Presentation By

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Problem Statement

Determine if it is possible to construct A triangle ABC in which $BC = 6cm, \angle B = 30^\circ$ and $AC - AB = 4cm$.

Solution

Symbol	Description
a	length of side BC
b	length of side CA
c	length of side AB
$\angle A$	angle at vertex A
$\angle B$	angle at vertex B
$\angle C$	angle at vertex C
K	$AC - AB = b - c$

Table: Variables Used

Solution

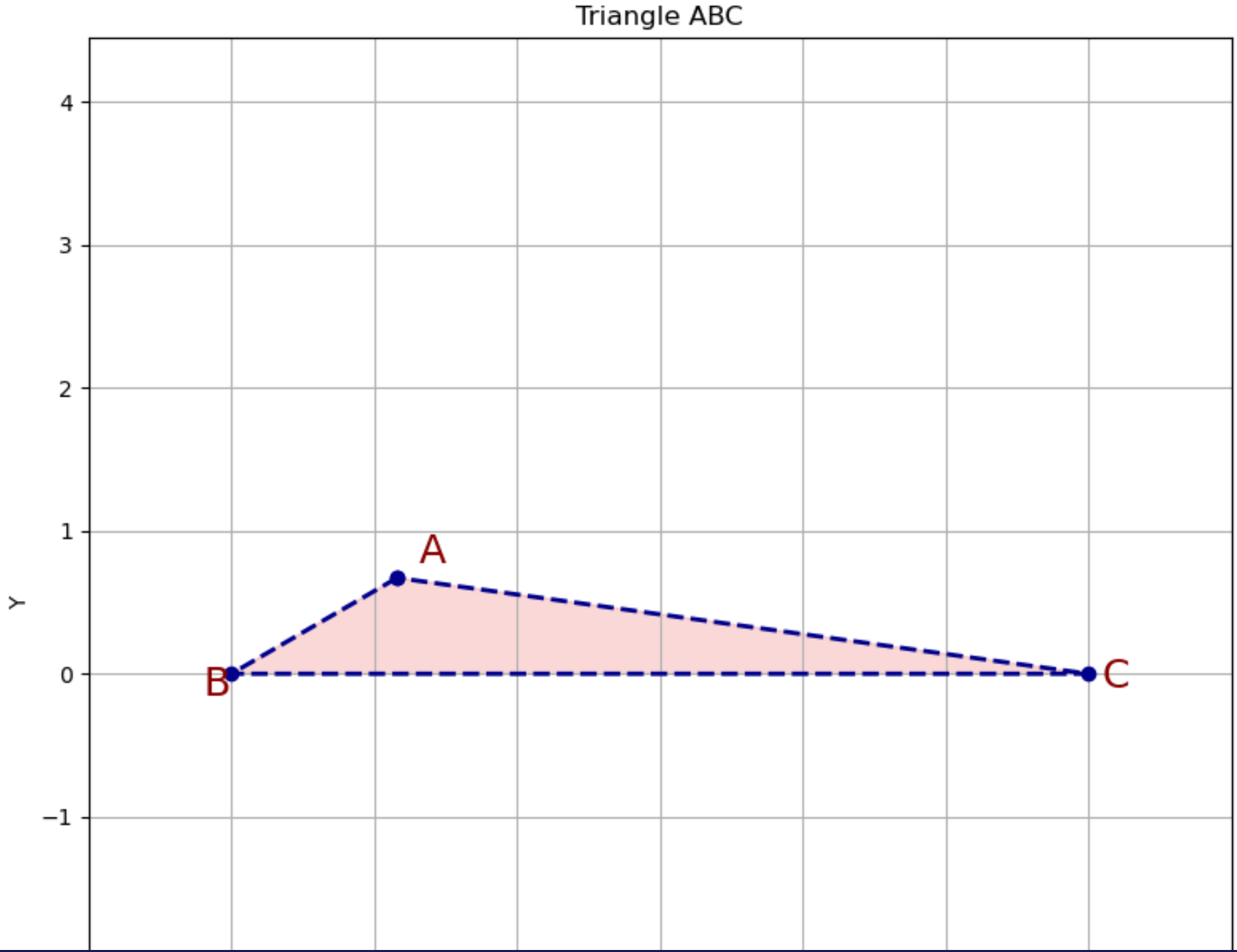
Using the cosine formula in $\triangle ABC$,

