Assignment 1

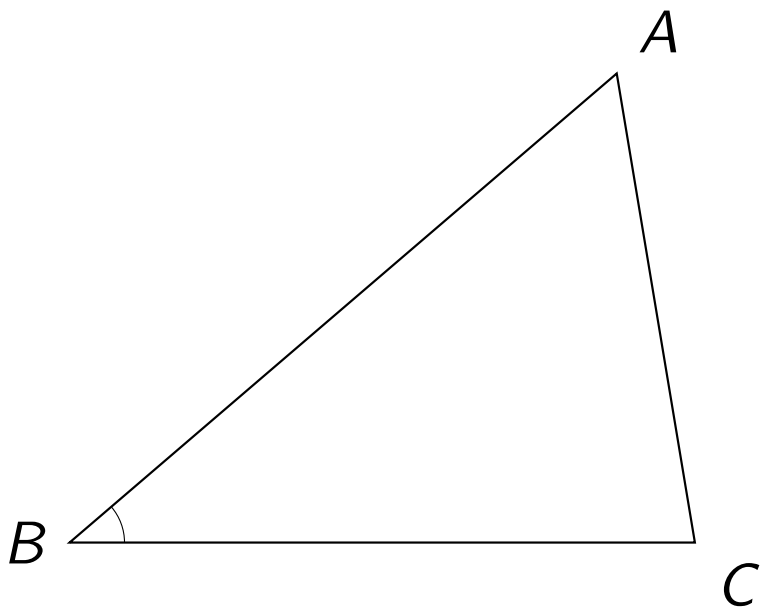
Ingilela Rohith
EE19BTECH11005

April 1, 2023

Problem Statement

Construct a triangle, given its base, a base angle and sum of other two sides.

Given the base BC, a base angle, say B and the sum AB + AC of the other two sides of a triangle ABC, you are required to construct it.



Solution

Using the cosine formula in $\triangle ABC$,

$$b^2 = a^2 + c^2 - 2acCosB \tag{3.1}$$

$$(b+c)(b-c) = a^2 - 2acCosB \tag{3.2}$$

$$or, K(b-c) = a^2 - 2acCosB \tag{3.3}$$

$$\text{where } K = b + c \tag{3.4}$$

$$Kb + c(2aCosB - K) = a^2 \tag{3.5}$$

Writing (3.4) and (3.5) into matrix form

$$\begin{pmatrix} 1 & 1 \\ K & 2aCosB - K \end{pmatrix} \begin{pmatrix} b \\ c \end{pmatrix} = \begin{pmatrix} K \\ a^2 \end{pmatrix} \tag{3.6}$$

Solve matrix (3.6) for 'c'

The coordinates of $\triangle ABC$ can then be expressed as

$$\mathbf{A} = c \begin{pmatrix} cosB \\ sinB \end{pmatrix}, \mathbf{B} = \begin{pmatrix} 0 \\ 0 \end{pmatrix}, \mathbf{C} = \begin{pmatrix} a \\ 0 \end{pmatrix} \tag{3.7}$$

Code

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

def construct_triangle(BC, angle_B, AB_plus_AC):
    a = BC
    K = AB_plus_AC
    B = np.deg2rad(angle_B)

    X = np.array([ [1, 1], [K, 2*a*np.cos(B) - K] ])
    D = np.array([ K, a*a ])
    c = np.linalg.solve(X, D)[1]

    A = (c * np.cos(B), c * np.sin(B))
    B = (0, 0)
    C = (a, 0)

    plt_line(A, B, 'A', 'B')
    plt_line(B, C, 'B', 'C')
    plt_line(C, A, 'C', 'A')
```

```
def plt_pnt(A, label=''):
        plt.plot(A[0], A[1], 'o')
        if label != '':
                plt.text(A[0], A[1], label)

def plt_line(A, B, labelA='', labelB='', plt_plts = True):
        plt.plot([A[0],B[0]], [A[1],B[1]], label=labelA+labelB)
        if plt_plts:
                plt_pnt(A, labelA)
                plt_pnt(B, labelB)

construct_triangle(7, 75, 13)

plt.grid(), plt.axis('equal')
plt.show()
```

Plot

The above code plots Fig.1.

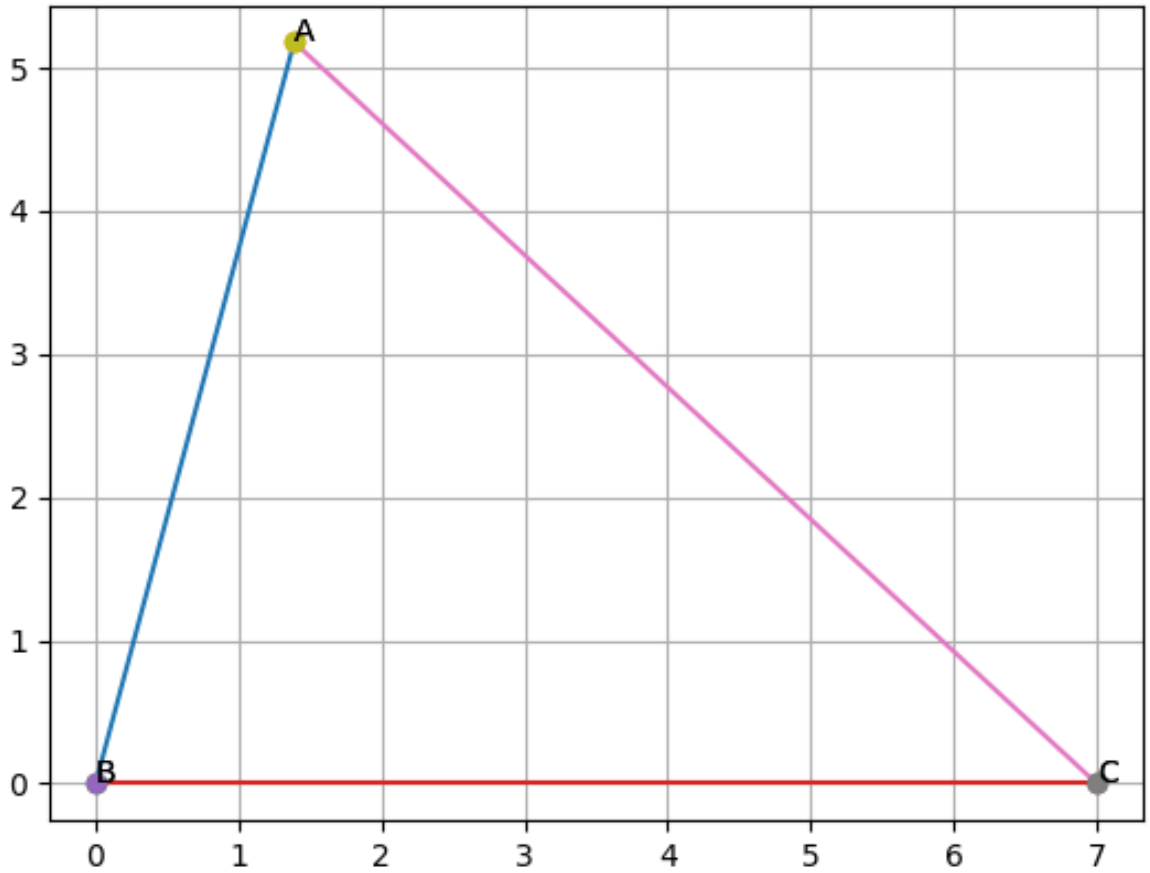


Figure: Triangle with BC=7; $\angle B = 75°$; AB + BC = 13