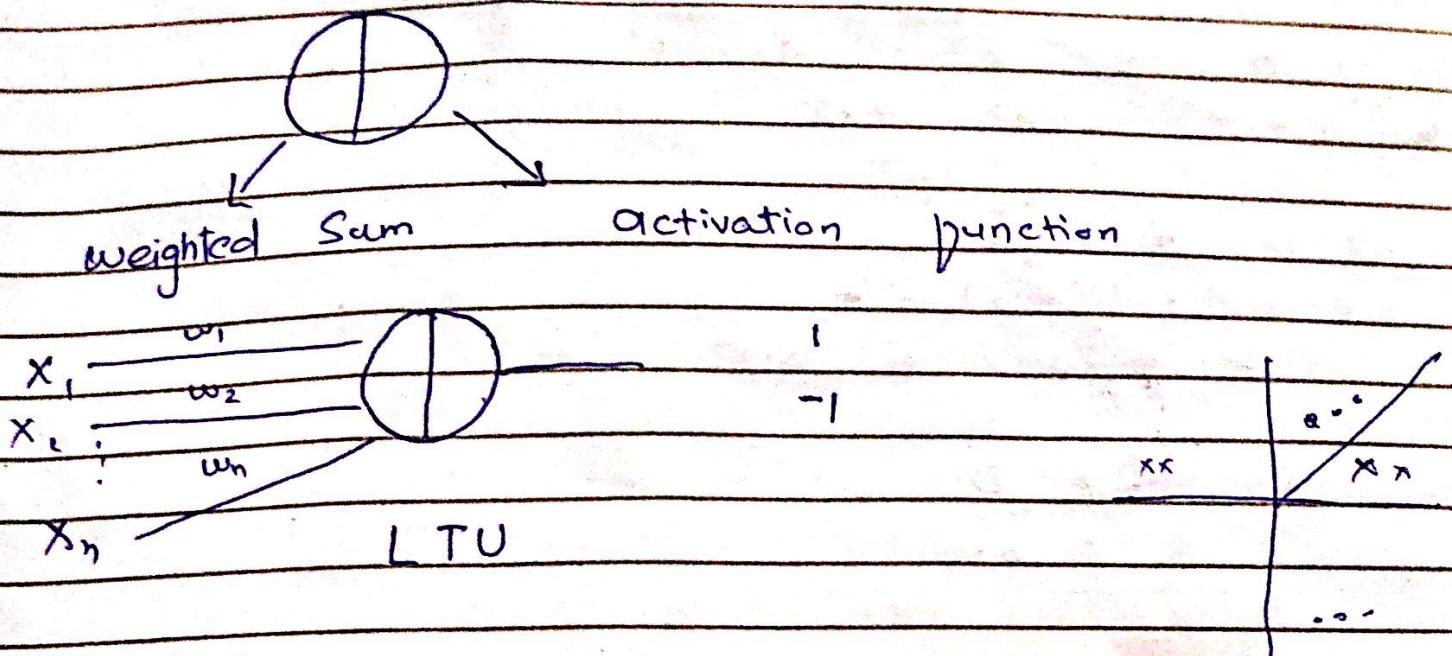


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# ANN



$$(x_1 w_1) + (x_2 w_2) + (x_n w_n) =$$

$$w_i = w_i + \Delta w_i$$

$$\Delta w_i = \eta (t - o) x_i$$

$$x_1 = 0 \quad x_2 = 0 \quad T = 0$$

$$w_1 = 0.1 \quad w_2 = 0.5$$

$$x_1 w_1 + x_2 w_2 = 0 + (-)(0.5) = 0$$
$$0 = T$$

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$$x_1 = 0 \quad x_2 = 1 \quad T = 1, 0 = 0$$
$$w_1 = 0.1 \quad , \omega_1 = 0.5$$

