2.4.23

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Question

Do the points $(3, 2)$, $(-2, -3)$, and $(2, 3)$ form a triangle? If so, name the type of triangle formed.

Theoretical solution

Let the position vectors of the points be:

$$\mathbf{A} = (3, 2), \quad \mathbf{B} = (-2, -3), \quad \mathbf{C} = (2, 3)$$

Calculate area of the triangle using vector cross product magnitude:

$$\text{Area} = \frac{1}{2} \left| (\mathbf{B} - \mathbf{A}) \times (\mathbf{C} - \mathbf{A}) \right| \tag{1}$$

Compute vectors:

$$\mathbf{B} - \mathbf{A} = (-2 - 3,\ -3 - 2) = (-5, -5) \tag{2}$$

$$\mathbf{C} - \mathbf{A} = (2 - 3,\ 3 - 2) = (-1, 1) \tag{3}$$

Theoretical solution

Calculate the 2D cross product magnitude:

$$\begin{aligned} |(\mathbf{B}-\mathbf{A}) \times (\mathbf{C}-\mathbf{A})| &= |(-5)(1) - (-5)(-1)| \\ &= |-5-5| = 10 \end{aligned} \tag{4}$$

Therefore,

$$\text{Area} = \frac{1}{2} \times 10 = 5 \neq 0 \tag{5}$$

Since area $\neq 0$, points are not collinear and hence form a triangle.
Length of side AB:

$$|\mathbf{B}-\mathbf{A}| = \sqrt{(-5)^2 + (-5)^2} = \sqrt{50} \tag{6}$$

Theoretical solution

Length of side BC:

$$|\mathbf{C}-\mathbf{B}| = \sqrt{(2+2)^2+(3+3)^2} = \sqrt{16+36} = \sqrt{52} \tag{7}$$

Length of side AC:

$$|\mathbf{C}-\mathbf{A}| = \sqrt{(-1)^2+1^2} = \sqrt{2} \tag{8}$$

Since

$$\sqrt{50} \neq \sqrt{52} \neq \sqrt{2}$$

all sides are unequal.

Yes, the points form a scalene triangle.

Python Code

```
    import matplotlib.pyplot as plt

# Define the coordinates of the points
A = (3, 2)
B = (-2, -3)
C = (2, 3)
```

Python Code

```
    # Plot lines connecting the points
plt.plot([B[0], A[0]], [B[1], A[1]], 'b-') # Line from B to A
plt.plot([B[0], C[0]], [B[1], C[1]], 'b-') # Line from B to C
plt.plot([A[0], C[0]], [A[1], C[1]], 'b-') # Line from A to C

# Plot the points themselves
plt.plot(A[0], A[1], 'ko') # Point A
plt.plot(B[0], B[1], 'ko') # Point B
plt.plot(C[0], C[1], 'ko') # Point C
```

Python Code

```
# Add labels near the points
plt.text(A[0] + 0.1, A[1], 'A(3,2)')
plt.text(B[0] - 1.5, B[1], 'B(-2,-3)')
plt.text(C[0] - 1, C[1], 'C(2,3)')

# Axes labels
plt.xlabel('x')
plt.ylabel('y')

# Grid and central axes
plt.grid(True)
plt.axhline(0, color='black', linewidth=0.5)
plt.axvline(0, color='black', linewidth=0.5)

# Title and show plot
plt.title('Graph of Points A, B, C')
plt.show()
```

C Code

```c
#include <stdio.h>

int main() {
    int x1=3,y1=2, x2=-2,y2=-3, x3=2,y3=3;

    int area = x1*(y2-y3) + x2*(y3-y1) + x3*(y1-y2);

    if(area == 0) {
        printf("Collinear, no triangle.\n");
    } else {
        printf("Triangle exists.\n");
    }

    return 0;
}
```

C Code

```c
#include <stdio.h>
#include <math.h>

int main() {
    int x1=3,y1=2, x2=-2,y2=-3, x3=2,y3=3;

    double AB = sqrt((x2-x1)*(x2-x1) + (y2-y1)*(y2-y1));
    double BC = sqrt((x3-x2)*(x3-x2) + (y3-y2)*(y3-y2));
    double AC = sqrt((x3-x1)*(x3-x1) + (y3-y1)*(y3-y1));

    printf("Side lengths:\n");
    printf("AB = %.2f\n", AB);
    printf("BC = %.2f\n", BC);
    printf("AC = %.2f\n", AC);

    return 0;
}
```

