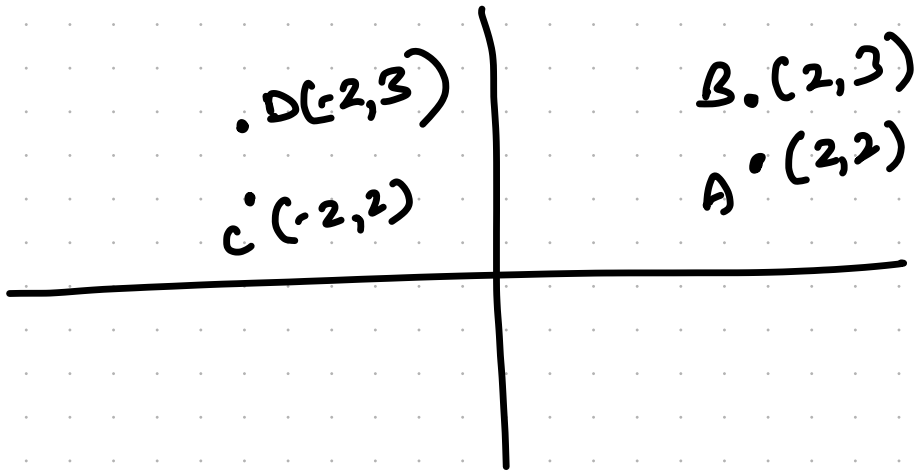
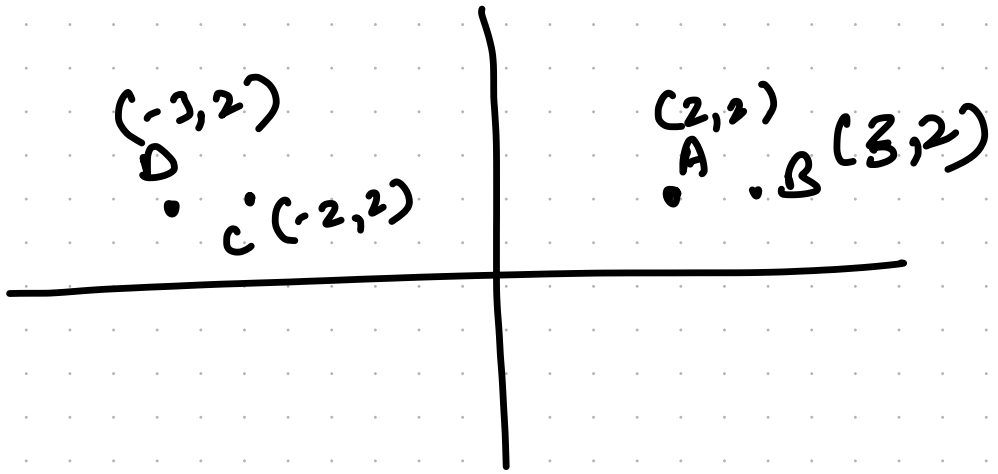


$$X = \begin{bmatrix} 2 & 2 \\ 2 & 3 \\ -2 & 3 \\ -2 & 2 \end{bmatrix} \in R^{N \times D}$$

$N = 4$

$D = 2$



$$X = \begin{bmatrix} 2 & 2 \\ 3 & 2 \\ -2 & 2 \\ -3 & 2 \end{bmatrix} \in \mathbb{R}^{N \times D}$$

$$R = \begin{bmatrix} 1 & 1 \\ -1 & 1 \end{bmatrix} \in \mathbb{R}^{D \times K}$$