$$x_1 w_1 + x_2 w_2 \\ 0(0.1) + 1(0.5) = 0 \\ 0 + 0.5 = 0.5$$

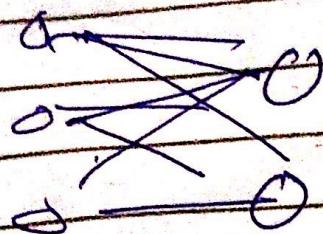
$$T \neq 0 \\ 1 \neq 0.5$$

$$w_1 = w_1 + \Delta w_1$$

$$w_1 = 0.1 + (0.5 * (1 - 0.5)) = 0$$

$$w_1 = 0.1$$

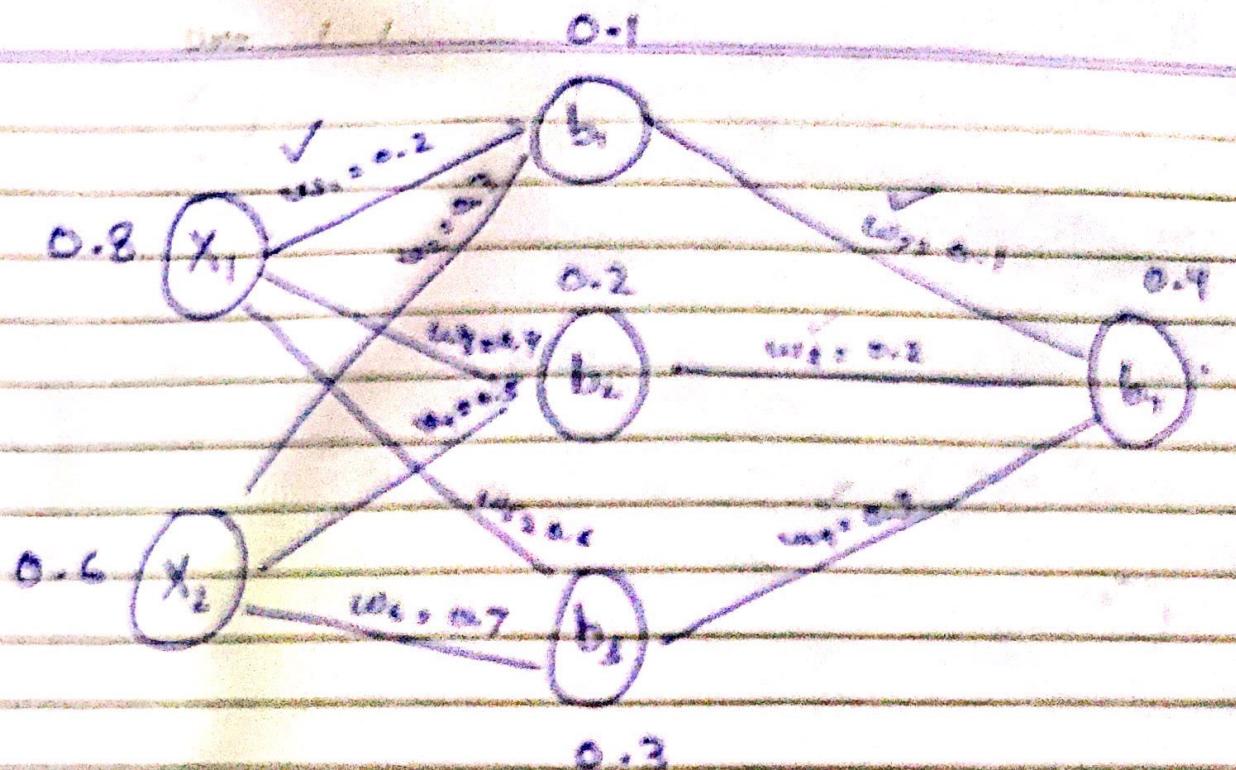
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$$\frac{1}{2} (T_1 - O_1)^2 + \frac{1}{2} (T_2 - O_2)^2$$

