Assignment 2

Digjoy Nandi - AI20BTECH11007

Download all python codes from

```
https://github.com/Digjoy12/Signal−Processing/tree
    /main/Assignment_2/Code
```

and latex codes from

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https://github.com/Digjoy12/Signal−Processing/
    blob/main/Assignment_2/main.tex
```

Problem

(Matrix - Q2.60) Find the matrix $\mathbf{X}$ so that

$$\mathbf{X}\begin{pmatrix}1 & 2 & 3\\4 & 5 & 6\end{pmatrix} = \begin{pmatrix}-7 & -8 & -9\\2 & 4 & 6\end{pmatrix}$$

Solution

Given,

$$\mathbf{X}\begin{pmatrix}1 & 2 & 3\\4 & 5 & 6\end{pmatrix}_{2\times3} = \begin{pmatrix}-7 & -8 & -9\\2 & 4 & 6\end{pmatrix}_{2\times3} \tag{0.0.1}$$

Therefore, $\mathbf{X}$ is a 2×2 matrix.
Let,

$$\mathbf{X} = \begin{pmatrix}a & b\\c & d\end{pmatrix} \tag{0.0.2}$$

Now our equation (0.0.1) becomes,

$$\begin{pmatrix}a & b\\c & d\end{pmatrix}\begin{pmatrix}1 & 2 & 3\\4 & 5 & 6\end{pmatrix} = \begin{pmatrix}-7 & -8 & -9\\2 & 4 & 6\end{pmatrix} \tag{0.0.3}$$

$$\implies \begin{pmatrix}a+4b & 2a+5b & 3a+6b\\c+4d & 2c+5d & 3c+6d\end{pmatrix} = \begin{pmatrix}-7 & -8 & -9\\2 & 4 & 6\end{pmatrix} \tag{0.0.4}$$

Since, the matrices are equal, therefore the corresponding elements are equal too.

$$a+4b = -7 \tag{0.0.5}$$
$$2a+5b = -8 \tag{0.0.6}$$
$$3a+6b = -9 \tag{0.0.7}$$
$$c+4d = 2 \tag{0.0.8}$$
$$2c+5d = 4 \tag{0.0.9}$$
$$3c+6d = 6 \tag{0.0.10}$$

Now, (0.0.5) and (0.0.6) are two equation with a and b variables, which can be expressed in vector form as

$$\begin{pmatrix}1 & 4\\2 & 5\end{pmatrix}\begin{pmatrix}a\\b\end{pmatrix} = \begin{pmatrix}-7\\-8\end{pmatrix} \tag{0.0.11}$$

The corresponding augmented matrix is

$$\left(\begin{array}{cc|c}1 & 4 & -7\\2 & 5 & -8\end{array}\right) \tag{0.0.12}$$

We use the Guass Jordan Elimination method as:

$$\left(\begin{array}{cc|c}1 & 4 & -7\\2 & 5 & -8\end{array}\right) \tag{0.0.13}$$
$$\xleftrightarrow{R_2\to R_2-2R_1}\left(\begin{array}{cc|c}1 & 4 & -7\\0 & -3 & 6\end{array}\right) \tag{0.0.14}$$
$$\xleftrightarrow{R_2\to \frac{-1}{3}R_2}\left(\begin{array}{cc|c}1 & 4 & -7\\0 & 1 & -2\end{array}\right) \tag{0.0.15}$$
$$\xleftrightarrow{R_1\to R_1-4R_2}\left(\begin{array}{cc|c}1 & 0 & 1\\0 & 1 & -2\end{array}\right) \tag{0.0.16}$$

Therefore, the values of a and b are:

$$a = 1 \tag{0.0.17}$$
$$b = -2 \tag{0.0.18}$$

Now, (0.0.5) and (0.0.6) are two equation with c and d variables, which can be expressed in vector form as

$$\begin{pmatrix}1 & 4\\2 & 5\end{pmatrix}\begin{pmatrix}c\\d\end{pmatrix} = \begin{pmatrix}2\\4\end{pmatrix} \tag{0.0.19}$$

The corresponding augmented matrix is

$$\left(\begin{array}{cc|c}1 & 4 & 2\\2 & 5 & 4\end{array}\right) \tag{0.0.20}$$

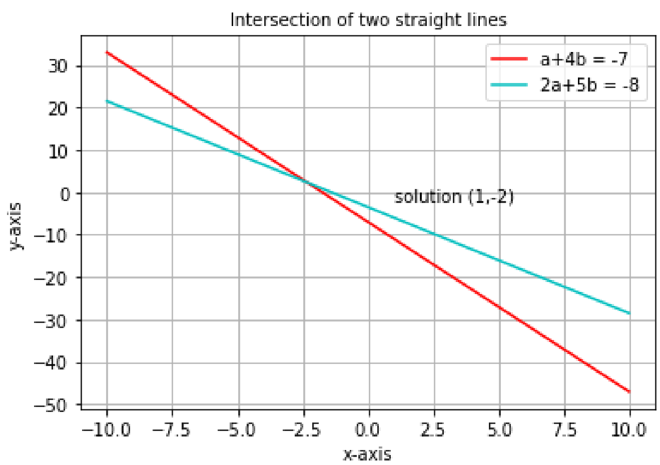

Fig. 0: Plot of the lines

We use the Guass Jordan Elimination method as:

$$\left(\begin{array}{cc|c} 1 & 4 & 2 \\ 2 & 5 & 4 \end{array}\right) \tag{0.0.21}$$

$$\xleftrightarrow{R_2 \to R_2 - 2R_1} \left(\begin{array}{cc|c} 1 & 4 & 2 \\ 0 & -3 & 0 \end{array}\right) \tag{0.0.22}$$

$$\xleftrightarrow{R_2 \to \frac{-1}{3} R_2} \left(\begin{array}{cc|c} 1 & 4 & 2 \\ 0 & 1 & 0 \end{array}\right) \tag{0.0.23}$$

$$\xleftrightarrow{R_1 \to R_1 - 4R_2} \left(\begin{array}{cc|c} 1 & 0 & 2 \\ 0 & 1 & 0 \end{array}\right) \tag{0.0.24}$$

Therefore, the values of c and d are:

$$a = 2 \tag{0.0.25}$$

$$b = 0 \tag{0.0.26}$$

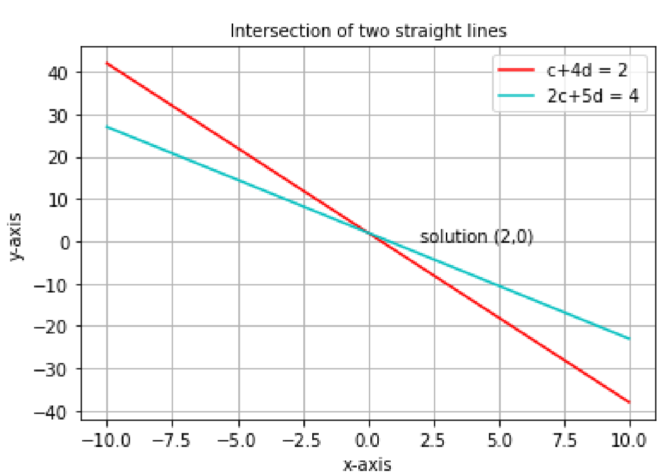

Fig. 0: Plot of the lines

Therefore, the matrix $\mathbf{X}$ is

$$\mathbf{X} = \begin{pmatrix} a & b \\ c & d \end{pmatrix} \tag{0.0.27}$$

$$= \begin{pmatrix} 1 & -2 \\ 2 & 0 \end{pmatrix} \tag{0.0.28}$$