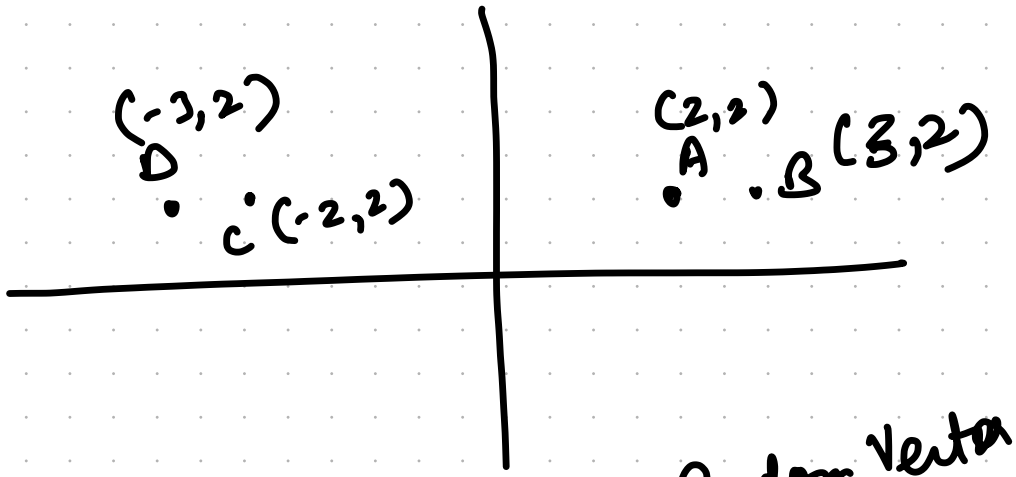
$K = 2$

$N = 4$

$D = 2$

Usually $K \ll D$

(Here for illustration $K = D = 2$)



Random Vector 1 (RV1)

$$X = \begin{bmatrix} 2 & 2 \\ 3 & 2 \\ -2 & 2 \\ -3 & 2 \end{bmatrix} \in R^{N \times D}$$

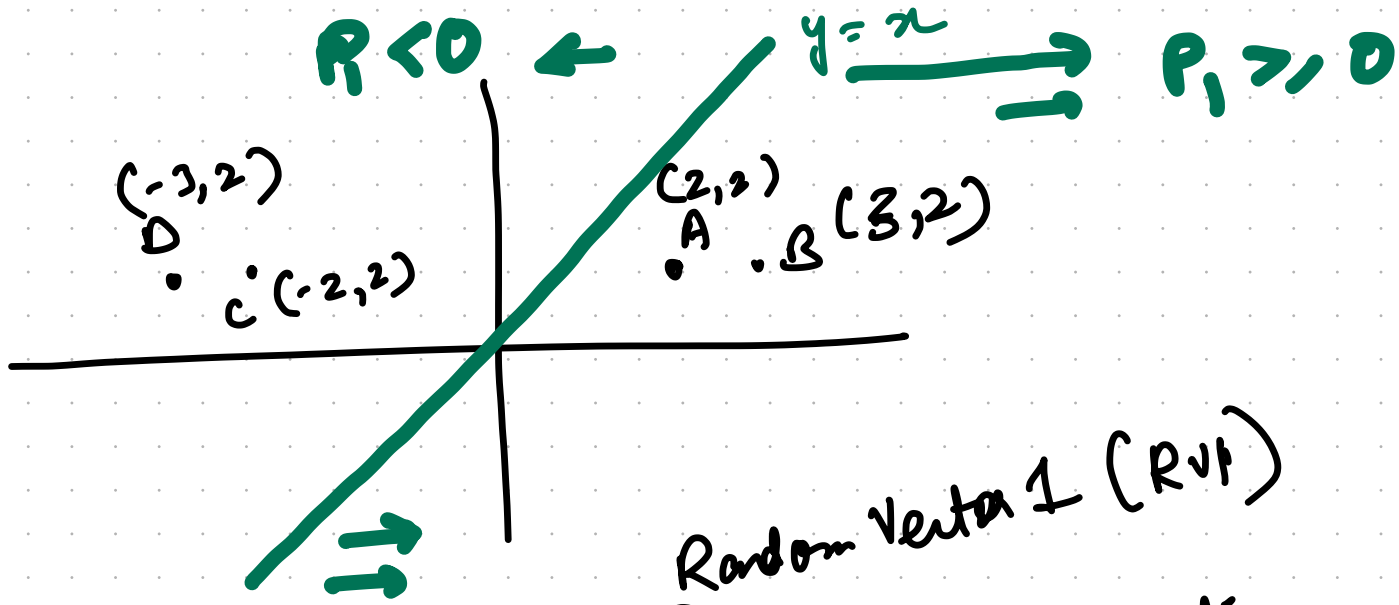
$$R = \begin{bmatrix} 1 & 1 \\ -1 & 1 \end{bmatrix} \in R^{D \times K}$$

