Assignment 1

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Area of Triangle

***Abstract*—This document contains the solution to find the Area of a Triangle, given the coordinates of the vertices.**

Download all python codes from

```
https://github.com/ashish−hk/Assignment1/blob/
    main/Assignment1.ipynb
```

Download latex-tikz codes from

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https://github.com/ashish−hk/Assignment1/blob/
    main/main.tex
```

1 Problem

Solve: **Problem set: Vector2, Example-2,1**

Find the areas of the triangles the coordinates of whose angular points are respectively:

$$\mathbf{P} = \begin{pmatrix} 1 \\ 3 \end{pmatrix}, \mathbf{Q} = \begin{pmatrix} -7 \\ 6 \end{pmatrix} \text{ and } \mathbf{R} = \begin{pmatrix} 5 \\ -1 \end{pmatrix}$$

2 Solution

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

$$\mathbf{Q} - \mathbf{P} = \begin{pmatrix} -7 \\ 6 \end{pmatrix} - \begin{pmatrix} 1 \\ 3 \end{pmatrix} \tag{2.0.1}$$

$$= \begin{pmatrix} -8 \\ 3 \end{pmatrix} \tag{2.0.2}$$

$$\mathbf{R} - \mathbf{P} = \begin{pmatrix} 5 \\ -1 \end{pmatrix} - \begin{pmatrix} 1 \\ 3 \end{pmatrix} \tag{2.0.3}$$

$$= \begin{pmatrix} 4 \\ -4 \end{pmatrix} \tag{2.0.4}$$

$$\because \text{Area of the Triangle} = \frac{1}{2} \left\| (\mathbf{Q} - \mathbf{P}) \times (\mathbf{R} - \mathbf{P}) \right\| \tag{2.0.5}$$

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

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

Substituting values from equation 2.0.1 and 2.0.3 in above equation 2.0.6, we'll get:

$$(\mathbf{Q} - \mathbf{P}) \times (\mathbf{R} - \mathbf{P}) = \begin{pmatrix} 0 & 0 & 3 \\ 0 & 0 & 8 \\ -3 & -8 & 0 \end{pmatrix} \times \begin{pmatrix} 4 \\ -4 \\ 0 \end{pmatrix} \tag{2.0.7}$$

$$= \begin{pmatrix} 0 \\ 0 \\ 20 \end{pmatrix} \tag{2.0.8}$$

$$\therefore \left\| (\mathbf{Q} - \mathbf{P}) \times (\mathbf{R} - \mathbf{P}) \right\| = \sqrt{0^2 + 0^2 + 20^2} = 20 \tag{2.0.9}$$

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

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

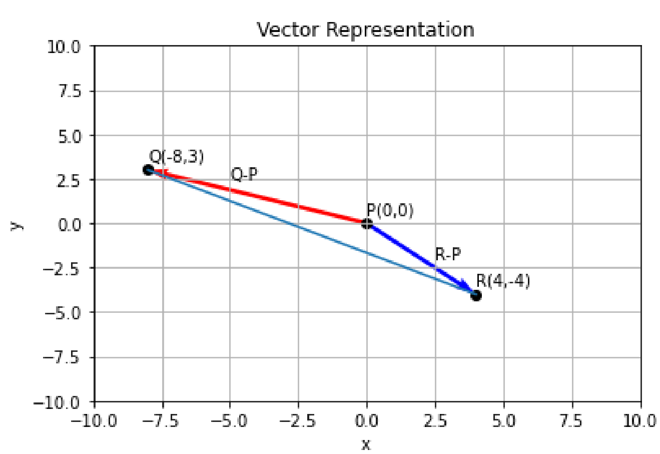

Fig. 1: Plot obtained from Python code