1.9.1

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Question

The distance between the points $(m, -n)$ and $(-m, n)$ is _____

given data

let **A** and **B** be the vectors such that:

Variable	**value**
A	$\begin{pmatrix} m \\ -n \end{pmatrix}$
B	$\begin{pmatrix} -m \\ n \end{pmatrix}$

Table: Variables used

Formula

Norm of **A** - **B** is given by:

$$\|\mathbf{A}-\mathbf{B}\| = \sqrt{\|\mathbf{A}\|^2 + \|\mathbf{B}\|^2 - 2A^{\top}\mathbf{B}}$$

finding distance between **A** and **B**

$$\begin{aligned}\|\mathbf{A}-\mathbf{B}\| &= \sqrt{\|\mathbf{A}\|^2+\|\mathbf{B}\|^2-2A^\top\mathbf{B}} \\ &= \sqrt{(m^2+n^2)-2(-m^2-n^2)+m^2+n^2} \\ &= \sqrt{4(m^2+n^2)} \\ &= 2\sqrt{m^2+n^2}\end{aligned}$$

Hence Distance between **A** and **B** is $2\sqrt{m^2+n^2}$.

Python Code

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

# Define m and n
m = 3
n = 4

# Define the points A and B
A = np.array([m, -n])
B = np.array([-m, n])
```

Python Code

```
# Calculate the distance between A and B
distance = 2 * np.sqrt(m**2 + n**2)
print(f"Distance between A{tuple(A)} and B{tuple(B)} is: {
    distance}")

# Create the plot
fig, ax = plt.subplots(figsize=(8, 6))
```

Python Code

```
# Plot points A and B
ax.scatter(A[0], A[1], color='red', s=100, label=f'A = {tuple(A)}
    ')
ax.scatter(B[0], B[1], color='blue', s=100, label=f'B = {tuple(B)
    }')

# Draw line segment between A and B
ax.plot([A[0], B[0]], [A[1], B[1]], 'k--', alpha=0.6, label='Line
     Segment AB')

# Plot origin for reference
ax.scatter(0, 0, color='black', s=80, label='Origin (0,0)')
```

Python Code

```
# Add labels for points
ax.text(A[0] + 0.2, A[1], 'A', fontsize=14)
ax.text(B[0] + 0.2, B[1], 'B', fontsize=14)
ax.text(0.2, 0.2, 'O', fontsize=14)
```

Python Code

```
# Set plot limits with some margin
margin = max(abs(m), abs(n)) + 1
ax.set_xlim(-margin, margin)
ax.set_ylim(-margin, margin)
```

Python Code

```
# Add grid, title, labels, legend
ax.grid(True, linestyle='--', alpha=0.5)
ax.set_title('Distance Between Points A and B', fontsize=16)
ax.set_xlabel('X-axis', fontsize=12)
ax.set_ylabel('Y-axis', fontsize=12)
ax.legend()

# Equal aspect ratio
ax.set_aspect('equal', adjustable='box')

plt.show()
```

C Code

```c
#include <stdio.h>
#include <math.h>
int main() {
    double m, n, distance;
    // Input values for m and n
    printf("Enter the value of m: ");
    scanf("%lf", &m);
```

C Code

```
    printf("Enter the value of n: ");
    scanf("%lf", &n);
    // Calculate distance using the formula
    distance = 2 * sqrt(m * m + n * n);
    // Print the result
    printf("Distance between the points (%.2lf, %.2lf) and (%.2lf
        , %.2lf) is: %.4lf\n",
           m, -n, -m, n, distance);
    return 0;
}
```

Python and C Code

```
import ctypes
import platform

# --- 1. Load the shared library ---
if platform.system() == "Windows":
    lib_path = "./libdistance.dll"
else:
    lib_path = "./libdistance.so"

try:
    lib = ctypes.CDLL(lib_path)
except OSError as e:
    print(f"Error loading library: {e}")
    print("Have you compiled distance_calc.c?")
    exit()
```

Python and C Code

```
# --- 2. Define the function signature ---
# Set the argument types
lib.calculate_distance.argtypes = [ctypes.c_double, ctypes.
    c_double]

# IMPORTANT: Set the return type.
# This tells ctypes that the C function returns a double value.
lib.calculate_distance.restype = ctypes.c_double
```

Python and C Code

```
# --- 3. Get input from the user in Python ---
try:
    m_val = float(input("Enter the value of m: "))
    n_val = float(input("Enter the value of n: "))
except ValueError:
    print("Invalid input. Please enter numbers.")
    exit()
```

Python and C Code

```
# --- 4. Call the C function and get the returned value ---
distance = lib.calculate_distance(m_val, n_val)

# --- 5. Print the result ---
print("\n--- Calculation performed by C ---")
print(f"Distance between the points ({m_val:.2f}, {-n_val:.2f})
    and ({-m_val:.2f}, {n_val:.2f}) is: {distance:.4f}")
```

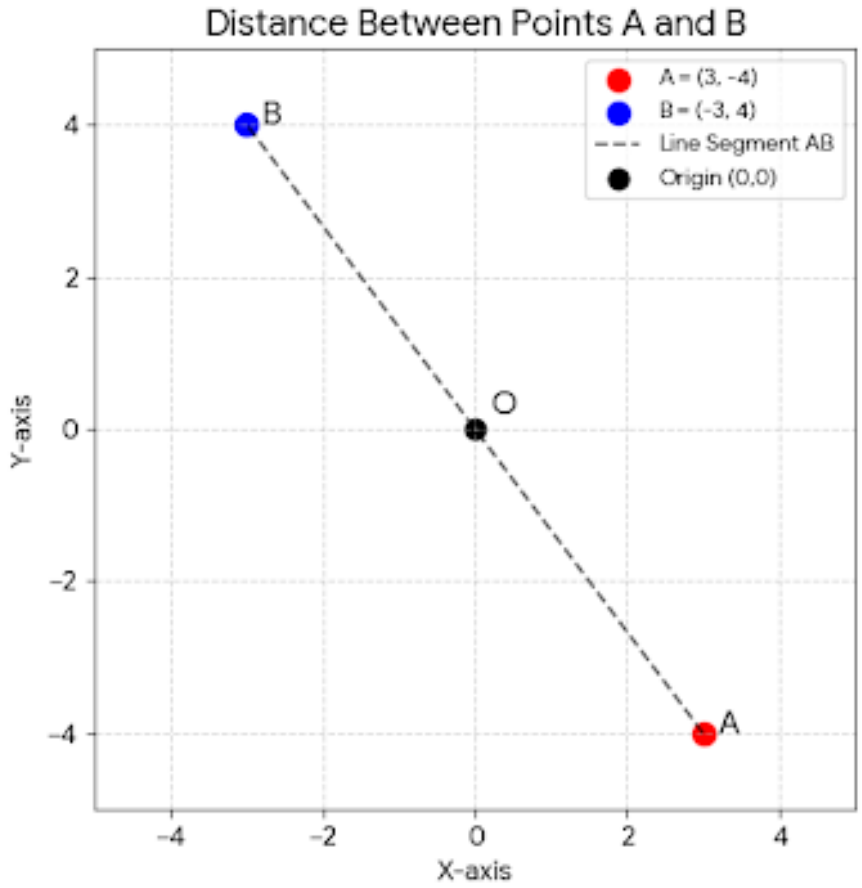
Distance Between Points A and B
A = (3, -4)
B = (-3, 4)
Line Segment AB
Origin (0,0)
B
O
A
Y-axis
X-axis
4
2
0
−2
−4
−4
−2
0
2
4

Figure: Plot