$N = 4$

$D = 2$

Projection of (x, y) using R.V.1 is:

$$P_1 = \begin{bmatrix} x & y \end{bmatrix} \begin{bmatrix} 1 \\ -1 \end{bmatrix} = x - y$$



Random Vector 1 (RV1)

$$X = \begin{bmatrix} 2 & 2 \\ 3 & 2 \\ -2 & 2 \\ -3 & 2 \end{bmatrix} \in R^{N \times D}$$

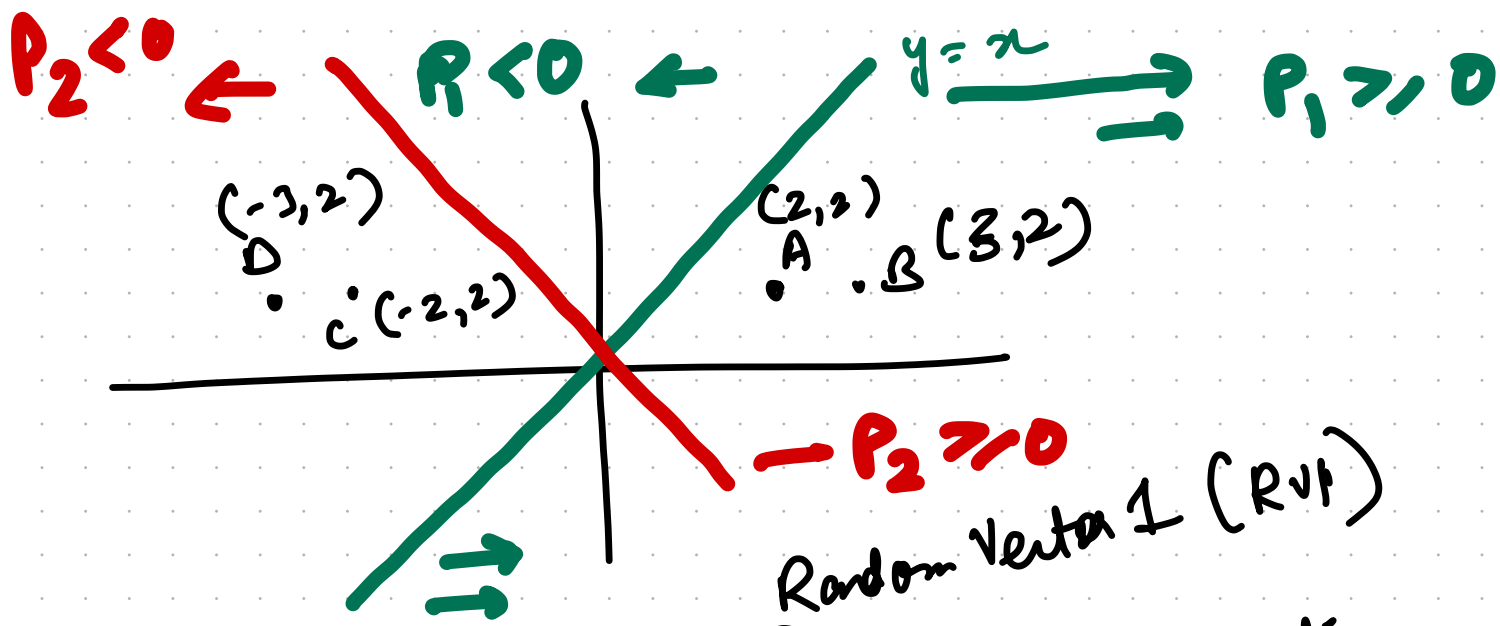
$$R = \begin{bmatrix} 1 & 1 \\ -1 & 1 \end{bmatrix} \in R^{D \times K}$$

