# Probability Assignment 1

EE22BTECH11210 - KARTHIKEYA HANU PRAKASH KANITHI

**Question :** Show that $\mathbf{A}$,$\mathbf{D}$,$\mathbf{G}$ are collinear
**Solution :**
Given that,

$$\mathbf{A} = \begin{pmatrix} 1 \\ -1 \end{pmatrix} \quad \mathbf{B} = \begin{pmatrix} -4 \\ 6 \end{pmatrix} \quad \mathbf{C} = \begin{pmatrix} -3 \\ -5 \end{pmatrix} \tag{1}$$

We need to show that points $\mathbf{A}$,$\mathbf{D}$,$\mathbf{G}$ are collinear

By taking reference from the previous problems, we can conclude that

From Problem 1.2.3 We know that, The point G is

$$\mathbf{G} = \begin{pmatrix} -2 \\ 0 \end{pmatrix}$$

And from Problem 1.2.1 We know that, The point D is

$$\mathbf{D} = \begin{pmatrix} \frac{-7}{2} \\ \frac{1}{2} \end{pmatrix}$$

In Problem 1.1.3, There is a theorem/law mentioned i.e.,

*Theorem* 1. Points $\mathbf{A}$,$\mathbf{B}$,$\mathbf{C}$ are defined to be collinear if

$$\text{rank}\begin{pmatrix} 1 & 1 & 1 \\ \mathbf{A} & \mathbf{B} & \mathbf{C} \end{pmatrix} = 2$$

Using Theorom 1: Let

$$R = \begin{pmatrix} 1 & 1 & 1 \\ a_{11} & d_{11} & g_{11} \\ a_{21} & d_{21} & g_{21} \end{pmatrix}$$

Then $\mathbf{A}$,$\mathbf{D}$,$\mathbf{G}$ are collinear points if and only if $\rho(R) = 2$ (Where $\rho(R) = 2$ represents rank of matrix R)
So, lets convert the matrix R into echoloen form by using Elementary operations

$$R = \begin{pmatrix} 1 & 1 & 1 \\ 1 & \frac{-7}{2} & -2 \\ 0 & -3 & -2 \end{pmatrix} \qquad (R_3 \to R_3 + R_1)$$

$$R = \begin{pmatrix} 1 & 1 & 1 \\ 0 & -\frac{-9}{2} & -3 \\ 0 & -3 & -2 \end{pmatrix} \qquad (R_2 \to R_2 - R_1)$$

$$R = \begin{pmatrix} 1 & 1 & 1 \\ 0 & \frac{-9}{2} & -3 \\ 0 & 0 & 0 \end{pmatrix} \qquad (R_3 \to R_3 - \frac{2}{3}R_2)$$

The above matrix R is in echoleon form and we can see that every element of row 3 is zero.
So, we can say that there are only 2 independent rows and the rank of matrix R i.e., $\rho(R) = 2$
As, we have proved that $\rho(R)$ is equal to 2, The theorom states that points $\mathbf{A}$,$\mathbf{D}$,$\mathbf{G}$ are collinear.