 \\ 2 \end{pmatrix} \tag{2.0.1}$$

$$(\mathbf{B} - \mathbf{A}) = \begin{pmatrix} 3 \\ 1 \end{pmatrix} \tag{2.0.2}$$

$$(\mathbf{C} - \mathbf{A}) = \begin{pmatrix} 4 \\ -3 \end{pmatrix} - \begin{pmatrix} -1 \\ 2 \end{pmatrix} \tag{2.0.3}$$

$$(\mathbf{C} - \mathbf{A}) = \begin{pmatrix} 5 \\ -5 \end{pmatrix} \tag{2.0.4}$$

$$\because \text{Area of the Triangle} = \frac{1}{2} \|(\mathbf{B} - \mathbf{A}) \times ((\mathbf{C} - \mathbf{A})\| \tag{2.0.5}$$

As the vector cross product of two vectors can also be expressed as the product of a skew-symmetric matrix and a vector.

$$\mathbf{P} \times \mathbf{Q} = \begin{pmatrix} 0 & -a_3 & a_2 \\ a_3 & 0 & -a_1 \\ -a_2 & a_1 & 0 \end{pmatrix} \times \begin{pmatrix} b_1 \\ b_2 \\ b_3 \end{pmatrix} \tag{2.0.6}$$

Substituting values from equation 2.0.2 and 2.0.4 in above equation 2.0.6, we'll get:

$$(\mathbf{B} - \mathbf{A}) \times (\mathbf{C} - \mathbf{A}) = \begin{pmatrix} 0 & 0 & 1 \\ 0 & 0 & -3 \\ -1 & 3 & 0 \end{pmatrix} \times \begin{pmatrix} 5 \\ -5 \\ 0 \end{pmatrix} \tag{2.0.7}$$

$$(\mathbf{B} - \mathbf{A}) \times (\mathbf{C} - \mathbf{A}) = \begin{pmatrix} 0 \\ 0 \\ -20 \end{pmatrix} \tag{2.0.8}$$

$$\therefore \|(\mathbf{B} - \mathbf{A}) \times (\mathbf{C} - \mathbf{A})\| = \sqrt{0^2 + 0^2 + (-20)^2} = 20 \tag{2.0.9}$$

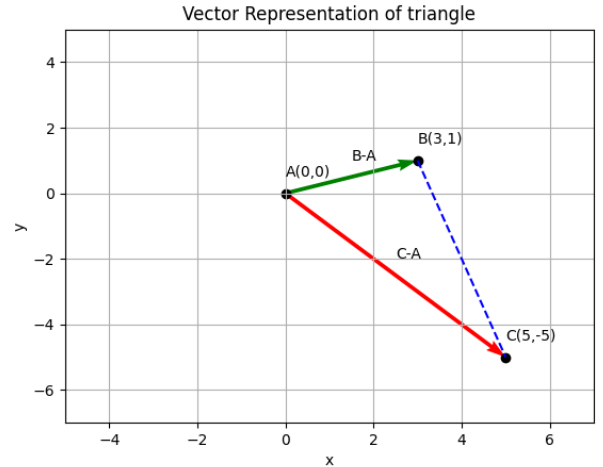Substituting value from equation 2.0.9 in equation 2.0.5, we'll get area of triangle:

$$\implies \frac{1}{2}(20) = 10 units^2$$

Fig. 1: Plot obtained from Python code