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September 3, 2025

Question

Find the area of a triangle formed by the points A(5,2), B(4,7) and C(7,-4)

Theoretical Solution

$$\mathbf{B} - \mathbf{A} = \begin{pmatrix} -1\\5 \end{pmatrix} \tag{1}$$

$$\mathbf{C} - \mathbf{A} = \begin{pmatrix} 2 \\ -6 \end{pmatrix} \tag{2}$$

$$\|(\mathbf{B} - \mathbf{A}) \times (\mathbf{C} - \mathbf{A})\| = \| \begin{pmatrix} |\mathbf{A}_{23} & \mathbf{B}_{23}| \\ |\mathbf{A}_{31} & \mathbf{B}_{31}| \\ |\mathbf{A}_{12} & \mathbf{B}_{12}| \end{pmatrix} \| = 4$$

(3)

Area of the triangle ABC =
$$\frac{1}{2} \| (\mathbf{B} - \mathbf{A}) \times (\mathbf{C} - \mathbf{A}) \|$$
 (4)

$$=2 (5)$$

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Conclusion

Therefore,

The area of triangle ABC is 2

```
#include <math.h>
// Function to compute triangle area using cross product
double triangle_area(double x1, double y1, double x2, double y2,
    double x3, double y3) {
   // Vectors B-A and C-A
   double ux = x2 - x1;
   double uy = y2 - y1;
   double vx = x3 - x1;
   double vy = y3 - y1;
   // Cross product (2D)
   double cross = ux * vy - uy * vx;
   // Area is half magnitude of cross product
   return 0.5 * fabs(cross):}
```

C plus Python code

```
import ctypes
 import matplotlib.pyplot as plt
 # Load the shared library
 lib = ctypes.CDLL(./triangle area.so)
 # Define the argument and return types
 lib.triangle_area.argtypes = [ctypes.c_double, ctypes.c_double,
                             ctypes.c_double, ctypes.c_double,
                             ctypes.c_double, ctypes.c_double]
 lib.triangle_area.restype = ctypes.c_double
 # Triangle vertices
A = (5, 2)
B = (4, 7)
 C = (7, -4)
```

C plus Python code

```
# Call the C function
 area = lib.triangle_area(A[0], A[1], B[0], B[1], C[0], C[1])
 print(Area of triangle ABC =, area)
 # ---- Plotting ----
 x \text{ vals} = [A[0], B[0], C[0], A[0]]
 y \text{ vals} = [A[1], B[1], C[1], A[1]]
 plt.plot(x vals, y vals, 'b-', linewidth=2, label=Triangle ABC)
 plt.scatter([A[0], B[0], C[0]], [A[1], B[1], C[1]], color='red')
 # Annotate points
 plt.text(A[0], A[1], A+str(A))
plt.text(B[0], B[1], B+str(B))
 plt.text(C[0], C[1], C+str(C))
```

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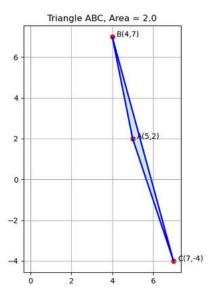
C plus Python code

Python code

```
import numpy as np
import matplotlib.pyplot as plt
# Given points
A = np.array([5, 2])
B = np.array([4, 7])
C = np.array([7, -4])
# Compute area using determinant formula
area = 0.5 * abs(A[0]*(B[1]-C[1]) + B[0]*(C[1]-A[1]) + C[0]*(A[0])
    [1]-B[1]))
print(Area of triangle:, area)
```

```
# Plot triangle
plt.figure(figsize=(6,6))
| |plt.plot([A[0], B[0], C[0], A[0]], [A[1], B[1], C[1], A[1]], 'b-'
     , linewidth=2)
| plt.fill([A[0], B[0], C[0]], [A[1], B[1], C[1]], color='skyblue',
      alpha=0.4)
 # Mark points
 plt.scatter(*A, color='r')
plt.text(A[0]+0.2, A[1], A(5,2), fontsize=10)
 plt.scatter(*B, color='r')
 plt.text(B[0]+0.2, B[1], B(4,7), fontsize=10)
 plt.scatter(*C, color='r')
 plt.text(C[0]+0.2, C[1], C(7,-4), fontsize=10)
```

Python code



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