$N = 4$

$D = 2$

Projection of (x, y) using R.V.1 is:

$$P_1 = \begin{bmatrix} x & y \end{bmatrix} \begin{bmatrix} 1 \\ -1 \end{bmatrix} = x - y$$



Random Vector 1 (RV1)

$$X = \begin{bmatrix} 2 & 2 \\ 3 & 2 \\ -2 & 2 \\ -3 & 2 \end{bmatrix} \in R^{N \times D}$$

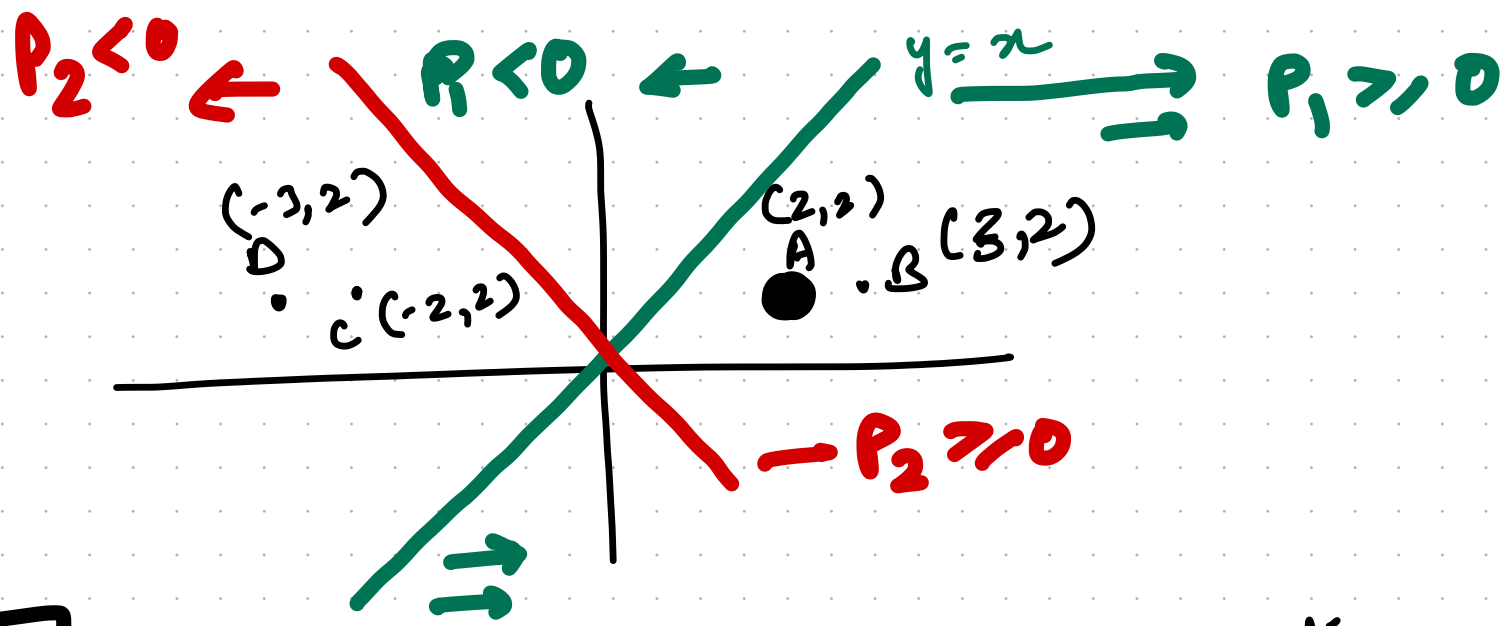
$$R = \begin{bmatrix} 1 & 1 \\ -1 & 1 \end{bmatrix} \in R^{D \times K}$$