C Code

```c
#include <stdio.h>
#include <math.h>

int main() {
    int x1=3,y1=2, x2=-2,y2=-3, x3=2,y3=3;

    double AB = sqrt((x2-x1)*(x2-x1) + (y2-y1)*(y2-y1));
    double BC = sqrt((x3-x2)*(x3-x2) + (y3-y2)*(y3-y2));
    double AC = sqrt((x3-x1)*(x3-x1) + (y3-y1)*(y3-y1));

    if(AB==BC && BC==AC)
        printf("Equilateral triangle\n");
    else if(AB==BC || BC==AC || AB==AC)
        printf("Isosceles triangle\n");
    else
        printf("Scalene triangle\n");

    return 0;
}
```

Python and C Code

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

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

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

Graphical Representation:

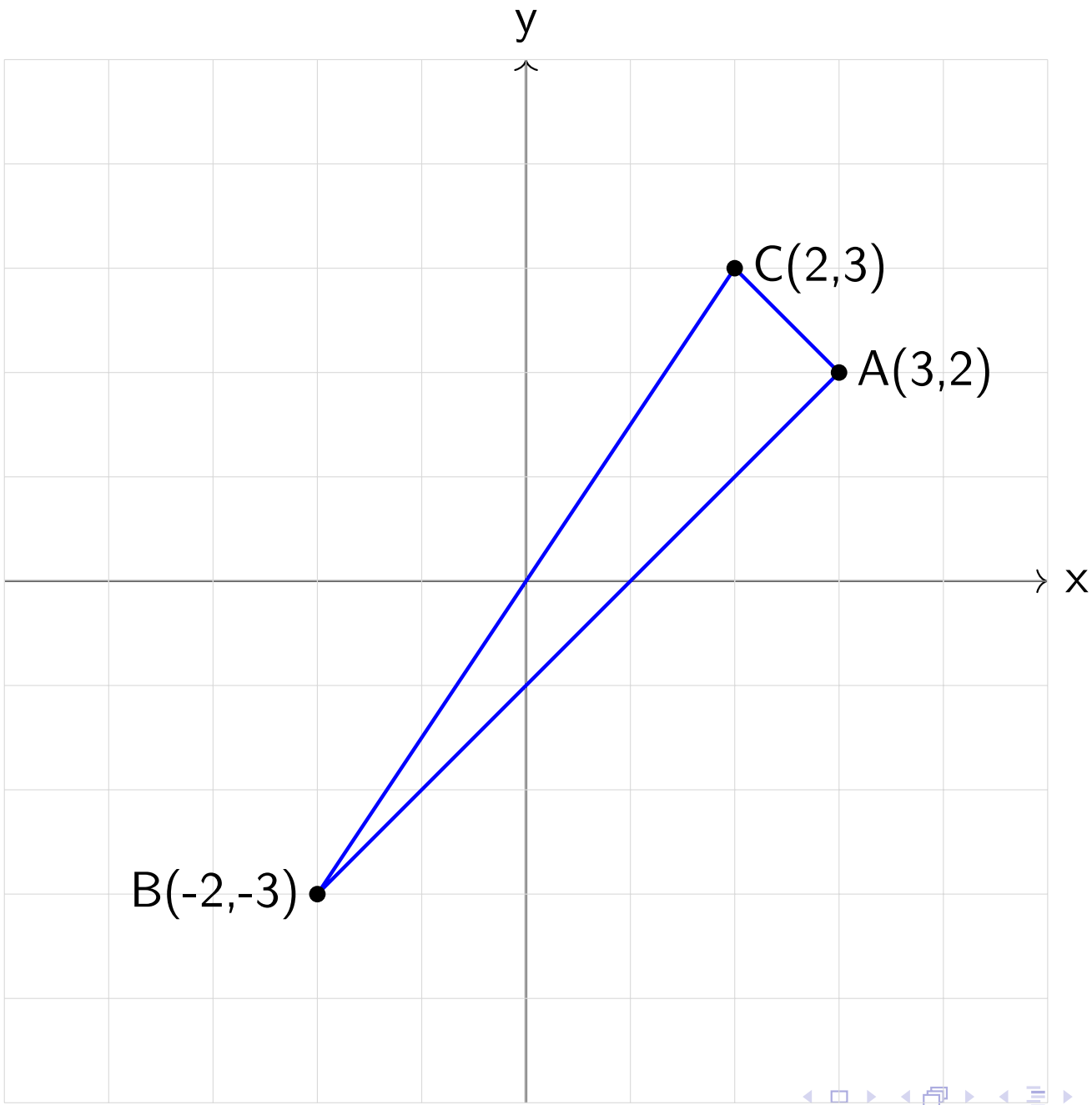

Fig. 0