z

①



function  $\rightarrow$  Sigmoid  $t = 0.9$

$$w_{11} = ? \quad w_{12} = ? \quad w_{33} = 0.1$$

$$\Delta w_i = w_{it} + \Delta w_i$$

$$\Delta w_i = (\eta) (\text{error}) (h_i)$$

$$O_{err} = \frac{1}{2} (T - O)^2$$

$$= \frac{1}{2} (0.9 - 0.4)^2$$

$$\approx \frac{1}{2} (0.5)^2 \Rightarrow \frac{1}{2} (0.25)$$

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(2)

$$O_{err} = 0.125$$

$$w_7 = 0.1 + (0.1 * 0.125 * 0.1)$$

$$w_7 = 0.1 + 0.00125$$

$$w_7 = 0.10125$$

$$b_{err} = \frac{w_7 - 0.1}{b_1}$$

error                              hidden error

$$b_{err} = b_{err} * w_7$$

$$= 0.125 * 0.1 \Rightarrow 0.0125$$

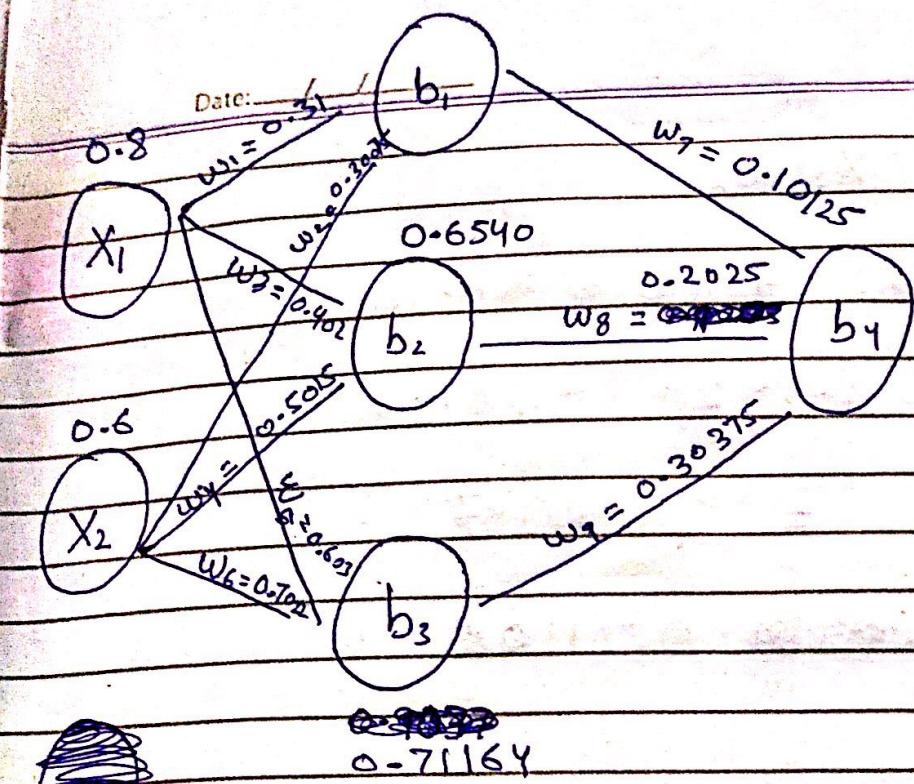
$$w_1 = 0.2 + (0.1 * 0.0125 * 0.8)$$

$$w_1 = 0.2 + 0.11 \Rightarrow 0.31$$

$$w_1 = 0.31$$

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0.51124



$$t = 0.9$$

$$\eta = 0.1$$

$$b_1 = X_1 w_1 + X_2 w_2$$

$$= 0.8 \times 0.31 + 0.6 \times 0.3025$$

$$= 0.0450$$

$$\text{Sigmoid} = 0.51124$$

