1.3.4

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Question

If A(1,3), B(-1,2), C(2,5) and D(x,4) are the vertices of a parallelogram ABCD, then the value of x is _____(10, 2012)

Theoretical Solution

In a parallelogram, the diagonals bisect each other. Therefore, the midpoint of diagonal AC equals the midpoint of diagonal BD:

$$\frac{\mathbf{A} + \mathbf{C}}{2} = \frac{\mathbf{B} + \mathbf{D}}{2} \tag{1}$$

$$\mathbf{A} + \mathbf{C} = \mathbf{B} + \mathbf{D} \tag{2}$$

$$D = A + C - B \tag{3}$$

Substituting the coordinates:

$$= \begin{pmatrix} 1+2-(-1)\\ 3+5-2 \end{pmatrix} \tag{5}$$

$$= \begin{pmatrix} 4 \\ 6 \end{pmatrix} \tag{6}$$

Theoretical Solution

This gives us the equations:

$$x = 4 \tag{7}$$

$$4 = 6 \tag{8}$$

this indicates that the assumption ABCD is a parallelogram with the given order might be incorrect. Perhaps the vertices are not in order A,B,C,DA,B,C,D. Let's try a different pairing.

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$$\frac{\mathbf{A} + \mathbf{D}}{2} = \frac{\mathbf{B} + \mathbf{C}}{2} \tag{9}$$

$$\mathbf{A} + \mathbf{D} = \mathbf{B} + \mathbf{C} \tag{10}$$

$$D = B + C - A \tag{11}$$

Theoretical Solution

Substituting the coordinates:

$$= \begin{pmatrix} -1+2-(-1)\\ 2+5-3 \end{pmatrix} \tag{13}$$

$$= \begin{pmatrix} 0 \\ 4 \end{pmatrix} \tag{14}$$

This gives us the equations:

$$x = 0 \tag{15}$$

$$4 = 4 \tag{16}$$

Main C Code

```
// main.c
#include <stdio.h>
// function declaration
int find_x(int Ax, int Ay, int Bx, int By, int Cx, int Cy, int Dy
    );
int main() {
    int Ax=1, Ay=3, Bx=-1, By=2, Cx=2, Cy=5, Dy=4;
    int x = find_x(Ax, Ay, Bx, By, Cx, Cy, Dy);
   printf("The value of x is: %d\n", x);
```

Main C Code

```
// save coordinates to file for Python
FILE *fp = fopen("coords.dat","w");
fprintf(fp,"%d %d\n",Ax,Ay);
fprintf(fp,"%d %d\n",Bx,By);
fprintf(fp,"%d %d\n",x,Dy);
fprintf(fp,"%d %d\n",Cx,Cy);
fclose(fp);

return 0;
}
```

C Function

```
// parallelogram.c
#include <stdio.h>
int find_x(int Ax, int Ay, int Bx, int By, int Cx, int Cy, int Dy
    ){
int Dx=Bx+Cx-Ax;
    return Dx;
}
```

Python Code

```
from ctypes import CDLL
import matplotlib.pyplot as plt
# load shared library
lib = CDLL("./libparallelogram.so")
# run C main program to generate coords.dat
import os
os.system("./main")
# read coords
coords = []
with open("coords.dat") as f:
    for line in f:
       x,y = map(int,line.split())
       coords.append((x,y))
# close polygon
coords.append(coords[0])
```

Python Code

```
# plot
 xs, ys = zip(*coords)
 plt.plot(xs, ys, marker='o')
plt.text(1,3,"A(1,3)")
 plt.text(-1,2,"B(-1,2)")
 plt.text(0,4,"D(0,4)")
 plt.text(2,5,"C(2,5)")
 plt.title("Parallelogram ABCD")
 plt.grid(True)
 plt.savefig("/home/r-nikhil/ee1030-2025/ai25btech11025/matgeo
     /1.3.4/figs/plotc.png")
 plt.show()
```

