MatGeo Presentation - Problem 2.5.32

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Question

Show that the points $(7, 10)$, $(-2, 5)$ and $(3, 4)$ are vertices of an isosceles right triangle.

Solution

$\rightarrow$ We have $\triangle$ABC with the given points.

Solution:

Points	**Name**
$\begin{pmatrix} 7 \\ 10 \end{pmatrix}$	Point **A**
$\begin{pmatrix} -2 \\ 5 \end{pmatrix}$	Point **B**
$\begin{pmatrix} 3 \\ 4 \end{pmatrix}$	Point **C**

Table: List of Points

Solution

$\rightarrow$ Finding the lengths of the sides:

$$\|\mathbf{B}-\mathbf{A}\|^2 = \begin{pmatrix}-9 & -5\end{pmatrix}\begin{pmatrix}-9\\-5\end{pmatrix} = 106 \implies \|\mathbf{B}-\mathbf{A}\| = \sqrt{106} \tag{0.1}$$

$$\|\mathbf{C}-\mathbf{B}\|^2 = \begin{pmatrix}5 & -1\end{pmatrix}\begin{pmatrix}5\\-1\end{pmatrix} = 26 \implies \|\mathbf{C}-\mathbf{B}\| = \sqrt{26} \tag{0.2}$$

$$\|\mathbf{A}-\mathbf{C}\|^2 = \begin{pmatrix}4 & 6\end{pmatrix}\begin{pmatrix}4\\6\end{pmatrix} = 52 \implies \|\mathbf{A}-\mathbf{C}\| = \sqrt{52} \tag{0.3}$$

$$\|\mathbf{B}-\mathbf{A}\|^2 + \|\mathbf{C}-\mathbf{B}\|^2 = 26+52 = 78 \neq 106 = \|\mathbf{A}-\mathbf{C}\|^2 \tag{0.4}$$

$\rightarrow$ From (1), (2) and (3), we know that the sides are different lengths, or $\triangle$ABC is not isosceles. From (4), we prove that $\triangle$ABC is not right-angled as well.

Solution

$\implies$ The $\triangle ABC$ is neither isosceles nor right-angled.

