

Problem 1.9.12

ee25btech11023-Venkata Sai

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Problem Statement

Find the length of the segment joining **A**($-6, 7$) and **B**($-1, -5$). Also, find the midpoint of AB.

Variable	Description	Values
A	Point	$(-6, 7)$
B	Point	$(-1, -5)$

Table: Variables given

Formulas

Formula:

The direction vector for the given two points **A** and **B** is given by **B - A**

Midpoint Formula:

$$\mathbf{P} = \frac{k(\mathbf{B}) + (\mathbf{A})}{k + 1} \quad (1.1)$$

Where:

$$k = 1$$

$$\mathbf{A} = \begin{pmatrix} -6 \\ 7 \end{pmatrix} \quad \mathbf{B} = \begin{pmatrix} -1 \\ -5 \end{pmatrix} \quad (1.2)$$

Obtaining Length of the segment

$$\mathbf{B} - \mathbf{A} = \begin{pmatrix} -1 - (-6) \\ -5 - 7 \end{pmatrix} = \begin{pmatrix} 5 \\ -12 \end{pmatrix} \quad (1.3)$$

$$d = \|\mathbf{B} - \mathbf{A}\| = \sqrt{(\mathbf{B} - \mathbf{A})^\top (\mathbf{B} - \mathbf{A})} \quad (1.4)$$

$$(\mathbf{B} - \mathbf{A})^\top (\mathbf{B} - \mathbf{A}) = (5 \quad -12) \begin{pmatrix} 5 \\ -12 \end{pmatrix} \quad (1.5)$$

$$= 5 \times 5 + -12 \times -12 = 169 \quad (1.6)$$

$$d = \sqrt{169} = 13 \quad (1.7)$$

Hence, the length of the segment **AB** is 13 units.

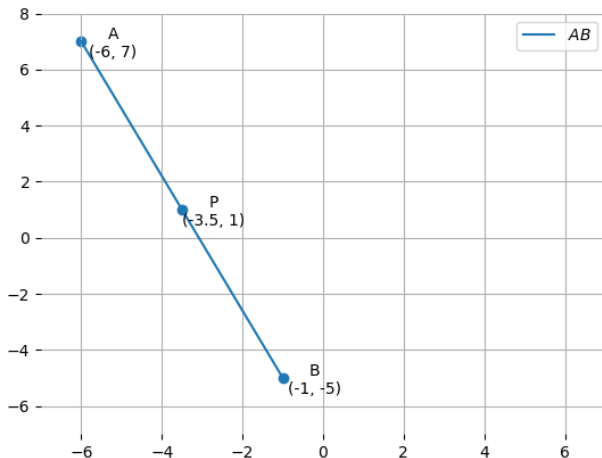
Finding Midpoint

$$\mathbf{P} = \frac{\mathbf{B} + \mathbf{A}}{2} = \frac{\begin{pmatrix} -6 \\ 7 \end{pmatrix} + \begin{pmatrix} -1 \\ -5 \end{pmatrix}}{2} = \frac{\begin{pmatrix} -7 \\ 2 \end{pmatrix}}{2} \quad (1.8)$$

$$= \begin{pmatrix} \frac{-7}{2} \\ 1 \end{pmatrix} \quad (1.9)$$

Hence the coordinates of \mathbf{P} are $(\frac{-7}{2}, 1)$

Plot



Figure

C Code for generating points on line

```
#include <math.h>
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <unistd.h>
#include <sys/socket.h>
#include <netinet/in.h>

#include "libs/matfun.h"
#include "libs/geofun.h"

int main() {
    double **k, **M, **C;
    int x1 = -6, x2 = -1, y1 = 7, y2 = -5;

    // Create matrices
    M = createMat(2, 2);
    k = createMat(2, 1);
    C = createMat(2, 1);
```


C Code for generating points on line

```
M[0][1] = x1;
M[1][1] = y1;

M[0][0] = x2;
M[1][0] = y2;

k[0][0] = 1.0 / 2; // weight for B (column 0)
k[1][0] = 1.0 / 2; // weight for A (column 1)

// Matrix multiplication: C = M * k
C = Matmul(M, k, 2, 2, 1);

// Write result to file
FILE *file = fopen("values.dat", "w");
if (file == NULL) {
    printf("Error opening file!\n");
    return 1;
}
```

C Code for generating points on line

```
    }  
    fprintf(file, "x\ty\t of C\n");  
    fprintf(file, "%.02lf\t%.02lf\n", C[0][0], C[1][0]); // x and  
        y of C  
  
    fclose(file);  
    printf("Results have been written to values.dat\n");  
  
    // Free memory  
    freeMat(M, 2);  
    freeMat(k, 2);  
    freeMat(C, 2);  
  
    return 0;  
}
```

Python Code for Plotting

```
# Code by /sdcard/github/matgeo/codes/CoordGeoVV Sharma  
# September 12, 2023  
# Revised July 21, 2024  
# Released under GNU GPL  
# Section Formula  
  
import sys  
sys.path.insert(0, '/workspaces/urban-potato/matgeo/codes/  
    CoordGeo/') # path to my scripts  
  
import numpy as np  
import matplotlib.pyplot as plt  
import matplotlib.image as mpimg  
# Local imports  
from line.funcs import *  
from triangle.funcs import *  
from conics.funcs import circ_gen
```

Python Code for Plotting

```
# Read data
data = np.loadtxt("values.dat", skiprows=1)

xc = data[0] # Extract x-coordinate (e.g., -1)
yc = data[1] # Extract y-coordinate (e.g., 4.5)

# Given points
A = np.array([-6, 7]).reshape(-1, 1)
B = np.array([-1, -5]).reshape(-1, 1)
P = np.array([xc, yc]).reshape(-1, 1)

# Generating line AB
x_AB = line_gen(A, B)

# Plotting
plt.plot(x_AB[0, :], x_AB[1, :], label='AB')
```

Python Code for Plotting

```
# Labeling the coordinates
tri_coords = np.block([[A, B, P]])
plt.scatter(tri_coords[0, :], tri_coords[1, :])

vert_labels = ['A', 'B', 'P']

# Helper function: format number with decimal only if needed
def fmt(val):
    return f"{val:.1f}" if abs(val - round(val)) > 1e-6 else f"{int(val)}"

for i, txt in enumerate(vert_labels):
    x = tri_coords[0, i].item()
    y = tri_coords[1, i].item()
    plt.annotate(f'{txt}\n({fmt(x)}, {fmt(y)})',
                (x, y),
                textcoords="offset points",
                xytext=(20, -10),
                ha='center')
```

Python Code for Plotting

```
ax = plt.gca()
ax.spines['left'].set_visible(False)
ax.spines['right'].set_visible(False)
ax.spines['top'].set_visible(False)
ax.spines['bottom'].set_visible(False)

plt.legend(loc='best')
plt.grid()

# Increase y-axis from -8 to 8 to show full range
plt.ylim(-7, 8)
plt.xlim(-7,7)

# Save and open
plt.show()
plt.savefig('../figs/fig1.png')
```