PCA Steps

- f1 f2 f3 target.

Step 1 : Mean centering

Step 2: find Covariance matrix

$$\begin{array}{c|ccc} & & & \\ f1 & var(f1) & cov(f1,f2) & cov(f1,f3) \\ f2 & cov(f2,f1) & var(f2) & cov(f2,f3) \\ f3 & cov(f3,f1) & cov(f3,f2) & var(f3) \\ & f1 & f2 & f3 \end{array}$$

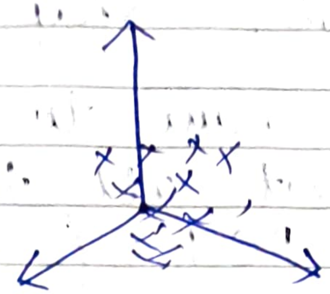
Step 3 find eigen vectors & values.

- you will get eigen vector & value for each dimension
- Eigen ~~va~~ vector with highest eigen value → PC1
- " " 2nd " " → PC2
- " " 3rd " " → PC3
- It's your choice, whether to choose only 1 PC ie bringing down 3d to 1D.

or choose 2 PC ie bring down 3d to 2D.

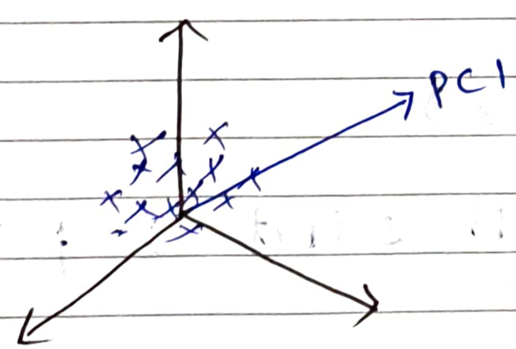
Q How to transform pts acc to no of PC.

Ans ① Ex - you have f1, f2, f3 (3D to 1D)



② You apply PCA, and you got 3 eigen vectors & value one for each dimension

③ You choose to bring data to 1D i.e selecting only one Principle component and that PC is in below graph



④ You want to project all the points onto PC1 that's how you will bring 3D to 1D.

⑤ And you project on PC1 by

→ $u^T x$, where $\vec{u}$ is PC1
& x is data point

- let's say our data shape is:
  (1000, 3) → 1000 pts in 3D.

- AND $\vec{u}$ ie PC is also a vector in 3 dimension. ∴ shape → (1, 3)

- Now you only have to dot product to project all those points on PC1 ($u^T x$)

- But you have to first transpose PC1 (as → u^T) → shape → (3, 1)

- $\underbrace{(1000, 3) \odot (3, 1)}_{\text{Dot product}}$

- You will get new data with shape (1000, 1)

Ex2 3D to 2D

- You will select 2 PC ie PC1 and PC2

- Data shape → (1000, 3)
- Eigen vectors shape (2, 3)
- Transpose → (3, 2)
- Dot product ⇒ (1000, 3).(3, 2)
- You will get → (1000, 2)