Assignment 7

1

1.0/1.0 point (graded)

PDF of a Gaussian RV with mean 2 and variance 2 is

- ( ) $f_X(x) = \frac{1}{\sqrt{8\pi}} e^{-\frac{(x-2)^2}{8}}$
- (•) $f_X(x) = \frac{1}{\sqrt{4\pi}} e^{-\frac{(x-2)^2}{4}}$
- ( ) $f_X(x) = \frac{1}{\sqrt{2\pi}} e^{-\frac{(x-2)^2}{2}}$
- ( ) $f_X(x) = \frac{1}{\sqrt{4\pi}} e^{-\frac{(x-2)}{4}}$

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The mean and covariance matrix of the multivariate Guassian are defined as

- (•) $E\{\bar{\mathbf{x}}\} = \bar{\boldsymbol{\mu}}, E\{(\bar{\mathbf{x}} - \bar{\boldsymbol{\mu}})(\bar{\mathbf{x}} - \bar{\boldsymbol{\mu}})^T\} = \mathbf{R}$
- ( ) $E\{\bar{\mathbf{x}}\} = \bar{\boldsymbol{\mu}}, E\{(\bar{\mathbf{x}} - \bar{\boldsymbol{\mu}})^2\} = \mathbf{R}$
- ( ) $E\{\bar{\mathbf{x}}\} = \mu, E\{(\bar{\mathbf{x}} - \bar{\boldsymbol{\mu}})^T(\bar{\mathbf{x}} - \bar{\boldsymbol{\mu}})\} = \mathbf{R}$
- ( ) $E\{\bar{\mathbf{x}}\} = \mu, E\{\bar{\mathbf{x}}\bar{\mathbf{x}}'\} = \mathbf{R}$

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PDF of a Gaussian random vector is

- ( ) $\frac{1}{\sqrt{(2\pi)^n|\mathbf{R}|}} e^{-\frac{1}{2}(\bar{\mathbf{x}}-\bar{\boldsymbol{\mu}})^T\mathbf{R}(\bar{\mathbf{x}}-\bar{\boldsymbol{\mu}})}$
- ( ) $\frac{1}{\sqrt{(2\pi)^n\mathbf{R}}} e^{-\frac{1}{2}(\bar{\mathbf{x}}-\bar{\boldsymbol{\mu}})^T\mathbf{R}^{-1}(\bar{\mathbf{x}}-\bar{\boldsymbol{\mu}})}$
- (•) $\frac{1}{\sqrt{(2\pi)^n|\mathbf{R}|}} e^{-\frac{1}{2}(\bar{\mathbf{x}}-\bar{\boldsymbol{\mu}})^T\mathbf{R}^{-1}(\bar{\mathbf{x}}-\bar{\boldsymbol{\mu}})}$
- ( ) $\frac{1}{\sqrt{(2\pi)^n\mathbf{R}}} e^{-\frac{1}{2}(\bar{\mathbf{x}}-\bar{\boldsymbol{\mu}})^T\mathbf{R}(\bar{\mathbf{x}}-\bar{\boldsymbol{\mu}})}$

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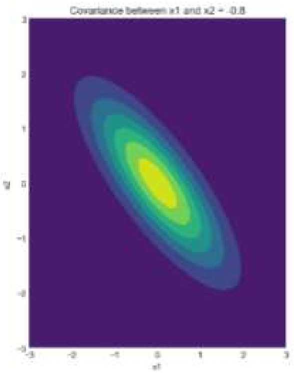
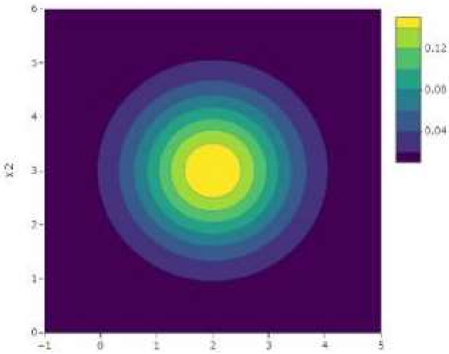
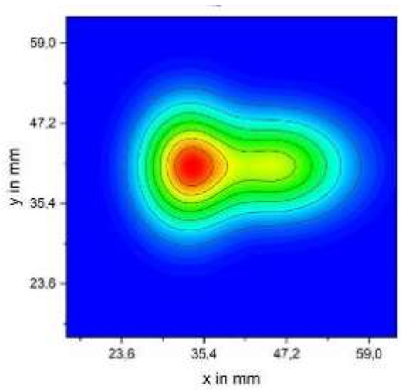
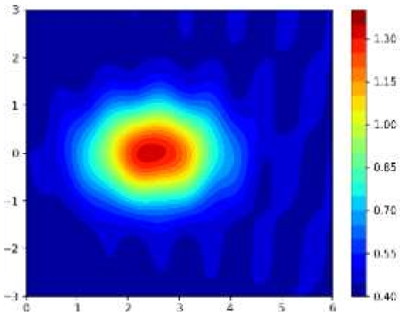
The contours of equal PDF of a 2D Gaussian with unequal variances of different components are given as









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The multivariate Gaussian PDF for parameters below is

$\bar{\mu} = \begin{bmatrix} 1 \\ 1 \end{bmatrix}$, $\mathbf{R} = \begin{bmatrix} 3 & -1 \\ -1 & 3 \end{bmatrix}$

