Computer experiment 1 (from Ch2, [Theodoridis 2009])

Notes: In the sequel, it is advisable to use the command

```
randn('seed',0)
```

before generating the data sets, in order to initialize the Gaussian random number generator to 0 (or any other fixed number). This is important for the reproducibility of the results.

Gaussian generator: Generate N l-dimensional vectors from a Gaussian distribution with mean m and covariance matrix S, using the *mvnrnd* MATLAB function.

Solution

Just type

```
mvnrnd(m,S,N)
```

1.

a) Generate a data set X_1 of $N = 1{,}000$ 2-D vectors that stem from three equiprobable classes modeled by normal distribution with mean vectors $\boldsymbol{\mu}_1 = [1,1]^T$, $\boldsymbol{\mu}_2 = [8,12]^T$, $\boldsymbol{\mu}_3 = [1,16]^T$ and covariance matrices $\Sigma_1 = \Sigma_2 = \Sigma_3 = 4I$, where I is the 2×2 identity matrix.

b) Apply the Bayesian, the Euclidean, and the Mahalanobis classifiers on X_1.

c) Compute the classification error for each classifier and draw your conclusions.

2.

a) Generate a data set X_2 of $N = 1{,}000$ 2-D vectors that stem from three equiprobable classes modeled by normal distribution with mean vectors $\boldsymbol{\mu}_1 = [1,1]^T$, $\boldsymbol{\mu}_2 = [7,14]^T$, $\boldsymbol{\mu}_3 = [1,16]^T$ and covariance matrices $\Sigma_1 = \Sigma_2 = \Sigma_3 = \begin{bmatrix} 4 & 3 \\ 3 & 5 \end{bmatrix}$.

b) Apply the Bayesian, the Euclidean, and the Mahalanobis classifiers on X_2

c) Compute the classification error for each classifier and draw your conclusions.

3.

a) Generate a data set X_3 of $N = 1{,}000$ 2-D vectors that stem from three equiprobable classes modeled by normal distribution with mean vectors $\boldsymbol{\mu}_1 = [1,1]^T$, $\boldsymbol{\mu}_2 = [6,8]^T$, $\boldsymbol{\mu}_3 = [1,13]^T$ and covariance matrices $\Sigma_1 = \Sigma_2 =$

$\Sigma_3 = 6I$, where I is the 2×2 identity matrix.

b) Apply the Bayesian, the Euclidean, and the Mahalanobis classifiers on X_3

c) Compute the classification error for each classifier and draw your conclusions.

4.

a) Generate a data set X_4 of $N = 1{,}000$ 2-D vectors that stem from three equiprobable classes modeled by normal distribution with mean vectors $\boldsymbol{\mu}_1 = [1,1]^T$, $\boldsymbol{\mu}_2 = [5,10]^T$, $\boldsymbol{\mu}_3 = [1,11]^T$ and covariance matrices $\Sigma_1 = \Sigma_2 = \Sigma_3 = \begin{bmatrix} 5 & 4 \\ 4 & 7 \end{bmatrix}$.

b) Apply the Bayesian, the Euclidean, and the Mahalanobis classifiers on X_4

c) Compute the classification error for each classifier and draw your conclusions.

5.

a) Generate two data sets X_5 and X_5' of $N = 1{,}000$ 2-D vectors each that stem from three classes modeled by normal distributions with mean vectors $\boldsymbol{\mu}_1 = [1,1]^T$, $\boldsymbol{\mu}_2 = [4,4]^T$, $\boldsymbol{\mu}_3 = [1,8]^T$ and covariance matrices $\Sigma_1 = \Sigma_2 = \Sigma_3 = 2I$. In the generation of X_5, the classes are assumed to be equiprobable, while in the generation of X_5', the prior probabilities of the classes are given by $P_1 = 0.7, P_2 = 0.1, P_3 = 0.2$.

b) Apply the Bayesian and the Euclidean, classifiers on both X_5 and X_5'.

c) Compute the classification error for each classifier for both datasets and draw your conclusions.

6.

a) Generate two data sets X_6 and X_6' of $N = 1{,}000$ 2-D vectors each that stem from three classes modeled by normal distributions with mean vectors $\boldsymbol{\mu}_1 = [1,1]^T$, $\boldsymbol{\mu}_2 = [7,7]^T$, $\boldsymbol{\mu}_3 = [1,15]^T$ and covariance matrices $\Sigma_1 = \begin{bmatrix} 1 & 0 \\ 0 & 12 \end{bmatrix}, \Sigma_2 = \begin{bmatrix} 2 & 3 \\ 3 & 8 \end{bmatrix}, \Sigma_3 = \begin{bmatrix} 2 & 0 \\ 0 & 2 \end{bmatrix}$. In the generation of X_6, the classes are assumed to be equiprobable, while in the generation of X_6', the prior probabilities of the classes are given by $P_1 = 0.6, P_2 = 0.3, P_3 = 0.1$..

b) Apply the Bayesian and the Euclidean, classifiers on both X_6 and X_6'.

c) Compute the classification error for each classifier for both datasets and draw your conclusions.