MatGeo Assignment

Problem 1.2.15

AI25BTECH11009 – Dasu Harshith Kumar

October 3, 2025

Question 1.2.15

Verify if the points

$$A(4,3),\ B(6,4),\ C(5,-6),\ D(-3,5)$$

are the vertices of a parallelogram.

Theoretical Solution

A quadrilateral is a parallelogram if the diagonals bisect each other, i.e., the midpoints of AC and BD are the same.
Midpoint of diagonal AC:

$$M_{AC} = \frac{A + C}{2} = \frac{1}{2}\begin{pmatrix} 4+5 \\ 3+(-6) \end{pmatrix} = \begin{pmatrix} 4.5 \\ -1.5 \end{pmatrix}$$

Theoretical Solution

Midpoint of diagonal BD:

$$M_{BD} = \frac{B + D}{2} = \frac{1}{2}\begin{pmatrix} 6 + (-3) \\ 4 + 5 \end{pmatrix} = \begin{pmatrix} 1.5 \\ 4.5 \end{pmatrix}$$

Since $M_{AC} \neq M_{BD}$, the diagonals do not bisect each other.

$$\therefore \; A, B, C, D \text{ do not form a parallelogram.}$$

C Code - Midpoint of diagonals

```c
// midpoint.c (part 1/2)
#include <stdio.h>

void midpoint(double x1, double y1, double x2, double y2,
              double* mx, double* my) {
    *mx = (x1 + x2) / 2.0;
    *my = (y1 + y2) / 2.0;
}

int main() {
    double mx, my;

    // AC midpoint
    midpoint(4, 3, 5, -6, &mx, &my);
    printf("Midpoint AC = (%lf, %lf)\n", mx, my);
```

C Code - Midpoint of diagonals (cont.)

```c
// midpoint.c (part 2/2)

// BD midpoint
midpoint(6, 4, -3, 5, &mx, &my);
printf("Midpoint BD = (%lf, %lf)\n", mx, my);

return 0;
}
```

Python Code

```python
# plot_parallelogram_check.py (part 1/2)
import matplotlib.pyplot as plt

A = (4, 3)
B = (6, 4)
C = (5, -6)
D = (-3, 5)

# Midpoints
M_AC = ((A[0]+C[0])/2, (A[1]+C[1])/2)
M_BD = ((B[0]+D[0])/2, (B[1]+D[1])/2)

print("Midpoint AC =", M_AC)
print("Midpoint BD =", M_BD)
```

Python Code (cont.)

```
# plot_parallelogram_check.py (part 2/2)
plt.figure(figsize=(6,6))
x = [A[0], B[0], C[0], D[0], A[0]]
y = [A[1], B[1], C[1], D[1], A[1]]
plt.plot(x, y, 'ro-')

for P, name in zip([A,B,C,D,M_AC,M_BD],
                   ['A','B','C','D','M_AC','M_BD']):
    plt.text(P[0]+0.2, P[1]+0.2, name, fontsize=10)

plt.grid(True)
plt.gca().set_aspect('equal', adjustable='box')
plt.title("Check if ABCD is a Parallelogram")

# Save (optional) and/or show
plt.savefig("figs/1_2_15.jpg", dpi=300, bbox_inches="tight")
plt.show()
```

Plot