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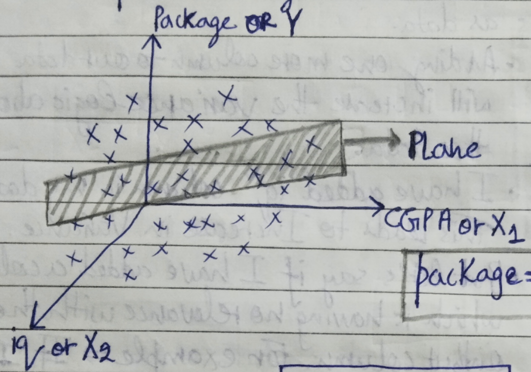
Multiple Linear Regression

- In Multiple Linear Regression there are more than one input columns...



CGPA	iq	Package
—	—	—
—	—	—

Data

$$\boxed{package = \beta_0 + \beta_1 * CGPA + \beta_2 * iq}$$

- Equation of Plane $\Rightarrow \boxed{mX_1 + nX_2 + b}$ which is also standardly written as:-

$\hat{Y} \Rightarrow \boxed{\beta_0 + \beta_1 X_1 + \beta_2 X_2}$ where $\Rightarrow \beta_0 = b$, $\beta_1 = m$, $\beta_2 = n$

- This equation in General written as:- $\boxed{\hat{Y} = \beta_0 + \sum_{i=1}^{n} \beta_i X_i}$

Q How to calculate the $\beta_0, \beta_1, \beta_2 \cdots \beta_n$?

Ans

$$\begin{bmatrix} \hat{y}_1 \\ \hat{y}_2 \\ \hat{y}_3 \\ \hat{y}_4 \\ \vdots \\ \hat{Y}_{100} \end{bmatrix} \Rightarrow \begin{bmatrix} \beta_0 & \beta_1 X_{11} & \beta_2 X_{12} & \beta_3 X_{13} \\ \beta_0 & \beta_1 X_{21} & \beta_2 X_{22} & \beta_3 X_{23} \\ \beta_0 & \beta_1 X_{31} & \beta_2 X_{32} & \beta_3 X_{33} \\ \beta_0 & \beta_1 X_{41} & \beta_2 X_{42} & \beta_3 X_{43} \\ & & \vdots & \\ \beta_0 & \beta_1 X_{100\,1} & \beta_2 X_{100\,2} & \beta_3 X_{100\,3} \end{bmatrix}$$

Y_Predicted Matrix

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- Assuming that now, we have columns = "m" and rows = "n".
In that case, the Matrix will be written as:-

$$\begin{bmatrix} \hat{Y}_1 \\ \hat{Y}_2 \\ \hat{Y}_3 \\ \vdots \\ \vdots \\ \hat{Y}_n \end{bmatrix} \Rightarrow \begin{bmatrix} \beta_0 & \beta_1 X_{11} & \beta_2 X_{12} & \beta_3 X_{13} & \cdots & \beta_m X_{1m} \\ \beta_0 & \beta_1 X_{21} & \beta_2 X_{22} & \beta_3 X_{23} & \cdots & \beta_m X_{2m} \\ \beta_0 & \beta_1 X_{31} & \beta_2 X_{32} & \beta_3 X_{33} & \cdots & \beta_m X_{3m} \\ & & \vdots & & & \\ \beta_0 & \beta_1 X_{n1} & \beta_2 X_{n2} & \beta_3 X_{n3} & \cdots & \beta_m X_{nm} \end{bmatrix}$$

Matrix_1 Matrix_2

- This Matrix 2 is rewritten as the following matrix :-

$$\begin{bmatrix} 1 & X_{11} & X_{12} & X_{13} & \cdots & X_{1m} \\ 1 & X_{21} & X_{22} & X_{23} & \cdots & X_{2m} \\ 1 & X_{31} & X_{32} & X_{33} & \cdots & X_{3m} \\ & & \vdots & & & \\ 1 & X_{n1} & X_{n2} & X_{n3} & \cdots & X_{nm} \end{bmatrix} \begin{bmatrix} \beta_0 \\ \beta_1 \\ \beta_2 \\ \vdots \\ \beta_m \end{bmatrix}$$

Matrix_a or X Matrix_b or β

$\therefore$ $\boxed{\text{Matrix\_a} * \text{Matrix\_b} = \text{Matrix\_2}}$ $\Rightarrow$ $\boxed{\hat{Y} = X\beta}$

$$e = \begin{bmatrix} Y_1 - \hat{Y}_1 \\ Y_2 - \hat{Y}_2 \\ Y_3 - \hat{Y}_3 \\ \vdots \\ Y_n - \hat{Y}_n \end{bmatrix}_{(1 \times n)}$$

As per the Loss Function $\Rightarrow$ $\boxed{\sum_{i=1}^{n} (Y_i - \hat{Y}_i)^2}$ "Mean Squared Error"

This Loss Function can be rewritten as:-

Loss Function = $\boxed{e^T e}$

$$\left[(Y_1 - \hat{Y}_1) \ (Y_2 - \hat{Y}_2) \ (Y_3 - \hat{Y}_3) \cdots\cdots (Y_n - \hat{Y}_n) \right]_{(n \times 1)} = e^T$$

$$\boxed{e^T \cdot e = \left[(Y_1 - \hat{Y}_1)^2 + (Y_2 - \hat{Y}_2)^2 \cdots\cdots (Y_n - \hat{Y}_n)^2 \right]_{(1 \times 1)}}$$

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So finally the "β" value or Formula is derived as :-

$$\boxed{\beta = (X^T X)^{-1} \cdot X^T Y}$$

where : $X = X\_train$
$Y = Y\_train$

let Say we have 3 dimensional data i.e.

CGPA	iq	package
X_1	X_2	Y

- For this data the β will provides you the 3 values :-

① β_0 → Intercept

② $\beta_1 X_1$ → Coefficient

③ $\beta_2 X_2$ → Coefficient