(Mahesh huddar) Naive Bayes classifier

→ Estimate conditional probabilites of each attributes {Color, legs, height, smelly} for the species classes: {M, H} using the data given in the table.

→ Using these probabilities estimate the probability values for the new instance —

(Color = Green, legs = 2, Height = Tall, and smelly = No)

No	Color	Legs	Height	Smelly	Species
1	White	3	Short	Yes	M
2	Green	2	Tall	No	M
3	Green	3	Short	Yes	M
4	White	3	Short	Yes	M
5	Green	2	Short	No	H
6	White	2	Tall	No	H
7	White	2	Tall	No	H
8	White	2	Short	Yes	H

New Instance

(Color = Green, legs = 2, Height = Tall & smelly = No)

→ $P(M) = 4/8 = 0.5$, $P(H) = 4/8 = 0.5$

Color	M	H
White	2/4	3/4
Green	2/4	1/4

Legs	M	H
2	1/4	4/4
3	3/4	0/4

Height	M	H
Tall	3/4	2/4
short	1/4	2/4

smelly	M	H
Yes	3/4	1/4
No	1/4	3/4

$P(M \mid \text{New Instance}) = p(M) * p(\text{Color=Green} \mid M) * p(\text{legs}=2 \mid M) * p(\text{Height=Tall} \mid M) * p(\text{smelly=no} \mid M) = 0.5 * 2/4 * 1/4 * 3/4 * 1/4 = \ldots$

$P(H \mid \text{New Instance}) = p(H) * p(\text{Color=Green} \mid H) * p(\text{legs}=2 \mid H) * p(\text{Height=Tall} \mid H) * p(\text{smelly=no} \mid H)$

$= 0.5 * 1/4 * 4/4 * 2/4 * 3/4 = 0.047$

PCA (Mahesh Huddar)
(Eduflair KTU CS) Youtube channel

Example

Given the data in table, reduce the dimension from 2 to 1 using the PCA Algorithm

F	Ex1	Ex2	Ex3	Ex4
x_1	4	8	10	5
x_2	7	4	2	12

Step-I Calculate Mean

$$\bar{X}_{1Mean} = \frac{4+8+10+5}{4}, \quad \bar{X}_{2mean} = \frac{7+4+2+12}{4}$$

$$\bar{X}_{1mean} = 27/4 = 6.75, \quad \bar{X}_{2mean} = \frac{25}{4} = 6.25$$

Step-II Calculation of the Covariance Matrix

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

$Cov(x_1, x)$ ~~6.75~~

$$= \frac{1}{N-1} \sum_{K=1}^{N} (x_{1K} - \bar{x}_1)(x_{1K} - \bar{x}_1) \quad (\text{here } N=4)$$

$$\cancel{= \frac{1}{3}((4-8)^2 +}$$

$$= \frac{1}{3}\left((4-6.75)^2 + (8-6.75)^2 + (10-6.75)^2 + (5-6.75)^2\right)$$

$$= 7.58$$

$$Cov(x_1, x_2) = \frac{1}{N-1} \sum_{K=1}^{N} (x_{1k} - \bar{x}_1)(x_{2K} - \bar{x}_2)$$

$$= \frac{1}{3}\{(4-6.75)(7-6.25) + (8-6.75)(4-6.25) + (10-6.75)(2-6.25) + (5-6.75)(12-6.25)\}$$

$$= \frac{1}{3}\{(-2.25)(0.75) + (1.25)(-2.25) + (3.25)(-4.25) + (-1.75)(5.75)\}$$

$$= \frac{1}{3}\{(-1.68) + (-2.81) + (-13.81) + (-10.0625)\} = -9.45$$

$$\mathrm{cov}(x_2, x_1) = \mathrm{Cov}(X_1, X_2) = -9.45$$

$$\mathrm{Cov}(X_2, X_2) = \frac{1}{N-1} \sum_{k=1}^{N} (x_{2k} - \bar{X}_2)(x_{2k} - \bar{X}_2)$$

$$= \frac{1}{3}\left((7-6.25)^2 + (4-6.25)^2 + (2-6.25)^2 + (12-6.25)^2 \right)$$

