1.7.2-Beamer

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Question

If A(1, 2), O(0, 0), and C(a, 6) are collinear, then the value of a is

Theoretical Solution

The given points are

$$A = (1, 2) \quad O = (0, 0) \quad C = (a, 6) \tag{1}$$

$$\mathbf{A} - \mathbf{O} = \begin{pmatrix} 1 \\ 2 \end{pmatrix} \tag{2}$$

$$\mathbf{C} - \mathbf{O} = \begin{pmatrix} a \\ 6 \end{pmatrix} \tag{3}$$

Theoretical Solution

Construct the matrix

$$M = \begin{pmatrix} 1 & a \\ 2 & 6 \end{pmatrix} \tag{4}$$

For the points to be collinear, the two vectors **OA** and **OC** must be linearly dependent
This means

$$\text{rank}(M) = 1 \quad \Leftrightarrow \quad \det(M) = 0 \tag{5}$$

$$\begin{pmatrix} 1 & a \\ 2 & 6 \end{pmatrix} \xrightarrow{R_2 \leftarrow R_2 - 2R_1} \begin{pmatrix} 1 & a \\ 0 & 6-2a \end{pmatrix} \tag{6}$$

Theoretical Solution

For the rank to drop,

$$6 - 2a = 0 \tag{7}$$

$$a = 3 \tag{8}$$

When $a = 3$,

$$\begin{pmatrix} 1 & 3 \\ 0 & 0 \end{pmatrix}$$

is the reduced row-echelon form (rank $= 1$)
The given points are collinear when

$$a = 3 \tag{9}$$

C Code

```c
#include <stdbool.h>

bool is_collinear(int a) {
    int det = 6 - 2*a; // determinant
    return (det == 0);
}
```

C plus Python code

```
import ctypes
import matplotlib.pyplot as plt

# Load the shared library
lib = ctypes.CDLL(./collinear.so)
lib.is_collinear.argtypes = [ctypes.c_int]
lib.is_collinear.restype = ctypes.c_bool

# Points
O = (0, 0)
A = (1, 2)
a = 3 # try changing this value
C = (a, 6)

# Check collinearity using C function
print(Collinear?, lib.is_collinear(a))
```

C plus Python code

```
# Plot points
plt.figure(figsize=(6,6))
plt.scatter(*O, color='black', label=O(0,0))
plt.scatter(*A, color='red', label=A(1,2))
plt.scatter(*C, color='blue', label=fC({a},6))

# If collinear, draw line through O, A, C
if lib.is_collinear(a):
    plt.plot([O[0], A[0], C[0]], [O[1], A[1], C[1]], 'g--', label
        =Collinear line)
else:
    # If not collinear, just connect O-A and O-C separately
    plt.plot([O[0], A[0]], [O[1], A[1]], 'r--')
    plt.plot([O[0], C[0]], [O[1], C[1]], 'b--')
```

C plus Python code

```
# Formatting
plt.axhline(0, color='black', linewidth=0.5)
plt.axvline(0, color='black', linewidth=0.5)
plt.grid(True, linestyle=--, alpha=0.6)
plt.legend()
plt.xlabel(x-axis)
plt.ylabel(y-axis)
plt.title(Collinearity Check of A, O, and C)
pltsave.fig(/sdcard/Matrix/ee1030-2025/ai25btech11016/Matgeo
    /1.2.24/figs/1.7.2.png)
plt.show()
```

Python plot code

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

# Points
O = np.array([0, 0])
A = np.array([1, 2])
C = np.array([3, 6]) # since a = 3

# Plot the points
plt.figure(figsize=(6,6))
plt.scatter(*O, color='black', label='O(0,0)')
plt.scatter(*A, color='red', label='A(1,2)')
plt.scatter(*C, color='blue', label='C(3,6)')
```

Python plot code

```
# Draw lines between them
plt.plot([O[0], A[0], C[0]], [O[1], A[1], C[1]], 'g--', label='
    Collinear line')

# Labels and formatting
plt.axhline(0, color='black', linewidth=0.5)
plt.axvline(0, color='black', linewidth=0.5)
plt.grid(True, linestyle='--', alpha=0.6)
plt.legend()
plt.xlabel(x-axis)
plt.ylabel(y-axis)

plt.savefig(/sdcard/Matrix/ee1030-2025/ai25btech11016/Matgeo
    /1.2.24/figs/1.7.2.png)
plt.show()
```

Plot

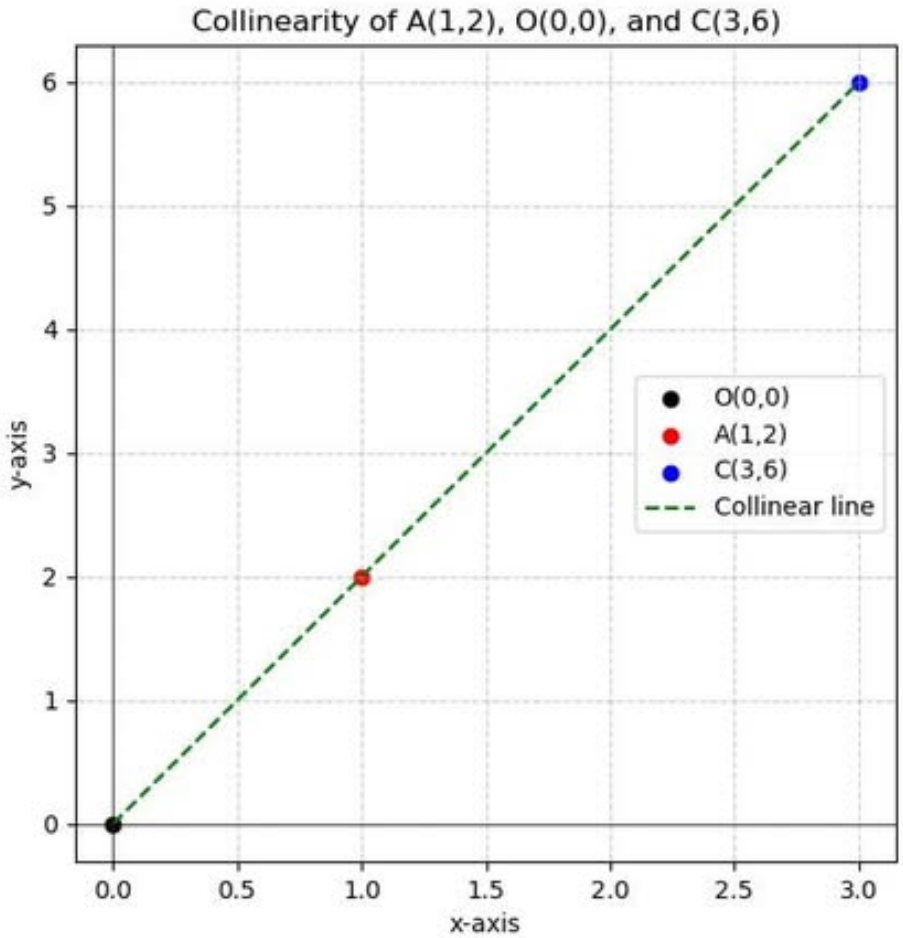
Collinearity of A(1,2), O(0,0), and C(3,6)
y-axis
x-axis
0
1
2
3
4
5
6
0.0
0.5
1.0
1.5
2.0
2.5
3.0
O(0,0)
A(1,2)
C(3,6)
Collinear line

Figure: