MatGeo Assignment - Problem 1.9.13

EE25BTECH11024

IIT Hyderabad

September 15, 2025

Problem Statement

A man goes 5 meters due west and then 12 meters due north. How far is he from the starting point?

Solution:

Let's assume that the man starts from the origin. He moves 5 m west to point A.

$$\mathbf{A} = 5\begin{pmatrix} -1 \\ 0 \end{pmatrix} \tag{1}$$

He then moves 12m north from B.

$$\mathbf{B} = 5\begin{pmatrix} -1 \\ 0 \end{pmatrix} + 12\begin{pmatrix} 0 \\ 1 \end{pmatrix} = \begin{pmatrix} -5 \\ 12 \end{pmatrix} \tag{2}$$

Therefore the corrdinates are

Symbol	Value	Description
0	$\begin{pmatrix} 0 \\ 0 \end{pmatrix}$	Origin
A	$\begin{pmatrix} -5 \\ 0 \end{pmatrix}$	First Point
B	$\begin{pmatrix} -5 \\ 12 \end{pmatrix}$	Second Point

Solution:

We need to find the distance between the starting point O and the final point B.

$$\mathbf{O} - \mathbf{B} = \begin{pmatrix} 0 \\ 0 \end{pmatrix} - \begin{pmatrix} -5 \\ 12 \end{pmatrix} = \begin{pmatrix} 5 \\ -12 \end{pmatrix} \tag{3}$$

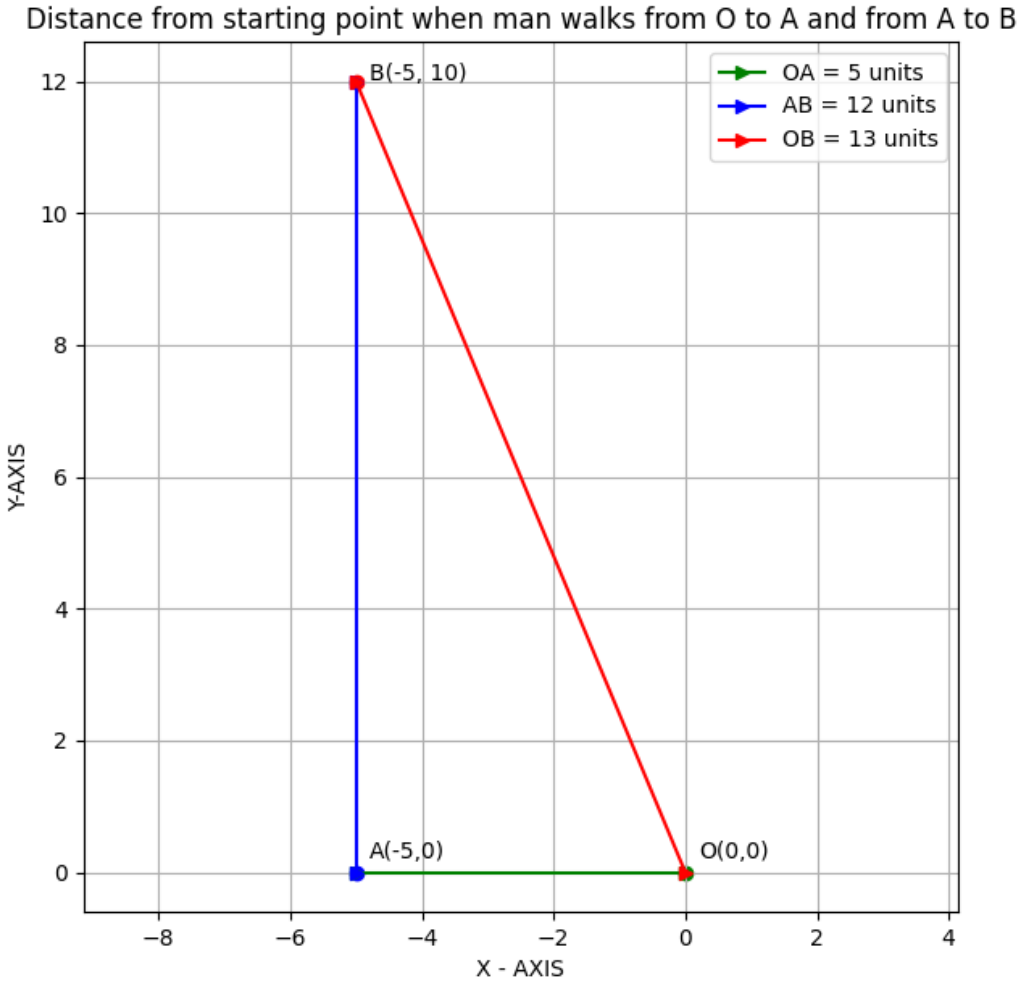
$$(\mathbf{0} - \mathbf{B})^{\top}(\mathbf{0} - \mathbf{B}) = 169 = \|0 - B\|^2 \tag{4}$$