- ○ $\frac{1}{\sqrt{16\pi}} e^{-\frac{1}{16}(3x_1^2+3x_2^2-6x_1-6x_2+2x_1x_2+8)}$
- ○ $\frac{1}{\sqrt{16\pi}} e^{-\frac{1}{16}(3x_1^2+3x_2^2-8x_1-8x_2+2x_1x_2+8)}$
- ◉ $\frac{1}{\sqrt{32\pi^2}} e^{-\frac{1}{16}(3x_1^2+3x_2^2-8x_1-8x_2+2x_1x_2+8)}$
- ○ $\frac{1}{\sqrt{32\pi}} e^{-\frac{1}{16}(3x_1^2+3x_2^2-6x_1-6x_2+2x_1x_2+8)}$

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6

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In LDA , we **choose** $\mathcal{C}_0$ if

- ◉ $p_0 \times p(\bar{\mathbf{x}}; \mathcal{C}_0) > p_1 \times p(\bar{\mathbf{x}}; \mathcal{C}_1)$
- ○ $p(\bar{\mathbf{x}}; \mathcal{C}_0) > p(\bar{\mathbf{x}}; \mathcal{C}_1)$
- ○ $p_0 \times p(\bar{\mathbf{x}}; \mathcal{C}_0) \leq p_1 \times p(\bar{\mathbf{x}}; \mathcal{C}_1)$
- ○ $p(\bar{\mathbf{x}}; \mathcal{C}_0) \leq p(\bar{\mathbf{x}}; \mathcal{C}_1)$

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The Gaussian discriminant classifier can be simplified as Choose $\mathcal{C}_0$ if

- ○ $\bar{\mathbf{h}}^T(\bar{\mathbf{x}} - \tilde{\mu}) < 0, \tilde{\mu} = \frac{1}{2}(\bar{\mu}_0 - \bar{\mu}_1), \bar{\mathbf{h}} = \mathbf{R}^{-1}(\bar{\mu}_0 - \bar{\mu}_1)$
- ◉ $\bar{\mathbf{h}}^T(\bar{\mathbf{x}} - \tilde{\mu}) \geq 0, \tilde{\mu} = \frac{1}{2}(\bar{\mu}_0 + \bar{\mu}_1), \bar{\mathbf{h}} = \mathbf{R}^{-1}(\bar{\mu}_0 - \bar{\mu}_1)$
- ○ $\bar{\mathbf{h}}^T(\bar{\mathbf{x}} - \tilde{\mu}) \geq 0, \tilde{\mu} = \frac{1}{2}(\bar{\mu}_0 - \bar{\mu}_1), \bar{\mathbf{h}} = (\bar{\mu}_0 - \bar{\mu}_1)$
- ○ $\bar{\mathbf{h}}^T(\bar{\mathbf{x}} - \tilde{\mu}) \geq 0, \tilde{\mu} = \frac{1}{2}(\bar{\mu}_0 + \bar{\mu}_1), \bar{\mathbf{h}} = (\bar{\mu}_0 - \bar{\mu}_1)$

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1.0/1.0 point (graded)

Consider the two classes C_0, C_1 distributed as below and determine when the classifier chooses $\mathcal{H}_0$. Consider $p_0 = p_1 = \frac{1}{2}$

$$\mathcal{C}_0 \sim N\left(\bar{\mathbf{\mu}}_0 = \begin{bmatrix}-8\\-6\end{bmatrix}, \mathbf{R} = \begin{bmatrix}\frac{1}{2} & 0\\ 0 & \frac{1}{4}\end{bmatrix}\right), \mathcal{C}_1 \sim N\left(\bar{\mathbf{\mu}}_1 = \begin{bmatrix}8\\6\end{bmatrix}, \mathbf{R} = \begin{bmatrix}\frac{1}{2} & 0\\ 0 & \frac{1}{4}\end{bmatrix}\right)$$

- (selected) $2x_1 + 3x_2 \leq 0$
- $2x_1 - 3x_2 \geq 2$
- $2x_1 + 5x_2 \leq -2$
- $3x_1 + 2x_2 \leq 0$

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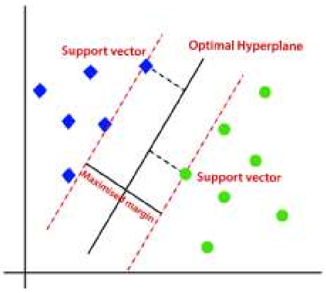
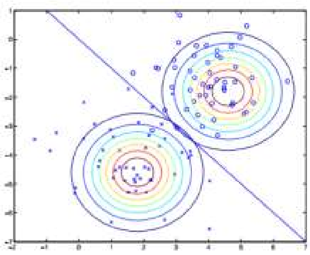
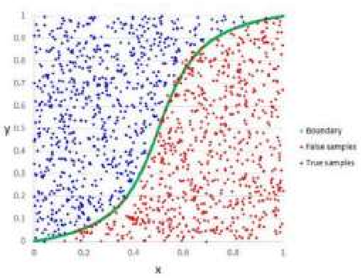
Gaussian discriminant classifier is shown by the picture

- 

- (selected) 
- 

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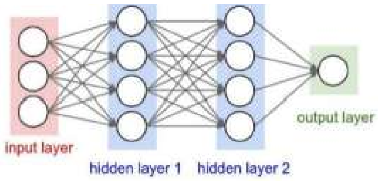

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10

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LDA can be imported in PYTHON as

- from sklearn.discriminant_analysis import LDA
- from sklearn.discriminant import LinearDiscriminantAnalysis
- from sklearn.discriminant_analysis import LinearDiscriminantAnalysis
- from sklearn.discriminant import LDA

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