$$b_2 = X_1 w_3 + X_2 w_4$$

$$= (0.8)(0.402) + (0.6)(0.505) \\ \approx 0.6225$$

$$\text{Sigmoid} = 0.6540$$

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$$b_3 = x_1 w_5 + x_2 w_6$$

$$= (0.8 * 0.603) + (0.6 * 0.7022)$$

$$= 0.4824 + 0.0421$$

$$= 0.52372$$

$$\text{Sigmoid} = \frac{1}{1 + e^{-0.52372}} = 0.71164$$

$$b_4 = b_1 w_7 + b_2 w_8 + b_3 w_9$$

$$= 0.51124 * 0.10125 + 0.6540 * 0.2028 +$$

$$0.71164 \cancel{0.52372} * 0.30375$$

$$= 0.40035$$

$$\text{Sigmoid} = 0.59877$$

$$\text{error} = \frac{1}{2} (0.9 - 0.59877)^2$$

$$= 0.09073$$

2

$$= 0.0453$$

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① Output error =  $\frac{1}{2} (\text{Target} - \text{Output})^2$

② Hidden\_error = Outputerror \* Weight (b/w output & hidden)

③  $w_{\text{new}} = w_{\text{old}} + \Delta w$

$$\Delta w = (\eta) (\text{error}) (\text{input})$$

## Stochastic

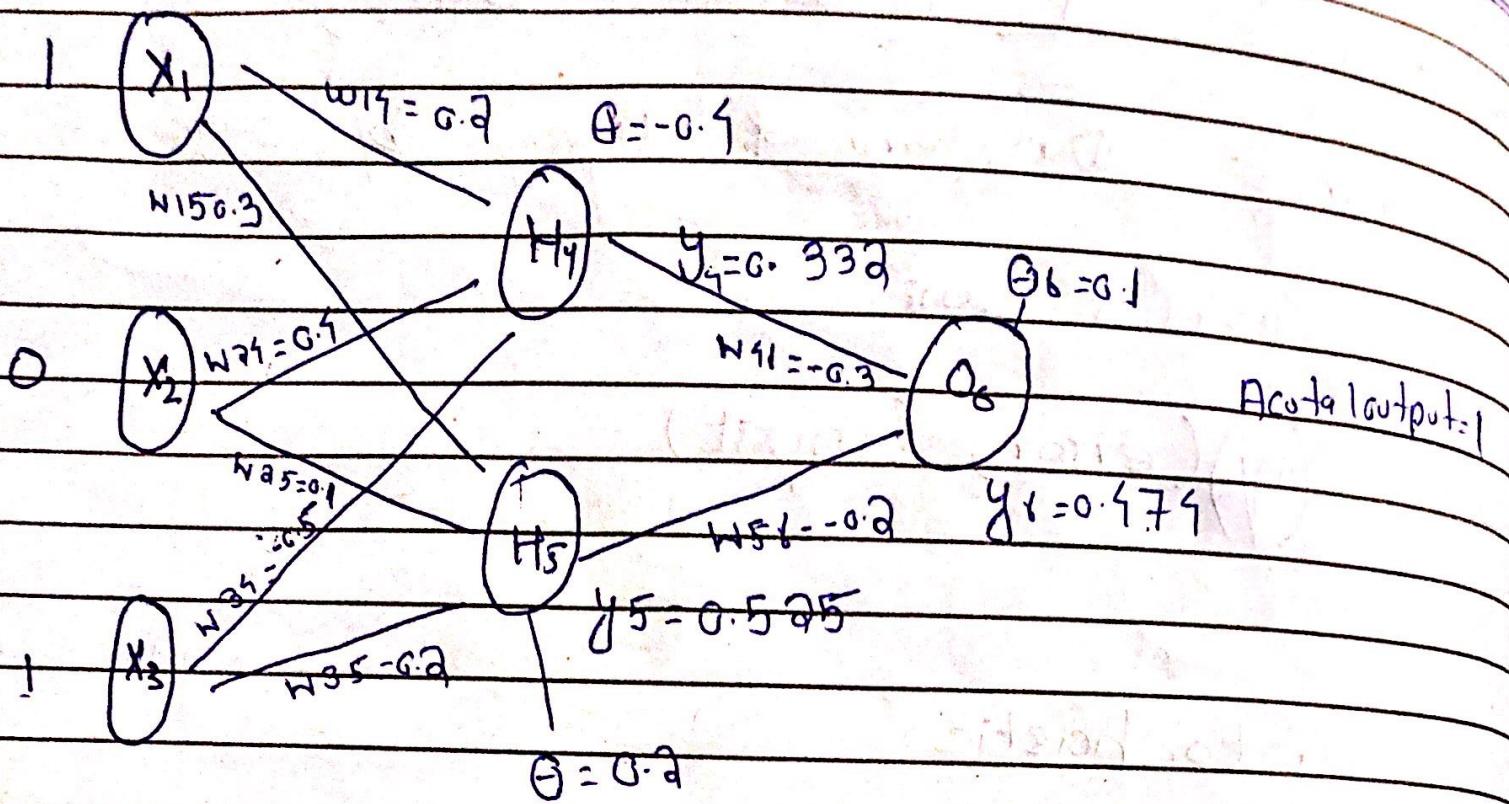
① Outputerror =  $\delta (1 - o)(t - o)$

