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**NPTEL (https://swayam.gov.in/explorer?ncCode=NPTEL) » Pattern Recognition And Application (course)**

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Course outline



# Week 3 : Assignment 3

Assignment not submitted **Due date: 2023-08-16, 23:59 IST.**

1) ***2 points***

Let $\mu$ is the mean vector and $\Sigma$ is the covariance matrix in a $d$ dimensional space. Which of the following is the correct expression for normal/Gaussian density function?

a) $P(X)=\frac{1}{(2\pi)^{d/2}\sqrt{|\Sigma|}}\exp\left[-\frac{1}{2}(X-\mu)^t\,\Sigma^{-1}(X-\mu)\right]$

b) $P(X)=\frac{1}{(2\pi)^{d/2}\,\Sigma}\exp\left[-\frac{1}{2}(X-\mu)^t\,\Sigma^{-1}(X-\mu)\right]$

c) $P(X)=\frac{1}{(2\pi)^{d/2}\sqrt{\Sigma}}\exp\left[-\frac{1}{2}(X-\mu)\Sigma^{-1}(X-\mu)^t\right]$

d) $P(X)=\frac{1}{(2\pi)^{d/2}\sqrt{\Sigma}}\exp\left[-\frac{1}{2}(X-\mu)^t\,\Sigma(X-\mu)\right]$

- a)
- b)
- c)
- d)

2) ***2 points***

Let $\left\{\begin{pmatrix}1\\1\end{pmatrix},\begin{pmatrix}2\\0\end{pmatrix},\begin{pmatrix}2\\2\end{pmatrix},\begin{pmatrix}3\\1\end{pmatrix}\right\}\in\omega_1$, $\left\{\begin{pmatrix}1\\1\end{pmatrix},\begin{pmatrix}2\\-1\end{pmatrix},\begin{pmatrix}2\\3\end{pmatrix},\begin{pmatrix}3\\1\end{pmatrix}\right\}\in\omega_2$. Compute the covariance matrix $\Sigma_1$ and $\Sigma_2$.

a) $\Sigma_1=\begin{bmatrix}0.5&0\\0&0.5\end{bmatrix}$, $\Sigma_2=\begin{bmatrix}0.5&0\\0&0.5\end{bmatrix}$

b) $\Sigma_1=\begin{bmatrix}0.5&0\\0&0.5\end{bmatrix}$, $\Sigma_2=\begin{bmatrix}2.0&0\\0&0.5\end{bmatrix}$

c) $\Sigma_1=\begin{bmatrix}0.5&0\\0&0.5\end{bmatrix}$, $\Sigma_2=\begin{bmatrix}0.5&0\\0&2.0\end{bmatrix}$

d) None of these

- a)
- b)
- c)
- d)

3) **_2 points_**

For a two class problem having $d$ dimensional binary feature vectors where $a_i=P\left(x_i=1/\omega_1\right)$ and $b_i=P\left(x_i=1/\omega_2\right)$. Assume all the features are statistically independent and classes are equi-probable. Which of the following corresponds to equation of decision surface?

a) $\sum_{i=1}^{d}\left[x_i\ln\left(\frac{a_i}{b_i}\right)+(1-x_i)\ln\left(\frac{1-a_i}{1-b_i}\right)\right]=0$

b) $\sum_{i=1}^{d}\left[x_i\ln\left(\frac{a_i}{b_i}\right)+(1-x_i)\ln\left(\frac{1-a_i}{1-b_i}\right)\right]+\ln\left(\frac{P(\omega_1)}{P(\omega_2)}\right)=0$

c) $\sum_{i=1}^{d}\left[x_i\ln\left(\frac{a_i}{b_i}\right)+(1-x_i)\ln\left(\frac{1-b_i}{1-a_i}\right)\right]+\ln\left(\frac{P(\omega_1)}{P(\omega_2)}\right)=0$

d) Both a and b

- a)
- b)
- c)
- d)

4) **_2 points_**

Let $\Sigma_i$ represents the covariance matrix for $i^{th}$ class. If the classes have the same co-variance matrix. The features are statistically independent and have same co-variance. Which of the following is true?

a) $\Sigma_i=\Sigma$, ($\Sigma$ is non-diagonal)

b) $\Sigma_i=\Sigma$, ($\Sigma$ is diagonal)

c) $\Sigma_i=\sigma^2 I$

d) None of these

- a)
- b)
- c)

d)

5) ***2 points***

For a two-dimension feature vector, the data points lies on the locus of a circle as shown in Figure 1. Let the covariance matrix be $\Sigma = \begin{bmatrix} \sigma_{11} & \sigma_{12} \\ \sigma_{21} & \sigma_{22} \end{bmatrix}$. Which of the following is/are correct?

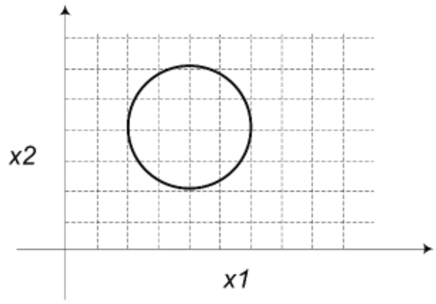


Figure 1.

I. $\sigma_{11} = \sigma_{22}$

II. $\sigma_{11} \neq \sigma_{22}$

III. $\sigma_{12} = \sigma_{21}$

IV. $\sigma_{12} = 0$

a) Only I and III
b) Only II and III
c) Only II, III and IV
d) Only I, III and IV

a)

b)

c)

d)

6) ***2 points***

For a two-dimension feature vector, the data points lies on the locus of an ellipse as shown in Figure 2. Let the covariance matrix be $\Sigma = \begin{bmatrix} \sigma_{11} & \sigma_{12} \\ \sigma_{21} & \sigma_{22} \end{bmatrix}$. Which of the following is/are correct?