$$= \frac{1}{3}\left((-0.75)^2 + (-2.25)^2 + (-4.25)^2 + (5.75)^2 \right)$$

$$= \frac{1}{3}(56.75) = 18.91$$

$$S = \begin{bmatrix} 7.58 & -9.45 \\ -9.45 & 18.91 \end{bmatrix}$$

<u>Step</u> 3:- Eignvalues of the Covariance matrix

The characteristic Equation of the covariance matrix is,

$$0 = \det(S - \lambda I)$$

$$0 = \begin{vmatrix} 7.58-\lambda & -9.45 \\ -9.45 & 18.91-\lambda \end{vmatrix}$$

$$0 = (7.58-\lambda)(18.91-\lambda) - (-9.45 \times -9.45) \longrightarrow (1)$$

<u>Assume</u> (after sol^n of equation (1)) $\Rightarrow \lambda_1 = 70 \quad \lambda_2 = 6$

Please calcutate λ with calculator, ~~we~~ I don't have calcutator so I just assumed λ value.

<u>Step</u> 4: Computation of eigenvectors

let $U = \begin{bmatrix} U_1 \\ U_2 \end{bmatrix} \Rightarrow \begin{bmatrix} 0 \\ 0 \end{bmatrix} = (S - \lambda I)(U)$

$$= \begin{bmatrix} 7.58-\lambda & -9.45 \\ -9.45 & 18.91-\lambda \end{bmatrix} \begin{bmatrix} U_1 \\ U_2 \end{bmatrix}$$

$$\begin{bmatrix} 0 \\ 0 \end{bmatrix} = \begin{bmatrix} (7.58-\lambda)U_1 - 9.45U_2 \\ -9.45u_1 + (18.91-\lambda)U_2 \end{bmatrix}$$

$$(7.58-\lambda)U_1 - 9.45U_2 = 0 \longrightarrow (2)$$

$$(-9.45)U_1 + (18.91-\lambda)U_2 = 0 \longrightarrow (3)$$

$\frac{}{21^2}$ $65+65+64$
$= 130+64 = 194+18$

d	One component of energy transfer when a high energy ion enters a wafer is collision with lattice nuclei. Many of these atoms are ejected from the lattice during the process. Some displaced substrate atoms have sufficient energy to collide with other substrate atoms to produce additional displaced atoms. As a result, the implantation process produces considerable substrate damage. What steps are needed to be taken in order to repair this damage?	7

from (2)

$$\frac{U_1}{9.45} = \frac{U_2}{7.58-\lambda} = t \text{ (let)}$$

$$U_1 = 9.45t$$
$$U_2 = (7.58-\lambda)t$$

$$U = \begin{bmatrix} 9.45 \\ 7.58-\lambda \end{bmatrix}$$ We will use λ_1 as we want only one Principle component.

→ To find a unit eigenvector, we compute the length of U_1 which is given by, $U_1 = \begin{bmatrix} 9.45 \\ 7.58-\lambda_1 \end{bmatrix}$

$$\|U_1\| = \sqrt{(9.45)^2 + (7.58-\lambda_1)^2}$$
$$= \sqrt{(9.45)^2 + (7.58-10)^2}$$
$$\approx 10$$

$$e_1 = \begin{bmatrix} 9.45 / \|U_1\| \\ (7.58-\lambda_1) / \|U_1\| \end{bmatrix} \approx \begin{bmatrix} 0.94 \\ -0.25 \end{bmatrix}$$

$$e_2 = \begin{bmatrix} 9.45 / \|U_2\| \\ (7.58-\lambda_2) / \|U_2\| \end{bmatrix}$$ → We are not intrested in U_2 for our analysis

Step 5: Computation of first PCs

$$e_1^T \begin{bmatrix} x_{1k} - \bar{X}_1 \\ X_{2k} - \bar{X}_2 \end{bmatrix} = [0.94 \;\; 0.25] \begin{bmatrix} x_{11} - \bar{X}_1 \\ x_{21} - \bar{X}_2 \end{bmatrix}$$
$$= 0.94(x_{11} - \bar{X}_1) + 0.25(x_{21} - \bar{X}_2)$$

≈ -4.3 (Assumption) please calculate calculate correct value with

Feature	Ex1	Ex2	Ex2	Ex3
x_1	4	8	10	5
x_2	7	4	2	12
First PCs	-4	-5	-2	-1

I have assumed these values please calculate correct values by calculator.