1.9.14

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Question

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

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 $\mathbf{M}$:

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

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

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

Length of Median

Then the median is:

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

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

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>

void get_points(double *points) {
    points[0] = 5; points[1] = -8; // R
    points[2] = -4; points[3] = -4; // Q
    points[4] = 2; points[5] = 2; // P
}
```

Python Code

```
import sys
import math
import numpy as np
import matplotlib.pyplot as plt
import ctypes

problem = ctypes.CDLL('/home/ganachari-vishwmabhar/ee1030-2025/
    EE25BTECH11025/ASSIGNMENTS/matgeo/1.5.13/codes/problem.so')
```

Python Code

```
P = np.array([2, 2])
Q = np.array([-4, -4])
R = np.array([5, -8])

# Calculate the midpoint M of PQ (for the median through R)
M = (P + Q) / 2

# Prepare plot
plt.figure()
# Plot the triangle
xs = [P[0], Q[0], R[0], P[0]]
ys = [P[1], Q[1], R[1], P[1]]
plt.plot(xs, ys, 'k-', label='Triangle')
```

Python Code

```
plt.plot([R[0], M[0]], [R[1], M[1]], 'r--', label='Median from R'
    )

# Mark vertices
plt.scatter([P[0], Q[0], R[0], M[0]], [P[1], Q[1], R[1], M[1]], c
    =['b','g','r','m'])
plt.text(P[0], P[1], 'P', fontsize=12)
plt.text(Q[0], Q[1], 'Q', fontsize=12)
plt.text(R[0], R[1], 'R', fontsize=12)
plt.text(M[0], M[1], 'M', fontsize=12)
```

Python Code

```
plt.axis('equal')
plt.grid(True)
plt.legend()
plt.title("Triangle PQR and Median through R")
plt.savefig("../figs/plot.png")
plt.show()
```

Plot

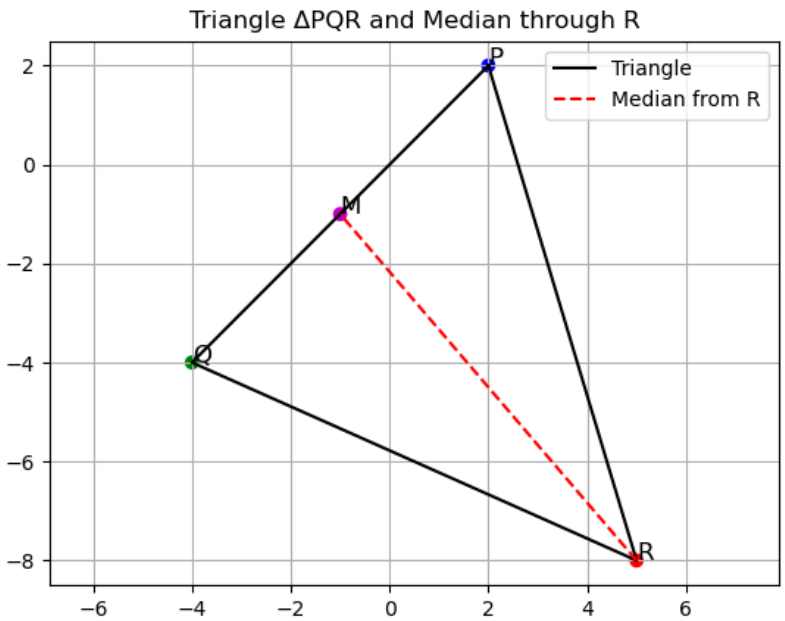

Figure: Plot of triangle PQR along with median