2.6.32

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Problem Statement

Find the area of the triangle whose vertices are

$$(1, -1), \quad (-4, 6), \quad (-3, 5).$$

Step 1: Define the vertices as vectors

$$A = \begin{pmatrix} 1 \\ -1 \end{pmatrix}, \quad B = \begin{pmatrix} -4 \\ 6 \end{pmatrix}, \quad C = \begin{pmatrix} -3 \\ 5 \end{pmatrix}$$

Step 2: Calculate the vectors $A - B$ and $B - C$

$$A - B = \begin{pmatrix} 1 \\ -1 \end{pmatrix} - \begin{pmatrix} -4 \\ 6 \end{pmatrix} = \begin{pmatrix} 5 \\ -7 \end{pmatrix}$$

$$B - C = \begin{pmatrix} -4 \\ 6 \end{pmatrix} - \begin{pmatrix} -3 \\ 5 \end{pmatrix} = \begin{pmatrix} -1 \\ 1 \end{pmatrix}$$

Step 3: Calculate the 2D cross product magnitude

For vectors $\mathbf{u} = \begin{pmatrix} u_1 \\ u_2 \end{pmatrix}$ and $\mathbf{v} = \begin{pmatrix} v_1 \\ v_2 \end{pmatrix}$, the 2D cross product is

$$\mathbf{u} \times \mathbf{v} = u_1 v_2 - u_2 v_1.$$

Applying this,

$$(A - B) \times (B - C) = 5 \times 1 - (-7) \times (-1) = 5 - 7 = -2$$

$$\Rightarrow \|(A - B) \times (B - C)\| = 2$$

Step 4: Calculate the area of the triangle

$$ar(ABC) = \frac{1}{2} \times \|(A - B) \times (B - C)\| = \frac{1}{2} \times 2 = 1$$

$$\boxed{ar(ABC) = 1 \text{ square unit}}$$

C Code (Part 1)

```c
#include <stdio.h>
#include <math.h> // For fabs()

double crossProduct(double u1, double u2, double v1, double v2) {
    return u1 * v2 - u2 * v1;
}

int main() {
    double Ax = 1, Ay = -1;
    double Bx = -4, By = 6;
    double Cx = -3, Cy = 5;
```

C Code (Part 2)

```
    double ABx = Ax - Bx;
    double ABy = Ay - By;
    double BCx = Bx - Cx;
    double BCy = By - Cy;

    double cross = crossProduct(ABx, ABy, BCx, BCy);
    double area = 0.5 * fabs(cross);

    printf(Area of triangle ABC = %.2f square units\n, area);
    return 0;
}
```

Python Code (Part 1)

```
import matplotlib.pyplot as plt

A = (1, -1)
B = (-4, 6)
C = (-3, 5)

x_coords = [A[0], B[0], C[0], A[0]]
y_coords = [A[1], B[1], C[1], A[1]]
```

Python Code (Part 2)

```
plt.figure()
plt.plot(x_coords, y_coords, 'b-', marker='o')

plt.text(A[0], A[1], 'A', fontsize=12, ha='right')
plt.text(B[0], B[1], 'B', fontsize=12, ha='right')
plt.text(C[0], C[1], 'C', fontsize=12, ha='right')

plt.gca().set_aspect('equal', adjustable='box')
plt.grid(True)

plt.title('Triangle ABC')
plt.xlabel('x')
plt.ylabel('y')

plt.savefig('python_plot.png')
plt.show()
```

Plot