1.9.14

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If **P** $= (2, 2)$, **Q** $= (-4, -4)$, and **R** $= (5, -8)$ are the vertices of a triangle ΔPQR, then find the length of the median through **R**.

Midpoint of $\mathbf{Q} - \mathbf{P}$

Given position vectors of the points are:

$$\mathbf{P} = \begin{pmatrix} 2 \\ 2 \end{pmatrix}, \mathbf{Q} = \begin{pmatrix} -4 \\ -4 \end{pmatrix}, \mathbf{R} = \begin{pmatrix} 5 \\ -8 \end{pmatrix} \tag{1}$$

Let the midpoint of vector $\mathbf{Q} - \mathbf{P}$ be $\mathbf{M}$:

$$\mathbf{M} = \frac{1}{2}\mathbf{P} + \frac{1}{2}\mathbf{Q} \tag{2}$$

$$\mathbf{M} = \begin{pmatrix} 1 \\ 1 \end{pmatrix} + \begin{pmatrix} -2 \\ -2 \end{pmatrix} \tag{3}$$

$$\mathbf{M} = \begin{pmatrix} -1 \\ -1 \end{pmatrix} \tag{4}$$

$$\mathbf{M} - \mathbf{R} = \begin{pmatrix} -1 \\ -1 \end{pmatrix} - \begin{pmatrix} 5 \\ -8 \end{pmatrix} \tag{5}$$

$$\mathbf{M} - \mathbf{R} = \begin{pmatrix} -6 \\ 7 \end{pmatrix} \tag{6}$$

The length of the median:

$$||\mathbf{M} - \mathbf{R}|| = \sqrt{(-6)^2 + (7)^2} \tag{7}$$

$$||\mathbf{M} - \mathbf{R}|| = \sqrt{85} \approx 9.219 \tag{8}$$

Thus the length of the median of the triangle through $\mathbf{R}$ is $\sqrt{85} \approx 9.219$.

C Code

```c
#include <stdio.h>
#include <math.h>
void make_data(double *points) {
    double Px = 2; double Py = 2;
    double Qx = -4; double Qy = -4;
    double Rx = 5; double Ry = -8;
    double Mx = (Px + Qx)/2; double My = (Py + Qy)/2;
    double value = sqrt(((Mx - Rx)*(Mx - Rx))+((My - Ry)*(My - Ry
        )));
    points[0] = Px;points[1] = Py;
    points[2] = Qx;points[3] = Qy;
    points[4] = Rx;points[5] = Ry;
    points[6] = Mx;points[7] = My;
    points[8] = value;
}
```

Python Code 1

```python
import ctypes as ct
import numpy as np

def get_data():
    lib = ct.CDLL("./problem.so")

    value = ct.c_double*9

    lib.make_data.argtypes = [ct.POINTER(ct.c_double)]

    points = value()

    lib.make_data(points)
```

```
Px = points[0]
Py = points[1]
Qx = points[2]
Qy = points[3]
Rx = points[4]
Ry = points[5]
Mx = points[6]
My = points[7]
values = points[8]
return Px, Py, Qx, Qy, Rx, Ry, Mx, My, values
```

Python Code 2

```python
import numpy as np
import matplotlib.pyplot as plt
from call import get_data

Px, Py, Qx, Qy, Rx, Ry, Mx, My, values = get_data()

a = ([Px, Qx, Rx, Mx, Px, Rx])
b = ([Py, Qy, Ry, My, Py, Ry])

plt.plot(a, b, color = 'black')

plt.text(Px, Py, 'P', fontsize=12, color = 'red')
plt.text(-4.4, -3.9, 'Q', fontsize=12, color = 'red')
```

Python Code

```python
plt.text(Rx, Ry, 'R', fontsize=12, color = 'red')
plt.text(-1.1, -0.8, 'M', fontsize=12, color = 'red')

plt.xlabel('X-axis')
plt.ylabel('Y-axis')
plt.axis('equal')
plt.grid(True)
plt.savefig('../figs/plot.png')
plt.show()
```
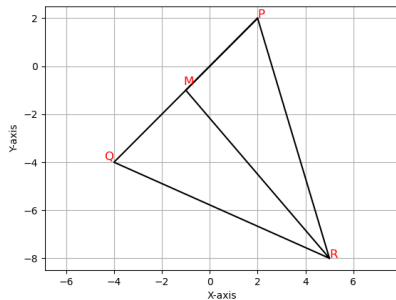
Figure: Plot of triangle PQR along with median