$N = 4$

$D = 2$

Projection of P_2 of (x, y) using

$$P = \begin{bmatrix} x & y \end{bmatrix} \begin{bmatrix} 1 \\ 1 \end{bmatrix} = x + y$$



$$X = \begin{bmatrix} 2 & 2 \\ 3 & 2 \\ -2 & 2 \\ -3 & 2 \end{bmatrix} \in R^{N \times D}$$

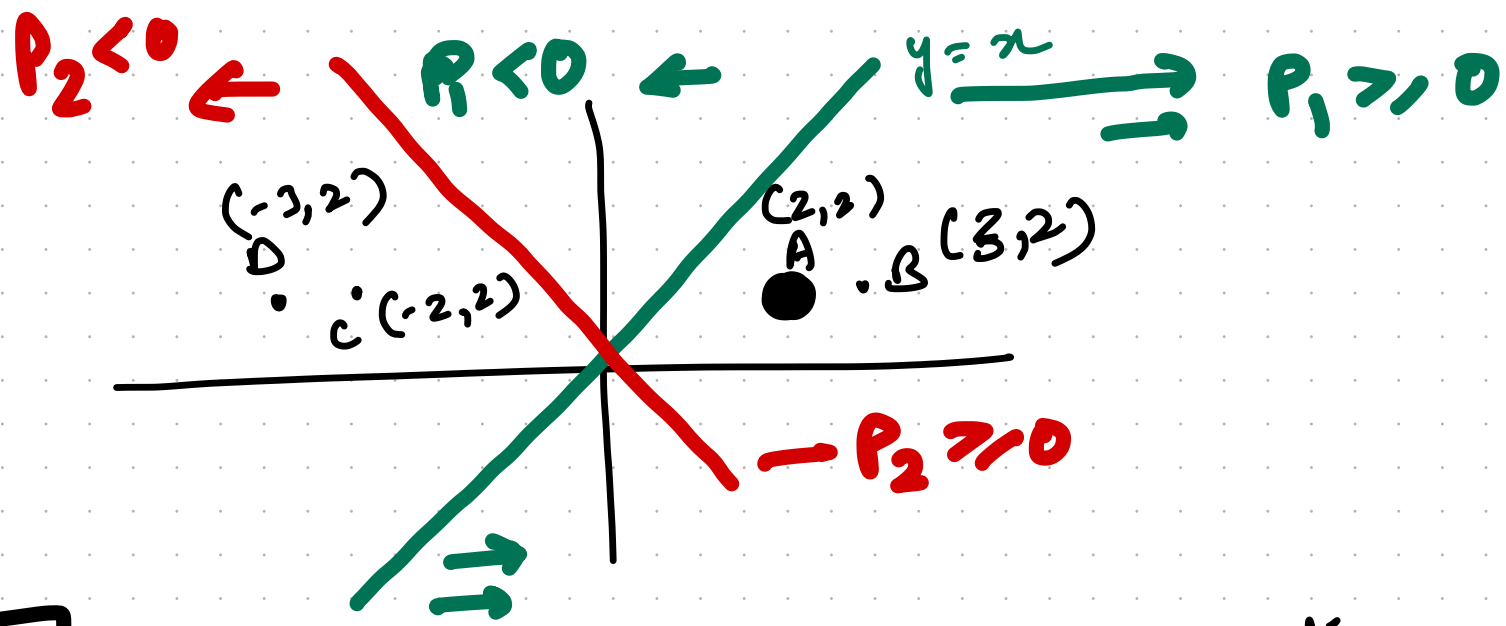
$$R = \begin{bmatrix} 1 & 1 \\ -1 & 1 \end{bmatrix} \in R^{D \times K}$$