Thus the desired distance is

$$d = \|\mathbf{O} - \mathbf{B}\| = \sqrt{169} = 13 \tag{5}$$

The distance between the man and the starting point = 13 See Figure **??**.

Resulting Graph



Python Code: plot.py (Native)

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

A = np.array([-5, 0])
B = np.array([-5, 12])
O = np.array([0, 0])

plt.figure(figsize = (7,7))
plt.plot([O[0], A[0]], [O[1],A[1]], 'g->', label = 'OA = 5 units')
plt.plot([A[0], B[0]], [A[1],B[1]], 'b->', label = 'AB = 12 units')
plt.plot([B[0], O[0]], [B[1],O[1]], 'r->', label = 'OB = 13 units')

plt.scatter(*O, color = "green")
plt.scatter(*A, color = "blue")
plt.scatter(*B, color = "red")

plt.text(O[0]+0.2, O[1]+0.2, "O(0,0)")
plt.text(A[0]+0.2, A[1]+0.2, "A(-5,0)")
plt.text(B[0]+0.2, B[1], "B(-5, 10)")
```

Python Code (Native Implementation – plot.py)

```
plt.xlabel("X - AXIS")
plt.ylabel("Y-AXIS")
plt.title("Distance from starting point when man walks from O to A and
    from A to B")
plt.legend()
plt.grid(True)
plt.axis("equal")
plt.savefig("fig2.png")
plt.show()
```

C Code (Shared Library – finddistance.c)

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

double find_distance(double x1, double y1, double x2, double y2){
    double d = sqrt(pow(x2-x1, 2) + pow(y2-y1, 2));
    return d;
}
```

Python Code: call.py (C + Python)

```
import ctypes #for interacting with c code (datatypes such as .so)
import numpy as np
import matplotlib.pyplot as plt

so = ctypes.CDLL("./find_distance.so") #loads my shared c library so
    that python can use it

so.find_distance.argtypes = [ctypes.c_double, ctypes.c_double, ctypes.
    c_double, ctypes.c_double]
so.find_distance.restype = ctypes.c_double

O = np.array([0,0])
A = np.array([-5,0])
B = np.array([-5,12])

d_OA = so.find_distance(O[0], O[1], A[0], A[1])
d_AB = so.find_distance(A[0], A[1], B[0], B[1])
d_OB = so.find_distance(O[0], O[1], B[0], B[1])
```

Python Code (C Integrated – call.py)

```
plt.figure(figsize = (7,7))
plt.plot([O[0], A[0]], [O[1], A[1]], 'g-', label = f"OA = {d_OA:.0f}
    units")
plt.plot([A[0], B[0]], [A[1], B[1]], 'b-', label = f"AB = {d_AB:.0f}
    units")
plt.plot([O[0], B[0]], [O[1], B[1]], 'r-', label = f"OB = {d_OB:.0f}
    units")

plt.scatter(*O, color = 'green')
plt.scatter(*A, color = 'blue')
plt.scatter(*B, color = 'red')

plt.text(O[0]+0.2, O[1]+0.2, "O(0,0)")
plt.text(A[0]+0.2, A[1]+0.2, "A(-5,0)")
plt.text(B[0]+0.2, B[1], "B(-5, 10)")
```

Python Code (C Integrated – call.py)

```
plt.xlabel("X-AXIS")
plt.ylabel("Y-AXIS")
plt.title("Distance from starting point when man walks from O to A and
    from A to B")
plt.legend()
plt.axis('equal')
plt.grid(True)
plt.savefig("fig2'.png")
plt.show()
```