② hidden error =  $o_h (1 - o_h) \sum_k w_{hk} \delta_{hk}$

agr ik sy 2dk weights  
nn tw sum kr den gg

③  $w_{\text{new}} = w_{\text{old}} + \Delta w$

$$\Delta w = (\gamma) (\text{error}) (\text{Input})$$



$$O_{6\text{err}} = O_6 (1 - O_6) (T - O_6)$$

$$= 0.474 (1 - 0.474) (1 - 0.474)$$

$$\boxed{\text{Output error} = 0.1311}$$

$$\text{hidden error} = h_5 (1 - h_5) w_{56} \text{ Output error}$$

$$\approx 0.525 (1 - 0.525) (-0.2) (0.1311)$$

$$= -0.0065$$

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$$H_4 [1 - H_4] w_{46} \text{ output}_4$$

$$= 0.332 [1 - 0.332] [1 - 0.3] [0.1311]$$
$$= -0.0087$$

-  $w_{46}$  old new  $\Delta w_{46}$

$$\Delta w_{46} = \eta (\text{target}) \text{ error} / (0.1311)$$
$$= -0.9 (0.332 / 0.1311)$$
$$= (-) -$$

$$\theta \cdot d = w_{14} = 0.9$$

$$= \eta (\text{input}) \text{ error} /$$

$$= 0.9 (1) (-0.0087)$$

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$$H_4 (1 - H_4) w_{46} \text{ output}_4$$

$$= 0.332 (1 - 0.332) (1 - 0.3) (0.1311)$$
$$= -0.0087$$

$$= w_{46} \text{ old newt } \Delta w_{46}$$

$$\Delta w_{46} = \eta \text{ (input)} \text{ (error)} (0.1311)$$
$$= -0.9 (0.332) (0.1311)$$

$$= (-)$$

$$\theta \cdot d = w_{46} = 0.9$$

$$= \eta \text{ (input)} \text{ (error)}$$

$$= 0.9 (1) (-0.0087)$$

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## PCA

76%

	$x_1$	$x_2$	PCA <sub>1</sub>	PCA <sub>2</sub>
S <sub>1</sub>	1	1	?	?
S <sub>2</sub>	2	1	?	?
S <sub>3</sub>	1	4	?	?

Find Mean

$$\textcircled{1} \quad \bar{x}_1 = \frac{1+2+1}{3} = \frac{4}{3}, \quad 1.33$$

$$\textcircled{2} \quad \bar{x}_2 = \frac{1+1+4}{3} = \frac{6}{3} = 2$$

Compute Covariance Matrix

$$\text{Cov}(x_1, x_2) = x_1 \begin{bmatrix} x_1 x_1 & x_1 x_2 \\ x_2 x_1 & x_2 x_2 \end{bmatrix}$$

