Matgeo Presentation - Problem 1.6.13

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Question

The points $(0, 5)$, $(0, -9)$ and $(3, 6)$ are not collinear.

Description

Solution:

point	Name
$(0, 5)$	Point A
$(0, -9)$	Point B
$(3, 6)$	Point C

Table: Variables Used

3 points are collinear if the rank of collinearity matrix is 1.Rank of matrix is1

$$(0.1)$$

means no.of rows with non zero entries is 1.

Solution

The collinearity matrix is given by $\qquad$ (0.2)

$$\left(\mathbf{B} - \mathbf{A} \quad \mathbf{C} - \mathbf{A}\right)^T = \begin{pmatrix} 0 & -14 \\ 3 & 1 \end{pmatrix} \tag{0.3}$$

$$\tag{0.4}$$

$$\begin{pmatrix} 0 & -14 \\ 3 & 1 \end{pmatrix} \xrightarrow{R_1 \leftrightarrow R_2} \begin{pmatrix} 3 & 1 \\ 0 & -14 \end{pmatrix} \tag{0.5}$$

$$\tag{0.6}$$

$$\begin{pmatrix} 3 & 1 \\ 0 & -14 \end{pmatrix} \xleftarrow{R_1 \leftarrow \frac{1}{3}R_1} \begin{pmatrix} 1 & \frac{1}{3} \\ 0 & -14 \end{pmatrix} \tag{0.7}$$

$$\begin{pmatrix} 1 & \frac{1}{3} \\ 0 & -14 \end{pmatrix} \xleftarrow{R_2 \leftarrow \frac{-1}{14}R_2} \begin{pmatrix} 1 & \frac{1}{3} \\ 0 & 1 \end{pmatrix} \tag{0.8}$$

conclusion

The above matrix now is in row echelon form.Rank of a matix in echelon form is number of non zero rows.so,The rank of the above collinearity matrix is 2
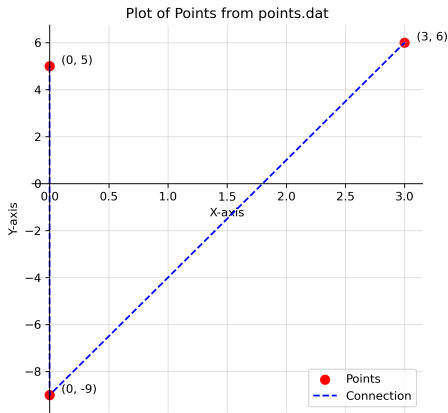
$\implies$ given 3 points A,B,C are not collinear.

Figure: A,B,C are not collinear

C Code: points.c

```c
#include <stdio.h>

int main() {
  FILE *fp;

  // -------------------
  // Question 1.6.13
  // -------------------

  fp = fopen("points.dat", "w");
  fprintf(fp, "%d,%d,%d\n", 0, 5, 0); // A
  fprintf(fp, "%d,%d,%d\n", 0, -9, 0); // B
  fprintf(fp, "%d,%d,%d\n", 3, 6, 0); // C
  fclose(fp);
  return 0;
}
```

Python: call_c.py

```python
import subprocess

# Compile the C program
subprocess.run(["gcc", "points.c", "-o", "points"])

# Run the compiled C program
result = subprocess.run(["./points"], capture_output=True, text=True)

# Print the output from the C program
print(result.stdout)
```

Python: plot.py

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

# Load the file, using comma as delimiter
points = np.loadtxt("points.dat", delimiter=",")

# Take only the first two columns (x, y)
x = points[:, 0]
y = points[:, 1]

# --- Plot ---
plt.figure(figsize=(6, 6))
plt.scatter(x, y, color="red", s=60, label="Points")
plt.plot(x, y, linestyle="--", color="blue", label="Connection")

# Annotate each point
for xi, yi in zip(x, y):
    plt.text(xi + 0.1, yi + 0.1, f"({xi:g}, {yi:g})")

# Axes setup
ax = plt.gca()
ax.spines["left"].set_position("zero")
ax.spines["bottom"].set_position("zero")
ax.spines["right"].set_color("none")
ax.spines["top"].set_color("none")

plt.xlabel("X-axis")
plt.ylabel("Y-axis")
plt.title("Plot of Points from points.dat")
plt.grid(True, alpha=0.4)
plt.legend()

# Save the figure
```

Python: plot.py

```
plt.savefig("points_plot.png", dpi=300, bbox_inches="tight")

# Show the figure
plt.show()
```