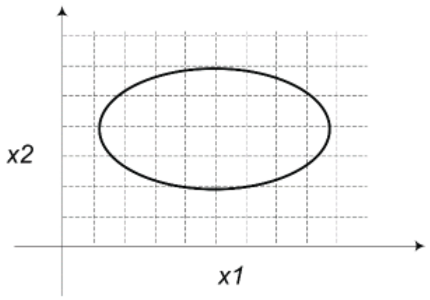


Figure 2.

I. $\sigma_{11} = \sigma_{22}$
II. $\sigma_{11} \neq \sigma_{22}$
III. $\sigma_{12} = \sigma_{21}$
IV. $\sigma_{12} = 0$

a) Only I and III
b) Only II and III
c) Only II, III and IV
d) Only I, III and IV

- a)
- b)
- c)
- d)

7) ***2 points***

For a two-dimension feature vector, the data points lies on the locus of an ellipse as shown in Figure 3. Let the covariance matrix be $\Sigma = \begin{bmatrix} \sigma_{11} & \sigma_{12} \\ \sigma_{21} & \sigma_{22} \end{bmatrix}$. Which of the following is/are correct?

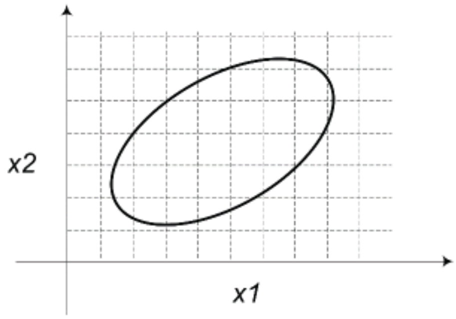


Figure 3.

I. $\sigma_{11} = \sigma_{22}$
II. $\sigma_{11} \neq \sigma_{22}$
III. $\sigma_{12} = \sigma_{21}$
IV. $\sigma_{12} = 0$

a) Only I and III
b) Only II and III
c) Only II, III and IV
d) Only I, III and IV

- a)
- b)
- c)
- d)

8) ***2 points***

For a two class problem, $\Sigma_i = \Sigma \neq \sigma^2 I$, where $\Sigma_i$ represents the covariance matrix for $i^{th}$ class. Both classes are normally distributed and Bayesian classifier is used. Assume $P(\omega_1) = P(\omega_1)$. Which of the following is true for decision boundary?

a) Decision boundary passes through the midpoint of the line segment joining the means of two classes
b) Decision boundary will be orthogonal bisector of the line joining the means of two classes.
c) Both a and b
d) None of the above

- a)
- b)
- c)
- d)

9) ***2 points***

For a two class problem, $\Sigma_i = \sigma^2 I$, where $\Sigma_i$ represents the covariance matrix for $i^{th}$ class. Both classes are normally distributed and Bayesian classifier is used. Assume $P(\omega_1) = P(\omega_1)$. Which of the following is true for decision boundary?

a) Decision boundary passes through the midpoint of the line segment joining the means of two classes
b) Decision boundary will be orthogonal bisector of the line joining the means of two classes.
c) Both a and b
d) None of the above

- a)
- b)
- c)
- d)

10) **2 points**

Let $\left\{\begin{pmatrix}1\\1\end{pmatrix},\begin{pmatrix}2\\0\end{pmatrix},\begin{pmatrix}2\\2\end{pmatrix},\begin{pmatrix}3\\1\end{pmatrix}\right\} \in \omega_1$, $\left\{\begin{pmatrix}6\\1\end{pmatrix},\begin{pmatrix}8\\-1\end{pmatrix},\begin{pmatrix}8\\3\end{pmatrix},\begin{pmatrix}10\\1\end{pmatrix}\right\} \in \omega_2$ as shown in Figure 4. For class $\omega_1$, $\mu_1 = \begin{pmatrix}2\\1\end{pmatrix}$, $\Sigma_1 = \begin{bmatrix}0.5 & 0\\0 & 0.5\end{bmatrix}$. For class $\omega_2$, $\mu_2 = \begin{pmatrix}8\\1\end{pmatrix}$ and $\Sigma_2 = \begin{bmatrix}2 & 0\\0 & 2\end{bmatrix}$. Assume classes are normally distributed and $P(\omega_1) = P(\omega_1)$. Classify an unknown feature vector $X = \begin{pmatrix}4.5\\1\end{pmatrix}$

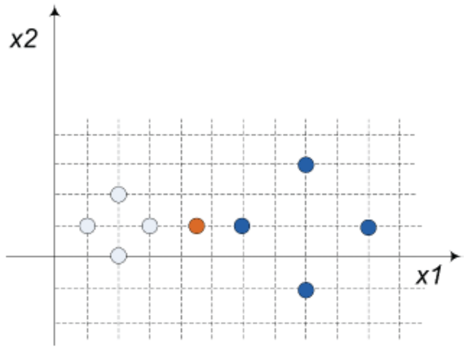


Figure 4.

a) $X \in \omega_1$
b) $X \in \omega_2$
c) $X$ lies on decision surface
d) None of the above

- a)
- b)
- c)
- d)

You may submit any number of times before the due date. The final submission will be considered for grading.

Submit Answers