$$(K + c)^2 = a^2 + c^2 - 2ac\cos B \tag{3.1}$$

$$\implies c = \frac{a^2 - K^2}{2(K + a\cos B)} \tag{3.2}$$

Substitute the values of K = 4 , a = 6 , and $\cos B = \cos 30^\circ = \frac{\sqrt{3}}{2}$ to get value of c. The coordinates of $\triangle ABC$ can be expressed as

$$\mathbf{A} = c\begin{pmatrix}\cos B\\ \sin B\end{pmatrix}, \mathbf{B} = \begin{pmatrix}0\\0\end{pmatrix}, \mathbf{C} = \begin{pmatrix}a\\0\end{pmatrix} \tag{3.3}$$


Triangle ABC
4
3
2
1
0
−1
Y
A
B
C

C Code

```
#include <stdlib.h>

typedef struct {
    double x;
    double y;
} Point;

void generate_continuous_point(double x1, double y1, double x2, double
     y2, double t, double *x, double *y) {
    *x = (1 - t) * x1 + t * x2;
    *y = (1 - t) * y1 + t * y2;
}
Point* generate_triangle_points(int num_points, Point v1, Point v2, Point
    v3) {
    Point* points = (Point*)malloc(sizeof(Point) * num_points * 3);
    double x, y;
```

C Code

```
    for (int i = 0; i < num_points; i++) {
            for(int j = 0; j < 3; j++){
              double t = (double)i / (num_points - 1);
             generate_continuous_point(v1.x, v1.y, v2.x, v2.y, t, &x, &y);
           points[j].x = x;
           points[j].y = y;
            }
     }
     return points;
}
void free_points(Point* points) {
     free(points);
}
```

Python Code for Plotting

```
import ctypes
import matplotlib.pyplot as plt

lib = ctypes.CDLL("./generate_points.so")
class Point(ctypes.Structure):
    _fields_ = [("x", ctypes.c_double), ("y", ctypes.c_double)]
lib.generate_triangle_points.restype = ctypes.POINTER(Point)
lib.generate_triangle_points.argtypes = [ctypes.c_int, Point, Point, Point]

num_points = 9999
v1, v2, v3 = Point(1.161, 0.671), Point(0.0, 0.0), Point(6.0, 0.0)
points = lib.generate_triangle_points(num_points, v1, v2, v3)
x_coords = [points[i].x for i in range(num_points)]
y_coords = [points[i].y for i in range(num_points)]
lib.free_points(points)
plt.figure(figsize=(8, 8))
```

Python Code for Plotting

```
plt.plot([v1.x, v2.x, v3.x, v1.x], [v1.y, v2.y, v3.y, v1.y], 'o--', color='
    darkblue', linewidth=2)
plt.fill([v1.x, v2.x, v3.x], [v1.y, v2.y, v3.y], color='lightcoral', alpha=0.3)

plt.text(v1.x + 0.15, v1.y + 0.1, 'A', fontsize=18, color='darkred')
plt.text(v2.x - 0.2, v2.y - 0.15, 'B', fontsize=18, color='darkred')
plt.text(v3.x + 0.1, v3.y - 0.1, 'C', fontsize=18, color='darkred')

plt.xlabel("X")
plt.ylabel("Y")
plt.title("Triangle ABC")
plt.grid(True)
plt.axis("equal")
plt.xlim(-1, 7)
plt.ylim(-1, 2)
plt.tight_layout()
plt.show()
```