$$\text{Cov}(x_1, x_1) = \frac{1}{n} [ (x_{11} - \bar{x}_1)^2 + (x_{12} - \bar{x}_{13})^2 + (x_{13} - \bar{x}_{13})^2 ]$$

$$= \frac{1}{3} [ (1 - 1.33)^2 + (2 - 1.33)^2 + (1 - 1.33)^2 ]$$

$$= \frac{1}{3} [ 0.667 ]$$

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$$\text{Cor}(x_1, x_2) = 0.222$$

$$\begin{aligned}\text{Cor}(x_1, x_2) &= \frac{1}{n} \left[ [x_{11} - \bar{x}_1] [x_{12} - \bar{x}_2] + [x_{12} - \bar{x}_1] [x_{22} - \bar{x}_2] \right. \\ &\quad \left. + [x_{13} - \bar{x}_1] [x_{23} - \bar{x}_2] \right] \\ &= \frac{1}{3} [(1 - 1.33)(1 - 2) + (2 - 1.33)(1 - 2) + (4 - 1.33)(2 - 2)] \\ &= \frac{1}{3} (-1)\end{aligned}$$

$$\text{Cor}(x_1, x_2) = -0.333$$

$$\text{Cor}(x_1, x_2) = \text{Cor}(x_2, x_1)$$

$$\text{Cor}(x_2, x_1) = -0.33$$

$$\begin{aligned}\text{Cor}(x_1, x_2) &= \frac{1}{n} \left[ [x_{21} - \bar{x}_2]^2 + [x_{22} - \bar{x}_2]^2 + [x_{23} - \bar{x}_2]^2 \right] \\ &= \frac{1}{3} [(1 - 2)^2 + (1 - 2)^2 + (4 - 2)^2] \\ &= \frac{1}{3} [11]\end{aligned}$$

$$\text{Cor}(x_1, x_2) = 3.66$$

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$$\text{Cor}(X_1, X_2) = \begin{bmatrix} 0.222 & -0.333 \\ -0.333 & 3.66 \end{bmatrix}$$

Eigen Value

$$\det(\text{Cor} - \lambda I) = 0$$

$$\det \left( \begin{bmatrix} 0.222 & -0.333 \\ -0.333 & 3.66 \end{bmatrix} - \begin{bmatrix} \lambda & 0 \\ 0 & \lambda \end{bmatrix} \right)$$

$$\det \left( \begin{bmatrix} 0.222 - \lambda & -0.333 \\ -0.333 & 3.66 - \lambda \end{bmatrix} \right)$$

$$(0.222 - \lambda)(3.66 - \lambda) - ((-0.333)(-0.333))$$

$$0.81252 - 0.222\lambda - 3.66\lambda + \lambda^2 - 0.110889$$

$$= \lambda^2 - 3.898\lambda + 0.70163$$

$$a = 1, b = -3.898, c = 0.70163$$

$$= \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

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$$\lambda_1 = 0.2178$$

Eigen

$$\lambda_2 = 3.2201$$

Vector

$\lambda_2 > \lambda_1$  So  $\lambda_2$  is PCA,

$$(C - \lambda I) U = 0$$

$$\begin{bmatrix} 0.222 - \lambda & -0.333 \\ -0.333 & 3.66 - \lambda \end{bmatrix} \begin{bmatrix} U_1 \\ U_2 \end{bmatrix} = 0$$

$$(0.222 - \lambda - 0.333) \begin{bmatrix} U_1 \\ U_2 \end{bmatrix} = 0$$

$$(0.222 - \lambda) U_1 - 0.333 U_2 = 0$$

$$(0.222 - \lambda) U_1 = 0.333 U_2$$

$$\frac{U_2}{0.222 - \lambda} = \frac{U_1}{0.333} = t \quad \text{and } t = 1$$

$$\frac{U_2}{0.222 - \lambda} = 1 \quad , \quad \frac{U_1}{0.333} = 1$$

$$U_2 = 0.222 - \lambda_1$$

$$U_1 = 0.333$$

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$$\lambda_2 = 0.222 - 3.2201$$

