Mat-Geo Problem Solution Series

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Outline

Table Of Contents

Problem

Problem Statement

Construct an equilateral triangle ABC with each side 5cm.

Solution

Matrix Representation

Let $\mathbf{A} = \mathbf{0}$, and $\mathbf{B} = \begin{pmatrix} 5 \\ 0 \end{pmatrix}$. $\mathbf{C}$ is the required vertex.

Since the triangle is equilateral,

$$\mathbf{C} = R\,(\mathbf{B} - \mathbf{A}) \tag{3.1}$$

$$R = \begin{pmatrix} \cos\frac{\pi}{3} & -\sin\frac{\pi}{3} \\ \sin\frac{\pi}{3} & \cos\frac{\pi}{3} \end{pmatrix} \tag{3.2}$$

where R is the rotation matrix which rotates the vector $\mathbf{B} - \mathbf{A}$ by angle $\frac{\pi}{3}$.

Calculation

On calculation,

$$\mathbf{C} = \begin{pmatrix} \frac{1}{2} & -\frac{\sqrt{3}}{2} \\ \frac{\sqrt{3}}{2} & \frac{1}{2} \end{pmatrix} \begin{pmatrix} 5 \\ 0 \end{pmatrix} \tag{3.3}$$

$$\mathbf{C} = \begin{pmatrix} \frac{5}{2} \\ \frac{5\sqrt{3}}{2} \end{pmatrix} \tag{3.4}$$

Graph

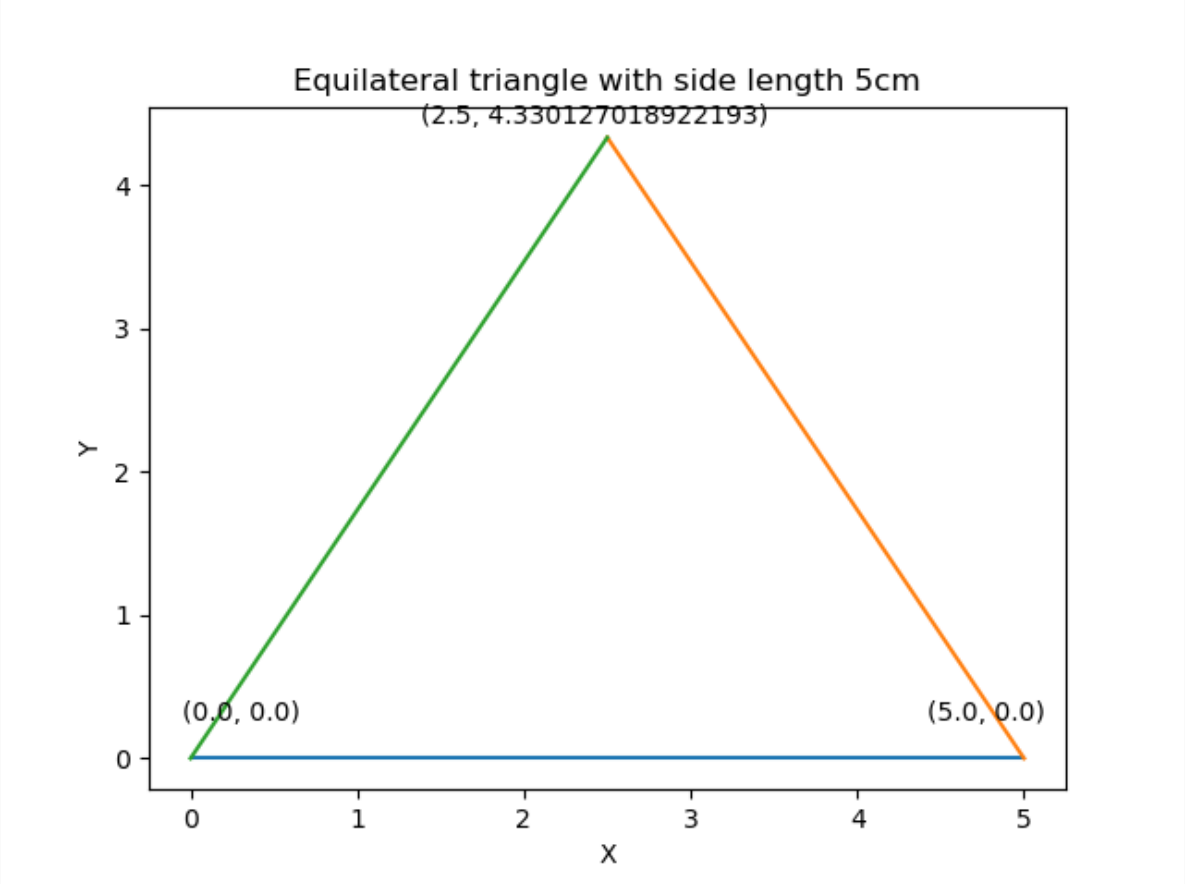

Figure 1: equilateral triangle of side 5cm