$N = 4$

$D = 2$

FOCUS ON A (2,2)

$$\underbrace{\begin{bmatrix} 2 & 2 \end{bmatrix}}_{(R)} \begin{bmatrix} 1 & 1 \\ -1 & 1 \end{bmatrix} = \begin{bmatrix} 0 & 4 \end{bmatrix} = P_A$$



$$X = \begin{bmatrix} 2 & 2 \\ 3 & 2 \\ -2 & 2 \\ -3 & 2 \end{bmatrix} \in R^{N \times D}$$

$$R = \begin{bmatrix} 1 & 1 \\ -1 & 1 \end{bmatrix} \in R^{D \times K}$$

$N = 4$

$D = 2$

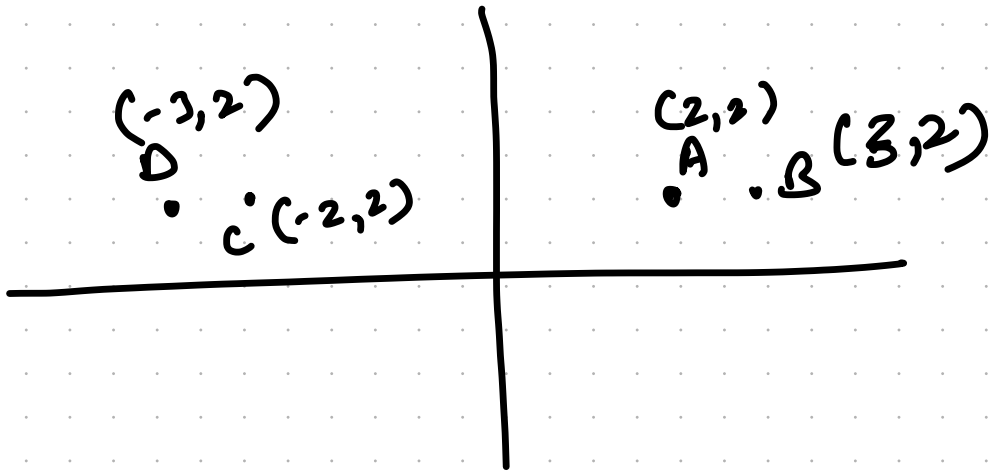
FOCUS ON A (2,2)

$$\begin{bmatrix} 2 & 2 \end{bmatrix} \begin{bmatrix} 1 & 1 \\ -1 & 1 \end{bmatrix} = \begin{bmatrix} 0 & 4 \end{bmatrix}$$

$(R) = P_A$

THRESHOLD PROJECTION (BINARIZE)

$T(P_A) = P_A \geq 0 = \begin{bmatrix} 1 & 1 \end{bmatrix}$



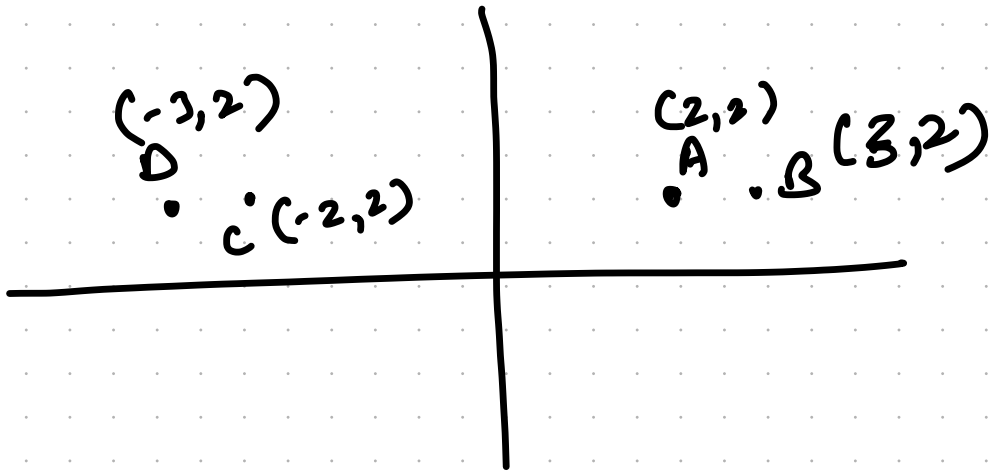
$$X = \begin{bmatrix} 2 & 2 \\ 3 & 2 \\ -2 & 2 \\ -3 & 2 \end{bmatrix} \in R^{N \times D}$$