$$\lambda_2 = -2.9981$$

$$e_1 = \begin{bmatrix} u_1 \\ u_2 \end{bmatrix} \Rightarrow \begin{bmatrix} 0.333 \\ 0.0042 \end{bmatrix}$$

$$e_2 = \begin{bmatrix} u_1 \\ u_2 \end{bmatrix} = \begin{bmatrix} 0.333 \\ -2.9981 \end{bmatrix}$$

$$2 = (-0.333 + 3.66 - \lambda) \begin{bmatrix} u_1 \\ u_2 \end{bmatrix} = 0$$

$$= -0.333 u_1 + (3.66 - \lambda) u_2$$

$$\frac{u_1}{3.66 - \lambda_2} = \frac{u_2}{-0.333} = t = 1$$

$$\boxed{u_1 = 3.66 - \lambda_2}, \boxed{u_2 = -0.333}$$

$$e_2 u_1 = 3.66 - 0.2178 = 3.4422$$

$$e_2 u_2 = 3.66 - \lambda_2, \boxed{u_2 = -0.333}$$

$$= 3.66 - 3.2201$$

$$\boxed{u_1 = 0.4899}$$

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$$e_1 = \begin{bmatrix} u_1 \\ u_2 \end{bmatrix} = \begin{bmatrix} 3.44 \\ -0.333 \end{bmatrix}$$

$$e_2 = \begin{bmatrix} u_1 \\ u_2 \end{bmatrix} = \begin{bmatrix} 0.4399 \\ -0.333 \end{bmatrix}$$

## Normalization

$$e_1 = \begin{bmatrix} 0.333 \\ 0.0042 \end{bmatrix} \Rightarrow \begin{bmatrix} 0.333 \\ \frac{0.0042}{\sqrt{(0.333)^2 + (0.0042)^2}} \end{bmatrix}$$
$$\begin{bmatrix} 0.333 \\ 0.0042 \\ \frac{0.0042}{\sqrt{(0.0042)^2 + (0.333)^2}} \end{bmatrix}$$

$$e_1 = \begin{bmatrix} 1 \\ 0.012 \end{bmatrix}$$

$$e_2 = \begin{bmatrix} u_1 \\ u_2 \end{bmatrix} \Rightarrow \begin{bmatrix} 0.333 \\ -2.9981 \end{bmatrix} \Rightarrow \begin{bmatrix} 0.333 \\ \frac{-2.9981}{\sqrt{(0.333)^2 + (-2.9981)^2}} \end{bmatrix}$$
$$\begin{bmatrix} 0.333 \\ -2.9981 \\ \frac{-2.9981}{\sqrt{(-2.9981)^2 + (0.333)^2}} \end{bmatrix}$$

$$e_2 = \begin{bmatrix} 0.11040 \\ -0.9939 \end{bmatrix}$$

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## 6 : New Dataset

$$P_{11} = e^{-t} \begin{bmatrix} 1 \\ 1 \end{bmatrix} \Rightarrow \begin{bmatrix} 1 & 0.012 \end{bmatrix} \begin{bmatrix} 1 \\ 1 \end{bmatrix}$$

$$= 1 \times 1 + 0.012 \times 1$$

$$P_{11} \Rightarrow 1 + 0.012 \Rightarrow 1.012$$

$$P_{12} \Rightarrow \begin{bmatrix} 1 & -0.012 \end{bmatrix} \begin{bmatrix} 2 \\ -1 \end{bmatrix}$$

$$\Rightarrow 1 \times 2 + 0.012 \times 1$$

$$\Rightarrow 2 + 0.012 \Rightarrow 2.012$$

$$P_{13} \Rightarrow \begin{bmatrix} 1 & -0.012 \end{bmatrix} \begin{bmatrix} 1 \\ 4 \end{bmatrix}$$

$$\Rightarrow 1 \times 1 + 0.012 \times 4$$

$$\Rightarrow 1 + 0.048$$

$$\Rightarrow 1.048$$