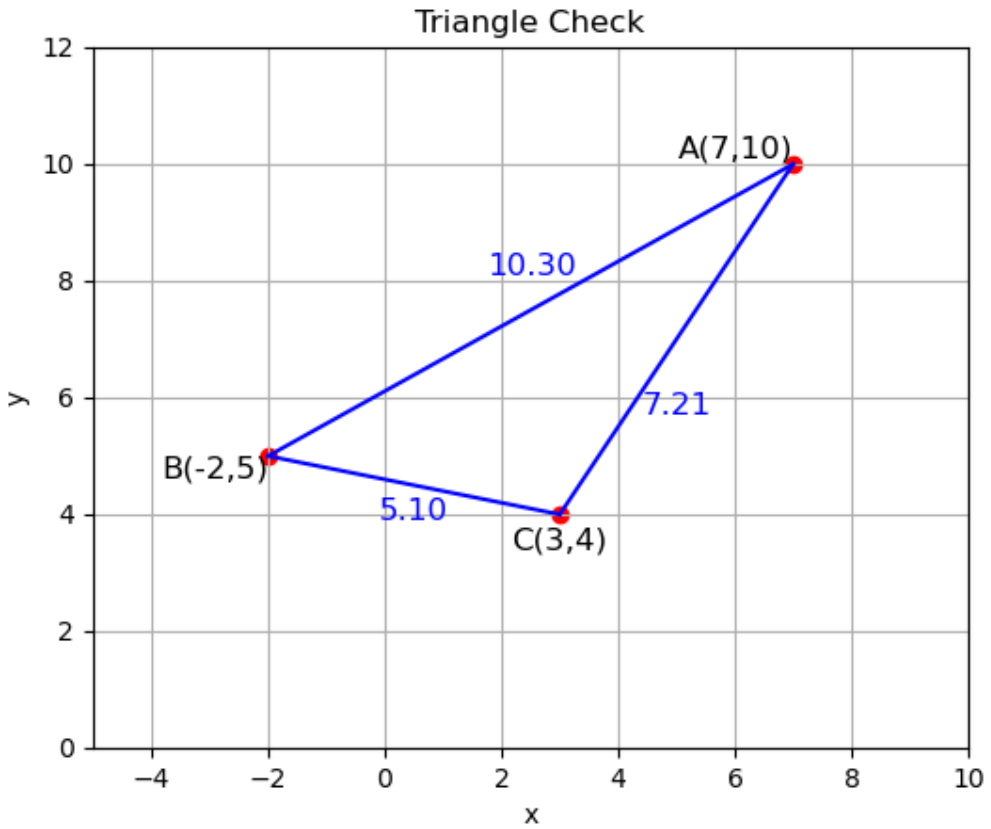

Figure: Plot of $\triangle ABC$

File: points.c

```
#include <stdio.h>

int main() {
  FILE *fp;

  // -------------------
  // Question 2.5.32
  // -------------------


  fp = fopen("points.dat", "w");
  fprintf(fp, "%d,%d,%d\n", 7, 10, 0); // A
  fprintf(fp, "%d,%d,%d\n", -2, 5, 0); // B
  fprintf(fp, "%d,%d,%d\n", 3, 4, 0); // C
  fclose(fp);
  return 0;
  }
```

File: call_c.py

```
import subprocess

# Compile the C program
subprocess.run(["gcc", "points.c", "-o", "points"])

# Run the compiled C program
result = subprocess.run(["./points"], capture_output=True, text=True)

# Print the output from the C program
print(result.stdout)
```

File: plot.py

```
import matplotlib.pyplot as plt
import numpy as np

# Points A(7,10), B(-2,5), C(3,4)
A = np.array([7, 10])
B = np.array([-2, 5])
C = np.array([3, 4])

# Function to calculate distance between two points
def distance(p1, p2):
    return np.sqrt((p2[0] - p1[0])**2 + (p2[1] - p1[1])**2)

# Calculate distances
AB = distance(A, B)
BC = distance(B, C)
CA = distance(C, A)

# Plotting the triangle
plt.figure(figsize=(6, 6))
plt.plot([A[0], B[0]], [A[1], B[1]], 'b-', label="AB")
plt.plot([B[0], C[0]], [B[1], C[1]], 'b-', label="BC")
plt.plot([C[0], A[0]], [C[1], A[1]], 'b-', label="CA")

# Annotating points
plt.text(A[0], A[1], 'A(7,10)', fontsize=12, ha='right', va='bottom')
plt.text(B[0], B[1], 'B(-2,5)', fontsize=12, ha='right', va='top')
plt.text(C[0], C[1] - 0.2, 'C(3,4)', fontsize=12, ha='center', va='top')

# Highlighting the vertices
plt.scatter([A[0], B[0], C[0]], [A[1], B[1], C[1]], color='red')
```

File: plot.py

```
# Displaying distances on the plot with offset adjustments
mid_AB = (A + B) / 2
mid_BC = (B + C) / 2
mid_CA = (C + A) / 2

# Adjusting text placement for better spacing
plt.text(mid_AB[0], mid_AB[1] + 0.6, f'{AB:.2f}', fontsize=12, color='blue', ha='center')
plt.text(mid_BC[0], mid_BC[1] - 0.6, f'{BC:.2f}', fontsize=12, color='blue', ha='center')
plt.text(mid_CA[0], mid_CA[1] - 1.3, f'{CA:.2f}', fontsize=12, color='blue', ha='center')

# Setting plot limits and labels
plt.xlim(-5, 10)
plt.ylim(0, 12)
plt.gca().set_aspect('equal', adjustable='box')
plt.xlabel('x')
plt.ylabel('y')
plt.title('Triangle␣Check')

# Show the plot
plt.grid(True)
plt.show()
```