3.3.2

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Construct a triangle with sides 5cm, 6cm and 7cm.

Solution:
Let triangle be $\triangle ABC$
Let AB=5cm BC=6cm CA=7cm
Take

$$\mathbf{A}\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \mathbf{B}\begin{pmatrix} 5 \\ 0 \end{pmatrix}, \mathbf{C}\begin{pmatrix} 7\cos A \\ 7\sin A \end{pmatrix}$$

$$\cos \mathbf{A} = \frac{AB^2 + AC^2 - BC^2}{2 \cdot AB \cdot AC} \tag{1}$$

$$\cos \mathbf{A} = \frac{5^2 + 7^2 - 6^2}{2 \cdot 5 \cdot 7} = \frac{19}{35} \tag{2}$$

$$\sin A = \frac{12\sqrt{6}}{35} \tag{3}$$

Therefore

$$\mathbf{C}\left(7 \cdot \tfrac{19}{35} \quad 7 \cdot \tfrac{12\sqrt{6}}{35}\right) \tag{4}$$

$$\mathbf{C} \left(\frac{19}{5} \quad , \frac{12\sqrt{6}}{5} \right) \tag{5}$$

C Code

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

int main() {
    // Side lengths
    double AB = 5.0; // between A and B
    double BC = 6.0; // between B and C
    double CA = 7.0; // between C and A

    // Coordinates of points
    double Ax = 0.0, Ay = 0.0;
    double Bx = AB, By = 0.0;

    // Calculate cosA using the law of cosines
    double cosA = (AB*AB + CA*CA - BC*BC) / (2 * AB * CA);

    // Calculate sinA using identity sin^2 A + cos^2 A = 1
    double sinA = sqrt(1 - cosA*cosA);
```

C Code

```c
    // Coordinates of C
    double Cx = CA * cosA;
    double Cy = CA * sinA;

    printf("Coordinates of A: (%.2f, %.2f)\n", Ax, Ay);
    printf("Coordinates of B: (%.2f, %.2f)\n", Bx, By);
    printf("Coordinates of C: (%.2f, %.2f)\n", Cx, Cy);

    return 0;
}
```

Python Code

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

# Side lengths
AB = 5
BC = 6
CA = 7

# Place A at (0,0), B at (5,0)
A = (0, 0)
B = (AB, 0)

# Calculate cosA using Law of Cosines
cosA = (AB**2 + CA**2 - BC**2) / (2 * AB * CA)
sinA = np.sqrt(1 - cosA**2)
```

Python Code

```python
# Coordinates of C
Cx = CA * cosA
Cy = CA * sinA
C = (Cx, Cy)

print('Coordinates of A:', A)
print('Coordinates of B:', B)
print('Coordinates of C:', (round(Cx, 2), round(Cy, 2)))

# 2D graph
plt.figure(figsize=(7,7))
plt.plot([A[0], B[0]], [A[1], B[1]], 'bo-', label='AB (5 cm)')
plt.plot([B[0], C[0]], [B[1], C[1]], 'go-', label='BC (6 cm)')
plt.plot([C[0], A[0]], [C[1], A[1]], 'ro-', label='CA (7 cm)')

for point, label in zip([A, B, C], ['A', 'B', 'C']):
    plt.text(point[0], point[1], label, fontsize=14, fontweight='
        bold', ha='right', color='black')
```

```python
plt.xlabel('X (cm)')
plt.ylabel('Y (cm)')
plt.title('Triangle with sides 5 cm, 6 cm, 7 cm')
plt.legend()
plt.grid(True)
plt.axis('equal')
plt.tight_layout()
plt.savefig('triangle_5_6_7.png', dpi=200)
plt.close()
```
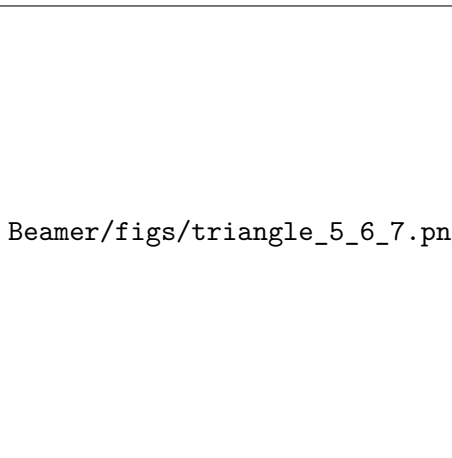
Plot

Beamer/figs/triangle_5_6_7.png

Figure: Caption