$$T(XR) = T\left(\begin{bmatrix} 2 & 2 \\ 3 & 2 \\ -2 & 2 \\ -3 & 2 \end{bmatrix}\begin{bmatrix} 1 & 1 \\ -1 & 1 \end{bmatrix}\right)$$

$$T(XR) = \begin{bmatrix} 1 & 1 \\ 1 & 1 \\ 0 & 1 \\ 0 & 0 \end{bmatrix}$$

$N = 4$

$D = 2$



$$X = \begin{bmatrix} 2 & 2 \\ 3 & 2 \\ -2 & 2 \\ -3 & 2 \end{bmatrix} \in R^{N \times D}$$

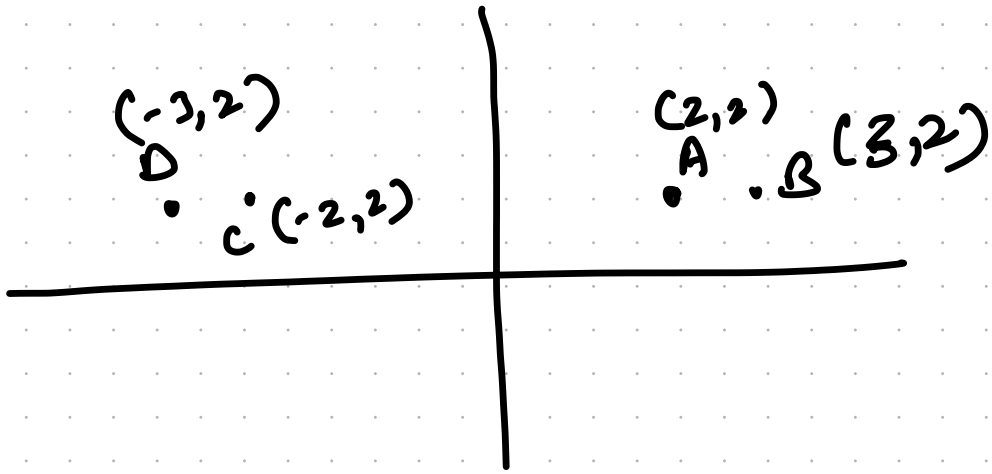
$$T(XR) = T\left(\begin{bmatrix} 2 & 2 \\ 3 & 2 \\ -2 & 2 \\ -3 & 2 \end{bmatrix}\begin{bmatrix} 1 & 1 \\ -1 & 1 \end{bmatrix}\right)$$

$$T(XR) = \begin{bmatrix} 1 & 1 \\ 1 & 1 \\ 0 & 1 \\ 0 & 0 \end{bmatrix}$$

A & B have same hash value

$N = 4$

$D = 2$



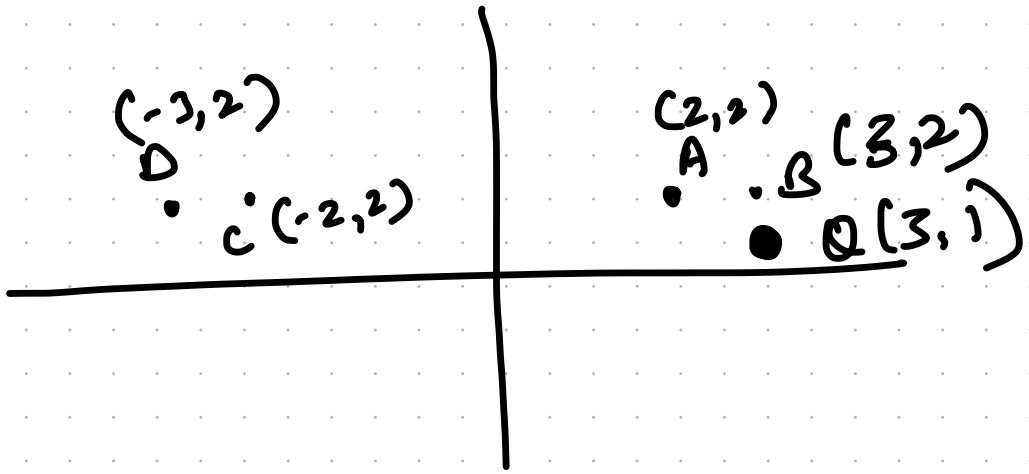
$$X = \begin{bmatrix} 2 & 2 \\ 3 & 2 \\ -2 & 2 \\ -3 & 2 \end{bmatrix} \in R^{N \times D}$$

$N = 4$

$D = 2$

Hash Table

11	→	(A, B)
01	→	C
00	→	D



$$X = \begin{bmatrix} 2 & 2 \\ 3 & 2 \\ -2 & 2 \\ -3 & 2 \end{bmatrix} \in R^{N \times D}$$

$N = 4$

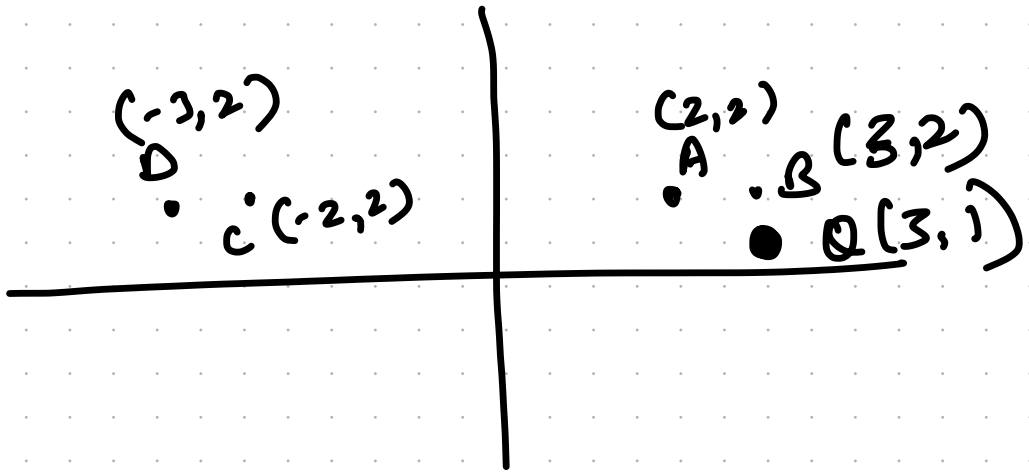
$D = 2$

Hash Table

11	→	(A, B)
01	→	C
00	→	D

TEST POINT Q (3,1)

$$T(QR) = T\left(\begin{bmatrix} 3 & 1 \end{bmatrix} \begin{bmatrix} 1 & 1 \\ -1 & 1 \end{bmatrix}\right) = 11$$



Sublinear Algo

$$X = \begin{bmatrix} 2 & 2 \\ 3 & 2 \\ -2 & 2 \\ -3 & 2 \end{bmatrix} \in R^{N \times D}$$

$N = 4$

$D = 2$

Hash Table

11	→	(A, B)
01	→	C
00	→	D

Need to Compare only in this bucket

TEST POINT Q (3,1)

$$T(QR) = T\left(\begin{bmatrix} 3 & 1 \end{bmatrix} \begin{bmatrix} 1 & 1 \\ -1 & 1 \end{bmatrix}\right) = 11$$